INCORPORATING DIGITAL STORYTELLING IN SECONDARY MATHEMATICS FOR ENGAGED LEARNING: A COLLABORATIVE ACTION RESEARCH STUDY

Puskar Singh Bohara

A Dissertation

Submitted to
School of Education

in Partial Fulfilment of the Requirements for the Degree of
Master of Philosophy in STEAM Education

Kathmandu University
Dhulikhel, Nepal

March 2023

AN ABSTRACT

of the *dissertation* of *Puskar Singh Bohara* for the degree of *Master of Philosophy in STEAM Education*presented on March 24, 2023 entitled *Incorporating Digital Storytelling in Secondary Mathematics for Engaged Learning; A Collaborative Action Research Study*

APPROVED BY

……..…….. ……..……..

Prof. Bal Chandra Luitel, PhD Asst. Prof Binod Prasad Pant

Dissertation SupervisorDissertation Supervisor

In my experience, I along with most mathematics teachers are not satisfied with pedagogical practice, student achievement, and engagement in mathematics learning. Most teachers are still transmitting decontextualized mathematical concepts from teachers' minds to students' minds through conventional pedagogy with fixed techniques and fixed algorithms which causes the learners' disengagement is the main problem of the education system in Nepal. So, enhancement in students' engagement, and teachers' pedagogical reformation are significant study challenges. To find an alternative solution to the disengagement problem, I set an objective of the study to use digital storytelling in secondary mathematics teaching as STEAM pedagogy to enhance learners' engagement. Since no study was conducted on digital storytelling in secondary mathematics, the study might contribute to the pedagogical, and educational sectors.

Furthermore, to solve the common students' disengagement problem through pedagogical reformation, we used the collaborative effort of five teachers (apart from me four other teachers), and six students of grade ten in a mathematics class at the government school of the Kailali district of Nepal as collaborative action research study. The study focused on the use of digital storytelling as a pedagogical tool of STEAM pedagogy in secondary mathematics and observed three types of engagements namely; emotional, behavioral, and cognitive engagement during the study. The study was conducted from the philosophical standpoint of interpretive and

critical paradigm which was guided by Vygotsky's social constructivism theory, and supported by the critical theory of Habermas.

The study's major findings were, enhancement of students' engagement (emotional, behavioral, and cognitive engagements), and teachers' pedagogical reformation through digital storytelling followed by critical reflection. During the study, passive classrooms were changed into the active classroom, single disciplinary to the integrated learning activity, the solution of textbook problems changed to contextual problem solving, and pedagogical reformation to constructivist pedagogy were observed. Some challenges such as lack of collaboration of all teachers at a time, lack of digital skills, and lack of time management were faced during the study. Use of other artistic pedagogical tools in mathematics teaching, and further studies required in mathematics for a better learning environment in school.

……. March 24, 2023

Puskar Singh Bohara

Degree Candidate

This dissertation entitled*Incorporating Digital Storytelling in SecondaryMathematics for Engaged Learning: A Collaborative Action Research Study* by *Puskar Singh Bohara* presented on March 24, 2023.

APPROVED BY

……. March 24, 2023

Prof. Bal Chandra Luitel, PhD

Dissertation Supervisor/ Dean / Chair of Research Committee

……. March 24, 2023

Asst. Prof. Binod Prasad Pant

Dissertation Supervisor/Acting Head of Department

……. March 24, 2023

Jaya Bishnu Pradhan, PhD

External Examiner

I understand and agree that my dissertation will become part of a permanent collection of the Kathmandu University Library. My signature below authorizes the release of my dissertation to any reader upon request for scholarly and research purposes.

……. March 24, 2023

Puskar Singh Bohara,

Degree Candidate

DECLARATION

I hereby declare that this dissertation has not been submitted for candidature for any other degree.

……. March 24, 2023

Puskar Singh Bohara

Degree Candidate

DEDICATION

This dissertation is dedicated to all mathematics teachers,educators, and students who always think of the new era of mathematics teaching and learning practice.

ACKNOWLEDGEMENTS

I express my deepest gratitude to my teacher cum dissertation supervisor, Dean, Prof. Bal Chandra Luitel, Ph.D., and Asst. Prof. Binod Prasad Pant, who guided me to complete this study. I would also like to acknowledge Dr. Man Prasad Wagle, Dr. Shree Krishna Wagley, Dr. RoshaniRajbanshi, Mr. Indra Mani Shrestha, Mr. Netra Kumar Manandhar, and Mr. NirojDahal faculty of STEAM Education for supporting me during my MPhil Journey. A special thanks to Mr. SandipDhungana, Mr. Harsh Bahadur Chand, Ms. Pritika Basnet for their regular support during the study.

Furthermore, I am grateful to Dr. Jaya Bishnu Pradhan, the external examiner, and the research committee members for offering me their valuable time and support in enhancing my research. Similarly, I extend my appreciation to my colleagues at Kathmandu University, faculty members of the university, and other academic institutions and organizations.

I want to extend my heartfelt thanks to Writing and Communication Center, my friendMr. Saroj Kumar Shah, and Mr. Birendra Bahadur Khadka for language and APA correction. Likewise, I would like to thank my Critical friends, Co-researchers, Students, all colleagues, and friends who directly or indirectly provided revelations to my study.

My heartfelt gratitude goes to my parents Mr. Dharma Singh Bohara and Mrs.Tulashi Devi Bohara for their ineffable inspiration and moral support. I am privileged that my loving parents, well-wishers, mathematics teachers, and students always trusted and supported me even during critical situations. Last but not least, my wife Parwati Devi Bohara, son Amrit Kumar Bohara and daughter Puja (Puspa) Bohara receive my deepest gratitude for their unwavering love and continuous support.

Puskar Singh Bohara,
Degree Candidate

TABLE OF CONTENT

.

ABBREVIATIONS

CAR	Collaborative Action Research
ETC	Educational Training Center
TPD	Teachers' Professional Development
ICT	Information and Communication Technology
SEE	Secondary Level Examination
KU	Kathmandu University
MPhil	Masters of Philosophy
PhD	Doctor of Philosophy
ERO	Education Review Office
DS	Digital story
DST	Digital storytelling
US	United States

LIST OF PICTURES

CHAPTER I
INTRODUCTION

Dear reader, I welcome you on this exciting journey of discovering ways of using digital storytelling in mathematics for engaged learning as collaborative action research work. In this study, I tried to create a constructivist classroom using digital storytelling (DST) in mathematics class to enhance engaged learning. In this study, we eleven members worked together six were students, and four otherteachers worked as co-researchers. During the study, we observed the disengaged of students in mathematics, created stories related to the content of mathematics, digitalized stories, presented them in class as interactive tools and observed the students' engagement during the class.

In this chapter, I have included my narrative, background related to pedagogy, Collaborative Action Research (CAR), and STEAM Pedagogy in the background section. After that, I presented the statement of the problem in which I outlined the main problem as teaching pedagogy. Furthermore, the purpose of conducting research and research questions related to research. In addition, I have addressed the significance of this study and finally, the delimitation of this study at the end of the chapter.

Who Am I as a Researcher?

I am a secondary-level Mathematics/Science teacher in a secondary-level government school. The school is situated in Lamki-Chuha municipality of the Kailali district of Nepal. I started teaching in 2005 after completing my master's degree in pure mathematics from Tribhuvan University. During my teaching career, I got many professional developments in-service training including ten months of in-service training conducted by Educational Training Center (ETC) Dipayal in 2010, Teachers' Professional Development (TPD) conducted by ETC Dipayal in 2016, Secondary level teachers' ICT in pedagogy training conducted by ETC Dipayal in 2017, National teachers training on the topic"I*nteractive Environmental Education and Local Curriculum on Environment*" conducted by Department of Education, of National Center for educational development, supported by Curriculum Development Center and Nepal PrakritiPathshala in 2017, and some leadership training conducted by various government and non-government organizations. But it had no positive impact

on my mathematics classes. I was not satisfied with the student's achievement in mathematics. Mathematics was considered a difficult subject and was a challenging job for me. From my long experience in teaching, I found that students were less interested in mathematics subjects, less participated in-class activities, fewer students completed homework and most of them bunked their mathematics classes were major problems related to mathematics learning. There was a low achievement in basic level grade eight and SEE examination results.

Furthermore, a minimum number of students choose mathematics in their future studies. Problems may be related to students, pedagogy, curriculum, school, and family (Algani, &Eshan, 2019). Among these problems, our pedagogy is vital role and is more responsible for low achievement, less interest, and less engagement. From there, student disengagement is the main problem of mathematics teaching-learning, directly related to the teacher's pedagogy. Furthermore, we (mathematics and science teachers) discussed together with each other about the pedagogy of mathematics and found that student disengagement is a problem in mathematics teaching.

On the other hand, the engagement of the learners is directly related to the pedagogy of the teacher. We can enhance engagement of the learner by reforming our pedagogical practice. So, our main challenge was improving our pedagogy to enhance students' engagement in mathematics. For this, I chose Kathmandu University (KU) for my MPhil Journey and finally joined MPhil in STEAM education in 2021. I found KU as a perfect place for my professional and personal development. The KU provided me not only anenvironment for content knowledge but also opportunities to develop the individual as well as professional skills.

After joining MPhil in STEAM education at Kathmandu University (KU) in 2021, I came to know different artistic approaches to improve pedagogy which enhances students' engagement in learning. The incorporation of different art activities such as Literary art (narrative, and story), Visual art (images, painting, sculpture), and Performing art (roleplay, drama, dance) in the classroom will develop creativity, aesthetic skill, ethical skills, and rhetoric skills (Taylor, 2021), which are likely to increase student's engagement in learning mathematics. Furthermore, I knew that story exists everywhere and in every moment of life. I realized that it would be helpful to make my mathematics class interesting, joyful, and more engaging by incorporating story. It will be better to present a story with the support of information

and communication technology (ICT), which is called digital storytelling (Robin, 2016). I planned to use the digital storytelling approach and collaboration with other teachers in my school to share more ideas and integrate different disciplines. According to Robin (2016), digital storytelling is the approach of presenting stories in the classes with the help of digital tools such as computers, projectors, sound systems, and other ICT materials. I discussed this with other colleagues (teachers) at my school and they were also interested in using digital storytelling (DST) in teaching. We decided to learn and use DST in our daily practice. But we (teachers) were of different disciplines; how can we use DST in different disciplines? At that time, I remember integrating other disciplines, I learned in STEAM education as STEAM pedagogy. We realize that integrating other disciplines will be possible only from STEAM perspective.

In STEAM pedagogy, two or more disciplines from the five disciplines Science, Technology, Engineering, Arts, and Mathematics are deliberately intertwined to empower students to engage in real-world experiences, increase creativity, and promote critical thinking with a collaborative approach to solve real-world issues. Project-based learning, design thinking projects, and Art-based pedagogy are incorporated into the STEAM method (Pant et al, 2020). Art is a bridge between the world of the rational mind of human being and the experience of being connected, which can help to create a more open field of knowledge for the learner, with higher potential and higher awareness about developing a culture with sustainable development (Ibarra &Sommerstand, 2019).

Without the inclusion of arts in mathematics and other disciplines in the national policy of Nepal, it will be challenging to develop a human resource that can solve problems of a real-life and rapidly changing world. Art in educational activities might be more helpful to solve daily life and real-world problems for the learner. Among different art-based pedagogical tools, digital storytelling is more appropriate in my context (Secondary level mathematics classroom) and collaboration with other teachers is better for sharing the ideas of different disciplines in DST. So, I selected "Incorporating digital Storytelling as STEAM pedagogy in Secondary mathematics for engaged learning as a research issue.

In this study, I have played two roles. One was as a teacher in which I conducted my regular mathematics class as usual. Another role was as a researcher, in which I worked with other co-researchers and critical friends. We worked together,

created DS, observed students' activities, discussed with them, collected information, and analyzed them to give meaning. So, I am a teacher-researchers as well as STEAM practitioner for this study.

Background of the Study

Our Pedagogical Practice

In general, pedagogy is commonly understood as an approach to teaching. Pedagogy refers to the instructional techniques and strategies used by teachers by which learning can take place and that can provide the space for developing knowledge, skills, and attitudes in specific contexts of learners (Sulyman&Oladoye, 2022). The pedagogy adopted in the classroom by teachers shapes their actions, activities, assignments, assessments, feedback, and other teaching strategies by considering theories of learning, contents, contexts, understanding, needs, backgrounds, and individual interests of learners (Education Science, 2021). Likewise, pedagogyis assumed as the art, science, or teaching profession, especially in education. Science includes the knowledge of theories and instructional strategies, whereas arts have how we can correctly put these theories into practice to gain experience (Khalil &Eikhider, 2016). Likewise, the Learning Portal (2021) focuses on the interaction among teachers, learners, and the learning environment with the specified learning task. From the above argument, it is clear that pedagogy is a learning package that comprises all learning activities for knowledge construction, and assessments for the holistic development of learners.

Pedagogy may be teacher-centric or student-centric with low-technology or high-technology; our aim must be how they change according to students' content, context, and need (Gok, 2017). Likewise, Sulyman and Oladoye (2022) emphasized the *Learning-Centered pedagogy* that focuses on the learning activities that should be conducted by considering context, the number of learners in the classroom, and the physical environment within the classroom, and learning materials in the classroom. So, from the above discussion and my experience, although there are many approaches to pedagogy in the classroom, the teacher has to consider the most effective means of delivery based on his/her ability, student needs, context, environment, instructional materials, subject and other conditions of the classroom.

Even in today's education system, teachers are using the old trend of pedagogies which only tends to compel students to memorize contents, and children's achievement is measured by how much children rote memorize the facts, events and

solutions of prefixed problems (Tabiin, 2019). In the context of Nepal, most teachers are practicing teacher-centered pedagogy still prevails in most school (Shrestha, 2020). Furthermore, only a few teachers are talking about the reformation of pedagogy, contextual mathematics activities, and the connection of mathematics with real life situations in our country (Luitel, 2019). This indicates that our present education system is dominated by teacher-centered pedagogy, and needs reform. In modern times, as the world is rapidly changing, our pedagogy of mathematics must be flexible.

Every day, the mathematics pedagogy in the classroom is changing from teacher-centered pedagogy to student-centered. In the case of mathematics teaching, teachers are facing different changing pedagogy according to a changing world, our school curriculum, and context. Our mathematics curriculum is culturally decontextualized in nature (Luitel, 2019; Pant, 2017). Even if students get a higher grade in mathematics, there might be difficulties in surviving in society, not utilizing knowledge in their culture and not using their mathematical knowledge to solve real-life problems. Most students become educated-unemployed in society after the completion of their studies. Teachers/ educators should transform traditional pedagogy to contextualize with learner-centered activities for learning mathematics, and other subjects. The teacher should change classroom activities to change and develop our conventional informing pedagogy to reform and transform pedagogy. Among different ideas of changing pedagogy in this case, I choose digital storytelling as a changing agent for transforming the pedagogy (Bleicher, 2014) of mathematics at the school level.

Our traditional and most helpful technique of teaching mathematics is transmitting teachers' knowledge to students' minds with fixed techniques and fixed algorithms, which follow; writing formulae, memorizing them, solving specific mathematical problems, and practicing until you can report the exam entirely (Pant, 2016). Many teachers are witnessing how the conventional classroom culture suppressed student ideas in the name of various contents namely,theorems, formulas, anddefinitions, and 'depositing the teacher’s ideas into students' heads’ (Luitel & Taylor, 2005). I found in a school that students are forced to recall, memorize, and practice many similar problems whose aim is to be ready for a written examination. This emphasizes the cognitive levels of remembering and understanding (Anderson &Krathwohl, 2001). Our teaching and learning activities show that banking pedagogy

is still in practice (Freire, 2005). I found this concept leads to the production of only solving the problem of the textbooks which will not support our students in enhancing creativity, reflexivity, imagination, communication skill, collaboration skill and solving real-life problems. So, I think some problems in our teaching mathematics can be solved by transforming our teaching pedagogy in the mathematics classroom. This leads to many questions related to pedagogy, can we have any alternative and effective pedagogy? Can we solve the pedagogical problem of mathematics by using STEAM pedagogy?

Connection with STEAM Pedagogy

In this situation, STEAM pedagogy is considered to be a new approach in education that may bring a revolutionary change in pedagogy (Pant et al., 2020). The main problems of our education are the decontextualized and culturally non-inclusive curricula (Luitel 2013, 2019), subject-centric, content-centric, and mark-centric pedagogy approaches to teaching (Luitel& Taylor, 2005). STEAM Education is not only for the regular course in university but also envies the principle of participation, collaboration, and productivity (Mehta et al., 2019). STEAM is a pedagogical approach that can integrate other disciplines in interdisciplinary, multidisciplinary, and transdisciplinary ways. STEAM pedagogy is assumed as a third space pedagogy that can generate the sequential development in informing, reforming, and transforming all pedagogies that emphasize transforming “selves” and “other selves” through the critical self-reflection along with the integrations between Science, Technology, Engineering, along with Arts and Mathematics disciplines. (Shrestha et al., 2021).

Furthermore, at the basic level of school education, STEAM pedagogy is already applied in several developed countries such as Japan, Australia, Singapore, and the United States (Tabiin, 2019). Similarly, China and Nepal practice STEAM education and STEAM pedagogies at the basic school level, and in higher universities in KathmanduUniversity. STEAM education isan integrated approach to learning that focuses on disciplinary content, and encourages students to think outside the box, critically, broadly, and creatively about complex real-world problems (Pant et al., 2020). So for meaningful and authentic learning, we should change our traditional teacher-centered pedagogical practices to a student-centered constructivist approach.

Pedagogical reformation is essential in mathematics classes and schools engaging students in learning. STEAM education promotes the pedagogical

reformation through which teachers must integrate other disciplines through artistic and modern technological components for better teaching-learning activities such as storytelling, and digital tools.

Connection with Digital Storytelling

Storytelling is the art of transferring ideas, thoughts, knowledge and information to others with the help of words and action in a joyful and exciting environment used in teaching-learning activities too. This traditional way of sharing knowledge has been used throughout human and social development since the ancient times (Smeda et al., 2014). But as the world has deviated toward modern technologies, our teaching-learning activities should incorporate modern technological tools. So, one can tell their story with the help of digital tools called digital stories (Robin, 2016). At this stage, some questions arise in my mind. Is it possible to use digital storytelling in mathematics? Can we merge storytelling with modern technological tools in education? How can we use digital storytelling in secondary mathematics? Can digital storytelling enhance engaged learning in mathematics?

Since digital storytelling is the merger between conventional storytelling and modern multimedia technology (Normann, 2011) it might be helpful in secondary mathematics to create an exciting and joyful learning environment in the classroom. To improve traditional storytelling and develop modern technological skills in learners i.e., 21st-century skills in learners' digital storytelling approach might be a helpful approach in education (Smeda et al., 2014). According to Smeda et al. (2014), digital storytelling not only transmits content knowledge but can also facilitate the environment for knowledge construction and potentially engage learners in integrating different disciplinary content in the classroom. Thus, the digital storytelling pedagogical approach is not only a merger between traditional and modern technologies but a tool for classroom interaction that mighthelp to make a constructivist classroom environment in secondary mathematics.

Improvement and transformation of our deep-rooted practice is a challenging task. To improve my professional practice, I planned to include other teachers and students in daily pedagogical practice for collaboration. In this study, other teachers and students support and suggest a different aspect of improving practice as critical friends for meaningful and authentic teaching-learning. We should change our traditional pedagogical practices, for this collaborative action research (CAR) might

be helpful in this study. According to Sagor (1993), collaborative action research aims to improve personal and professional practice. He argued that teachers could conduct an inquiry together for personal and professional development. So, through CAR, I choose digital storytelling as a STEAM pedagogical approach to improve my pedagogical practice, engaged learning, and learning environment in the mathematics classroom.

Statement of the Problem

As a secondary-level mathematics/Science teacher, I found that less interest in secondary level students in mathematics subjects, less participation in-class activities, many students leaving mathematics class, and fewer students completing homework given by the teacher. The classroom activities of the students have a direct effect on learning achievements. Different results of basic level, and secondary level (SEE) show that students' mathematics achievement is decreasing daily.The Education Review Office shows that according to the basis of the National Assessment of Student Achievement study (ERO, 2018) shows that 32% fall below the basic level has 5% of the tested curriculum, 70% of students are under the 28% achievement of grade five in mathematics. Similarly, The Education Review Office (ERO, 2019) shows that 32% at the basic level and 59% of grade 10 students are at a low achievement level. From the above facts, it is clear that there was a low achievement in grade 5, grade 8, and SEE results. From these, the achievement of mathematics could be more satisfactory. There may be different causes of decreasing learning achievement, student disengagement is the main problem of mathematics teaching-learning. Still, the learners' engagement might be related to the teacher's pedagogy.

We (teacher[1]) discussed the pedagogy of mathematics together with other secondary-level teachers. I also discussed with two mathematics teachers (co-researchers, and critical friends in the study) regarding learners' classroom engagement, and connection with teachers' pedagogy. They had the same problem but did not have any solution so far. Both critical friends Mr. Bhim Sir, and Mr. Damber Sir said that, *"students disengagement is our common problem but how can we solve it?*"Most teachers pointed out that disengaging students and teachers' pedagogies are the main problems. One of my critical friendsMr. Bal Bdr. Sir said, "*this is a common problem of all teachers, most students are disengaged in the classroom. Is there any*

[1] Here teachers refers to myself, and critical friends working in the same school

solution for this problem?" We discussed the problemwith other critical friends and other teachers in my school. All teachers aligned with the same problems, but did not have any solution for the problem. We (researchers) concluded that students' disengagement is the main problem of mathematics teaching which can be solved by reforming teachers' pedagogy. I have realized some of the current complications related to the teachers' pedagogy in teaching/learning mathematics for students, teachers and educators in a classroom activity in Nepalese schools.

Although mathematics is the backbone of the education system, in our country Nepal there are some problems in learning mathematics, they may be students' problems, teachers' problems, schools' problems, curriculum problems, and pedagogy problems, or maybe other problems in content and context. All the above evidence shows that teaching and learning in school mathematics in Nepal are influenced by traditional teacher-centered pedagogy supported by the 'Banking Model' (Freire, 1970). Although there are many problems in secondary-level mathematics learning we are discussing the pedagogical problem and how pedagogy is changing in mathematics specifically STEAM pedagogy. In my experience as a mathematics student, teacher, and researcher, I feel that most students believe mathematics is a hard subject; most teachers believe mathematics is algorithmic, a systemic subject that has fixed learning methods.

In the context of my country Nepal, the traditional education system, and old teacher-centered pedagogy promotes conventional disciplinary values, mindset, and contents memorization, which have been creating a narrow mindset for learners, and disempowering space in education (Pant et al., 2020) To overcome these challenges and to reform the educational system and pedagogy, different artistic approaches such as poem, song, story, or digital storytelling might be useful techniques for better learning. The use of technology in pedagogy makes the learning process easier, faster, cheaper, and affordable along with support for the easy visualization of the content with context (Tabiin, 2019). Digital storytelling might be helpful to conceptualize the content, facilitate more discussion, helped to assign class work, and create students' attention and motivate students (Robin, 2008, 2016; Smeda et al., 2012). Furthermore, Robin (2008, 20016), Smeda et al., (2012) emphasized that digital storytelling can be used as a merger between conventional storytelling and modern multimedia technology, can facilitate a constructivist approach to learning, and can develop communication and digital skills in learners.

As an MPhil scholar, many questions aroused in my mind. How can we change our traditional pedagogy in mathematics to digital storytelling as STEAM pedagogy in our classroom? What is the teacher's perception of digital storytelling pedagogy? How can we integrate mathematics with another discipline? Is a mathematics teacher able to deliver content with digital storytelling as STEAM pedagogy? How can we develop pedagogy as STEAM pedagogy in secondary mathematics? I discussed it with other teachers in my school. We did not get any appropriate solutions for these questions but we found the possibilities of art-based pedagogy in mathematics and other disciplines as an alternative. We will try to find a solution by using digital storytelling as STEAM pedagogy for a collaborative approach across disciplines in a constructive way (Boice et al., 2021). In addition, it is found that traditional pedagogical problems can be solved by using the STEAM pedagogical approach in collaboration with stakeholders (Pant et al., 2020). Furthermore, the learners' engagement might enhance by changing activities of our classroom practice and collaboration with other stakeholders (Bertrand &Namukasa, 2020). These studies indicated that DST might enhance students' engagement in learning. But from literature, I did not find any study regarding DST in secondary mathematics to enhance the students' engagement. So, the study contributed to some aspects of pedagogy, and the engagement of learners.

Traditional pedagogical practice in the classroom and the students' disengagement are major problems in teaching-learning mathematics that can be mitigated by working together in creative ways. So, I think it is researchable problem whose solution might be useful not only for mathematics teachers in government schools but also for all teachers of various disciplines working at schools in Nepal.

Purpose of Study

The main purpose of the study is to use digital storytelling in secondary mathematics teaching as STEAM pedagogy to enhance students' engagement through collaborative action research (CAR) in the government school of Nepal.

Research Question

In this study, I want to explore answers to the following questions:

- How do teachers enhance students' engagement through the digital storytelling approach as STEAM pedagogy in the mathematics classroom?
- What are improvements in pedagogical practice through digital storytelling?

Significance of Study

As per the purpose of the study, it tried to explore how digital storytelling as STEAM pedagogy increases the student's engagement in mathematics learning through Collaborative Action Research (CAR). In my experience, CAR might be a powerful methodology for the improvement of teachers' practice and the health of the school through collaboration. This study became more helpful for me, and my co-researchers because it provides many opportunities for collaboration to plan for the study, create digital stories and integrate other disciplines, and improve my presentation of DS in the classroom. The finding of this study will be useful for other teachers who want to use an artistic approach in mathematics such as storytelling, digital storytelling (DST), and other literary art in mathematics. This study guided the effective ways of using digital storytelling in mathematics for the interactive classroom so that students might be engaged in the knowledge construction process.

This research might be helpful for the researcher and co-researcher. It will help to explore the perception of teachers about digital storytelling as STEAM pedagogy and to transform teachers' pedagogy from traditional to progressive and then develop transformative abilities to teach in the classroom. The finding of the research will be helpful to educational professionals to know how to integrate Science, Technology, and Engineering, withMathematics, and arts through collaborative work so that teacher pedagogy will become more meaningful. So, this research will be helpful for teachers and teacher educators of schools to incorporate artistic elements into their pedagogy.

The study in this research also focuses on the active participation of learners in a joyful environment and connects course content to the real-life context. During the implementation of the plan in the classroom, students might get opportunities to learn content knowledge but also got the opportunities for sharing views, emotions, ideas, and meaning making of mathematical contents. Students might engage in teaching-learning activities, and they were using their efforts on constructing content knowledge as well as relating mathematical content with context and got the opportunities for the imagination of new events that might come in life. So, these types of activities are also essential for learners to construct mathematical as well as real-life skills.

This study tried to elaborate on how DST can incorporate in mathematics pedagogy as an interactive tool for a better learning environment in the classroom.

The study provided the foundation of artistic components that can incorporate into traditional mathematics curricula and textbooks. So, this study would be useful for curriculum designers and writers, it provides ways to incorporate DST in the mathematics curriculum, textbooks, and other journals of mathematics.

In conclusion, this study is to be also helpful for learners, teachers, educators, and curriculum designers/developers to improve our current pedagogy to progressive, to rethink and redesign the curriculum, to make new educational plans, and then to develop transformative learning abilities of learners to fulfill the need and demand of changing 21st century's educational development. So, this study might have some contribution in educational sectors that promotes the artistic pedagogy in mathematics as well as other disciplines by integrating them and enhancing thelearners' engagement inthe classroom.

Delimitation of the Study

The study hasn't focused oncreating digital stories in digital storytelling (DST), it is on the implication in secondary mathematics at the government school of Nepal. It is delimited to only the use of DST in the secondary mathematics classroom to observe three engagements, namely, emotional, behavioral, and cognitive engagement (discussed briefly in the thematic review section) of the learners and integration of disciplines through DST as a part of STEAM pedagogy.

Furthermore, the study is delimited to observe students' engagement by using DST in the single unit *'Simple and Compound interest'* of mathematics of grade ten in a single government school by using DST. The study focuses only on students' classroom activities for emotional, behavioral, and cognitive engagement (Discussed in thematic review section briefly) which did not include any other aspect of learning such as students' learning achievement or assessment system in the classroom.

Chapter Summary

In this chapter, I have discussed my short narrative regarding role in the study. I have the role of teacher-researcher in the study. Likewise, in background section, I have discussed teachers' pedagogy in my context, need of CAR, and connection with STEAM Pedagogy. After that, I presented that students' disengagement as a main challenge of teachers, and should mitigate with the help of reforming teachers' pedagogy. Furthermore, the purpose of conducting research and research questions related to research. Lastly, I have addressed the significance of the study and, the delimitation of the study at the end of the chapter.

CHAPTER II
LITERATURE REVIEW

In this chapter, I have included the thematic review regarding STEAM Pedagogy which includes storytelling and digital storytelling pedagogy which became helpful in finding connections and gaps in the study regarding the disengagement of learners, and the use of DST to mitigate it. In addition, I have included Vygotsky's Social constructivism as the major theory which guides this research. Lastly, I have included some relevant previous research as an empirical review in connection to DST in secondary mathematics, and STEAM pedagogy to enhance learners' engagement along with a research gap.

Thematic Review

I discussed STEAM Pedagogy, Storytelling and digital storytelling, and student engagement. STEAM pedagogy will help integrate other disciplines, such as Science, Technology, and Art, with mathematics, giving students a holistic, contextualized, and collaborative learning environment through art-based digital stories.

STEAM Pedagogy

Initially, it was assumed that in the United States (U.S.) the National Science Foundation introduced the major idea of STEAM Education in 1959 A.D. as a development of the original STEM acronym with the traditional element Art. STEM was the integration of different disciplines such as Science, Technology, Engineering, and Mathematics which can develop highly competent and skillful human resources to deal withthe challenges of a rapidly changing world (Chesky&Wolfmeyer, 2015 as cited in Pant et al., 2020). Later, arts were integrated with STEAM to develop more esthetic, moral, and ethical human resources with empowerment, motivation, and self-awareness for sustainable development. Art will provide the opportunities to perceive knowledge and construct new patterns to understand the self and complex world. Thus STEAM Education, and STEAM pedagogical approach are helpful in enabling students to engage in experiential learning through different activities which can connect knowledge with the context of students.

Various pedagogical approaches are arising from STEAM Philosophy such as arts-based pedagogy, ethical dilemma pedagogy, project-based learning, design thinking, collaborative learning, and so on. Among these different STEAM Pedagogical approaches, I briefly elaborated on Art-based pedagogy, especially the Digital storytelling approach as STEAM pedagogy with collaborative action research used for this study.

Since the ancient era, mathematics has been assumed as a principal leading discipline with sources of creative and critical knowledge. However, due to teachers' traditional 'transferring' pedagogy, learners do not use such knowledge to solvereal-life problems in changing world. Pant et al., (2020) argued that solving complex real-life problems with the help of single traditional pedagogical approaches is almost impossible, so teachers should cross the boundary of traditional pedagogy and welcome multidisciplinary, interdisciplinary, and transdisciplinary alternative ways of teaching-learning. So, to solve real-world problems learners need to develop multi-disciplinary skills and knowledge. This is possible only from STEAM approaches pedagogy, an integrated, interdisciplinary, and transdisciplinary approach to learning. In the STEAM approach learners are encouraged and motivated to think critically, work creatively and use multi-knowledge simultaneously to solve real-world problems. Pant (2017) suggested self-reflection as the best technique to improve pedagogical skills, whereas Pant et al., (2020) focused on ICT (technologies) and art integration on pedagogies as STEAM approaches, which makes pedagogy interesting, joyful, and more creative to develop critical thinking in the learner.

In this study, besides presenting DS in the mathematical classroom, I regularly used the interactive activities in the mathematics classroom which are helpful in developing STEAM skills. My regular activities in the mathematics classroom as suggested by Tabiin (2019) such as asking brane-storming questions, facilitating learners to cooperate with others, allowing them for creative thinking, providing enough time for solving problems, allowing them to explore experiences and imagination, providing opportunities for all learners to answer and allow learners to look for unusual new ideas. In this study, we researchers[2] and participants collected fictional and non-fictional stories(see sample story in annex) containing contextual mathematical content collaboratively, created informative stories, digitalized them

[2] Here researchers refer to the co-researcher/critical friends, and me

and presented them in the mathematics classroom. In this study informative or instructing digital stories (Robin, 2006) had a vital role in classroom activities that makes appropriate context for the collection of experiences of students related to the learners' engagement.

Storytelling

Generally, astory is the sequential description of experience or events, whether real or imaginary, and storytelling is the method of presenting stories (Barzaq, 2009). In the story, there must bea clear description of experience, concepts, ideas, and life lessons through different artistic approaches. It is assumed that the storytelling tradition is as old as the birth of humans on earth and is used in every stage of human life (Godbole, 1988). Storytelling provides children with a window to a new world. It offers opportunities to learn new ideas and information in different ways through hearing exciting stories. Storytelling is a form of art in which words and actions express ideas and concepts. Storytelling is the most commonly used genre in our daily life and throughout history. We tell stories, share stories, andtalk about events, places, ideas, and dreamtime stories in every instant of human development. Stories are the key sources of knowledge transmission (Barzaq, 2009). Storytelling is a pedagogical tool that supports and promotes experiential learning that engages students in learning through reducing depersonalization, motivating learners, develop and enhancing cognitive aspects along with emotion (Freeman &Burkette, 2019).

Stories have universal nature in our lives, society, and universe. These stories provided knowledge, skills, and perceptions regarding the context, human lives, culture, and community. If we have to give a new concept about any new knowledge, then storytelling will be an effective way of teaching. If we relate the content of mathematics with stories then classroom activities will be more interesting, concentrated, and emotional than other pedagogies. Using a story, we can give a small concept to a significant philosophy to the learner in an exciting way. While college or school students turn out to be fascinated, they have interaction, and when they engage, they are more likely to assume significantly, technique, and learn(Freeman &Burkette, 2019, p. 36). So, to enhance the students' interest we (teachers) must introduce interesting pedagogical tools which lead to better learning. In this study, I collected different fictional and non-fictional stories, and contextualized and digitalized them to make the digital story (DS).

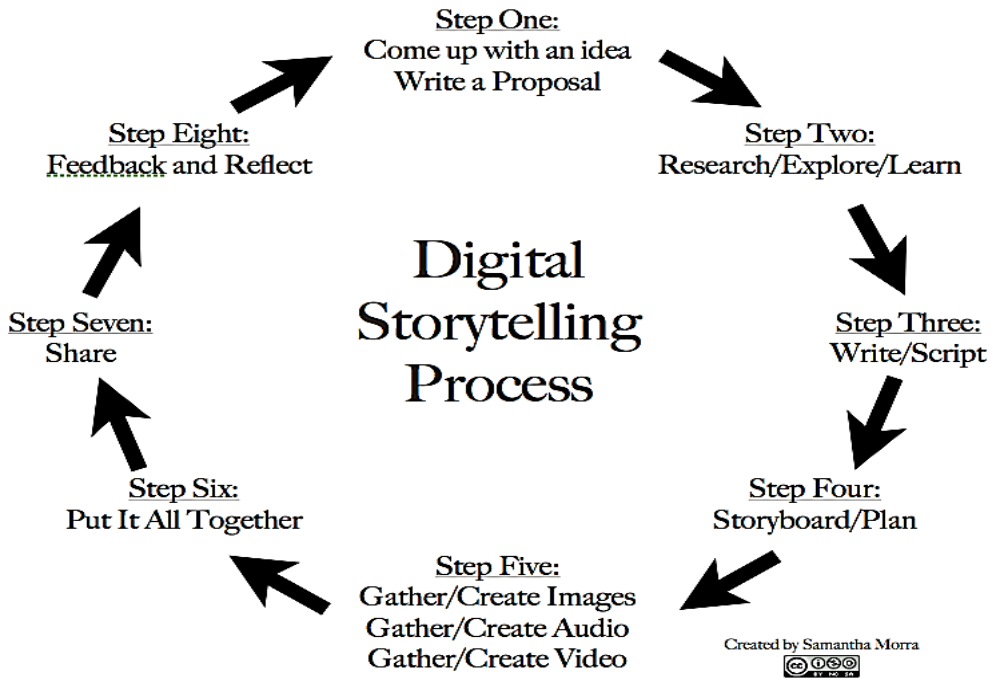
Digital Storytelling

The concept of digital storytelling was used and developed at the center for digital storytelling in 1980 in the theatre community of California for the recording, production, and dissemination of stories. Generally, digital stories are relatively short and informative stories or narratives presented through digital tools such as a projector, laptop, and sound system in teaching-learning. Digital storytelling is the amalgamation of the art of storytelling with digital multimedia in which images, audio, videos, songs, narration, and texts are presented digitally (Robin, 2016). Digital storytelling has a growing phenomenon in educational settings. According to Robin (2006), there are three types of digital stories: personal narratives (stories), historical documentaries, and stories that inform or instruct.

According to Robin (2006), in a personal narrative, one can describe a personal experience, thought, feeling, and belief of the person who portrayed the event and what was happening at a certain time. These stories help to share personal experiences, culture, and particular events people face. Likewise, in historical stories, one can describe the life of people, institutions, or countries that show long events. Similarly, informational or instructional digital stories are transferring or sending messages to the people or viewers related to the knowledge, information, and rules in the specific area of education. These stories are more useful for instructing the disciplinary contents with context. For example, mathematical content can be contextualized. In this study, I will use stories that inform or instruct in which digital stories are to convey mathematical concepts through DST as instructional material related to the mathematics content and concepts of mathematics in the classroom.

In this study, story refers to informative or instructional stories (Robin, 2006) which include the contextual content of mathematics i.e., story will be created concerning the connection of content and the social context of the learner. In other words, I will create stories with mathematical ideas in a social setting, which is fundamental means of meaning-making (Borasi et al., 1990). I made contextual stories about the content of compound interest in grade ten and will present them through the help of digital tools such as PowerPoint, Geogebra, images, videos, narrations, and different sounds in grade ten mathematics teaching, especially for simple and compound interest chapters. Digital storytelling is more suited to make a constructivist classroom (Robin, 2016) where students will be able to construct their meaning through multi-faceted stories and part of stories. This study followed eight

steps to create digital storytelling for the process of digital storytelling as idea of Morra (2013). This made digital storytelling more authentic in this study.



Picture 1.1: Process of digital storytelling (Morra, S., 2013)

Process of Digital Storytelling

In this study, the making and using digital storytelling in the mathematics classroom is carried out in 8 stages; start with an appropriate idea, research/explore/learn, write a script for the idea, storyboard/plan, gather and create images for the story, audio, and video, put it all together to create a digital story, share, and reflection and feedback from others for improvement (Morra, 2013) as follows.

Start with an Idea

I started with an idea of mathematical content and context which we have to teach in the classroom of secondary mathematics. From this mathematical contextual content of mathematics, I set the intended learning outcome of that story related to the curriculum of grade ten mathematics.

Research/Explore/Learn

After the mathematical idea of a story, I searched, explored, and learned about the topic, information of content, and authenticity of digital storytelling. For this, I used content from the curriculum, critical friends, and other teachers for clearer topics and content.

Writing Script

In this stage, I choose the characters, and language in the digital story, and construct the script of the story. I arranged the content and write up a short script for the story which gave the whole scenario of the digital story.

Storyboard/Plan

In this stage, I made a simple plan of the digital story which includes the concept, sound, and images. I found a possible solution to the way by which digital stories move ahead for the meaningful and clear concept of the mathematical content. I choose the context which was closer to the content of grade ten mathematics.

Gather and Create

In this stage, I used digital tools such as a computer/laptop and sound system to create the digital story in power point slides in which I combined text, images, sound, and videos for teaching-learning activities. As for as possible we used power point text for narration, background songs, images, and videos for a more precise illustration of mathematical concepts. I acknowledged and kept the references of sources of sound, images, and videos to maintain copyright and avoid plagiarism in digital stories.

Put It All Together

In this stage, I revised or improved the story plan and digital story to better illustrate of the concept. I critiqued the digital story and shared it with other co-researchers for further betterment or improvement. Is there any alternative and better way of designing a story? Is this way is appropriate for my context? Is there a place for improvement? In this stage, I also analyzed the digital story for improvement and completed the digital story.

Share/Presentation

In this stage, I presented the digital story in the classroom, started interaction/discussion with students, and allowed them to construct mathematical concepts by interacting in their groups. During the presentation of DS in the classroom we (Researchers) observed the engagement of the students, collected their ideas and views of students, and made meaning of the study.

Reflection and Feedback

Lastly, I reflected on my class and activities in the mathematics classroom and took reflection from critical friends and students. I took short interviews with participants to collect more information, feelings, and views for more

precisereflection and feedback to improve digital stories for next time. I assigned students to collect similar stories, collected stories from students, modify them and digitize them for the next class. In this way, I provided opportunities for participants to collect and prepare stories for deeper knowledge construction and to engage in different learning activities. So, in this way, we (researcher and participants) co-constructed knowledge, concept, and meaning of the contextual content.

Types of Digital Stories (DS)

There may be various types of digital stories according to types of content i.e. fictional and nonfictional, a combination of education and technology, and ways of presentation. However, Robin (2006) classifies DS into three types:

- Personal narratives
- Historical documentaries
- Informative or instructing stories

DS as Personal Narratives

Personal narratives refer to the story teller's personal events, which can express thestoryteller's idea. It is personal writing by which the storyteller can describe life events of his/her life, thoughts, feelings, and experience in which events are presented in the same order of happening (Robin, 2006). This type of DS includes the many aspects of the educational experience of the storyteller. In a personal narrative, the storyteller can share life events with others by which there might be a transfer of knowledge, experience, belief, and attitude of the storyteller of context and culture with others. In such types of DS, learners can collect the long experience of the teller in a short time.

DS as Historical Documentaries

Historical documentaries are information about an event, persons, intuitions, places, and ideas from the past in a short time. It may include any documents, photos, videos, online materials, bibliographic sources, and any artifacts by which the storyteller expresses ideas about a particular topic (Robin, 2006). In historical documentaries, facts, photos, video clips, and all other artifacts are collected and then digitalized using suitable technological tools.

DS as Informative or Instructing Stories

Informative or instructing stories are valuable information, skills, or knowledge about a specific topic of interest or topic of objective. It is intended to

transfer information or massage from the storyteller to the viewers which can include knowledge, and skills about related topics or subjects (Robin, 2006). This DS includes specific knowledge for a particular subject area such as mathematics, science, health, engineering, and so on as instructional materials. In this study, I tried to include contents, information, mathematical concepts, life skills, and other disciplinary contents in DS by which we (researcher, and co-researchers) observed the learners' engagement in the classroom of the government school of Nepal.

Students' Engagement in Learning

Generally, student engagement measures students' involvement in learning activities and interaction with teachers and students. In its eleventh edition, *Merriam Webster's Collegiate Dictionary* lists engagement as "commitment", aligned with behavioral engagement. Similarly, *New Oxford American Dictionary* expresses to engage as "attract or involve" which shows the alignment between emotional and behavioral engagement. Likewise, student engagement is about students' active involvement based on the attention, curiosity, interest, and passion that student shows during learning activities (Poondej, &Lerdpornkulrat, 2016). Student engagement is essential for the improving learning, personal and professional development, and positive impact on learning outcomes.

On the other hand, a lack of student engagement plays a vital role in creating difficulties in effective learning (Heaslip et al., 2014). Thus, the promoting students' engagement through different artistic activities in learning is a significant problem for teachers and educators. STEAM Education also focuses on engaged learning and the theme of engaged learning is 'teach less, learn more' for individual learning. This indicates that engaged learning is student-centered in that students are involved in various learning activities inside and outside the classroom to learn mathematical concepts contextually.

Literature shows that student engagement is not only a single way but multilayered construct consisting of behavioral, emotional, and cognitive engagement with together layering (Fredricks et al., 2004). In the multifaceted nature of engagement, behavioral engagement aligned with the idea of participation of learners, emotional engagement includes the ideas of positive or negative reactions towards teachers, colleagues, academicians, and school, whereas cognitive engagement aligned with the idea of investment of learners (Fredricks et al., 2004). So,engagement

can be considered a multidimensional construct that is all about the situation of students and how they feel, behave and act.

On the other hand, Reeve and Tseng (2011) focus on the four aspects of student engagement: agentic engagement, behavioral engagement, emotional engagement, and cognitive engagement. Likewise, Agentic engagement shows how students control his/her own goal, action, and destiny which supports self-control for personal growth (Reeve, & Tseng, 2011). During the study, students will express their opinions and preferences for the betterment of the class. Since agentic engagement is the results from behavioral, emotional, and cognitive engagement, this study focused only these three aspects of engagement, i.e., behavioral, emotional, and cognitive engagement through digital storytelling in classroom activities.

Besides developing these engagements as components and separately on learners, it would be better to develop all engagements simultaneously because the fusion of behavior, emotion, and cognition may provide a richer characterization of the learners which leads the better performance of the learners in teaching-learning (Fredricks et al., 2004). So, in this study, researchers and co-researchers tried to observe the influence of digital storytelling (DST) on learners and tried to implement and use DST in better ways in the mathematics classroom. Although, there are various engagement types, Iwill briefly discuss only behavioral, emotional, and cognitive engagement which guides my study.

Behavioral Engagement

Behavioral engagement refers to the change in behavior during classroom activities. According to Fredricks and colleagues (2004), the behavioral engagement of the learners is related to compliance with attendance and involvement in learning activities. Students listen, observe the events, take notes and ask questions during class and pay attention in class. It relates to active participation in group work, classroom interaction/discussion, and expressing views during and after the teaching-learning activities. Suppose the learners have more attendance in the classroom or outside the classroom activities and have active involvement in the learning activities. In that case, learners' achievement will be enhanced, resulting better learning. In this study, I observed the effort, persistence, curiosity, attention, asking questions, and contribution (Reeve, & Tseng, 2011) for the participation of the students in learning activities for behavioral engagement.

Emotional Engagement

Another emotional engagement refers to the emotion expressed by students during classroom activities. According to Fredricks et al. (2004), the emotional engagement of the learner is related to positive affective reactions including enjoyment, happiness and sadness, anxiety in learning activities, and a sense of belonging. Students will express their feelings, body language, verbal or facial expressions, and curiosity during and after the classroom activities through digital storytelling in class. It is related to the feeling and intrinsic expression of the learners during the teaching-learning activities. In this study, we observed the learners' emotion, self-referential words used by the learners, and the overall connotation of feelings (Reeve, & Tseng, 2011) during and after the learning activities in mathematics class.

Cognitive Engagement

According to Fredricks et al. (2004), the learners' cognitive engagementis related to the investment in one's activities and appreciation of challenges during the learning activities. It is all about cognitive development i.e. depth of the knowledge gained by the learners and self-regulation through the teaching-learning activities which show the regular use of new words and skills during and after the teaching-learning activities. It helps to direct the attention towards the object of learning and create new mathematical concepts through DST in the classroom. During the interaction in the classroom, students tried to connect their own experiences with new mathematical concepts in a joyful and interesting classroom environment.

In this study, we[3] observed the use of new concepts, skills, understanding, meaning-making, and ways of solving mathematical problems (Reeve, & Tseng, 2011) during and after the teaching-learning activities. So, during DST we realized that DST is more suited to make constructivist classrooms (Robin, 2016) which enhanced behavioral, emotional, and cognitive engagement in this study. While presenting digital stories within the classroom, discussion, interaction, group work, class work, and interview we (researchers and co-researchers) observed behavioral, emotional, and cognitive engagement simultaneously. Lastly, we reflected on classroom activities, experiences, and the need to improve our teaching-learning activities.

[3] Here we refers to the group of researchers

Theoretical Review

My study aims to introduce digital storytelling in mathematics teaching and practice digital storytelling as STEAM pedagogy through collaborative action research to enhance students' engagement in mathematics learning in the government school of Nepal. Under this sub-topic, I reviewed the major theory which will guide my research and how this theory guides the research. The following theory; Vygotsky's Social constructivism will be compatible with my research. So, Vygotsky's Social constructivism theory is reviewed here.

Vygotsky's Social Constructivism

Lev Vygotsky is a Russian psychologist considered the pioneer of social constructivist theory. According to Vygotsky's Social constructivist theory, learning results from mental construction, in which constructing, meaning making, and constructing knowledge occurs (Vygotsky, 1978). Furthermore, the social constructivist theory considers learning as a social activity, and knowledge cannot be passively received but is actively constructed through social interaction and emphasis on learners 'prior experience. It shows that social interaction plays a crucial role in learners 'intellectual development and knowledge-building. Furthermore, Lev Vygotsky's theory of social construction emphasized the effect of the environment i.e. friends, family, and culture on teaching-learning (Amineh&Asl, 2015), Prior knowledge, and social interaction. According to this theory, the learner initially performs a task with the help of another person and then finally performs themselves.We use the social constructivism approach in the mathematics classroom to develop the mathematical concepts and change teacher-centered pedagogy to learner-centered pedagogy. Scaffolding and collaboration are the main keys to social constructivism.

In this constructivism, teachers can use small-group student-to-students discussion, teacher-students dialogue, and whole-class dialogue for social interaction and scaffolding (Taylor, 2014). With the help of these activities, the teacher can find the zone of proximal development (ZPD) for every learner. The ZPD represents the possible learning by the learner with the help of some instructions or support from teachers, which is known as scaffolding. This theory helped me to collaborate and interact with focused groups during the construction, implementation, and reflection of digital stories in mathematics. This theory helped me to select a way of improving

my practice in teaching mathematics by using digital storytelling,which increased students' engagement in learning activities.

Social constructivism believes that Knowledge cannot be deposited in the mind of learners as in the banking concept of Freire (2005), it can be constructed through the active participation of the learner in social interaction with different social groups. When individual learners give meaning to his/her experience through social interaction and collaboration, actual knowledge is constructed.This social constructivism theory helped this research to conduct diverse student-centered STEAM pedagogy. This theory helped teachers, and students to construct new and creative mathematical knowledge by collaborating and making synergies with other subjects in learning groups or with teachers or student-teacher collaboration in and out of class. This theory is relevant to my research because it describes the understanding and ways of meaning-making of individuals and groups. This theory promotes collaboration and communication among the social group through which learners can create knowledge through social interaction. Integrating digital storytelling pedagogy can increase interaction and engagement in learning activities.

Furthermore, I am working as a mathematics teacher at a secondary level. I found that Students' disengagement is the major issue in teaching-learning mathematics atthe secondary level. Disengagement might not be resolved in single and unique ways during teaching-learning activities in the classroom. There might be various ways to enhance the engagement of learners. I believe in multiple realities and multiple forms of knowledge construction. I value the experience, collaboration, interaction, and scaffolding for the knowledge construction of mathematical concepts. Also, I value equality, respect for diversities, and mental activities which will increase students' engagement in mathematics learning. In my study, I choose digital storytelling (DST) as an artistic tool to make an interactive classroom and enhance the learners' engagement. By using DST in the classroom, students can interact with each other and teachers. During the interaction, a teacher-facilitated and hence learners can reform the current intellectual level to a higher level (Vygotsky, 1978). The teacher helps the learner develop his or her understanding of the content and actively participates in interaction to construct mathematical knowledge.

Generally in Nepal, mathematic instructors are still practicing ready-made suggestions, tricks, and techniques for solving numerous textbooks' mathematical issues(Pant, 2017) which only develop abstract knowledge of students in the

classroom teaching. In this study, I tried to present contextual content-based stories or narratives with the help of digital tools in PowerPoint, paused the story between presentations, and started the discussion in the classroom. Through the discussion and interaction between groups of students, they tried to construct the meaning of the mathematical contents, found confusion, and misunderstanding, and tried to relate the context. During the presentation of digital stories and discussion, I asked some critical questions that helped me to find the ZPD and with the help of scaffolding, through which learners tried to enhance mathematical contextual content knowledge. During these activities,co-researchers or critical friends helped me in the presentation of stories, discussion, meaning-making, and observation of students' engagement in the classroom.By using this pedagogical approach as a collaborative and constructivist approach,we (teachers as well as students) worked as a team by which learners became a useful technique to enhance learners' behavioral, emotional, and cognitive engagement in mathematics class.

Critical Theory of Habermas

Besides Vygotsky's social constructivism theory, Habermas critical theory (emancipatory interest) also guided my study. A philosopher of morality based on the consensus Habermas determined the mode of generating knowledge, and see or claimed the knowledge is valid. Those areas define cognitive hobbies and are grounded in exceptional components of social life, work, discussion, and power. The knowledge of learners is interrelated with their interests. According to Habermas (1972), there are three types of knowledge constitutive interest namely; technical, practical, and emancipatory interest (Habermas, 2005). According to Habermas technical interest focus on controlling the environment, Practical interest focused on understanding the environment, and emancipatory interest give rise to self-autonomy through self-reflection (Grundy, 1987). Here, I am going to review emancipatory interest only for the study.

The emancipatory interest recognizes the self-information or self-reflection by which learner can construct their knowledge through empowerment in which they couldmanage their own lives in autonomous and accountable ways (Grundy, 1987). According to Habermas (1972), knowledge is generated by self-emancipation through critical reflection leading to the transformation of self. The critical or emancipatory interest seeks to transform the condition through self-reflection (Grundy, 1987). In the study, students were allowed for more discussion, and reflection on their habits,

emotion, and learning activities using DSTs in the mathematics classroom by which students can transform themselves from their previous disengaged nature to the more engaged. During the study, I used self-reflection in my practice, which not only transformed students' engagement but also helped us to transform our pedagogy. In the study, I applied self-reflection to my action, analyzed them, and applied the conclusion in my classroom. It is more about knowing why, questioning, and self-reflection for transformation. So, emancipatory interest gives rise to a critical perspective on our practice to deconstruct hegemony and false consciousness. In the study, my belief was to transform my pedagogy, and transformation on students' engagement in learning activities through self-reflection, and deconstruction of deep-rooted beliefs.

Empirical Review

Under this part of the literature review, I reviewed some supportive books, research reports, journal articles, seminar papers, and dissertations as literature related to digital storytelling, STEAM Pedagogy related to mathematics, and students' engagement in learning. I found only limited supportive literature based on digital storytelling as STEAM pedagogy to enhance students' engagement in mathematics learning. Here, I reviewed some literature related to digital storytelling, STEAM pedagogy, and students' engagement in learning which supports my study.

Study in STEAM Education/Pedagogy

Tabiin (2019) conducted qualitative descriptive research with the class teacher, Head teacher, and students to apply the new STEAM method in the early childhood of Multiara paradise Indonesia. The author used interviews, observation, and documentation for data collection and reduction. Also, the author used the data display and conclusion as data analysis technique. The research found that the use of STEAM pedagogy is very important for children's development, and learners' ability to think broadly, build a logical thinking and solve social problems. The author emphasizes active learning, focusing on a solution, supporting logical and systematic ways of thinking, stimulating children to solve problems, and sharpening critical thinking abilities. Using the STEAM method, a student must show determination, creativity, cooperation, and flexibility in behavior. The research suggested activities such as, encouraginga student to pay attention to someone, describe things that they see and do, ask the question 'what' rather than 'why', listin one-to-one correspondence

fashion, allowing children to envision the space around and other student-centered activities.

The author indicates that STEAM pedagogy focuses on using hand and mind to learn in specific contexts to change the education system; this paper is silent on how they can learn and implement them in higher-level learning. The paper suggests ways to sharpen STEAM abilities such as encouraging children to pay attention, describe what they see and do, ask what rather than why questions, count by using one-to-one correspondence techniques, and allow the student to imagine the space around them. These suggested ways might not be applicable for all contexts, individual learners, and higher levels which is just activity based silent about other artistic, Design thinking, context-based, and project-based learning.

Pant et al. (2020) conducted a PRA study in two schools in the Kavre district taking four teachers as participants to help teachers to prepare and implement the different STEAM projects in the mathematics classroom. The authors conducted a workshop, collected teachers' experiences, developed an action plan, and then conducteda study to develop innovative pedagogy in teaching mathematics. The workshop was conducted in three cycles; in the first cycle, instructors were asked to share reflections on their daily practices; during the second cycle they were asked to prepare various projects implementing various points of view in teaching mathematics; and in the third cycle, they update their projects based on the insight of the two cycles. The transformative learning theory guided the study byMeziro (1991), and theLiving theory by Whitehead (2008), whose combined focus was improving pedagogy. The study aimed to explore the progressive pedagogy that contributes to improving the performance of teachers and students in teaching-learning mathematics.

During the process, the authors emphasized critical reflection on mathematics teachers' deep-rooted beliefs, practices, and ideologies to transform practice. Still, they could not focus on the using the STEAM project in the classroom. Although the finding was focused on the innovative STEAM pedagogy the study was insufficient to provide implementation and enhancement of the performance part of STEAM pedagogy in the mathematics classroom. Although the study had some weak aspects, it was the foundation of developing STEAM pedagogy for meaningful mathematics learning which will be helpful in mathematics teaching-learning and other disciplines.

Pant et al. (2020) prepared an argumented paper based on relevant literature focusing on art-based pedagogy and argued that integrating art and technology as the

STEAM pedagogy in teacher professional development. This paper sheds light on how the STEAM pedagogy equally applies to pre-service and in-service teachers to develop interdisciplinary ways of understanding and solving a real-world problem. In this paper, the authors reviewed various national and international research journals that have put the ideas of integrating technologies and art for better teaching-learning experiences. The authors pointed out the policy, significance, and use of technology in the educational and pedagogical sectors of the government of Nepal. Still, they were silent about the improvement of teachers' practice. Furthermore, the authors asserted that collaborative work with policymakers, curriculum designers, and teachers to STEAM education would transform our traditional educational system through which learners can solve real-life problems. Although the paper did not focus on improving teachers' practice and implementation of STEAM pedagogies in school, shed light on the necessity and effort of STEAM education in Nepal.

Bertrand and Namukasa (2020) conducted a qualitative case study to understand the STEAM pedagogical programs and student learning in a school in Ontario, Canada. Authors used interviews with participants, observations of events, and data analysis of a curriculum. Out of the total population, the authors took 103 participants as a sample which included directors, instructors, and students. The main aimwas to focus on a particular process, such as an event, person, process, and another area of interest by which the researcher selected several representative casesthat can be generalized. The study incorporates the skills taught in the school: critical thinking, problem-solving, collaboration, communication, creativity, and innovation. The authors discovered that student mastering targeted students developing perseverance and flexibility and mastering transferable competencies.The authors harassed ongoing engagement with stakeholders, which has the capability and hobby to trade in pedagogy and instructors' improvement. Task design, STEAM models, and interdisciplinary learning experiences are three multilayered uses for the theoretical models of the study. However, the author focused on interdisciplinary and multilayered but did not indicate about STEAM pedagogical approach.

Muntomimah and Wijayanthi (2020) examined using descriptive qualitative evaluation, content evaluation, and library research in written text to applicable documents in Malang, Indonesia to observe different abilities in an early child after using the STEAM Loose part method. The author of this study stresses freedom to explore anidea, solvea problem, and think about content along with context so that the

children can have space to think, analyze the activity, and determine the best way to complete the project. The author tried to solve the problem by collecting data, compiling/classifying, and analyzing. It is found that the natural environment, multicultural class, dynamics of the classroom, activities by playing, freedom process in classroom communication, freedom during the manufacturing process, and experience sharing in the classroom are essential factors for the STEAM Loose part method (Muntomimah&Wijayanthi, 2020). Creative thinking, critical thinking, problem-solving, and learning through nature are the main learning abilities students can build by applying the STEAM Loose part of pedagogy in teaching and learning. The author is silent about STEAM pedagogy in the secondary mathematics classroom.

Rawat et al., (2021) conducted an auto/ethnographic inquiry exploring the critical life incidents of the first author's journey regarding learning mathematics that promotes the critical thinking of authors as a student and teachers. It portrays a paradigmatic shift from traditional to constructivism by connecting his personal experiences with major themes. The authors tried to thinknarratively, which followed the joining a School and then dropping out, and finally back to School and dropping ina school of the First Teaching and a Pedagogical Boomerang. Based on these themes, he focused on the pedagogical boomerang during learning and teaching mathematics. The author focused on the transforming the pedagogy of learning and teaching mathematics through a balanced way of local and global knowledge for equity along with access and empowerment of learners with the knowledge, and skills of learnersand teachers. The author did not mention the collaborative approach in mathematics to construct knowledge of mathematics.

Shrestha (2021) studied "Exploring mathematics pedagogy through the lenses of Habermas's knowledge-constitutive interests". The study was action research with 15 M.Ed. students studying the course called "Curricula in Mathematics Education" in the second semester for six months with 16 classes. Throughout the research, he used a "plan, act, observe, and reflect" spiral model. Data were analyzed based on Habermas' knowledge-constitutive interests, namely,Technical, Practical, and Emancipatory interest in different types of knowing "what", "How", and "Why" along with instrumental (objective), Communicative (subjective) and Transformative (critical) knowledge. He found that teachers mostly practice transmitting of knowledge from the 'comfort zone'. He concluded that they must pass through a

transformative learning process by integrating others' worldviews into their worldview which can develop personal and professional practice.

Al Wafi et al., (2022) studied the development of STEAM-based instructional materials in the school in Indonesia to observe the learners' critical thinking. In this study, the authors used to research and development (R & D) design as a research design as a trial design in educational research. The study used the Analysis, Design, Development, Implementation, and Evaluation (ADDIE) model. The study was conducted in the presence of 2 instructional material expert, validators, and 1 media expert validator. The study included7 subject teachers, and 143 class VIII students from different secondary schools were included for the purpose. During the study,the authors used the needs analysis sheet along with a teaching cloth validation sheet, and a device for checks was used because the tools were used as the instrument of the study. The authors interpreted events, analyzed data, explained the findings, and self-regulated as critical thinking indicators. Teaching materials were improved to validate by suggestions and comments of the material experts and media experts. The average of the critical thinking indicator was 0.68. They conclude that STEAM-based pedagogy on Human Respiratory System instructional materials effectively improve learners' learning and critical thinking skills.

Although the study was focused on the critical thinking skill promoted by STEAM education, the study was silent about the possibilities of other collaboration, communication, and Creative skills using STEAM-based teaching material which are also essential skills for the 21st century. The study was based on the STEAM-based teaching material in grade VIII in the science classroom, it opens the door for other grades and other disciplines.

Storytelling and Digital storytelling

A qualitative study on digital storytelling in second language learning was conducted by Normann (2011), which was based on the students' reflectionsin a lower secondary school in Norway. The purpose of the study was set to explore learners' meta-reflection on the learning potential when DST is used in the classroom. Depth interviews, reflection logs, and primary questionnaires were used for the data collection, and data were discussed in three themes i.e. motivation, learning, and digital storytelling. In the study, 6 students were chosen for the individual interview including both genders, mixed levels of proficiency in English, and experience collected from the questionnaire. It changed into determined that learners recognize

DST as an all-embracing hobby for learning, increases motivation for student learning, and digital storytelling as a relevant way of sharing documents and knowledge in English language class. Furthermore, it was found that scaffolding and contextualization are essential for learning, and students not only learn from digital storytelling but also learn from their friends. The study shows that digital storytelling not only transfers content knowledge but also develops listening, speaking, writing, and meaning-making skills. The study builds the foundation of an innovative pedagogy such as digital storytelling in the classroom. Although the study was conducted for English for lower secondary Norwegian schools, it shows the indication of the use of digital storytelling in several disciplines i.e. in secondary mathematics in Nepal.

A multi-site case study on the effectiveness of DST in the classroom was conducted by Smeda, et al. (2014) in one Australian school at both primary and secondary (P-12) levels whose aim was to create a constructivist learning space with the help of digital storytelling in the classroom. In the study, five different cases were built for the study of different students. Both quantitative and qualitative methods/tools were applied in the collection and analysis of data. During the study, a four-scale rubric was used to gather quantitative data whereas interviews (teachers and students), and observation (Pre-observation, fix-timed observation, and field observation) were used to gather qualitative data. During the study, two workshops for teachers were conducted to describe the concepts and ways of creating a digital story with the help of moviemaker software. The main finding of the study was that the level of students engagement was not so smooth i.e. fluctuate in working and creating a DS, collaboration and collaboration skills were increased in students and teachers, provides flexible and learning by doing environment, enhance digital skills in the students for creating a DS. The study tried not only to implement DST in the classroom but also tried to provide strategies on how to integrate it into teaching for novice teachers. Although the researcher claimed in presenting a new and clear framework for creating digital storytelling the study was silent in using digital storytelling in other disciplines, opportunities, and challenges faced during implementation in the classroom.

The quasi-experimental study was conducted by IstenicStarčič et al. (2016) at the University of Primorska Faculty of Education, Slovenia in the academic year 2011-12 for preservice teachers of preschool and primary school to explore an

integrational approach to using ICT for multimodal design along with digital storytelling in mathematics teaching. The study was focused on the integration of ICT with mathematics for preservice teachers to develop a lesson plan, design, and presentation in the classroom. For the study 115 preservice instructors aged 19–20 years participated (50 Primary teachers and 65 pre-school instructors) in the study and a mixed-method of data collection was used. SPSS 20 and IBM SPSS statistical tools for quantitative and coding, categorizing, and schematizing processes were used for qualitative data analysis. The major finding of the study was the integrated approach appears to be more beneficial and contributes to broader the competencies of instructors. Furthermore, the study shows that these two models can facilitate preservice instructors' to develop pedagogical along with content knowledge for mathematics. Although the study focused on the use of ICT as multimodal design and digital storytelling in teaching mathematics at the pre/primary level the study was silent for secondary-level mathematics teaching.

The action-based research was conducted by Ahmed (2020) by setting the aim, to explore the modern methods of teaching and learning by using digital stories as a pedagogical tool in Sikkam, India. The principle goal of the look at become to explore the pedagogical blessings of a multilingual setup, engage college students' creativity, enhance digital literacy and awareness, and integrate technology as a pedagogical tool. Initially, Sikkam was divided into four administrative districts and then three schools were selected from each administrative district by using stratified sampling techniques. Overall, 250 students ranging from grades 6 to 12, and teachers from each school participated in the workshop conducted in three stages namely; preproduction, production, and post-production. During the study,workshops were conducted taking permission from the authority of the education department of Sikkim. The findings of the study were, that digital storytelling adds local and contextual knowledge to learning, diversification of learning content provides mono to multilingual setup, provides a collaborative and interactive environment for learning, and both teachers and students were encouraged to teach inter-cultural and multilingual interactions in learning, fosters the creation of personal archives, and develop the creativity and critical skills. The study focused on the production and use of digital storytelling through the workshop in the multilingual classroom but seem silent on the aspect use of DST in the classroom to deliver disciplinary content.

Eroglu and Okur (2021) conducted a quasi-experimental design quantitative research that aimed to seek the effectiveness of digital storytelling in seventh-grade 35 students as a study group regarding digital literacy. The research was implemented in a private secondary school in the district of Kars by taking permission from the ethics committee. The data collection tools used a digital literacy scale and personal knowledge for the research. Digital literacy scales were used on attitude, Technical, Cognitive, and Social aspect to compare the progress in experimental controlled groups. The authors found significant differences in pre-take-a-look-at and publish-check rankings in the group by using digital storytelling. The main finding was that digital storytelling has a positive and significant effect on learning based on digital literacy along with enhancing the awareness of learners of digital literacy. So, their finding was that DSTprovides digital literacy abilities in 7th-grade students and concludes that DST is a much more effective approach to learning in 7th-grade students. However, the study explores howDST enhances learners' digital skills; it does not address how teachers use digital storytelling in mathematics and is silent about learners' engagement in mathematics.

Yuliani and Hartanto (2021) conducted the research development model-based mixed-method research which aimed to design digital storytelling, study the implementation, and find out the practical use of digital storytelling for online English learning. The authors used questionnaires to collect quantitative data and interviews were conducted to collect information from participants. The research was conducted in three stages; planning, designing, and development. The authors set out how digital storytelling could help students and teachers to engage for educational content and awareness. The research was conducted by taking a sample of 180 junior high school students, eight in-service teachers, and 2 evaluators. The major finding of the research was the practicality of DSTin designing, developing, and implementing online learning along with the high appropriates for online English learning. The authors focused on creating a constructivist learning environment, fostering foreign language skills, and introducing students' culture through digital storytelling. However, the authors focused on planning, designing, and implementing digital storytelling in online English learning. Still, they were silent about the application of digital storytelling in other subjects, in physical classes, and skills developed in students after implementation.

In the context of Nepal, I tried to find literature in some databases such as Google scholar, Shodhganga, the online library of Tribhuvan University, Library of Kathmandu University, and others. A few pieces of literature were found regarding digital storytelling that was not related to the school education, especially not the pedagogical aspect. So, I did not mention it here.

In the review mentioned above, it is found that studies have not to give much attention to STEAM pedagogy as the collaborative and constructivist approach in secondary mathematics in Nepali schools. Also, I could not find any literature related to digital storytelling to enhance students'secondary-level mathematics engagement. So this research can contribute to students, teachers/educators, and researchers about STEAM pedagogy as a collaborative and constructive approach.

Research Gap

From the review of various research journals, books, dissertations, and other literature, I realized that researchers are focusing on STEAM Pedagogy approaches for better learning mathematics. But reviewed literature should have discussed digital storytelling as an art-based approach in STEAM pedagogy to increase student engagement. Moreover, the literature did not address integrating of other disciplines with mathematics through digital storytelling in teaching-learning. Nonetheless, I searched literatures regarding DST on Google scholar, Tribhuvan University online library, Kathmandu library, Sodhganga, and Research gate up to December 2022, but I didn't find any study about using digital storytelling in mathematics as STEAM pedagogy to increase students' engagement in mathematics learning in the context of Nepal. So, I realize that there is a research gap in using DS in teaching mathematics to enhance the engagement of the learner. Therefore, my research aimed to fulfill the mentioned knowledge gaps in the research area.

On the other hand, before my MPhil journey from KU, I used traditional algorithmic pedagogy and chalk-and-talk methods to teach mathematics in secondary-level schools. Now, I realize that my pedagogy is being reformed in that I allowed students interaction in the mathematics classroom to construct their mathematical knowledge. In addition to this, I improved and transformed my daily practice from traditional pedagogy to progressive i.e. reforming and transforming pedagogy. Furthermore, we realized from the study that there are several issues in government schools regarding the pedagogy of teachers, and the students' engagement. To contribute to such an issue, there is a need to study this issue in government schools

of Nepal, which might be helpful for teachers and students to enhance students' engagement in teaching-learning secondary-level mathematics. So, this study might contribute to some extent to reforming the pedagogy of mathematics teachers in government schools of Nepal which might be one idea to enhance the students' engagement in mathematics classes.

Chapter Summary

In this chapter, I included the thematic review regarding STEAM Pedagogy which provides for storytelling and digital storytelling pedagogy which became helpful finding connections, and a gap in the study regarding the disengagement of learners. I tried to incorporate story, and digital storytelling in the educational sector along with their type such as personal, historical, and informative in the educational sector. In addition, I have included Vygotsky's Social constructivism as the major theory andtheCritical theory of Habermas as a supportive theory in the study. Lastly, I have included some relevant previous research as an empirical review in connection to DST in secondary mathematics, and STEAM pedagogy to enhance the learners' engagementwhich helped me in finding the research gap.

CHAPTER III
RESEARCH METHODOLOGY

This chapter addressed the research design that was used in this research to answer the research questions. It includes the research paradigm,axiological ontological, epistemological standpoints, research design, study location, participants, information collection tools, quality standards, the research process, and ethical considerations.

Philosophical Dimension

Research philosophy refers to dealing with the source, and nature, anddevelopment of knowledge (Bajpai, 2011). In general, a research philosophy is a belief about how ideas about the research ideas guide data collection, analyze the data, and meaning-making. Here, I am going to briefly explain the philosophical aspects of research such as paradigms, ontology, epistemology, and axiology that guided and directed my study.

Research Paradigm: Interpretive

As per my research purpose to use digital storytelling as STEAM pedagogy to enhance students' engagement in mathematics learning, it followed the subjectivity, experience of participants, and understanding of meaning-making of individuals and groups for some extent of research. Many teachers of mathematics have many problems related to pedagogy, the learning environment for engagement in learning mathematics in school. Although there are many problems in school concerning pedagogy, the environment of the school, and culture which compelled teachers'pedagogical boomerang (Rawat et al., 2021), teachers are engaging and struggling to improve pedagogy and develop different skills in students. In this research, I aimed to explore the perception of participants about digital storytelling as STEAM pedagogy and learning process to enhance engagement in learning, and the meaning of learning mathematics by standing in participants' shoes along with realizing their feelings (Taylor & Medina, 2011). Furthermore, I seek to understand and interpret the thinking and meaning-making process through interaction with participants. I wanted to understand the subjective world of participants about

engagement in learning mathematics. So, I chose the interpretive paradigm for my study.

Research Paradigm: Interpretive and Critical

On the other hand, my study is also directed toward the development of my as well as the participants' daily practice, the interpretivism is not sufficient for me to transform my pedagogical practice in my study. I realized that the interpretation is not the solution to the problem, there should be some action for the solution. This study focused on the identification of problems, solution of problems, and advocating for positive change through empowering, motivating, and transforming participants to enhance engagement in mathematics learning (Taylor & Medina, 2011). The reformation of pedagogy is crucial for the development of teachers' traditional pedagogy in school mathematics. During this research, the researcher and participants had also been empowered and motivated for change which is called the Deep Democracy, and through different activities, they can develop imaginative and critical thinking abilities (Kincheloe, & McLaren, 2011). In this research, participants focused on the solution to disengagement problems through different activities through digital storytelling in mathematics class for a better learning process. This research participant participated in critical issues for change, minimizing inequality/ injustice in education, and flagging up for social change through the DST. The central notion of the critical research paradigm is to transform practice in a more democratic way to promote social justice (Taylor, 2014). So, I selected the research paradigm for the research study as the "critical paradigm".

In my research, I used interpretive and the critical paradigm together because I had to explore the perception of participants on digital storytelling as STEAM pedagogy and develop my pedagogy, to solve professional problems through interaction,collaboration, and reflection on the action. During the study, I used critical reflection process for each DST classes by which I tried to identify, challenge, and evaluate my deeply rooted assumption regarding teaching-learning activities (Luitel &Dahal, 2020). This made me to think for reformation on my pedagogy. The process of critical reflection helped me to make change in learning environment as well as to improve my understanding of my action, discussion with critical friend, and learning surroundings (Luitel, et al., 2022). The interpretative paradigm helped to explore the perception, experience, and context for meaning-making whereas the Critical paradigm helped to advocate for the solution, empower, and take action for the

researchers/ participants. In which participant becomes aware of the phenomenon, he/she raised their critical consciousness and makes a clearer and better vision of engagement in learning mathematics in school by using DST.

In the critical paradigm, participants demonstrate critical self-awareness, Self-motivation, and a critical understanding of appropriate solutions to problems (Taylor & Medina, 2011).The critical teacher will use critical reflexivity which allows self-reflective inquiry to change and transform personal and professional practice (Taylor et al., 2012). This way the study became helpful in CAR, to transform the teacher's self-practice and perception of the learners.

The other reason for selecting these two paradigms namely, the interpretive and the critical paradigm will be found in the following philosophical aspect: ontology, epistemology, and axiology.

Axiological Standpoints

As I have been driven by the notion of research as/for pedagogical change, I start with the clarification of my axiological standpoint. My value for this study is to transform my pedagogical approach to enhancing the students' engagement through collaboration in the mathematics classroom for better learning and knowledge in society by using DST (Robin, 2016). This study may be influenced by the value of researchers and participants, which is influenced by the activities and belief systems of participants. Our values always influenced our plan, our action, analysis, and interpretation during the study. So, my axiological standpointis value-laden because my value is to change my pedagogical practice and to promote DST as STEAM pedagogy in mathematics learning in government schools.

Ontological Standpoints

Now my concern is how participants make meaning and perception about digital storytelling as STEAM pedagogy to enhance engagement in learning and benefits from it. So, my ontology is subjective, with multiple realities that may differ from person to person (Guba,& Lincoln, 1994). Here ontology refers to what counts real in my pedagogical process. Since different participants have different beliefs, perceptions, assumptions, and experiences so they can construct different meanings for the same situation in learning. On the other hand, reality exists historically in participants and can be created under social action. So, the reality in collaborative action research refers to multiple realities which will be explored by interacting with participants.

Epistemological Standpoints

In my study, I believed that realities and knowledge are socially constructed entities. There was interaction, dialogue, and question-answer with participants on information collected through DST. I sensed them because no information has meaning without interpretation. But the interpretation may be different for different human beings and we have to shape it with some extra activities. The assumption in this paradigm is knowledge can be created by interaction with society with power relations and the condition of society. So epistemology is social constructivism with subjective interpretation (Guba & Lincoln, 1994) because every society has a different belief, knowledge-generating systems, and perspectives.

Research Design: Collaborative Action Research

In this study, I applied action research to use digital stories (DS) in the mathematics classroom along with the continuous support of the other teachers and students as participants, co-researchers, and critical friends. We seek a common problem for all participant teachers (co-researchers), planned together for the implementation of DS in the classroom, and improvement of stories, collected feedback, and reflected onthe action together collaboratively to find a solution to our common challenges in teaching mathematics by which we can share, and use our experiences during the study. So the study was collaborative action research (CAR) under the interpretative and critical paradigm as a research methodology in which we used digital storytelling (DST) as STEAM pedagogy as research design. According to Sagor(1993), in collaborative action research in the teaching-learning process, the researchers seek to change the learning culture, should collect information through the observation of documents, interviewparticipants, and focus on solving problems or issues, so the research design was guided by the qualitative method. Collaborative action research focuses on positive change in the school environment and the teacher's profession. In collaborative research, there is the main role of action in small sample size, and critical friends with the interpretation of phenomena for the proper solution rather than literature review, which may be the characteristics of qualitative research (Creswell, 2012).

In my experience, most government schools have no suitable environment for interaction among teachers as well as among students; there is a dominant character among different cultures. Our teaching and learning activities are traditional, with monotonous classrooms without any creative activities. Generally, teachers of

government schools seem to be reluctant to do collaborative activities in the classroom of mathematics as well as other subjects resulting from the frustration, irritation, and decreasing creativity of teachers and students too. Collaborative action research can create more dynamic, interesting, and full of activities. In this study, teachers of the same school realized the same problems and tried to transform our class from monotonous to active class, the algorithmic process to dynamic and diverse activities by inquiring about our practice. To investigate and improve our teaching and learning practice, I and my participants/critical friends of mathematics/science subjectsconcluded that collaborative action research is the most suitable design. This study stood on the teaching-learning activities of a single unit, Simple and compound interest of grade ten in which I used digital storytelling as an instructional tool that was conducted in the CAR model.

Generally, CAR is considered as a teacher's research based on the assumption that teachers work best on their problems if they identify problems themselves when they encourage planning, conduction of plans, observation, and evaluation of plans for improvements collaboratively. We (researchers) emphasized the collaboration of participants during the whole project for the betterment of our traditional teaching practice, which can support the researcher and participants for personal and professional growth. So, we came to realize that CAR is the appropriate option for incorporating digital storytelling as a STEAM pedagogical tool for improvement in teaching-learning activities in school mathematics.

The term collaboration refers to the cooperation between two or more co-workers to accomplish common goals (Clift et al., 1990). The co-planning between two or more teachers to solve or improve any pedagogical skills through the research is collaborative action research (CAR). In this case, the researcher worked together, planned together, acted, and reflected until achieving the goal. Through these activities, teachers can polish their professional skills for future professional careers.

Collaborative action research (CAR) originated from action research (Messiou, 2018), so it follows the same cyclic process as action research. Researchers (teachers) planned for all phases of action research mentioned by Burns (2015) based on the idea developed by Kurt Lewin (1946). The CAR is helpful for the professional development of mathematics teachers in school (Sagor, 1993), so it became helpful in the mathematics classroom to enhance students' engagement.

According to Sagor (1993), the purpose of collaborative action research is to improve personal and professional practice. He argued that the teacher conducts an inquiry for improvement on personal and pedagogical in three steps i.e. initiating action, monitoring and adjusting the action, and evaluating action. He focuses on initiating action which refers to the research for action in which a teacher seeks information to understand probable solutionsto problems. The monitoring and adjusting related to the improvement and engagement of work are called research in action. Similarly evaluating action is about preparing the final report of the action that evaluates teachers' actions, findings, and conclusion which is called research of action. These three steps belong to understanding research, monitoring the research, and evaluating research. These steps are essential for improving the teacher's action for better performance.

Oja and Smulyan (1989) mentioned that collaborative action research has three forms; the first is collaboration, the second focuses on practice and the third is professional development. In this research, we (Researchers[4]) focus on collaboration for professional development. In collaborative action research, two or more teachers develop a plan in a combined way to conduct research. By collaborating with co-researcher, we can share ideas, combine appropriate ideas for a solution, and develop democratic leadership between the team and spiral action. In this case, our collaborative action research moves forward with the help of a spiral action cycle of planning for a solution, action for a solution, observation, and reflection with the cooperation of ideas of researchers (Oja&Smulyan, 1989) on the idea of action research by Kurt Lewin (1946). The goal of our research is to improve our professional development with the help of collaboration with a co-worker as a goal of collaborative action research. During the study, collaborative action research helps to develop skills from which they can learn and use research skills in practice by working together with sharing ideas in a cooperative environment. So, collaborative action research is suitable for this study.

Sagor (1993) mentions five steps for collaborative action research which are; Problem formulation, action planning, data collection, analysis, and reporting of results. In this research, I use the critical paradigm with my ontological as well as epistemological, and axiological assumptions. As I worked collaboratively with my

[4] Here, Researchers are me, and critical friends/co-researchers

research participants (teacher and students), I welcomed and value their multiple realities which are related to my study, which may be affected by beliefs, values, and practices of people (ontology) by integrating their subjective experiences and making meaning out of them through their interactions (epistemology). Since truth varies from person to person, my axiological assumption was value-laden. I always respected my research participants as subjects but did not object so that they could involve themselves in the interaction and participation throughout the research study.

Study Location

The study was conducted in one of the secondary level government schools of Lamkichuha Municipality Ward No-10, Kailali, Sudurpaschim province, the western part of Nepal, where I have been serving for the last three years at the secondary level as a math/science teacher. The school was established in 1968 and is a community school fully funded by the government of Nepal. 29 teachers are working together in the school. The school is serving approximately 1050 students in K-12 and about 350 students in secondary level i.e. 9-12 grades (School record 2019/20). The school is situated in the western of Lamki-Chuha Municipality Ward No. 10, with a dense population of middle economic class community with diverse social cultures. Lamki-Chuha Municipality as well as the school is rich in socio-cultural diversity, including Tharu, Newar, Gurung, Braman, etc. communities from different districts of Nepal and India.

Selection of Co-researchers/Critical Friends, and Their Role

In this study, initially, I had chosen two co-workers (Mathematics teachersMr. Bhim Sir, and Mr. Damber Sir, Pseudo named to preserve the confidentiality of the co-researchers/participants) who have been facing the challenges of students' disengagement, who were interested to participate, provided feedback, and critiqued for the betterment of the study as critical friends the study (Costa &Kallick, 1993). After sometimes latter, when we started to prepare digital stories in mathematics then we felt there was a need for other subject teachers to improve the context of DS, and to incorporate more disciplinary knowledge in DSs. So, we invited two other teachers one of a social studies (Mr. Palli Sir) subject and the other was of finance subject (Mr. Bal Bdr. Sir). After that, four teachers of various subjects helped me in creating DS, provided feedback for improvement, and works as critical friends during the study.

In CAR, there is vital role of critical friends who can play diverse roles such as advisor or consultant, supporter, facilitator, critical thinker, and participant for

teacher-searcher (Kember et al., 1997). I had discussed with a critical friend in all steps of the study so that study will be more authentic and can draw appropriate meaning from the event, content, and context in the study location. I expect support from critical friends in the observation of events, intervention, documentation, and feedback, which arises critical questions for alternative ideas in the study, meaning-making, and interpretation of the information/text (Mat Noor, &Shafee, 2020). So, a critical friend has a greater role not only as a participant but also as the co-constructor of knowledge in this research study.

Likewise, I selected six students from grade ten as co-researcher in the study. I discussed with critical friends the role of student co-researchers in the study. One of my critical friends Mr. Palli Sir suggested we should givea role to students too for class observation and giveaninterview by which we can collect students' voices in a better way. All other critical friends agreed with Mr. Palli Sir, and we decided to give the responsibility of class observation, and give an interview to collect students' voices in the research study. Indeed, student co-researchers helped to collect real voices, and activities of students in the classroom during the study.

Research Participants

In this study, pseudonyms are used to address the participants. For the study, two mathematics/Science teachers (Mr. Bhim Sir, and Mr. Damber Sir), one social studies teacher (Mr. Palli Sir), one finance teacher (Mr. Bal Bdr. Sir), and a group of grade ten students were selected for working groups/ participants as a sample from the whole students of the school. The participants for this research were selected by purposive sampling method (judgments will be done according to the interest of students and teachers, who can manage time for activities in extra time, culture, a different cluster of area, etc.) including boys and girls in the same proportion with the phenomenon of interest (Cresswell, 2012).

Here, I selected a group of participantsas a co-researcher team which contains 6 students of grades 10 along with four teachers as co-researchers, twomathematics/science teachers, one social subject teacher, and one finance subject teacher as working-group/co-researcher in which these teachers will act as a critical friend too (Kember et al., 1997) and all grade 10B students of batch 2022 as participants for the implementation of the plan in the classroom. I choose section B of grade ten because the other mathematics teacher (Mr. Bhim Sir, pseudonym used in the study) teaches mathematics in the class. This helped me to collect the real

experiences of students through interviewsin the school regarding classroom activities in the mathematics classroom. If I took my class where I teach mathematics then there might be hesitation for students to express views and experiences regarding teaching-learning activities in the mathematics classroom. So, I selected another class in grade ten where I do not teach mathematics.

Now, I presented here, a small introductory part of my co-researchers team which comprised four teachers who played both co-researchers and critical friends' roles, and 6 students as co-researcher in this study.

First Participant-Teacher/Critical Friend (Mr. Bhim Sir)

The first participant in this study is a secondary mathematics teacher teaching in one of the reputed community schools in Kailali. He is 31 years young energetic teacher in the school who wants to participate in various activities in school. He is from Lamki-Chuha municipality 02, Kailali. His background study is pure science and teaching mathematics for 8 years in different secondary schools in the Kailali district. He pursued his M.A., and B.Ed. in mathematics from Tribhuvan University (TU) in 2016, and 2018 respectively. He was in the teaching field after completing his B.Sc. from TU in 2013. He was also facing the challenges of students' disengagement in his classroom, and he was trying to make his mathematics classroom more effective. He was worried about the teaching-learning activities, and the achievement of students. He was seeking opportunities to make better teaching-learning activities in his classroom. I found this person as a resourceful personality for this study because he was facing the same challenges as me. He also participated in various professional development training and tried new experiences. We discussed together many times innovative pedagogical techniques and tools for engagement. We concluded to conduct action research by using DST in the mathematics classroom. To get more ideas, and support in the study, we planned to work together with other teachers too. So, we invited other teachers Mr. Damber Sir, Mr. Bal Bdr. Sir and Mr. Palli Sir to conduct the study collaboratively.

Mr. Bhim Sir has participated in all activities such as creating DSs, and class observation. He also gave feedback, and suggestions, and provided his experience through in-depth interviews before, during, and after the study. He also supported me in this study to improve observation, and interview guidelines to collect text data from other observers, and interviews. He is named Mr. Bhim Sir in this transcribe to maintain the confidentiality of the participant. He observed many DST classes, and

the interview was taken in an in-person conversation. I collected the major ideas from his participation, and experience through observation form, and recorded interviews. Later, I transcribed it in the conversation form and verified it with him in another sitting. In the study, he was not the only participant in text data collection, but also provided ideas, feedback, and support during the study. So, he is a critical friend in the study.

The Second Participant-Teacher/Critical Friend (Mr. Damber Sir)

The second participant in this study is basic-level permanent mathematics, and science teacher teaching in one of the reputed community schools in Kailali. He is 41 years young energetic teacher in the school who also wants to conduct and participate in various activities in school. He is from Bedkot municipality 6, Kanchanpur but now he lives in Lamki-Chuha municipality 10, Kailali. He also teaches mathematics, and science subjects since 2015 after completing his M.Ed. education at TU. He has participated and conducted in several educational research activities during his study, and teaching. One of his major research (M. Ed. Dissertation) was the attitude of lower secondary mathematics teachers' toward mathematics subjects. Being a mathematics/science teacher, he was also facing the challenges of students' disengagement in his classroom, and he was also trying to make his mathematics classroom more engaging activities in his mathematics and science classroom. When we both (Me and Mr. Bhim sir) proposed and introduced him to the study, he became excited to participate, contribute to the study, and learn from the study.

After his acceptance to participate in the study, he actively participated in creating DSs, added new ideas regarding context and contents, and participate in class observation. Furthermore, he gave feedback, and suggestions to improve the classroom activities in the classroom. He also provided his experience through in-depth interviews before, during, and after the study. He also supported me in this study to improve observation, and interview guidelines to collect text data through the observations, and interviews. He is named Mr. Damber Sir in this dissertation to maintain the confidentiality of the participant. In the study, I also collected ideas and experiences through recorded interviews several times during the study. Later, I transcribed it from the recorded conversation and verified it with him in another sitting. In the study, he was not only a participant teacher for text data collection, but also provided ideas, feedback, and support to improve ways of presentation of DSs,

and interaction in the classroom during the study. So, he is also a critical friend in the study.

The Third Participant-Teacher/Critical Friend (Mr. BalBdr. Sir)

The third participant in this study is a very active, energetic, and very experienced secondary level teacher teaching in the same community schools in Kailali. He is 58 years old teacher in the school who has the experience to conduct and participate in various teachers' professional development, and teaching-learning activities in/outside the school. He is from Janalikot rural municipality-02, Achham district but now he lives in Lamki-Chuha municipality 06, Kailali. He teaches Finance subject since 2003 at the secondary level, especially in grades 11 and 12 in the same school. He has completed his M.Com. Degree from Gujrat University in 1995. Before 2003, he was working in social service in a reputed finance company in the Indian social sector. He has participated and conducted in several educational, and social activities during his social, and teaching service. I requested him to participate, and help in the study so that I can integrate social, cultural, and contextual aspects into the DS.

After his acceptance to participate in the study, he actively participated in most activities of DST namely; creating DSs, adding new ideas regarding context and contents, participating in class observation, giving feedback, suggestions for improvement of the presentation of DSs, and providing his experience through in-depth interviews before, during, and after the study. He also supports me in this study to improve classroom activities along with improvement on observation, and interview guidelines which becomes helpful to collect text data through the observations, and interviews. He is named Mr. Bal Bdr. Sir in this dissertation to maintain the confidentiality of the participant. During the study, like other participant teachers, I also collected ideas and experiences through recorded in-depth interviews several times. Later, I transcribed it from the recorded conversation and verified it with him in another sitting. In the study, he was not only a participant teacher for text data collection, but also provided major ideas, feedback, and guidance to improve ways of presentation of DSs, and interaction in the classroom during the study. So, he is also a critical friend in the study.

The Fourth Participant-Teacher/Critical Friend (Mr. Palli Sir)

The fourth participant in this study is Mr. Palli Sir, who is a very active, energetic, and very experience secondary level social subject teacher teaching in the

same community schools in Kailali. He is 47 years old teacher in the school who is a subject expert, and a teacher educator in the Kailali district who works in the teachers' professional development intheteaching-learning field of education. He is from Bedkot municipality-04, Kanchanpur district but now he lives in Lamki-Chuha municipality 08, Kailali. He teaches the social subject at the secondary level in the same school since 2006. He completed his M.A. Degree from TU in 2005. He has experience in participating in and conducting several educational, and social activities during his social, and teaching service. I requested him to participate, and help in the study so that I can integrate his experience of social, cultural, and contextual aspects in the DST.

After his acceptance to participate in the study, he actively participated in all activities of DST namely; creating DSs, contextualization of DSs, class observation, giving feedback, and suggestions for classroom activities, and provided his experience through in-depth interviews before, during, and after the study. He is named Mr. Palli Sir in this dissertation to maintain the confidentiality of the participant. During the study, like other participant teachers, I also collected ideas and experiences through recorded in-depth interviews several times. Later, I transcribed it from the recorded conversation which verified it with him in another sitting. In the study, he was not only a participant teacher for text data collection, but he played a vital role in guiding the study for the improvement of the classroom activities during the study. So, he is also a critical friend in the study.

Student-Participants

Even though I have selected grade ten section B having 52 students from a reputed secondary level school to implement the plan of the study, I have selected six students of the same class as co-researchers or participants for focus group discussion, and data collection purposes. I selected those six students who were eager to participate in various co-curricular activities in the school. For this, I conducted a classroom interaction on the 14th of March 2022 in the mathematics period to inform students about the activity, and to collect pre-information for the study which comprise the scenario of the class, students' perception regarding the pedagogy of the mathematics teacher, learning culture of the classroom, and student's interest. After the interaction, I asked them whether they were interested to learn mathematics through DST or not. Most students in the class were very interested in learning mathematics through the use of DST. Finally, I asked them to raise their hand to six

students from that class who are most interested in such co-curricular activities to participate voluntarily in process of creating DSs, and text data collection.

In this process, I selected four female students Miss. Nabina 15 years old, Miss. Juna 17 years old, Miss. Chetana, and Miss. Sarika 17 years old along with two male students Mr. Akendra 15 years old, and Mr. Dipak 15 years old, as co-researcher group for the study from the same classes. All six students are from middle economic, and educated families. After the selection process, I oriented them regarding the process of the study, classroom observation guidelines, and semi-structured interview (for a sample of classroom observation, and interview guidelines in the appendix). All six students helped me withdata collection through class observation and in-depth interviews. They collected classroom activities through observation, put students' opinions, and experiences through in-depth interviews during the study.

Study Cycle

In the study cycle, we followed the cycle of collaborative action research of the idea Riel (2019) which followStudy and Plan, Take action, Collect and analyze evidence, and reflect. In this study as a critical researcher, I have to deeply involve myself in a prolonged engagement with my research participants (teachers and students), trying to empower, motivate and develop critical thinking for change in the field to understand the culturally different situations, they feel 'deep democracy' (Taylor & Medina 2011) and transform traditional pedagogical approach as STEAM pedagogy. Moreover, this paradigm enabled me to generate and understand local understandings of the life-world experiences of my research participants, which, in turn, help me to generate context-based understandings of their thoughts, beliefs, and values.

Although, there are many ideas and steps in collaborative action research and as collaborative action research (CAR) originated from action research (Messiou, 2018), so I choose and follow the same cyclic process as in action research. For the study, we planned for all phases of action research mentioned by Kemmis et al., (2014) based on the idea developed by Kurt Lewin (1946) and McNiff (2002). For this study, we choose a cyclic process of action research having steps to Study and Plan, Take action, Collect and analyze evidence, and reflect based on my research problem (Riel, 2019). Here, I am going to briefly describe each step that I will follow in the study which will guide and control my study in each step.

For this study, I planned activities for 30 days as the first cycle of the study but based on the need for the content, context, situation, and result of the first cycle, we re-planned and conducted the next cycle of the study. The second cycle of the study was helpful to conceptualize the content, interpretation of engagement, and conclusion of the study. On any unclear reflection, interpretation, meaning-making, and conclusion of the study then we conducted the interaction with a focused group during the study for some unclear events and ideas only.

Study and Plan

We prepared a new pedagogical plan “digital storytelling approach guided by Critical reflection” based on the philosophy of STEAM education in which stories will be constructed and presented with the help of digital devices (Projector, sound system, digital smart board, and other devices) and teaching-learning activities will be guided by social constructivism. I prepared different digital stories and lesson plans. Finally, presented DSs in the mathematics class with the help of digital devices along with interaction for the single unit "Simple and compound interest" of grade ten. Initially, I developed ten digital stories, interactions, and creation of DS about thirtyday'sactivities as thefirst cycle of the study. For the study, a ten-day DST lesson plan was constructed based on the 5E model of inquiry-based learning (Duran & Duran, 2004).For the sample lesson plan, see the appendix-2.

According to Duran and Duran (2004), the 5E instructional model comprises engage, explore, explain, elaborate, and evaluating stage of learning.In engage stage, students were allowed to participate in different activities that stimulated their thinking and helped them to assess prior knowledge regarding mathematical contents with some brainstorming questions. In explore stage, students were given time to think, make a plan, investigate, and organized collected information from each part of DST. Likewise, in the explaining phase, students were allowed to explain and clarify their understanding of DST. Similarly, in the elaboration stage, students are allowed to collect and elaborate their understanding through discussion with a group of students and teachers. Finally, in the evaluation stage, I evaluated not only the students but also my whole classroom activities in the classroom.

We set a plan to collect the experience of teachers and students regarding classroom activities of students. For this, I conducted one round of interviews with three teachers (Mr. Bhim Sir, Mr. Damber Sir, and Mr. Palli Sir), and classroom interaction with grade ten students to understand the classroom scenario before the

study. After that presentation of DST in the mathematics class of grade ten, observation and interviews of participants-students were conducted simultaneously. Traditional classes, digital storytelling pedagogical classes, observation, interviews, and reflection were conducted on simultaneous or alternative days that will help to improve class activities. All lesson plans and digital stories were devoted to enhancing students' engagement in learning mathematics and expanded accordingly as reflection and re-plan.

In this study, every class started with critical/brainstorming, guessing, imagination, and funny questioning. After the conclusion of the initial questions, I presented digital stories in class. During the presentation of digital stories, I paused the story, and then I started the class discussion so that students can construct mathematical knowledge by interacting with each other. During the presentation of DS, the class was observed by critical friends and they helped me to better meaning-making. For meaning-making and interpretation of any event, we (researcher and co-researcher as critical friends) worked together to get a better and more authentic result of the study. Critical friends in my study were advisors or consultants, facilitators, and critical thinkers for teacher-searcher along with diverse roles in the DST to improve the practice (Kember et al., 1997). Every class ended with the reflection of the participants. I shared my reflection, interpretations, and meaning-making with my critical friend and with other participants during the study from which I got support and feedback from critical friends during the study.

Take Action

To take the action on my study, I prepared ten digital stories and discussed those stories with my critical friends to get feedback regarding the contents, and context of the stories (See plan used to create stories in appendix3). Every class was observed by participant teachers/critical friends or a group of participant students this process of observation of the DST classroom helped me to collect feedback and perception of teachers and students respectively. Before every DST class, I distributed the semi-structured observation form (see sample observation form in appendix4) to collect the text data from observers, and oriented them for the objective of the class and study. After the distribution of the observation form to the assigned observers, I prepared ready all the digital tools such as a laptop, projector, and smart board in the grade ten section B of the secondary school. Generally, when all pre-work for the DST was ready, I divided the whole class into 5 to 6 small groups for discussion then

I stared the presentation of DS in class. Which generally followed the following method.

Each DST class was started with two to three brain storming questions, contextual questions, or imagination questions on the first slide or first photo of the DS. By showing the photos or first slide of the DS, I asked some questions like; what was the context of the story?What will be the story about? What will be the situation of the man in the context? What might be a problem? Is the contextual situation of the story similar to your context or different? Those questions helped me to create an interesting, and joyful class by which it grab the attention of the students toward the DS. After some discussion in their respective group, students reached some conclusions regarding those brainstorming and guessing questions. In some cases, I helped or facilitated the students so that they reached in appropriate conclusion by which dealing with the story became easy to contextualize.

Picture 3.1:Some pictures used for brainstorming section of DST

Generally, the first section of the DS was about the characters, and context of the DS. In most of the digital stories, there wasa rural context in DS, which showed a similar context of the students because most students were from the rural context of the study site. Students tried to connect stories with their context, and they became ready to answer the contextual questions during the DST. In some digital stories, there werethe contexts of a bank or economic institution, and in some cases, there were contexts of school. During the DST in mathematics class, I observed that the contextual part of the DS was very important to grab the attention of the students, create an emotional environment in the classroom, and control the behavior of the students in the classroom. The fact was aligned with the views of all critical friends.

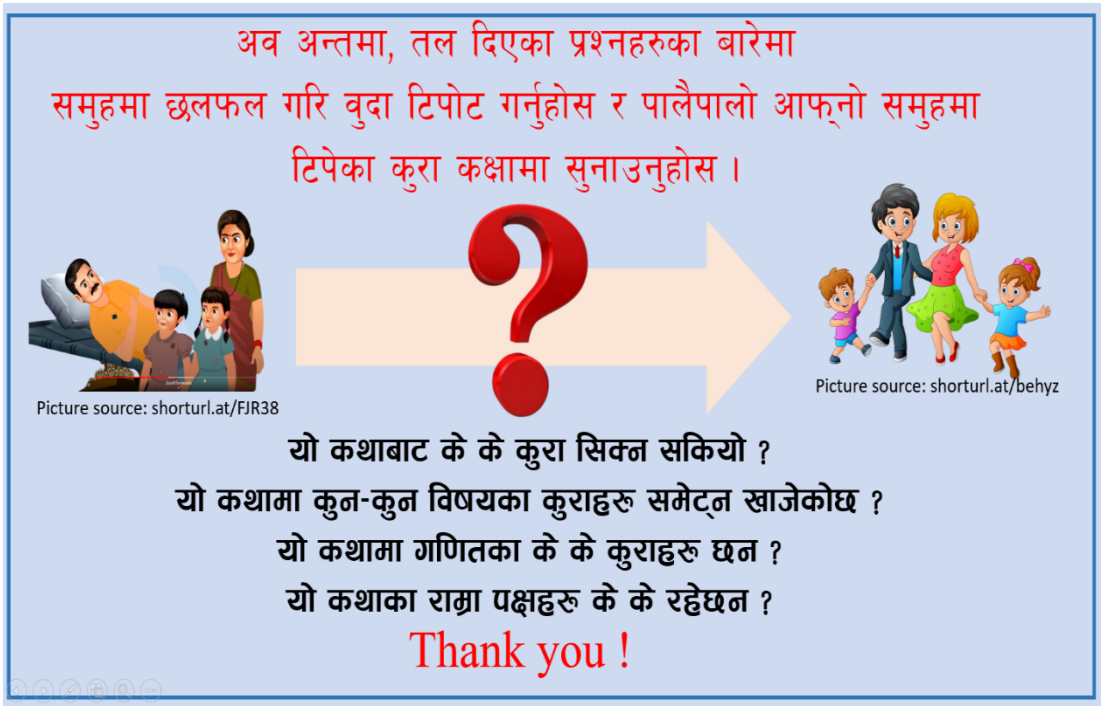
After observation of the DST, one of my critical friendsMr. Bhim Sir said that *'your initial part of the story in which you choose character and context was very impressive which became able to control all the classroom activities'*. Similarly,

during the informal discussion on leisure time in school, other critical friendsMr. Damber Sir support the same view. He said,*'the brainstorming and situational part of the digital stories indicates the scenarios of the stories which became helpful, and a clue to answer the contextual questions for students…… contextual and brainstorming ideas in the stories I like most'*. Likewise, the views of participant students werethe same as the critical friend. Some of the participant students expressed their views during the interaction and practice class as, *'the ways of presentation of stories, and initial questions from photos/videos opened our mind to think about it……it compelled us for thinking along with joy in the classroom……it catches our mind…….. it controlled the students in the classroom*'. In the context part, I tried to introduce the protagonist and antagonist characters. The protagonist plays a positive role which is simple in his/her character and the antagonist plays an anti-role in the story which plays a vital role to create the problem and makingthe story interesting (Porteous, & Lindsay, 2019).The contexts of the digital stories helped students to imagine their context, think about the situation, relate their context, and contrast with their context.

After introducing characters and context, there wasthe condition of posing problems in the DS. Through the activities of the antagonist in the DS, she/he plays problem-posing or problem-creating activities, and situations in the stories provided the environment for learners to think critically about the solution to the problems. After the presentation of the problem in the stories, students were allowed to think and discuss in the group to find suitable solutions. During the problem-posing section of the story, students were allowed to put their viewson probable solutions individually and in a group. In the problem-posing section of the DS, students discussed the solution to several contextual problems. They discussed solutions to social problems, science problems, mathematical problems, ethical problems, technological problems, and the nature of human beings related to the content of SI and CI in digital stories.

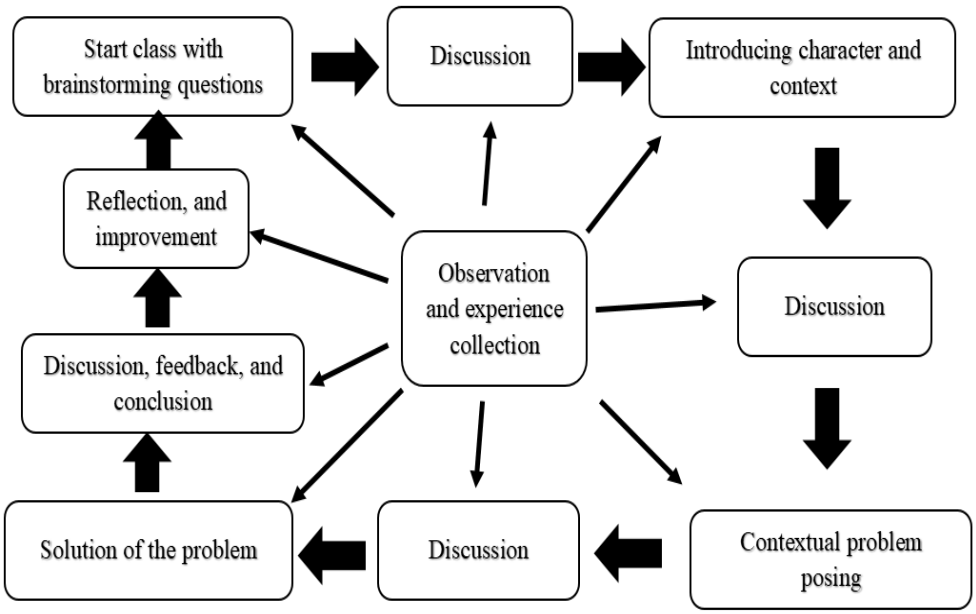
At the end section of the digital stories, there were sample solutions to the problems posed in the stories. There was no unique solution for the problems in the DS. It only provided ideas for the solutions for the students, by which students discussed whether there is an alternative solution or not for the problems in the DS. From the discussion, we observed that there were many subjective solutions to the problems in the DS. Indeed, there wasthe construction of new knowledge from social

interaction in the class (Vygotsky, 1978). The activities in the group showed that students' minds are not empty vessels, there are possibilities forthe creation of new and exciting knowledge. In some mathematical problems, there was practice time during the session. During practice time, students were assigned to solve some similar mathematical problems in a group and shared them in the class.



Picture 3.2: Sample picture of end discussion of DST classes

Before wrapping up every DST class, I conducted the interaction with students about the stories and assessment of the classroom activities. From the interaction with students in the class, I collected some ideas regarding the understanding of contents, context, views of students, and various disciplines incorporated in the DS. I realized that the discussions at the end of the DST classes provided opportunities for the learners to reimagine, and memorize the contents of the stories. In short, I allowed discussion in the group of students to conclude each stage of the storytelling, and their activities were observed during the presentation of the story in class. The general process of presentation of DST in the mathematics classroom is shown in the figure given below.



Picture 3.3: Process of DST in the mathematics classroom

We implemented the plan of DST in the mathematics class of grade ten of a secondary school in Kailali, Nepal, and informative or instructional digital stories (Robin, 2006) were used as tools for social interaction in the classroom. Each class started with initial brainstorming questions, and interactive questions for critical, imaginative, and funny answers to motivate students by showing the first scene or picture of the DS.

During every activity of DST, I observed students' engagement in different aspects such as behavior, emotion, and cognitive engagement. Each class ended with feedback from the students, critical reflection in group and self, and preparing lesson plans for the next class. The plan was reformed many times during the class according to the situation of the class for improvement. After each class, I reflected on my teaching pedagogy (Pant, 2017), and based on discussions with co-researchers and participants, I prepared lesson plans as well as digital stories. The process, I used during the implementation of DST in secondary mathematics classroom described above is one of the major finding of the study.

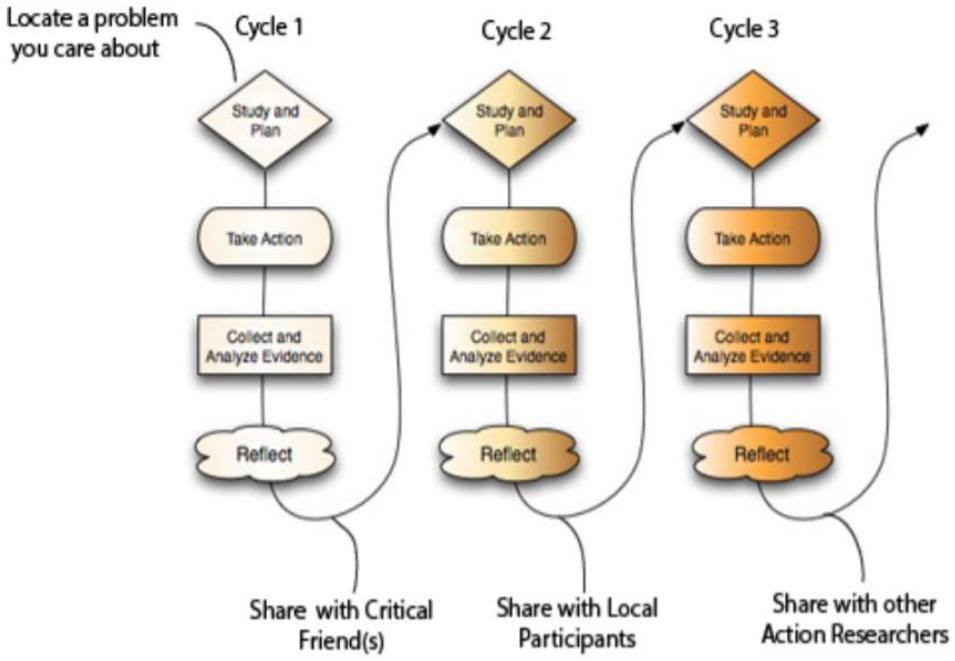
Collect and Analyze the Evidence

During and after the completion of each class, I collected information through different types of observations such as reflection notes, participant interaction, interviews, and a diary of participants. I kept a record of all activities related to the objective of the studies during classes, interviews, interactions, story presentations,

and during other informal talks. Further information collection ideas and processes are discussed later in the sub-title ‘information collection tools’. I transcribed the information collected through the different data collection approaches, coding and arranging, thematizing, meaning-making (Creswell, 2012; Saldana, 2021), and sharing interpretation during the study process.

Reflection

I reflected on each step of action research (observation on the interview, collaborative discussion, and classroom activities) from which I created meaning for each activity of students in the classroom (Pant, 2017). In this step, I used the critical reflection (See a sample of critical reflection in appendix5) of my classes and the critical reflection of others' co-researchers which helped to decide on the effectiveness of the classes. The process of critical reflection helped me to examine my deep rooted assumptions, and seek alternative solutions in my practice (Luitel &Dahal, 2020; Luitel, et al., 2022). I shared my reflection as well as other co-researchers reflections to get a deeper insight and conclusion. The sharing my experiences, and critical reflection with critical friend helped, and provided new pedagogical space through DST for me. This process also helped me whether I had to stop or conduct the next cycle of my study and I got a better insight into meaning-making and interpretation. In this way, we realized that DST improved our practice in the classroom and enhanced the behavioral, emotional, and cognitive students' engagement in learning activities. From the reflection and feedback from critical friends, I decided whether to stop or conduct the next cycle of the study.



Picture 3.4: Collaborative Action Research; Source: Riel, (2019, p. 2).

Data/ Text Collection Approach

To manage data collection process, I prepared, and implemented data collection plan (See in the appendix-6) for the study. Data/Text collection approach was a semi-structured interview questionnaire (face to face, telephone, and video chatting) with participants, observation of activities, and audiovisual materials (pictures, videos, and sounds during activities) for this research as suggested by Creswell (2012) along with a focus group discussion and sharing experience(Gill, et al., 2008). For this, I used the interview and observation guidelines as tools by which all data were gathered and the research question was addressed. I used the following tools for data collection during the study.

Semi-Structured Interview

Primary information was collected from students-participants through repeated interviews till saturation with open-end questions with the help of semi-structured questionnaires, texts, methods of expression, and experiences. In semi-structured interviews, general, critical thinking, and opinion-based questions were discussed along with note-taking, recording, and video recording processes during face-to-face interviews with the student, and teacher participants with the help of interview guidelines (See interview guidelines for teachers in Appendix-7), and student-participant (See interview guidelines for students in appendix-8). During the

study, I conducted formal and informal discussions with participants to get a deeper understanding ofthe study.

I also used telephone calls and video chatting through different social media (messenger chat, zoom meeting, and google meet) for interviews to clarify the ideas among the group of critical friends, especially for teacher participants. The informal discussion with my critical friends was helpful not only to collect data during the study but also helpful to improve digital stories and my classroom practice.

Focus Group Discussions

In the information collection process, I made unstructured small groups of participants containing approximately six (with convenience, without any fixed rule) and four teachers to collect experience, feeling, progress, reflection, and re-plan of the whole project. In the study, I conducted three focused group discussions (FGD) at the beginning, middle, and end of the study. The FGD at the beginning of the study helped me to collect a general classroom scenario of the mathematics classroom, which indicated the disengaged scenario of the classroom (discussed in chapter IV). Likewise, the FGD during and end of the study provided the experience of students which helped me to collect the views, and perceptions of the students in DST classes.During the collection of information, scheduled meetings, interactions, ideas, and experience-sharing sessions were conducted in discussion with focused groups of participants. In the focus group discussion, I collected the views, ideas, and experiences of the participants at one time and facts obtained from many people's discussions. Also, the recording was maintained with the permission of the groups.

Observation

The observation of the whole process was conducted simultaneously with the help of my observation, critical friends, and observation of the group of students along with interviews, discussions, and activities of the plan. I observed the classroom activities from my side with the help of the observation form (See a sample of the observation guideline in the appendix-4). During DST, the classroom activities were observed by teachers (Critical friends), and a group of students. I prepared the semi-structured observation formand provided responsibilities of observation for critical friends, and peers of student participants. For this, I oriented participant teachers (critical friends), and student participants for what aspect of the activities should be observed before the DST. For student participant observation, I divide the student

participant (co-researchers) into three peers and assigned them to observe the classroom activities alternatively in their turn as participant observers.

In the study, participant and non-participant observations were conducted to observe verbal and non-verbal communication, the position of participants, actions and feelings of the participant along with taking photos taking and video recording simultaneously (Barrett, &Twycross, 2018). The research-oriented observation was conducted during the study period which supported the facilitation and improvement process of the conducting plane. On the other hand, the students' engagement towards mathematics learning was observed through the observational guidelines and along with different means such as class discussion, tests, and assignments. During and after the observation process, I prepared short reflection notes for future use in my research while analyzing the information.

Diaryand Field Notes

A personal diary was used as another important means of primary information collection. I used a diary to collect and keep a record of my life experience, daily activities, class assignment records, and self-reflection in an action plan for improvement and implementation during the study. Moreover, a diary was used as a personal account to collect personal information related to the study, in which personal ideas, observations, feeling, reactions, explanations, context, and reflections will be included (Kemmis et al., 2014). I jut down some special events during the study in my diary and used them during the data analysis. In such a way, I generated some essential information during the study by using a diary. In my study diary, it was helpful to collect my observation, thought, feeling, and emotions during the information collection.

Analysis, Interpretation, and MeaningMaking

In collaborative action research, information/text data was in the form of field notes, interview transcripts, audio, videos, and different images collected from the field, on transcribing all events, interviews, documents, and audiovisual materials researcher tries to seek relation among collected transcripts. In this study, qualitative information was analyzed by transcribing data, coding information, identifying themes/patterns, and summarizing the information to draw meaning and conclusions from the information collected in the bottom-up approach (Creswell, 2012; Saldana, 2021). Initially, based on the research questions, research text data were collected in recorded/transcribed form, arrangedin chronological ways, with different ideas, and

themes, and then sought relation between these ideas.Lastly, I summarized the facts, refined, interpretations, conclusions, and finding. I followed the quality standard of the critical paradigm that will guide and control my study.

Quality Standards

The quality standard refers to the nature of each research paradigm by which the reader can judge the quality of research concerning the role of the researcher and the truth of the research. There may be different approaches and criteria for the quality standard of research which will be influenced by the nature of the paradigm and types of research. As this is qualitative research, I followed honesty, depth, richness, and triangulation in data collection. As the research is based on criticism guided by interpretivism, I was chosen both guidelines for the quality standard of research. For quality standards of the whole research, I used critical reflexivity, praxis as transformative action, pedagogical thoughtfulness, and authenticity for DS on critical paradigm which were helpful for this study to guide my study and control my study during information collection and analysis information.

Critical Reflectivity

Critical reflexivity refers to the critical self-awareness and critical understanding of the complex phenomenon of the school society and school culture (Roulston, 2010). During the study, I write a reflection journal after each digital classroom and interview which helped me to better meaning-making. In this study, I tried to demonstrate my critical self-awareness, and critical understanding of the project along with the social context and try to decolonize learners' practice of hegemonic ideology for contextualization of mathematics. I tried to generate and connect social interests with the mathematical concepts of students' by enhancing critical self-awareness and critical understanding.

Praxis

In this study, praxis refers to the transformational action of the research by which the researcher can relate the theory of mathematics with traditional as well as modern practice in a pedagogical context to increase the consciousness of the co-researcher and participants (Luitel &Dahal, 2020). The consciousness of the co-researchers and participants can be increased through the sequences of action along with critical reflection (Maseko, 2018). So, in this study, I tried to develop a research environment for social restructuring with high consciousness of learners through a continuous sequence of action followed by critical reflection to develop a better

pedagogical practice of teachers, and to envisage a bright future for learners that empower co-researchers and learners to raise critical voices.

Pedagogical Thoughtfulness

From this study, I tried to address the pedagogical thoughtfulness of the readers. For this, I had chosen the method that readers can evoke questions, reflect and examine their pedagogical practice to elaborate the critical awareness and critical understanding of readers. In this study, I tried to express the text more engaging by describing every context of the study so that readers might question on finding of the study along with the context. On reading the text, a reader can examine, reflect, and compare his/her practice with the context, and finding of the study.

Authenticity

To make the digital stories used in this study more authentic, I tried to connect and relate the contents of the stories with the outcomes of the secondary mathematics curriculum so that they can support students to construct authentic knowledge in the mathematics classroom. Since, authenticity refers to the realness, genuineness, and trueness to maintain the quality of the study (Lehman et al., 2019). Every digital story used in this study tried to create meaning and a sense of the intended learning outcome of the curriculum to maintain the quality of digital stories and study. Hence, digital stories were constructed through the guidelines of eight steps by Morra (2013), so that they were genuine, can contextualize the mathematical content knowledge, provide conceptual clarity, and will contribute to the educational goal.

Similarly, while maintaining the research report more authentic, I tried to be fairer a representative to all participants and the text data were interpretative following the social construction of knowledge. This fact is represented by the fairness in the collection of text data through observation, and interviews during the study. Likewise, research participants benefitted from the knowledge construction through the DST so this study is educative. Moreover, the problem is associated with the society of the educational community which tends to solve from the use of DST so that the study is found catalytic. Lastly, the study empowered the participants to resolve the problems of disengaging the learners. So the study is tactical. Hence, it was found that the study is fairness, educative, catalytic, and tactical so it is authentic.

Ethical Considerations

To make this research more ethical, I followed all requirements of qualitative research, especially collaborative action research (CAR). The research proposal

wassubmitted to the ethics sub-committee of Kathmandu University (KU) for ethics approval. Research permission was obtained from the participants and followed a full explanation of the goal, purpose, and objectives of the research. The participants were given a full explanation of the research design, use of research, proposal, and their roles in the research process. The participants were informed of their rights to withdraw or share a thought from the research process at any time. Research participants were fully informed about the nature and meanings of the study through briefing and discussing sessions. The research setting reflected a cooperative, collaborative co-worker relationship among CAR groups.

All participants were given the authority to correct, give a suggestion, inform research and complain about the research information through interaction and written sheets, which were provided for their personal use. The contact and address of the authorized person of the university, researcher, and participants, as well as co-researchers, were shared between the research participants (Co-researcher and focus groups) to provide information, complaints, and opinions regarding the research issues. The confidentiality of participants' identities in the transcripts or research was guaranteed by the use of anonymous labels before and during the research. Additional consent and support were obtained from the participants during the research with negotiation, whose pictures and photos were disclosed or not in the thesis report. The research team was awarded and was neutral about the religion, caste, language used, gender, and political ideology of participants.

Furthermore, Problems that occurred during the study were solved by discussion and negotiation between the researcher and participant in a pleasant environment as far as possible. Other ethical ideas and norms were constructed with deep discussion with the CAR team in the beginning and during the research. We allowed student participants to put their views without hesitation, we support them to express ideas and situations in the classroom without any mental pressure. We were trying to provide an environment so that students feel free to express any ideas in groups of students, and teachers. In that way, we did not manipulate the power relation as a teacher during the study.

Chapter Summary

In this chapter, I have presented the philosophical dimension; interpretive, and critical research paradigm, axiological standpoint, ontological standpoint, and epistemological standpoint of the collaborative action research study. I addition to

this, I described a secondary-level government school as a study location along with the introduction of four co-researchers or critical friends, and six students as participants. Furthermore, I included the study cycle, and process of presentation of DST that I used in the study, tools for data collection, the process of collection and analyzation of data, and norms of quality standards for the study.

CHAPTER IV
LANDSCAPE OF CLASSROOM BEFORE DIGITAL STORYTELLING

In this section, I have presented the detailed landscape of the classroom environment before the implementation of digital storytelling (DST) in the mathematics class of the secondary-level school. In this section, I am going to explain the landscape of the classroom before DST with the help of field data collected before, and during the implementation of the DST. My major finding and discussion of the study are based on the data collected through classroom observation, pre-interview with students and teachers, and reflective notes collected after every DST class.

To overview the classroom scenario of the mathematics class of grade ten, I conducted the pre-interview with two mathematics teachers having experience of more than five years in the related field, conducted the interaction with the grade ten students, and conducted sequences of interviews with six students until the saturation during DST, and my personal experience of teaching mathematics at the same level. I have collected field data, coded them, categorized them, and find the theme for the scenarios intheclassroom before the DST in the mathematics classroom. After the completion of the analysis of the field data, I found three major themes and ideas that emerged for the scenarios before the implementation of DST in the secondary-level mathematics class.

The Environment of Mathematics Classroom

In this study, the classroom environment is the classroom learning environment that comprises the physical infrastructure, technological tools, sitting arrangement of the students, number of students, and position of the teachers during teaching-learning activities in the class. Furthermore, it was found that classrooms of mathematics in government schools are culturally diverse concerning the culture of family and learning capacity of the students which was difficult to manage by teachers in the classroom. During the data collection of the study, I conducted sequences of in-depth interviews with participants. I asked the questions regarding the influence of the school environment on the learning of mathematics. Student-participant Mrs. CS said that*Among many reasons, the school environment is one of*

the causes of decreasing interest of the students and disengaging students in learning mathematics. It means that there were many factors influencing the learning of the students. School environment plays a vital role in learning. Furthermore, the teacher Mr. Damber Sir of the school focused on the school environment related to the learning of students. He stated,*in my opinion, the school environment of the school is directly propositional to the learning of the students*(21 June 2022). This indicates that if the school environment such as physical infrastructure and learning environment are managed well thenthe learning of the students would be enhanced. This indicates the influence of the school environment on students' learning. During the analysis of the data, I found that the classroom environment is categorized into three sub-themes namely; physical environment, sitting arrangement, and culturally diverse setups.

The Physical Environment of Classroom

The physical environment of the classroom in this context is the physical infrastructures present in the mathematics classroom which were found helpful for teaching learning activities. In this context, I have mentioned the infrastructure present in the classroom which might be helpful to create a better learning environment for the learners such as bench-desks, textbooks present the classroom, instructional materials, book corners, ICT tools, and other teaching-learning resources. In this study, physical infrastructures were supposed to provide a learning environment for learning. But, we found that physical infrastructure was not sufficient for engaged learners.

I found that most of the classes inthe community and institutional school of the Sudurpaschim province had a minimal amount of infrastructure in the classroom. There were only the parallel arrangement of a bench desk and a white/black board in the front wall of the classroom. These infrastructures were not sufficient to support learning mathematics. Supporting this factthe social subject teacher Mr. Palli Sir said, '*definitely the school environment influence students' learning. Physical, educational environment of school, books in library, e-library, ground of school, management of classroom, and structure of desk-bench plays important role in learning*' (16 May 2022). Furthermore, the statement regarding the parallel sitting arrangement was accepted by classroom observers. Such types of fixed and parallel arrangements of bench and desk in the classroom did not support the various activities in the classroom. So, due to the lack of various activities in the classroom teacher could not

grab the attention of the learners which was the cause of the disengagement of the learners.

On the other hand, in most schools, there was a lack of teaching materials and ICT tools in the classroom. The social subject teacher Mr. Palli Sir said, '*In our school, there are no teaching materials, only white board in our class for teaching*' (16 May 2022). The fact was supported by the mathematics teacher Mr. Damber Sir. He argued that *'indeed, there are no teaching materials in our school*' (21 May 2022). This showed that there were no teaching materials in school and teachers were not using teaching materials in their classrooms. It was found that some schools had managed some technological tools such as smart boards, projectors, and computers in a few classrooms. All six student-co-researchers focused on the fact that *'there were no ICT tools and other instructional materials in their mathematics classes in previous schools'*. These facts also indicated that there was no use of ICT tools in the mathematics classroom.

In those schools, most teachers were not using any kinds of art and digital tools in teaching mathematics and other disciplines in their classes. The social subject teacher Mr. Palli Sir supported the fact by saying, *'Song, poem and the story will make a more interesting, creative, and engaged classroom……Although the artistic approach and digital tools are more fruitful for effective teaching, I never used these techniques in my classroom*' (16 May 2022). Furthermore, the mathematics teacher Mr. Bhim Sir said that 'at *all times, teaching materials may not be possible to use in class due to many constraints such that time-bound, nature of curriculum and availability of materials in the school*' (17 May 2022). It means, the less use of artistic approaches, teaching materials, and digital tools in classrooms caused disengaged learning.

Sitting Arrangement in Classroom

In this study, the sitting arrangement is only the sitting position of students, and teachers in the mathematics classroom. Generally, it was found that most government school in Nepal has fixed set of bench and disk arranged in row and column. Supporting this fact the mathematics teacher Mr. Damber Sir said, '*in most of the school, I found traditional parallel sitting arrangement of bench-desk in class which follows rows and column sitting pattern of students in classroom……..bench and desk are fixed in the classroom so we cannot rearrange them*' (21 May 2022). The situation might be one of the barriersto extra co-curricular activities in the classroom.

Picture 4.1: Parallel arrangement of Bench-desk in classroom

The difficulties in rearranging the benchdesk in the classroom might affect the classroom activities. The mathematics teacher Mr. Bhim Sir supported the fact of parallel ways of sitting arrangement in the classroom by saying that, *' till now we are using parallel ways of sitting arrangement because there is the availability of only such types of bench desk'*. He focused on the types of bench-desk which were suitable for the parallel way of arrangement. Likewise, the finance teacherMr. Bal Bdr. Sir said that *'parallel setting arrange might be more helpful for those schools in which there are maximum students in a class, and teaching pedagogy is descriptive, we are in the same category, hahaha……*'. On the other hand, In my experience, such types of arrangements were suitable for general rectangular-shaped classrooms, and they increased the sitting capacity for the maximum number of students in the small room.

From the interviews of teachers, it was found that most of the classes of the government school had a maximum number of students in a classroom. In each class, at least 50 students were sitting in parallel ways in a small classroom, so that there was a minimum place for classroom activities, and group work in the classroom. This fact is also accepted in the interviews, and classroom observation from students-participants on the various date during the data collection. So, the way of sitting arrangement was one of the causes of students' disengagement in learning mathematics.

Culturally Diverse Classroom

In this context, here I talk learning culture, religious culture, and learning abilities of the students in the mathematics class. Generally, the learning culture of the government school was found flexible regarding the regularities, activities, and assessment system in the government school. The mathematics teacher Mr. Bhim Sir was aligned with the facts and said, '*there is no reward and punishment system in school……. grading system in school, mathematics is considered as a difficult subject*'. Due to the no punishment system in schools, students were demotivated towards learning mathematics, and due to the misunderstanding of the grading system, students believed that no one would fail in the exam. So students were not engaged.

On the other hand, it was found that the classrooms of secondary-level mathematics were multicultural and multilingual in terms of religion and learners' abilities (Panthi&Belbase, 2017). The fact indicates that there was some deficiency in fulfilling the need of all learners, which caused less interest in mathematics learning. Furthermore, the finding regarding the cultural context of the multilingual and multicultural context was aligned with the finding of Giri (2021), in which he states that it becomes much challenging to handle such classroom by single lingual teachers. Multicultural and multilingual classes might be difficult to deal with a teacher from a single culture. So, the multicultural environment of the classroom had caused the disengaged learning of the learners.

Pedagogy of Mathematics Teachers

It was found that the pedagogy of teachers plays a vital role in students learning. Most teachers were using the traditional teacher-centered pedagogy in secondary mathematics classes in Nepal, and most students were not satisfied with the pedagogy of mathematics teachers for transmitting content knowledge to the students' minds. Here I tried to explain the perspectives of students and teachers in brief regarding the pedagogy of mathematics teachers in their classrooms. I took the in-depth interview with six students and tried to explore their perceptions, and experiences regarding the pedagogy of mathematics teachers.

Students' Perspectives

During the in-depth interview with the student-participants, I asked them, *'how do your mathematics teachers generally teach mathematics?'* Most of the student-

participants replied and agreed on the fact that generally, mathematics teachers were using traditional ways of teaching mathematics. One student Mrs. NS said,

> *'when our mathematics teacher inters in the classroom then he starts writing in white board ……when writing together with the teacher we cannot understand the mathematics in class and our mind diverted outwards the class. There was no use of poem, song, story in mathematics which diverts our mind from mathematics to the other activities.*

In the above statements of the participants, it shows that the monotonous ways of teaching mathematics cause dissatisfaction among students in mathematics learning. In the same question,Mr. Dipak said, *generally, the teacher uses monotonous way in teaching mathematics in which he writes in board and we copy in the notebook from the board*. The same fact is supported by another student Mrs. SS. She said, *'our mathematics teachers start with writing formula on board, ask for memorizing them, solve text book problems and allows students for practice the similar questions*.

She indicated the memorization of mathematical facts without understanding any facts in monotonous ways of learning. This fact is also supported by the other student-participants Mr. Akendra. He said, *'we cannot understand the ways of teaching so we become weak in mathematics which is one of the causes of disengagement in learning'* (8th June 2022). He indicated that the ways of teaching should be understandable for all students through which students can understand mathematical as well as other concepts in the classroom. It means that from the perspectives of the students, most teachers were using traditional ways of teaching mathematics.

Teachers' Perspectives of Pedagogy

After taking the views of students-participants, now I describe the perspectives of teachers regarding the pedagogy of mathematics. From participant-teachers and my experience as a mathematics teacher, I observed that teachers were still practicing traditional teacher-centered pedagogy in mathematics teaching. Most mathematics teachers were using traditional pedagogy for various reasons. During the collection of field data, I interviewed two mathematics teachers to collect their views regarding the pedagogy of teachers in secondary-level mathematics. Both the mathematics teachers of a reputed secondary school, Mr. Damber Sir and Mr. Bhim Sir accepted the fact of using traditional pedagogy for teaching mathematics. They said, ' *generally we are*

using the chalk-and-talk method for teaching mathematics. Furthermore, Mr. Bhim Sir added, *'I start with the introduction of content, and formula then starts solving the mathematical textbook problem in whiteboard'*. This indicates that most of the teachers were using the teacher-centered traditional method.

In a probing question, I asked why most teachers were using traditional pedagogy in teaching mathematics even if they know about student-centered pedagogy. The teacher Mr. Bhim Sir said, *'among many reasons, thelaziness of mathematics teachers is one main cause. On the other hand, the teacher has to complete a huge syllabus in a short time. So teachers are not using instructional materials in the classroom'.* These facts collected from the teacher indicated that due to the various challenges, most teachers were using traditional teacher-centered pedagogy in their classrooms. Likewise, the finance teacher Mr. Bal Bdr. Sir also supported the fact of monotonous teacher-centered pedagogy by saying, *'I don't know about mathematics subject but in other social subjects, I found that most teachers are using the oral method in their classes. They describe subject contents loudly in class without caring about students whether they are listening or not'*. This fact agrees with the fact that most teachers still use monotonous descriptive teacher-centered pedagogy without using instructional materials.

Furthermore, my finding about the pedagogy of mathematics teacher is aligned with finding of Pant (2016). He argued that in the context of the government school of Nepal, teachers' pedagogy for mathematics teaching-learning focuses on memorizing of certain mathematical facts, postulates, formulae, theorems, and algorithms for solving certain textbook mathematical problems (Pant, 2016). This fact is also the witness of the scenarios ina mathematics classroom in which most teachers' were practicing the traditional teacher-centered pedagogy. It could be one of the causes of disengagement of learners. Likewise, I found that my finding regarding the teachers' pedagogy agrees the finding of Pant (2017) concerning how mathematics teachers are using traditional ways of teaching mathematics. He argued that most teachers wished to be smart, and tricky. For this they focused decontextualized textbook problems.

The above facts were a witness for teachers generally using traditional pedagogy in teaching secondary mathematics. Before the study, most of teachers had no constructivist environment and social interaction in the classroom. After finding the ways of teaching mathematics, I tried to collect views regarding the effect of

traditional pedagogy on students' engagement in learning mathematics. During the in-depth interview with studentparticipants, most participants expressed the fact that most of the students did not like mathematics atthe secondary level. Among the various reasons, teachers' pedagogy was one of the factors.

Students' Activities in Classroom

In this context, the students' activities in the classroom indicated all the activities conducted by students inside the classroom before DST. In this theme, I observed the learning activities of students in mathematics classes through observation, interaction in the classroom, and other activities of students which were not related to the learning activities. From the data analysis process, I found two major subthemes; namely, learning activities, and interactions of students with peers and teachers with other activities before the DST. The scenario enabled me to compare the engagement of students before and after the DST in the study.

Learning Activities

It was found from the data analysis before the DST that most students were inactive in learning activities in the classroom. During the data collection with a grade ten student-participant Mrs. Nabina, I asked the question-*how you learned mathematics in the classroom?*She said, *'mostly, I learn mathematics from mathematics teachers, and I practice mathematics when I get free time in class but most of the students are not practicing mathematics'* (26 May 2022). It indicated that students learned mathematics from the teacher and with a lot of practice in the classroom. Those students who liked to practice mathematics in the classroom would learn mathematics on their own.

Likewise, most so-called weak students in mathematics would not enjoy mathematics teaching-learning activities. They would feel overloaded in practicing and learning mathematics. One of the student-participants Mr. Dipak said, '*most of the students do not like to participate in learning activities, and there is no active participation'* (10, June 2022). This indicates that most of the students in mathematics classes were inactive and not interested to participate and practice mathematics.

But most students would not practice the problems of mathematics. They would not ask any questions to other so they were becoming weaker in mathematics. Every mathematics teachers were interested to teach mathematics in pin drop silence in their classroom. No one was allowed to speak when the teacher taught. Here, I put

a small event regarding the classroom environment regardingand expectations of the mathematics teachers.

It was the day of 14 January 2022. It was tiffin time in the school. Most of the teachers were in the canteen for their regular tea. The rest of the teachers were sitting in the staffroom. I was sitting in a chair inside the staffroom. There were some teacher-staffs in the staff room talking informally about the classroom, and school environment. They were sharing their experience of teaching. One of the teachers said, ' *Sir, how can we control students in our classroom? Some students disturb the whole class during teaching'.*

'Same problem is here, said another Nepali teacher. At the same time,another teacher Mr. Palli Sir said, *'students are being more undisciplined nowadays. We have to control them. Otherwise, they will disturb the whole school environment*.

*How can we control them?*asked another teacher. After listening to the situation in the class, the mathematics teacher Mr. Dipak said, ' *to control the class I want to share some tips'*. He started to share his ideas-

'Initially, I ask formulas to those students who cannot memorize. I threaten them by saying that, I want a pin drop silence during the classes. Generally, I control my classes by saying that if anyone speaks during the class then he/she should solve the mathematics problem on the board. After this, the whole class becomes silent because they don't know how to solve mathematical problems.

Other teachers were enjoying listening to the ideas to control the class. *'This is a good idea and I am also using the same technique in my class too'*, said another mathematics teacher Mr. Bhim Sir. I found that all the other teachers were also supporting those ideas by saying that it was a good idea to control the class. I was listening to their interaction, thinking about finalizing my research topic, and trying to find an actual scenario of the classroom.

From the above discussion, it was clear that most teachers need pin drop silence during their classes. They did not like any disturbance in their classroom. It means that they did not allow any kind of interaction, and discussion among the group of students in the classroom. Most of the teachers were not aware of the importance of classroom discussion, and they assumed that silent classes were good classes. They were aligned on the statement that silent classes provide a good environment for transmitting mathematical concepts or knowledge from the teachers' minds to the

students' minds. Such types of classroom environments might become monotonous environments which might be one of the causes of disengaged learners.

Interaction in Classroom

Interaction in the classroom is essential for better learning, but from the data analysis of the data collected it was not satisfactory in mathematics class of government school. It was found that there was less amount of interaction between students and teachers during the mathematics class before the DST. The sub-theme indicated the landscape of the classroom regarding the interaction in the mathematics classroom in which there was minimum interaction for learning before the use of digital stories in mathematics.

During the data collection process, I asked questions regarding the ways of interaction between students and students, students and teachers, and interaction/discussion with others during mathematics class to the students-participants. Most of the students agreed,*'there is no interaction during mathematics class*'. During the interview with the student-participant in school, I discussed the nature of the mathematics teacher and whether he/she allowed interaction in the classroom or not. I asked, was there classroom interaction in the mathematics classroom?

One of the participants, Mrs. Nabina said, *'No sir! if we start a discussion in the classroom then it becomes noise in the classroom. No noise is allowed in our classroom, especially in the mathematics classroom*' (26 May 2022). Furthermore, she added,*'our mathematics teacher needsa quite silent classroom. He says, keep quite here, if you want to talk then go outside the classroom*'. This is also evidence that the mathematics teachers wouldn’t allow any interaction during the mathematics teaching-learning activities.

Picture 4.2: Grade ten students in mathematics classes before DST

Likewise,another student-participant Miss.Sarika indicated disengaging behavior of poor performer students. Poor performers students in the classroom did not interested in learning mathematics. The student-participant Miss.Sarikasaid that *'they disturbed other students during teaching-learning activities, they participates in non-learning activities such as bullying or threatening behavior, and they did not practice mathematics. So they were being weak in mathematics'* (14 June 2022). The statement shows that most so-called weak students have distracted minds and they tried to disturb others during mathematics learning. Some of the students only actively participate in teaching-learning activities, and they participate in discussions with other students to get mathematical concepts.

Likewise, all critical friends argued that "*our classroom environment and our pedagogies are also promoting disengagement of learners.*" If there is no place for students' activities in our classroom then how students can be active in the classroom? So, there was a need to transform the classroom environment, and pedagogy of teachers for better learning in which students can interact and collaborate with other students in the classroom.

The situation found in the study before using DST in mathematics classrooms was aligned with the finding of Panthi and Belbase (2017). They found that most school has cultural issues which are related to the diversity of language and ethnicity, equality and access, economic status, gender issues, pedagogical choice, and professional organization. I found that there was unequal participation in learning activities due to various reasons such as the infrastructure of the classroom, the

pedagogical aspect of teachers, and students learning activities in the classroom. Furthermore, the constitution of Nepal (2015) tried to incorporate a right to education in their mother tong at the secondary level for all Nepali people but there isaproblem with implementation atthe secondary level.

In summary, before using DSTs in mathematics classes there were no interactions in the classroom. Students were assumed as passive receivers of content knowledge in which teaching as a process of copying knowledge from teachers' heads to students' heads. There was no environment for social interaction and collaboration among learners that had been creating a disengaging environment for learners.

Chapter Summary

In this chapter, I presented the field findings collected during different phases of the study. I visualize the classroom landscape of the mathematics classes which would influence learning before DST. It was found that classroom environments before DST were divided into three categories namely physical infrastructure, sitting arrangement, and culturally diverse classrooms. Likewise, the pedagogy of mathematics teachers was traditional, and teacher-centered which would promote rote memorization rather than understanding the mathematical concepts. These all aspects of teaching and learning in the mathematics classroom were creating disengaging rather than engaging environments for the learners.

CHAPTER V
THE LANDSCAPE OF CLASSROOM DURING DIGITAL STORYTELLING

In this section, I have presented the detailed landscape of the classroom environment during the implementation of digital storytelling (DST) in the mathematics class of the secondary-level school. I have explained the influence of the DST with the help of field data collected before, during, and after the implementation of the DST. My major finding and discussion of the study are based on the data collected through classroom observation, interviews with students and teachers, and reflective notes collected during the DST classes. This section has provided the landscape of the classroom activities after the DST in the mathematics classroom. Here follows the themes that emerged during the analysis of the field text data.

Learners' engagement through DST

My purpose of the study is to use digital storytelling in mathematics teaching as STEAM pedagogy to enhance students' engagement through collaborative action research in the government school of Nepal. The main focus of the use of DST in mathematics classes was to observe and analysis the various engagements of the learners. As I already mentioned in chapter two, engagement is a multilayered entity that comprise the emotional, behavioral, and cognitive engagement of the learners (Fredricks et al., 2004). Before the implementation of the plan, there was less amount of engagement in mathematics but after the use of the DST in mathematics, I found a significant difference in all three types of engagement of learners.

Emotional engagement through DST

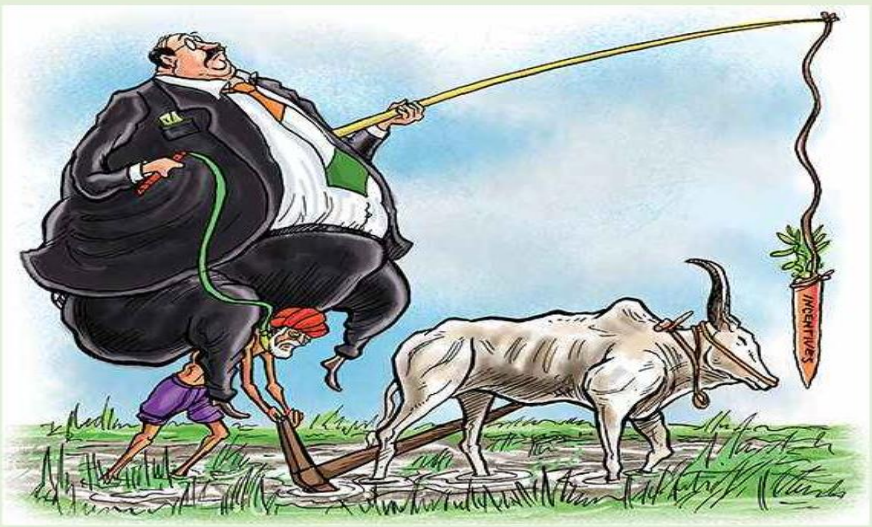
Emotional engagement is the emotion expressed by students during the teaching-learning activities in the classroom, and outside the classroom. During the DST, I always started digital stories (See sample of DS in appendix-9) with some pictures along with brainstorming questions, some guessing questions, and some questions based on the prior understanding of the students.At that time, it was found that most of the students were emotionally attached to the story, and tried to answer the questions accordingly.

It was the day of 22 May 2022, the first day of DST in the classroom. I started some discussion regarding my study in the class ten section B of my classes. There were 52 students present in the class. I divided them into six groups simply which were near to each other, and made a rule to discuss within the group. They agreed on the rule, and then I started the discussion by saying, *'here, I am going to present a story which help you to understand some mathematical concepts and context'*. Then most of the students were were sucked, and they were saying, '*story sir?' Yes!* I said, and they laughed, '*Hahhahaa… Really sir?'*

Then after that event, I convinced them and started DS by showing a picture on the smart board. '*Look at the picture'*, I said. They looked at a picture and again began to laugh. Again, I asked them, '*what is a picture about? What does the picture want to show? , What is the situation?...'*

Some students tried to answer without thinking, some discussed within the group, and some students listened to others' answers.

The first story was about the condition of the poor farmer and how he got rid of the situation



Picture 5.1: Context in DST for discussion in the mathematics classroom

As I mentioned in chapter III, every story started with such types of pictures followed by some context, and then discussion questions. In each section of the DS, students were enjoying and felt happy participatingin the discussion and answering the question during each section of the stories. From my observation and my

reflection, all students were found to enjoy, and feel happy during the DST. Such conditions of the classroom indicated that DST provided and was able to create an emotionally attached surrounding insidethe classroom which is part of the emotional learners' engagementin the mathematics classroom through DST.

On the other hand, during the in-depth interview with student-participants, I interviewed the six student-participants. Almost all participants focused on the emotional engagement of the classroom through the use of DS in mathematics classes. During the in-depth interview with one of the participants Miss.Nabina, I asked her a question regarding the classroom situation during the DST. She said that *'in the story, there are various events, use of the smart board, sound in the story, and discussion on group makes class interesting, joyful, and grab the attention of the students'* (26 May 2022). Likewise, the other student-participant Mr. Akendra added the same facts about joyful and interesting classes through the DST. He said,*'all students in the class were listening and looking at events of stories by making more interest on the stories…..they were feeling happier on answering between the stories*' (8th June 2022). In digital stories, students not only listen to the story but also observed the situation of the society by which students can learn not only the content of mathematics but also their context in a joyful environment. Most of the students were discussing in their group to find new answersto the contextual problems. During the DST, I observed that the discussion in the group and sharing of their ideas in the classroom helped them to construct their knowledge and created an environment to support each other in the mathematics classroom.

Picture 5.2:Context in DST for discussion in the mathematics classroom

Similar views were found from another student-participant Miss. Sarika during the interview regarding the classroom environment during and after the use of DST. She said,

> *'I never enjoyed mathematics class before, I feel joyful the first time when I got the opportunity of putting feelings, emotions, and views in the classroom. Likewise, we got many ideas and questions in interesting ways through the different situations of human lives……., I learned mathematics and other behavioral skills through such types of stories. So it made me happy, joyful and surprised even in certain conditions. I feel very happy knowing that it is a new method of learning mathematics and other disciplines'*(14 June 2022).

In general, there was no provision for use of arts such as poems, songs, and stories in mathematics teaching before the DST. Before the DST, students were bounded by the boundary line of right and wrong, fear of teachers, and rote memorization of facts in the mathematics classroom. But after the use of DST in the mathematics classroom, they feel free to discuss within the classroom, there was no fear of the wrong answer, feel sharing culture in the mathematics classroom, and they got support from their friends and teachers. They feel the storytelling was new and joyful pedagogy for mathematics teaching.

Similarly, another student-participants Miss. Juna express feelings regarding the various context, and content in the DS and had various emotions such as happiness, sadness, and others according to the situation of the story. She expresses her feeling regarding the DST as,

> *'The mood of the students was found depending upon the situation of the stories. For example, if the story was in a happy, and funny situation then students became happy where as if the story was in a sad situation then students became emotionally sad. ……when a happy situation came into the story then students were using happy and funny words such as wow, great, good, etc. whereas when a sad situation came into the story then students were using sad words such as oh god, so sad, it's not good, and so on'* (13th July 2022).

From the above argument of the student-participants from Miss. Juna, and other participants, DST was not only creating a joyful, happy, and interesting learning

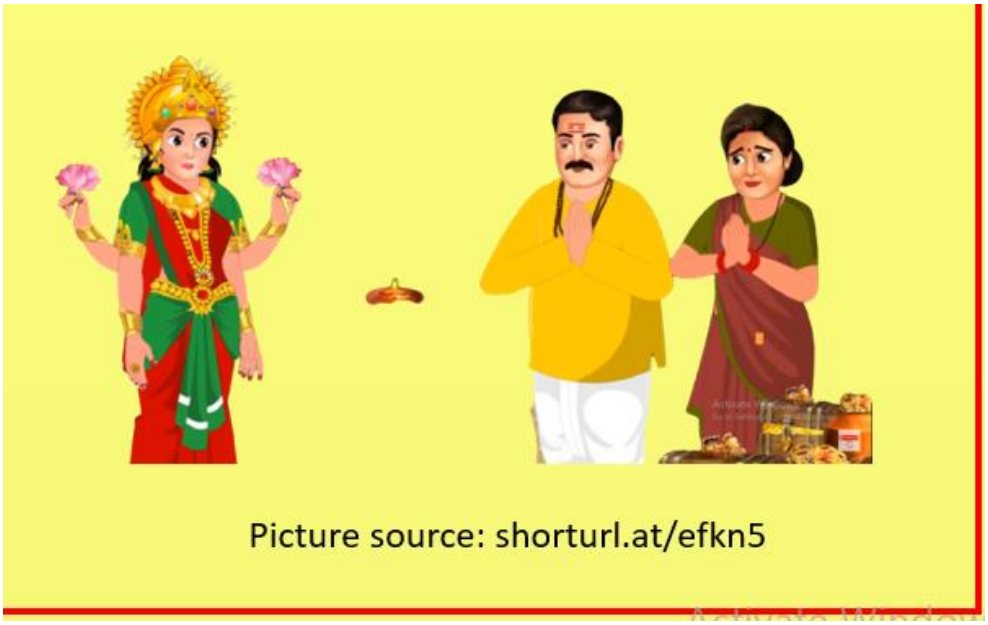
environment in the mathematics classroom but also was helpful to create an emotionally attached classroom.

Furthermore, during the interaction after the DST, the critical friend Mr. Palli sir said, "most *students were enjoying the story in the classroom, they were showing their emotions such as happiness, and sadness during classes*". Likewise, another critical friend Mr. Bhim sir added, "*most students were relating the context of the story with their context, so they were more emotional in the mathematics classes.*"

This phenomenon is supported by Lassance, et al.(2022) by saying that the appropriate activities according to the video are engagement in the video and more chances of content learning. Furthermore, the finding of emotional development through DST is aligned with the finding of Ahmad (2020), who focused on the practice of DST asa tool to develop emotional sentiment in learners. It is clear that from DST, students were emotionally attached to their content and context.

Behavioral Engagement through DST

In the classroom context during DST, I observed behavioral engagement as the change in behavior of the students during and outside the classroom activities. Based on class observation, interviews with participants, and my reflection it is found that most of the students were able to change their behavior from the use of DST. As I described in chapter IV of the study, before the use of DST it was observed that most of the students were not actively engaged in participation in learning activities, they did not take part in answering and questioning, and they did not show interest in learning mathematics but after the use of the DST in the mathematics classroom, it was found that such types of behaviors of students were found changed. From the class observation during the DST, and my reflection after using DST, it can be assumed that most of the students actively participated in learning activities, and the answer-questioning process and they put their views in various contexts.



Picture 5.3: Cultural aspects through DST in the mathematics classroom

On the other hand, students claim that they learned much behavior from the use of DST in the mathematics classroom. When I present a scene or picture of the story then they were observed monotonously until the break of the story. During the data text collection from the interview with studentparticipants, I asked what the behavior of the students was during DST. The participant Mr. Dipak said that *'when a new event came then we observed seriously, and tried to understand the context of the story so that we internalized the situation*' (20 June 2022). Most of the participants explain the same ways of observation and listening to the story on the smart board. The fact showed that the DS was able to concentrate the mind of learners, they have changed the ways of observation of the events in the class. It showed that students were motivated intrinsically through the context of the stories. Likewise, another participant Miss. Juna said that *'by observing the events we feel easy to answer the questions during the story… it was easy to remember the events on the story. So there was no need for rote memorization of the facts, formula, and steps of the calculation'* (13 July 2022). These facts from the studentparticipants showed the way by which students' behavior changed from rote memorization to recalling the events, understanding them, and internalizing them for better learning of the context.

Likewise, I observed that those students who were silent, and passive during the mathematics classes before the use of DST in the classroom were found active in discussion, sharing ideas, and answering questions during the DST. I found in most of the observation sheets that, most of the students were engaged in the group discussion

during the discussion time, and they tried to constructthe best answers to the issues during the DST in their group. Throughout the interview with the student-participants, I asked the question, how did you engage in discussion during the DST? What behavior did you observe in the other students? What was the difference between the usual and DST classroom? Most of the participants replied that *'when one part of the story finished then discussion questions were started……., At that time teacher allowed us for discussion, and then we engaged in the discussion to find a new, and better solution within the group'*(class interaction on -14 July 2022). During the presentation of the DS in mathematics classes, there were always discussion questions in between the section of the stories. During the discussion with the student-participant, I asked the question, how can you learn from the discussion in the group?One of the participants Mr. Dipak added on it as *there were more opportunities to learn from others in the group because some students were more talented in the group'* (20 June 2022). It indicated that there were various types of students in every group, some of them were more knowledgeable in mathematics and some of them were more knowledgeable in other disciplines. All students were getting help from others in the group and they were generating new knowledge from social interaction. In the group, there wasan environment of scaffolding within the group.So, from the discussion, we can say that students can construct their knowledge from social interaction. Furthermore, students can get scaffolding from the students who were more knowledgeable in the group.

Picture 5.4: Group discussion in a classroom during DST

It was found that most of the students in mathematics classes engaged themselves in finding the subjective solution to the contextual problems. On the question, what types of answers were students find from the discussion? One of the student-participants Mr. Dipak said that' *in mathematical questions, we found a single answer but in the case of other questions related to society there were many answers from many students*' (10 June 2022). Similarly, other participants,Miss. Juna added that *'we can find more answers from the discussion, many students had many answers. So there were chances of many and new answers during the discussion'* (15 July 2022). From the above argumentation, it is clear that students got various answers from the interaction or discussion of subjective context. But in the case of mathematical content, there wasan objective answer because we are taking mathematics to a pure and objective nature. On the other hand, in the social problem,there might be various solutions in various contexts. So, from the discussion in the group students were able to construct and create subjective solutions to social problems. From the various stories, students were learning various aspects of society, and hence they were able to find new and subjective answers to social problems.

On the other hand, I observed during the DST that moststudents were keenly engaged in answering the question, and discussion in their groups. I observed that there was less number of students who were engaged in the process of note-taking during the DST. After observing the activities of the students for regular three days, I felt that there might be less time for note-taking during the DST. I interacted with students on the day 27th of May 2022 and observed some notebooks of the students in their classroom. I found that less number of students took notes during the DST due to the more engagement in discussion and looking on DST. After the interaction with the students in classes, they said that there was not sufficient time for note-taking during storytelling, they were busy withthe discussion, answering, and enjoying. At the end of the interaction classes, I realized that there was less amount of time between each section of the stories. From the next day, I planned to provide enough time for discussion, presentation, and note-taking in DST. After that, I found that most of the students were also engaged in note-taking too.

From the above discussion, it was found that students were engaged in listening, observation of the events, note-taking, asking questions during class, and paying attention in class during the DST.

My finding of the study is also aligned with the finding of Tabiin (2019) in which the author argued that doing some activities such as encouraging students to pay attention, describing things that students see, and do, asking the questions what rather than why, and giving opportunities to answer helps to change their behavior. In DST, I tried to give opportunities to participate in students-centered activities during the classes by which I found the behavior of students were changing in the classroom from silent listener to active learners.

During the DST in the mathematics class, it was found that DSs are adding value to the individuals' experience by opening new opportunities for collaboration, support,and interaction in the group of students (Ahmed, 2020). This indicates that the use of DST as a pedagogical tool tried to change the behavior of students for scaffolding in the group and social interaction for knowledge construction (Vygotsky, 1978). It is the symptoms of students actively contributingto learning activities and showing various behavior during DST that refersto the enhancement of the behavioral students' engagement (Fredricks, et. al, 2004).

Furthermore, it is observed that the effort, persistence, curiosity, attention, asking questions, and contribution of the students during the DST (Reeve, & Tseng, 2011). From these facts, we can say that DST can enhance students' behavioral engagement by engaging students in various group activities in mathematics classes.

Cognitive Engagement through DST

In this study, we observed the students' engagement in learning and using mathematical conceptsin their context for the aspect of cognitive engagement through the DST. In this study, I observed only the basic concepts of simple and compound interest, the pros and cons of the interest system, and the necessity of the interest system along with their calculation as a cognitive aspect in the mathematics classroom by using DST. It was observed that basic concepts of simple and compound interest could be developed easily by using DST in a joyful classroom environment along with the active participation of students in discussion. Here, I am going to elaborate on some events where I found cognitive development during DST in the mathematics classroom.

It was the 30th of May 2022, the fourth day of the DST in class ten. There was a leisure period for grade ten students, and we plan to conduct the DST classes in grade ten. I requested the critical friend DT for class observation, and he agreed to

observation. Then we entered the class of grade ten, students greeted us *'Good morning, sir*.

We replied *'good morning, and sit down please'*. All students were sited in their sit along with smiling.They were feeling happy after observing two teachers in the classroom at a time. They already guessed that it might be of storytelling class, one student asked '*sir, is today also a story class*?'

I said, '*yes*'. They smiled with curiosity. The critical friend DT sited with students and started to observe the classes. I prepared a laptop and smart board ready for DST in the class. As the day before, I divided the whole class into six groups by combining two benches. I started the classes by welcoming them and allowing them to observe the classroom scenario in the first picture. They compare and contrast the classroom in the picture and the real class. They found that the smart board, white board, laptop, projector, and book corners were in both classes. They also pointed out that, there was a lack of watch in their classroom. I started the remaining story in the class along with interaction with students.

The story was about the teaching style of Ramlal sir, who was a mathematics teacher and tried to explore new pedagogy for teaching mathematics in his school. In the story, Ramlal sir brings his students toa bank to interact with the manager. The manager informed and interacted with students about simple and compound interests.

The manager started a discussion with students by introducing the concept of interest as,

> '*The interest is the extra amount of money from borrowing money from someone. In simple interest, interest is simply calculated for any time, but in a compound, interest borrowers have to pay interest on interest after a certain time. It means simple interest is calculated based onthe principal/amount of the loan whereas compound interest is calculated on the principal quantity and accrued interest of the previous duration. So, compound interest is called interest on interest'*.

After the end of the section of the story, I beguine with some discussion questions in the classroom. I asked, *'what might bethe differencesbetween simple, and compound interest?'* One student of one group replied that *'simple interest counts only based onthe principal for the whole time but compound interest is interest on interest'.* After some time another student fromanother group adds on that,*' simple interest will be less whereas compound interest will be more'.* Likewise, another

student added that*' interest might be accumulated in principal in certain time'.* Similarly, other students added a similar aspect along with an example in their context of the classes.

During the class discussion, I took answers and views randomly from the group of students. I found that most students were able to respondto the question regarding the basic concepts of the interest system. After that, we concluded the concepts of simpleinterest (SI) and compound interest (CI) in the classes through more discussion.In the second part of the story, there wasa discussion regarding the benefits of compound interest. After pausing the story, I allowed the students to find the pros and cons of the CI through the group discussion. One of the students said that ' *CI can help investors rapidly grow their money*'. Other students from other groups added that 'CI *can be beneficial for the long-term investor '*. Likewise, the other group added that *'CI can increase size and mass of investment, but it might be harmful tothose people who receive loans and cannot pay in a short period, so it is beneficial for investor only'*. Similarly, another group added, *'CI can help the business by providing the importance of wealth and ways of creating wealth from investing in various organizations*.'

From these statements from the students in class during DST, we can say that students understood simple, and compound interests in their way. They were able to explain these mathematical concepts in their context.

The other day, there wasa discussion on the interest rate in DST. The story was about the agreement on setting a 10 % interest rate for one farmer in the village. They (villagers) agreed to set a 10% interest rate. One of the teachers in the story described that *'if someone pays 10 rupees as an interest of 100 rupees per year then it is called 10% interest rate'*. The teacher describes the way of calculating a simple interest of 50,000 as follows,

Rs. 100 has one-year interest rs.10

Rs. 1000 has one-year interest rs. 100

Similarly, rs.50,000 has one-year interest rs. 100*50= 5000.

After the event in the story, I asked a similar question for the calculation of interest by the same method. I asked them to solve interest of 20000 for one year at the rate of 12% per year.It turned into observed that maximum of the students had been capable to solve their issues by discussing them in their group. Similarly, they calculated by using a formula for simple interest as

I =.

$$= \frac{20000x1x12}{100}$$

$$= 2400$$

From the calculation of the students in their group, I concluded that they understand mathematical concepts in multiple ways, and they were able to make meaning and were able to construct mathematical knowledge through discussion with in their group. They were participating actively in their group in a calculation, sharing ideas, and supporting others. I found that there was a culture of sharing ideas, supporting others, and constructing new knowledge from social interaction.

On the other two days (9th June, and 13th June 2022) were stories about the calculation of CI without using a formula (using the concepts of SI) for two and three years respectively. On the 9th of June of 2022, the stories comprised the calculation process of CI by using the SI concepts which follows the following algorithmic table by taking P= 50000, R= 10%, and T= 2 years.

At simple interest	At compound interest
For 1st year, P=50000 I $= \frac{50000x1x10}{100}$ = 5000 SI= 50000+5000 =55000	At the end of 1st year, $I = \frac{PxTxR}{100}$ $= \frac{50000x1x10}{100}$ = 5000 CA= 50000+5000 = 55000 Which is P for the second year
For 2nd year, P= 50000 $I = \frac{PxTxR}{100}$ $= \frac{50000x1x10}{100}$	At the end of 2nd year, $I = \frac{PxTxR}{100}$ $= \frac{55000x1x10}{100}$ = 5500

= 5000 SA = 55000+5000 =60000 ∴ SI for two year= SA-P = 60000-50000 = 10000	CA= 55000+5500 = 60500 ∴ CI for two year= CA-P = 60500-50000 = 10500
∴ CI > SI, for the same time	

Table: Calculation of CI by using SI concepts

Similarly, stories were presented to calculate CI for three using the concepts of SIon 13th June 2022. But it was seen that most of the students were not clear through DST in the calculation part. After that there raised a question on our tool; are DSTs not suitable for cognitive engagement? Is there any need for modification in classroom activities? I discussed this with critical friends. They recommended using DSTs along with other practice work in the group. From the classes and discussions with critical friends, I realized that there was a need for some more practice in the calculation part.

In next day, I conducted the practice class for the calculation of CI by using SI concepts. Students work in similar ways as before but there was enough time for interaction within the group, and practice. I was facilitating in calculation part in some groups. Then after, I found that most of the students were able to calculate CI. From the fact, we can say that students can construct their knowledge through social interaction, and scaffolding (Vygotsky, 1978). For better learning, along with the DST, practice is also essential for the cognitive development of the students. The interaction by using the audio-visual modality in the group of students, and practice lead to better learning surroundingthat encourage students to engage with learning from various perspectives (Ahmed, 2020).

In addition, during the use of DST in the schoolroom, most students were trying to find the meaning of CI and SI along with the calculation strategy of problem-solving which indicate the engaged learning of the learners (Barkley, 2010). Likewise, DST can engage and encourage students to learn difficult subject matters in easier ways (Tajeri, 2017). This indicates that the engagement of the learners can be enhanced through DST. Likewise, the combination of story and digital technology can deliver composite concepts in simple and easier ways that might be muchmore

effective in teaching-learning (Dupain & Maguire, 2005 as cited in Tajeri, 2017). This fact indicates that the mathematical concepts can easily be delivered through DST which enhances the cognitive engagement of the learners.

Furthermore, it is supported by Tajeri (2017) by saying that the use of DS in the educational sector becomes a powerful tool to engage both teachers and school students in teaching-mastering activities in the study room. Likewise,the effectiveness of DST and technology depend upon the techniques used to present the DS to make a better classroom environment (Robin, 2008). Furthermore, Ahmed (2020) added that the use of DSs as pedagogical tools not only enhancesthe cognitive development of learners but also provided the cognitive-cultural participation of learners.

In addition to this, Smeda et al., (2014) already stated that DST is an innovative as well as progressive method to engage students in constructing knowledge. During the study, I found that using DSTs might not be enough for cognitive engagement, and better learning of learners but also there was a need for scaffolding, collaboration, practice, and interaction. This also indicates that a better classroom environment can create by using DST which might enhance the engagement of the learners.

Integration of Disciplines through DST

In this study, here I observed only the integration of other disciplines in STEAM pedagogy. During the field work and analysis of the field text data, it was observed that there wasan integration of the other STEAM disciplines in the DST. There are many ways of integration of disciplinary content such as multidisciplinary, interdisciplinary, and transdisciplinary integration. Here we observed that there wasa transdisciplinary disciplinary approach tothe integration of disciplinary content in DST. In this study, DST played a vital role to integrate much disciplinary content by crossing the boundary of discipline in which it tried to explore contents from several disciplines. In the DST, digital stories comprised contextual contents of science, engineering, arts (liberal), technology, mathematics,and social and other ethical content which tried to enhance transdisciplinary skills in learners. During the DST in grade ten, I collected text-data from observation, FGD, and interviews with participants. Now, I am going to present some evidence for the integration of other disciplines in the DST.

Picture 5.5:Showing multiple disciplines in digital stories

I mentioned here a screen shot of the presentation in the DST in grade ten. We can observe that there are social norms and respect given to the monk by a couple of the farmers, along with environmental science content, mathematical content, and art component. This component indicated that there is an integration of the social subject along with social norms, along with the mediation. On the other side of the slide, we can observe the beautifully designed, neat, and clean environment of the garden. This indicated the integration of environmental science and engineering part in DST. Likewise, the story presentation with the help of technological tools such as laptops, computers, projectors, smart boards, and sound systems belongs to the integration of the technology in DST. From the above scene of the DS, we can observe social skills, the designing of the slides for presentation, environmental science, and the ethical, and technological aspects of the DST.

During the text data collection from an interview with student-participants, I asked about the contents of other disciplines in DST. All participants were informed that there wasthe inclusion of other disciplines in DST. When I was taking an interview with the grade ten students Miss.Nabina on the 23rd and 30th of May 2022 in the school library, she explain the contents included in the DST. During the interview with the participant Miss. Nabinasaid, *'in the story of a farmer, there were contents of mathematics, science, health education, sociology, and behavior'*. On probing questions she explain the contents of each discipline as, *' in the mathematics,*

there were concepts of simple interest (SI), and compound interest (CI), cleanness of environment, weather, their effects in health, a human lifestyle of rural people, and how they were helping each other, and ways to help marginalized people'.These facts indicated that there wasan integration of mathematics, science, health, and sociology in the DST.

Furthermore, I asked ifthere was any design or use of technology byMr. Dipak. He replied that *'yes sir! There wasagood design of the presentation, use of a projector, laptop, and smart board'*. This information indicates that there wasthe integration of engineering, and technologies in the DST. Her information indicated that there wasan integration of the contents from other disciplines besides mathematics.

On the day of 8th June 2022, I interviewed the studentparticipant Mr. Akendra and asked questions regarding the contents of other disciplines in the DST. He focused on the inclusion of other disciplines too. He said that '*there were contents of our health and ethical contents which indicated the better ways of living…… ways of living with harmony in society, how to give and take respectful support to others.*' On the probing question, can you specify any example of other content? He replied,

> *'Cleanness and maintaining hygiene was related to health, the well-managed garden was related to the science…..... activities of the people in society was related with the society, the ways of supporting each other, concepts and ways of calculation of SI and CI in mathematics……design of contents, garden, firm, and presentation of DST by using technology. So, I think there were many contents from other disciplines, and we got opportunities to learn many subjects from stories'*.

Above mentioned argument also indicates the integration of the contents from other disciplines along with STEAM disciplines. Furthermore, during the interview with another student-participant on 10th June 2022 Mr. Dipak, I asked about the other subject included in the DST. He replied that *'there was no single subject content but many in the stories such as social subject, cultural subject along with mathematics and science. ……there wasa solution of social problems and their solutions in stories, we can learn ethical contents from a social situation and can use those solutions in our life*'. The statement of Mr. Dipakis also aligned with the integration of the social, culture, and ethical contents through DST.

On the probing question, 'was there any other subject content in the stories? Can you remember'? Miss. Chetana replied *'yes sir! There were SI and CI of mathematics, Pollution and environmental facts of science, hygiene maintain of health subjects, and interesting facts from the social subject in the stories*'. Furthermore, on probing questionsshe added on the integration of designing of stories, and presentation of the stories by using ICT tools. She said that *'the design and ways of presentation through the smart board was excellent'*. This fact indicates the integration of engineering and technology in the DST. From the argument ofMiss. Chetana, wecan assume that there was the integration of other disciplines along with the STEAM disciplines in the DST.

Likewise, during the text data collection through the interview with the student-participant, another student Miss. Sarika said,

> *'Besides the mathematical content, I found that there was ethical content that touched my heart, contents of social norms which are essential for students, and much emotional content in stories that attracted our mind towards the contents which compelled us to think about the solution of the problem……..the ways of presentation of the stories through digital tools in the class was new for us which made the classroom activities more interesting, joyful, and attractive classroom'* (14th June 2022).

The facts presented by Miss. Sarika was also an indication of the other disciplines especially social and emotional content through the use of digital tools such as laptops, projectors, and the smart board makes DST more interesting.

Likewise, other studentsMiss. Juna also mentioned the same ideas of integration of mathematics, science, technology, and behavioral skills in the DST. During the in-depth interview. I asked about the content in the stories which comprise the other subjects. She said *'There were many contents of mathematics about concepts along with calculation of SI and CI about the course of class ten, many theories of science, social problems and their possible solutions, contents of science and technology,…… ways of supporting others in society,……. the new ways of storytelling through the use of technology was new and interesting'*(13 July 2022). The fact from Miss. Juna was also an indication of the integration of mathematics, social subject, science, and technology in the DST. The other student-participant Mr. Akendra also supports the same fact of integration of the STEAM and other disciplines in the DST.

On the other hand, stories are part of liberal art which was integrated with technology in DST. So, it is clear that there was the integration of STEAM disciplines in DST along with the integration of contextual problems. Furthermore, there were no disciplinary boundaries in the stories with clear connections among various disciplines.

This argument is supported by Ahmed (2020) by saying that DSs cannot be limited to the innovational pedagogical tools but it is providing the trans-disciplinary ground for pedagogical, and curriculum integration. The data collection in the study indicated that there was interconnection among various disciplines which focused on behavioral skills. So, it indicates the integration of disciplines. During the DST in the classroom, learners develop various self-orientation toward the disciplines and social skills through individual and group activities which indicates the transdisciplinary integration of disciplines (Broersma, 2014).

Likewise, most digital stories tried to provide a complete experience for students' emotional, behavioral, cognitive, and social as well as physical development (Amaliyah et al., 2007). This aspect in the DS indicates the integration of STEAM disciplines along with real-life skills. So. I think that the integration was interdisciplinary and transdisciplinary integration of STEAM, and other disciplines too.

My purpose and research question seeks the incorporation of DST in secondary mathematics to enhance the learners' engagementin the classroom. It was found that using social interaction in the classroom through the use of DST, reflection on action, and practice to improve knowledge was helpful to enhance the engagement of learners. Furthermore, in the context of Nepal, along with interaction with the help of DST in the mathematics classroom, there might be a need for reflection, and sufficient practice to enhance the emotional, behavioral, and cognitive engagement of the learners. Likewise, by the use of critical reflection on action, the teacher can improve or reform his/her pedagogical practice. I think this is the extension of Vygotsky's social constructivism in the context of Nepal.

Chapter Summary

In this chapter, I presented the field findings collected during different phases of the study which tried to visualize the classroom landscape of the mathematics classes, which could influence the learning during DST. It included how DST enhanced students' engagement in mathematics classroom, and how various

disciplines could be integrated in mathematics class through the use of DSTs. In the chapter, I tried to explain how teacher could enhance all three types of engagement namely- emotional, behavioral, and cognitive engagement enhanced by DST in secondary mathematics classroom.

CHAPTER VI
EMERGING UNDERSTANDING AND DISCUSSION

In this section, I have presented the emerging understanding of the use of DST in the secondary mathematics classroom of the government school of Nepal. I have made an understanding through the comparison of the scenarios inthe classroom before and after the implementation of digital storytelling (DST) in the mathematics class of the secondary level school. In this section, I have explained the overall understanding through the use of DST regarding the research questionof how to use DST to enhance engagement in the classroom. I have also discussed the challenges faced during the study.

Engaged Learning inDST Classroom

Before using DST, based on literature, interview with mathematics teachers, interaction with students, and my personal experience, it was found that in mathematics class there wasmonotonous, pin drop silence in the mathematics classroom during mathematics teaching-learning as described in chapter IV. Before DST, there wasa process of solving mathematical problems from the exercise of the textbook by a teacher. Students would be told to copy the solution from the whiteboard/blackboard to the notebook without discussing it with teachers and other students in the classroom. Everyone in the classroom had to maintain pin drop silence in the mathematics classroom. There would be the only sound of teachers describing the algorithmic process of solving mathematical problems. Such types of disciplinary values and mindsets of teachers were creating a narrow and disempowering environment in school education (Pant et al., 2020). To challenge such types of problems in education, teachers had to create multi-dimensional activities in the classroom.

During DST, the classroom environment changed in which students were allowed to participate in multiple activities in the classroom. Students were allowed to participate in thinking through brainstorming questions, and discussion/interaction in the classroom. They were allowed to put their views in the classroom, support each other, use alternative ways of solving problems, contextual problems, contents from various disciplines, and real-life skills. There was not the only environment for

mathematics learning but also it focusedonthe holistic development of the learners through the integration of various activities in the classroom.

Passive to Active Constructivist Classroom

Before the use of DST in the classroom, there were passive learners in mathematics they did not allow for discussion during the mathematics teaching-learning activities as discussed in chapter IV. Students had only one work to copy the solution to textbook problems from the board to their notebooks of the students without any discussion or interaction. After copying they were allowed to practice similar questions from the exercise in the textbook. Mathematics teachers are still singly teaching mathematicsand they are still presenting mathematics subject as a collection of facts, and formulas that should be memorized by students without understanding their concepts and without any questioning in the passive mode of classroom activities (Pant, 2017). There was the same condition inthe mathematics classroom before using DST. There wasa transmission of knowledge through the not-so-helpful pedagogy of the mathematics teacher (Luitel, 2009 as cited in Pant, 2017). This scenario was changed during the use of DST in the mathematics classroom.

During the study, it is found that there was an enhancement in collaboration, support, communication, and activeness of students, and built leadership among the group of students. From the text data discussed in chapter V, students have participated in various activities in groupwork, they discussed in a group, construct their knowledge by supporting eachother in a group, and they shared their views in the group and classroom. This indicates the constructivist classroom in which students tried to construct their knowledge through interaction (Vygotsky, 1978). In the study, DS were used as tools for interaction in the classroom by which teachers can find the ZPD of the learners, and support them individually or in a group for a better learning environment. Likewise, learning from group activities aligned with the fact that learning is a social phenomenon that takes place in social activities (Vygotsky, 1978). From the group discussion, there wasan environment of construction of knowledge through interaction in their group with scaffolding through the use of DST.

It is found that there was a change in students' activities in a classroom during the use of the DST. Likewise, DST provided the ground for interaction among the group of students. Students were sharing their ideas and asking questions to teachers and other students in the group. It was observed that most of the students were creating their knowledge through suitable questioning, interaction, and interpretation

of the contextual situation (Dahal et al., 2019). The same fasts were collected through the data collection process during the study. During the text data collection from the various means of data collection tools such as interviews, observation, reflection, and personal diary for the study, it was observed that most students actively participated in learning activities in the mathematics classroom through DST. Most of the students were transformed from passive listeners to active learners in the mathematics classroom through the DST. This fact was supported by Barkley (2010),who states that engaged learning is the transformation of students' activeness from passive recipients to active participation in learning activities. Active participation includesdiscussion, elaboration, sharing of ideas, questioning, communicating, and the problem-solving process by which learners try to find the meaning of what they learned (Barkley, 2010). This indicated that the transformation of activities from passive listening to active participation in learning activities is a form of engagement. As I already mentioned, in this study, DS was used as the tool to provide interaction and collaboration in the classroom among the students. Interaction and collaboration bring individuals together to resolve their problems, learn new mathematical concepts, communicate with eachother, produce creative ideas, and increase the effectiveness of learning in the classroom (Dahal et al., 2022). This indicates that the use of DST in the classroom enhanced the collaboration and interaction in the classroom among the students and teacher which leads to the learners' engagementin the classroom.

The finding of the study is supported by the finding of Smeda et al., (2014) by saying that DST is an innovative, and progressive pedagogical model which can engage students in deep learning. Likewise, Robin (2008) already stated that DST has powerful potential to engage students as well as teachers in learning activities. From the study, I found that students were engaged in various learning activities during DST which is aligned with Vygotsky's social constructivism theory. In our context, during the DST, students were allowed to engage in interaction and various activities by which they were constructing mathematical knowledge. In this study, engagement was enhanced through the application of the DST in the mathematics classroom.

Single Disciplinary Content to the Integration of Disciplines

Before DST, there was disciplinary content for discussion at a single time. Teachers usedto teach a single subject for one specified time in secondary school. There were assigned one subject teacher for each subject in secondary level school, and each teacher had to teach one subject only in one period. At the beginning of the

study, I interviewed teachers and students to know the classroom activities before DST. All teachers and students said that one teacher could teach a single subject only. Most teachers agreed with the fact that they did not know about other disciplinary content knowledge of other disciplines. So, the single and monotonous teaching-learning activities were changed into various disciplinary activities in the mathematics classroom.

On DST, every DS comprises contents of various disciplines with contextual knowledge. It was found that there was no fixed disciplinary content discussion in the classroom during the implementation of DST in grade ten. Every DS contained the contents of mathematics, science, design, liberal art in the form of a story, and inclusion of technology. This indicated the integration of STEAM disciplines in DST. Furthermore, there was a bluer boarder between various disciplines, focused on the contextual, real-life problems, and their solution through the DST. Such types of integration that focus on the real-life situation by blurring the boundaries of the disciplines indicate the interdisciplinary and transdisciplinary integration of the disciplines (Broersma, 2014). The integration aspects of the STEAM pedagogy were incorporated in the DST. From the fact mentioned above, we can consider that DST is a pedagogical tool for STEAM pedagogy.

Solution of Textbook Problems to the Contextual Issues

Before the study, mathematics teachers were using the traditional method of solving textbook problems through algorithmic ways. It allowed students to rote memorization of formulas and facts rather than developing concepts (Pant, 2017). Students were happy by getting answers to the textbook problems without a conceptual understanding of the mathematical concepts. A few so-called talented students could solve similar questions, copy them in the final exam, and get higher marks. This was the scenario of teaching-leaning mathematics in the classroom before the study.

During the use of DS in the mathematics classroom, it was found that the previous scenario of the classroom was changed. Every DS were started with various context, showed contextual problems, and led to the solution of the contextual problems. Students observed the various social contexts through videos of DSTs which provided opportunities for students to know, and understand the various social situations through social interaction.

I found that DST provides opportunities to understand, and relate mathematical problems with students' context. This finding is aligned with Wu and Chen (2020), and Castleden et al., (2013). They argued that DST provides opportunities for deeper understanding of context, culture, and content. Students from one context understand the other rural as well as urban contexts from the DST. So, from the use of DST in mathematics or other subject classrooms, the nature of solutions might be changed from solutions of textbook problems to solutions of real-life problems.

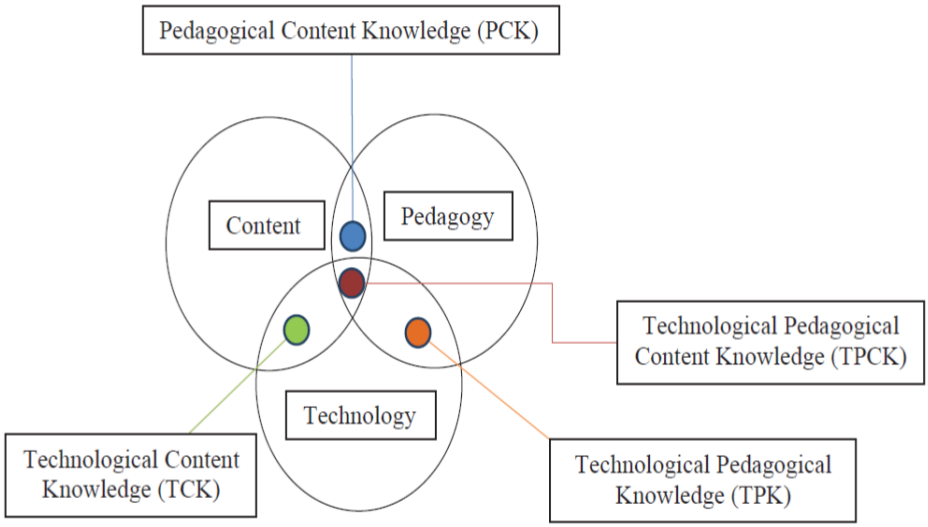
My Professional Development from Informing to Reforming Teacher

Before my educational journey from KU, my pedagogical practice was conventional in which I would focus on the absolutist views in teaching mathematics, and promoting rote learning in my mathematics classroom. I believed in disciplinary egocentrism (Connor et al, 2015 as cited in Pant et al., 2020). Also, I believed mathematics as a superior subject to other subjects in school-level education. My students were trying to rote memorizing the mathematical concepts without understanding and demonstrating basic skills in the mathematics classroom. With such knowledge and skills, students were not able to solve complex real-world problems. To contribute to such a problem, and to change my pedagogical practice, I chose DST in secondary mathematics for my MPhil research study.

From the study, I found that DST is not only a pedagogical tool to deliver a story but is a pedagogical technique to reform pedagogical activities in the classroom. Likewise, it is the reformation of the teaching-learning activities from teacher-centered pedagogy to the student-centered social interaction pedagogy for knowledge construction and developed art of presentation of content, context, and culture through the integration of technologies in teaching-learning activities.

The finding of the study was supported by Wu, and Chen (2020). They argued that the DS not only focuses on the classroom interaction and skills of the students but also helps teachers to create environment for collaboration with other, and improve professional skills.The study provided me an opportunity not only to reform classroom activities of students but also to develop pedagogical skills in which pedagogy and content integrate with technological tools. Indeed, I realized that there was not only pedagogical development in the process of DST, it also focused on the integration of technological tools in my teaching-learning activities. The study forced me to develop technological, pedagogical, and content knowledge through the use of

DST in the mathematics classroom, which is the TPACK model of instruction (Koehler & Mishra, 2006). The TPACK model is the improvement on the pedagogical content knowledge (PCK) by Shulman (1987), in which Koehler and Mishra (2006) add the third component of technology in the PCK model of instruction (Ahmed, 2020).



Picture 6.1: TPACK instructional model. (Koehler & Mishra, 2006)

Furthermore, in the study besides PCK, and TPCAK model of instruction, I used the advanced and innovative STEAM pedagogy in this study. It focused not only on single disciplines but also focused on the holistic development of the students through various teaching-learning activities, and integration of disciplines. Furthermore, in this study, I focused on what to teach, how to teach, why to teach, and what would be the outcome of teaching-learning activities, which challenged my conceptual understanding of teaching (Jamil et al., 2018). From such critical aspect, one can transform his/her pedagogical practice. From this critical perspective, I realized that it was the first step of pedagogical transformation that was possible through critical self-reflection (Grundy, 1987).This indicates one keystone for my professional development which might be the beginning of changing my pedagogy from transmission of knowledge to facilitation.

From the study and literature, I found that STEAM pedagogy can only provide an environment for the learners by which they can think more broadly and critically

about the complex problems of the real-world (Pant et al, 2020). I realized that STEAM pedagogy is a more advanced and innovative approach tothe professional development of teachers.

Discussions

The study focused the students' emotional, behavioral, and cognitive engagement. Most critical friends and students participant expressed that, "*classes were interesting, motivating, and joyful through DST*". In the study, I observed that students' emotional, behavioral, and cognitive engagement was enhanced through DST. The finding enhancing the engagement of the study was aligned with the finding of many other research studies in other disciplines, and the level of students whose focus was on the positive attitude of students toward learning, the satisfaction of learners, and educative class through DST (Eroglu&Okur, 2021;Saritepeci, 2021). My study provided the place for DSTs in secondary mathematics to enhance the engagement of learners which was a contribution of the study.

Before DST, there was a process of solving mathematical problems from the exercise of the textbook by a teacher. Students would copy the solution from the whiteboard/blackboard to the notebook without discussing it with teachers and other students in the classroom. Everyone in the classroom would maintain pin drop silence in the mathematics classroom. There used to be the only sound of teachers describing the algorithmic process of solving mathematical problems.Such types of disciplinary values and mindsets of teachers were creating a narrow and disempowering environment in school education (Pant et al., 2020).

During the study, students were allowed to participate in thinking through brainstorming questions, and discussion/interaction in the classroom. They were allowed to put their views in the classroom, supporting each other. They used alternative ways of solving problems, contextual problems, contents from various disciplines, social norms and values, and real-life skills. DST provided opportunities for multiple funny, and educative activities in the classroom. It was also observed in the study by Saritepeci (2021) and Eroglu and Okur (2021) in their studies. I found that students were not only focused on the engagement, and content of mathematics, but they were also learning social values and norms along with verities of topics from DSs. It was supported by Saripudin et al., (2021) in their value-based DST.

Before the study, most mathematics teachers were teaching mathematics in a single way. They were still presenting mathematics subject as a collection of facts,

and formulas that should be memorized by students without understanding their concepts and without any questioning in the passive mode of classroom activities (Pant, 2017). There was the same condition in the mathematics classroom before using DST. There was a transmission of knowledge through the not-so-helpful pedagogy of the mathematics teacher (Luitel, 2009 as cited in Pant, 2017).

During the study, it was observed that most of the students were creating their knowledge through suitable questioning, interaction, and interpretation of the contextual situation (Dahal, et al., 2019). Barkley (2010) states that engaged learning is the transformation of students' activeness from passive recipients to active participation in learning activities.Active participation includes discussion, elaboration, sharing of ideas, questioning, communicating, and the problem-solving process by which learners try to find the meaning of what they learned (Barkley, 2010).

Interaction and collaboration bring individuals together to resolve their problems, learn new mathematical concepts, communicate with each other, produce creative ideas, and increase the effectiveness of learning in the classroom (Dahal et al., 2022). Likewise, Saritepeci (2021) argued that DST develops self-confidence in the learners that motivate students to participate in classroom tasks. The finding was supported by the finding of Smeda et al., (2014) by saying that DST is an innovative pedagogical approach that can engage students in deep learning.

Before the study, all teachers and students were saying that one teacher can teach a single subject only. Most teachers aligned with the fact that they did not know about other disciplinary content knowledge of other disciplines. So, the single and monotonous teaching-learning activities were changed into various disciplinary activities in the mathematics classroom.

In the study, every DS contained the contents of mathematics, science, designing of DS, liberal art in the form of a story, and inclusion of technology along with other social norms and values. The facts were supported by Saripudin et al., (2021) by saying that DSs are not limited to single disciplinary contents. It provides verities of contents. Such types of integration that focus on the real-life situation by blurring the boundaries of the disciplines indicate the interdisciplinary and transdisciplinary integration of the disciplines (Broersma, 2014). So, my study focused on the integration of various disciplinary contents which might be a step for my professional development.

Before the study, most teachers were using the traditional method of solving textbook problems through algorithmic ways. It allowed students to rote memorization of formulas and facts rather than developing concepts (Pant, 2017).A few so-called talented students could solve similar questions they memorized, copy them in the final exam, and get higher marks in the final examination

DST provides opportunities to understand and relate mathematical problems with students' context. This finding is aligned with Wu, and Chen (2020), and Castleden et al., (2013), who argued that DST provides opportunities for a deeper understanding of context, culture, and content. In this study, DST provided the space for the integration of other disciplines along with the contextualization of contents which are the fundamental aspect of STEAM pedagogy. So, the study provides the space for STEAM pedagogy.

Before the study, my pedagogical practice was conventional in which I would focus on the absolutist views in teaching mathematics, and promoting rote learning in my mathematics classroom. I believed in disciplinary egocentrism (Connor et al, 2015 as cited in Pant et al., 2020). For me, mathematics was a superior subject to other subjects in school-level education.to rote memorize the mathematical concepts without understanding, and demonstrate basic skills in the mathematics classroom

During the study, I found that DST is not only a pedagogical tool to deliver a story but is a pedagogical technique to reform pedagogical activities in the classroom, which was supported by Wu, and Chen (2020). They argued that the DS not only focused on the classroom interaction and skills of the students but also helps teachers to create an environment for collaboration with other, and improve professional skills.

Furthermore, the study helped me to develop my pedagogical skills by using the TPACK model of instruction (Koehler & Mishra, 2006). The TPACK model is the improvement on the pedagogical content knowledge (PCK). Koehler and Mishra (2006) add the third component of technology in the PCK model of instruction (Ahmed, 2020).

Likewise, during the study, I focused on what to teach, how to teach, why to teach, and what would be the outcome of teaching-learning activities, which challenged my conceptual understanding of teaching (Jamil et al., 2018). I realized that it was the first step of pedagogical transformation that was possible through critical self-reflection (Grundy, 1987)

Finally, I realized that I was using STEAM pedagogy that only provided an environment for the learners by which they could think more broadly and critically about the complex problems of the real-world (Pant et al, 2020). In that way, I found myself in the way of reforming my pedagogical practice.

My purpose and research question seeks the incorporation of DST in secondary mathematics to enhance the engagement of learners in the classroom of government school of Nepal. Indeed, it was found that using social interaction in the classroom through the use of DST, reflection on action, and practice to improve knowledge was helpful to enhance the engagement of learners. Furthermore, in the context of Nepal, there are low resources in school. DST might be helpful tool for better learning environment. Likewise, along with interaction with the help of DST in the mathematics classroom, there might be a need for reflection, and sufficient practice to enhance the emotional, behavioral, and cognitive engagement of the learners. Likewise, it is found that by the use of critical reflection on action, the teacher can not only improve but also reform his/her pedagogical practice from conventional to constructivist. I think this is the extension of Vygotsky's social constructivism theory in the context of Nepal.

Challenges Faced During Study

The study was collaborative action research in which we planned to use DST in mathematics classrooms collaboratively. I felt some challenges in the collaboration part in which we faced some difficulties during the work. On the other hand, during the stage of preparation, implementation, and improvement of DST there were many challenges that I faced. Even though there were many opportunities, I faced some challenges during the study using DST in the secondary mathematics classroom of a government school in Nepal. Below, I have expressed some of the challenges of which teachers should be aware during the implementation of the DST in any class.

Challenges of Collaboration

Before the beginning of the study, my assumption was to improve DST with supports from the participants during preparing stories, integrating of disciplinary contents, and presentation of DST in the classroom, observation of the classroom activities, interviews with participants, reflection, feedback, and meaning-making process. For this purpose, I selected 4 teachers as critical friends as well as co-researcher, and six students in grade ten as co-researcher purposefully.

Initially, we planned to conduct the study after school time in the classes and started to create stories. During the story creation process, I observed that there were some co-researchers absent in the discussion and creation of the DS process. In the same situation, it was clear that there could be difficulties during the whole study. I felt the challenges of being together and working together for all ten members of the study at the same time. After some days, we changed the modality of creation of DS in which I prepared stories and then discussed with critical friends for feedback and improvement in their suitable time.

Challenges of Digital Skills

For a good DST, there should be a need for balance between contents, presentation of pictures and videos, suitable sound, and time for interaction in the classroom (Robin, 2006). At the beginning of the study in April 2022, we were just ready for the content of the stories; we collected content, and tried to integrate some other disciplinary content into the story. But after preparing 2/3 stories there were challenges with digitizing. We did not have any idea about the video mixing in the storyboard. So, there was a challenge due to the lack of digital skills on teachers during preparation of DSs (Eroglu&Okur, 2021). We discussed the problems in the co-researchers group. But, there was no solution to such a problem. Most critical friend said,*"this is not our sector, we don't know about digitalization of stories"*. One of my critical friends Mr. Bal Bdr. Sir suggested, "*we may take alternative ways of mixing videos or any other…We have to find alternative, and simple way or we have to search for help from any technical friend."* After the discussion, I searched for technician who could help. I did not find any technical person who could help me. But, I found some literature about DST. I found that DST wasnot only videos or movies but was a combination of contents, pictures/videos, sound, and digital tools (Robin, 2008). Then we planned to create digital stories with the help of suitable pictures, sound, and contents in the PowerPoint slides and then converted them into videos. In this way, we prepared the videos of DS by using PowerPoint slides and sound.

The teachers or students should have sufficient technical skills such as the use of cameras, microphones, and multimedia to create DS for better DST (Robin, 2006). From the above situation, we realized that for a better DST the teacher or researcher should have sound knowledge of digital tools. So, before planning the use of DST,

teachers, educators, and researchers should be aware of the digital skills used in the DS along with the techniques of presentation.

Challenges of Time Management

From the study, I found that creating the DS is a more time-consuming task for teachers and students. Initially, it was the end of April 2022. Schools were not running smoothly due to the admission process, and most of the teachers had free time for discussion. We planned to create stories collaboratively but later it was found that it took 2 to 3 days for stories, and then 2 to 3 days for digitalization of a story. For single DS, it took 6 to 7 days on working each component of the story. Then, there aroused a question that it wouldn't be possible to create all stories at the same speed for the study. After creating one DS, we discussed the situation and time for the study. One of my critical friend Mr. Bhim Sir said, "We *may not manage enough time for this, it will take so long time to prepare digital stories"*. We concluded that it might take more time than the proposed time of the study. Indeed, it was a challenge to create 10 stories in a short time (within one month) for the study. In that case, time management was one of the main challenges for us. Due to the nature of DSs, learning about technologies takes more time than others (Eroglu&Okur, 2021). So, I felt that time management was the major challenges for me during the study.

Likewise, challenges of my study are supported by Robin (2006). He argued that the teacher, educator, or researcher should be aware that DST is time-consuming, and might take several attempts to finalize the DS. From the above argument, I realized that creating a DS is not a simple task, and it might take a long time. So, everyone who wants to create the DS should be aware of the challenge of time before planning for the DS.

Chapter Summary

The chapter was about my emerging understanding, and change during the study through the use of DST in mathematics classroom. During the study, and after the study, I found that students were engaged in various learning activities. Monotonous pedagogy was changed into the various activities, passive classroom changed into active constructivist classroom, single disciplinary content to integration of disciplines, solution of textbook problem to contextual problems, and informing pedagogies to reforming classroom activities through the use of DST in mathematics classroom. Furthermore, I also observed some challenges such as challenges of collaboration, challenges of digital skills, and challenges of time management of the

participant, and critical friends during the study.

CHAPTER VII
CONCLUSION AND IMPLICATIONS

This chapter presents the overall reflection of the study. I have presented the engagement of learners during the implication of the study. I observed that through the use of informative or instructional DSTs in mathematics classroom the emotional, behavioral, and cognitive engagement were enhanced. In this chapter, I have discussed briefly about my reflection, conclusion of the study, and its implications.

My Final Reflection onStudy

The purpose of the study was incorporating the DST as STEAM pedagogy in secondary mathematics classrooms for the engagement of the learners. In this study, I used the DST as a pedagogical tool for mathematics teaching along with the integration of other STEAM disciplines. I used teaching as an experiment by using DST in the secondary level classroom of a government school in Nepal. It was found that there was an enhancement in engagement. It developed a positive attitude toward the mathematics. Similarly, I have put my effort to understand some challenges during the implementation of DST in the mathematics classroom.

Methodological Reflection

For the study, I adopted collaborative action research (CAR) study method that was my novice experience to work with other teachers together. Initially, I discussed with other teachers of the school regarding pedagogical practice, and its reformation from which I found common problem as students' disengagement in classroom. I made a group of five teachers, and six students to work together for pedagogical reformation of teachers. We[5] made action plan, prepared digital stories incorporating other disciplinary content, implemented our plan in classroom, reflected our practice, discussed for improvement, and applied improvement in next classes collaboratively (Clift, Veal, Johnson &Holland, 1990). As suggested by Sagor (1993), we followed five steps for collaborative action research which were problem formulation, action planning, data collection, data analysis, and reporting of results. Such collaboration helped me to improve my plan, DSs, presentation, and observation of students' activities in mathematics classroom.

[5] Here we refers to the co-researcher teachers/critical friends

Collaboration with other teachers was my novice experience in my teaching career. It helped me to improve my practice by incorporating others' idea in classroom activities, to integrate other disciplines, and to add context in learning activities. Indeed, working with teachers in the study provided new opportunities to improve my personal and professional practices (Sagor, 1993).

Theoretical Reflection

From the beginning of the study, we[6] interacted in various stages with other teachers of the school to find the problem of the study, planning of the study, implementation, and improve our daily practice. Likewise, students were allowed to discuss to find a solution to the problem during DST in mathematics classes. During the study, I observed students' active participation in learning activities of various disciplinary contents through DST. Most of the students participated in learning activities such as discussion, interaction, answering questions, showing emotional behavior, and cognitive enhancement. Most students were constructing their knowledge through interaction, and participation in group activities during and between DST in mathematics class. Likewise, the teacher and other students of the group were supporting each other in various obstacles during learning. This indicated that there was a constructivist approach to learning through the DST which is supported by Vygotsky's social constructivism.

Furthermore, the use of DST in secondary mathematics not only tried to change the students' behavior but also helps students to develop mathematical concepts and solutionsto contextual problems. The result of the study indicated that students had positive effects on emotional engagement, behavioral engagement, and cognitive engagement through DST in the secondary-level classroom of a government school in Nepal. The student's engagement helps them to develop a positive interest and perception of mathematics.

Likewise, the study was not only followed by social interaction with co-researchers, there were critical reflections simultaneously on my action which really helped me to improve my pedagogical practice. During the study, I used self-reflection in my practice which not only transformed students' engagement but also helped us to transform my pedagogy. In the study, I applied self-reflection with a critical perspective to my action, analyzed them, and applied the conclusion in my

[6] Here we refers to the co-researcher teachers

next classroom. It was more about knowing why, questioning, and self-reflection for the reformation of my practice. So, Habermas emancipatory interest (1972) gives rise to a critical perspective on my practice to deconstruct hegemony and false consciousness. The finding of the study indicated that only social interaction might not be sufficient for the cognitive engagement of all learners in secondary mathematics, there should be a need for critical reflection on their work along with enough practice, and active participation (Pant, 2017). In this way, both Vygotsky's social constructivism (1978), and the Critical theory of Habermas (1972) guided my study in every stage of the study.

On the other hand, DST can be used as a tool for STEAM pedagogy atthe secondary level by which teachers might use the transdisciplinary integration of STEAM as well as other disciplines. During the implementation of DST in secondary-level classrooms students not only learn disciplinary content but also got opportunities to learn life skills for the 21st century such as communication, collaboration, creativity, and critical thinking along with problem-solving skills. The above facts indicated that DST can be used in the classroom for multiple purposes.

Along with the engagement of learners, and integration of disciplines through DST, I found that the study was helpful for my professional development. Indeed, my teachers-centered pedagogy was reformed to the various activity-based pedagogy, my activities became student-centered and active constructivist activities. Furthermore, the integration of various disciplines in mathematics, and providing an environment for the solution of the contextual problem was one of the major achievementsof the study.

However, I also faced challenges during my study. Some of the challenges were regarding working in a group of teachers and students, digital skill-related challenges, and some challenges were regarding the creation and presentation of DS in the classroom. During the time of facing the challenges, I found new, exciting, and alternative ways of learning.

Conclusion of the Study

Based on my purpose and research question of the study, it was found that DST can be incorporated in secondary-level mathematics classroom to enhance students' engagement. The study focused on how DST can be incorporated into teachers' pedagogy for engaged learning in secondary mathematics as a tool for STEAM pedagogy in government schools of Nepal. The study showed that students'

engagement was enhanced through the use of DST, and DS can be used as an interactive tool to make a constructivist classroom environment. From the study, I found that the DST helped to enhance three types of engagement namely emotional engagement, behavioral engagement, and cognitive engagement. The use of DST in the secondary level classrooms of government schools created an interesting, joyful, and entertaining environment that might help the learning achievement of the students. Easy learning and engagement of learners also develop their positive attitude toward mathematics.

Furthermore, the study focused on not only telling a story in the classroom for entertainment purposes but also focused on how the student can learn mathematical concepts, and skills, and how can a teacher use DST for interaction in the classroom to construct new knowledge. For this, the teacher can start DST with brainstorming and discussion questions, pause DST in each section of the story to allow discussion, find the solution to the contextual problem in the group, and improvise the solution with the help of other groups and the teacher in the classroom. From this study, I claim that DST is a pedagogical tool for STEAM pedagogy which helps to integrate not only disciplinary content but also life skills for the 21st century. Likewise, DST also helps teachers to reform and transform their pedagogical practice of teaching and learning which might be helpful for professional development.

Besides this, there are some challenges to using DST in secondary-level mathematics as well as other subjects. While conducting mathematics class using DST, I faced some challenges. I got new alternatives by which teachers can modify the situation and use new techniques to handle the situation for a better teaching-learning environment in the classroom. From this, I realized that challenges are not problems but opportunities for new and alternative solutions.

So, as a teacher-researcher, I suggest to all teachers of mathematics as well as other subject teachers to use DST or some other forms of art in their pedagogy for a better teaching-learning environment, and experience. The use of DST in mathematics teaching and learning is important for visualization, and contextualization of the problems by which students can find solutions to real-life problems.

Implications of the Study

Digital storytelling is an emerging, innovative, and creative tool for the enhancement of teachers' pedagogical skills(Ahmed, 2020). This particular study was a small step toward filling the vast pedagogical gap in the educational sector. It was

just the initiation to reform pedagogical activities by using DST as an innovative tool in the secondary mathematics classroom. In the future, the use of DST in the classroom might be a milestone for pedagogical enhancement for teachers, educators, and researchers. For this purpose, there is a need for further research in this field.

Although. It is not so easy to create DS and there are many challenges in implementing DST in secondary mathematics class, it helps to make the class entertaining, joyful, attentive, participative, and can provide contextual knowledge in classroom activities. The use of DST in the secondary mathematics classroom is an important step for the art-based classroom in STEAM pedagogy for a better learning environment in the classroom.

Likewise, this study focused only on the classroom engagement of students and observed only students' activities during the DST in grade ten mathematics. Furthermore, this is the sample experimental study for the implementation of DST as one form of art in the mathematics classroom of the government school of Nepal, supposed to enhance engagement of the secondary level students.

What did not work during digital storytelling?

Initially, I planned to create stories with the group of students and teachers collaboratively. But after two discussions with co-researchers (teachers and students), I observed that it took three to four days to complete a basic story. If we go through the same process, it would take more than forty-five days in the creation process only. So, it was almost impossible to create DSTs in the group. To overcome that problem, we decided to discuss only improvement for contextualization and the digitalization process before the presentation of DST in classroom.

Likewise, I planned to observe all classes with all critical friends and collect feedback to improve in the next classes. After two or three classes, we realized that observation by all critical friends became almost impossible because all critical friends would not be free for forty-five days. To overcome the problem, we made a plan to observe classes with each critical friend one by one. And also gave the same responsivities to students. After that, all classes were observed by a group of students and critical friends. Finally we realized that the process of observation of classroom by students, and teachers were more suitable to take the perceptions of teachers, and students simultaneously.

Furthermore, I planned to create animation videos as digital stories for the study by learning animation from computer institutes or any resources. I consulted all

computer institutes within Lamkichuha municipality and some institutes in Kathmandu valley for online support. But, I did not find any support from computer institutes. I discussed with my critical friends, and reached at conclusion to make videos by using powerpoint, and a sound system.

Lastly, we observed that students were engaged very well emotionally, and behaviorally during DST, but it was not sufficient for cognitive engagement to solve complex contextualized mathematical problems related to secondary curriculum for students. After that, we allowed students for regular practice to solving mathematical problems in small groups of students and observed an enhancement in learners' cognitive engagement. From that, we concluded that DST with regular practice of students in small groups might be helpful for learners' cognitive engagement.

Limitations of the Study

This study was carried out through collaborative action research in which five teachers (I along with four critical friends), and six grade ten students were collaboratively involved. The study was implemented and observed in a single mathematics class of a secondary level government school of Kailali district, Nepal in short period of time. Information was generated through the reflections of classroom, observations, and interviews with teachers (co-researchers/critical friends), and students-participants in time within 45 days. So, time was not sufficient for the study.

The finding of the study were based on the data collected in small sample through the interviews during the use of DST in mathematics. It was for a single unit of mathematics (Simple and compound interest) to observe emotional, behavior, and cognitive engagement of students. Other chapters of secondary level mathematics were not included in DST for the study.

Suggestions for Further Study

The study found that DST is one of the pedagogical tools to enhance students' engagement. It is a step to incorporate arts in secondary mathematics. Similar art-based and other forms of art-integrated studies can be carried out in another context, subject, and topics. Likewise, a similar, study can be carried out to integrate arts and other disciplines into the pedagogy, curriculum, and assessment system in Nepal and other counties. It might be a cornerstone for the education system for STEAM education in Nepal.

The study was conducted to observe students' engagement during DST in secondary level mathematics classes. Similar study can be carried out to observe the

21st century skills by using DST in the mathematics class for basic, secondary, and higher-level schools.

I suggest other teachers, educators, and researchers carry out a similar study at the Ph.D. level and in other educational fields on various levels of mathematics. The incorporation of any form of arts in teachers' pedagogy might be beneficial for all students and the educational field to create a better learning environment in mathematics as well as other disciplines.

REFERENCES

Ahmed, I. (2020). *Paradigms of engagement: digital storytelling as pedagogical strategy in multilingual societies*. [Doctoral Thesis]. Sikkim University,School of Language and Literature. http://hdl.handle.net/10603/377469

Al Wafi, M., Lisdiana, L., &Sumarti, S. S. (2022). Development of steam-based human respiratory system teaching materials to improve students' critical thinking skills. *Journal of Innovative Science Education*, *11*(3) 302-311.

Algani, Y. &Eshan, J. (2019). Reasons and suggested solutions for low-level academic achievement in mathematics. *International e-Journal of Educational Studies*, *3*(6), 181-190. DOI: 10.31458/iejes.604884

Amaliyah, N., Sapriya, S., &Maryani, E. (2007). A trans-disciplinary approach and inquiry-based learning model of social studies. *World Transactions on Engineering and Technology Education,15*(2), 174-177.

Amineh, R. J., &Asl, H. D. (2015). Review of constructivism and social constructivism. *Journal of Social Sciences, Literature and Languages,1*(1), 9-16.

Anderson, L. W., &Krathwohl, D. R. (2001). *A taxonomy for learning, teaching and assessing: a revision of bloom's taxonomy of educational objectives: Complete edition*. Longman.

Bajpai, N. (2011). *Business research methods*. Pearson Education Limited

Barkley, E. F., (2010). *Student engagement techniques; A hand book of college faculty*. Jossey-Bass press.

Barrett, D. &Twycross, A. (2018). Data collection in qualitative research. *Evidence-Based Nursing Journals27*(3), 63-64. http://dx.doi.org/10.1136/eb-2018-102939

Barzaq. M. (2009). Integrating sequential thinking thought teaching stories in the curriculum. *Action Research.Al ñQattanCenterforEducational Research and Development QCERD*. https://www.researchgate.net/publication/341592543_Story_Telling [accessed Apr 25 2023].

Bertrand, M. G., &Namukasa, I. K. (2020). STEAM education: student learning and transferable skills. *Journal of Research in Innovative Teaching & Learning*, *13*(1), 43–56. https://doi.org/10.1108/JRIT-01-2020-0003

Bleicher, R. E., (2014) A collaborative action research approach to professional learning.*Professional Development in Education*, *40*(5), 802-821.

Boice, K. L., Jackson, J. R., Alemdar, M., Rao, A. E., Grossman, S., &Usselman, M. (2021). Supporting teachers on their STEAM journey: A collaborative STEAM teacher training program. *Center for Education Integrating Science, Mathematics, and Computing* (CEISM), 1-20.

Borasi, R., Sheedy, J. R., & Siegel, M. (1990). The power of stories in learning mathematics. *Language Arts*, *67*(2), 174–189. http://www.Junator.org/stable/41961719

Broersma, C. (2014). Is it time to change? Infusing the transdisciplinary approach into social work studies. *Journal of Sociology and Social Work*, *2*(2), 145-154. DOI:10.15640/Junasw.v2n2a9

Castleden, H., Daley, K., Sloan Morgan, V., &Sylvestre, P. (2013). Settlers unsettled: Using field schools and digital stories to transform geographies of ignorance about Indigenous peoples in Canada. *Journal of Geography in Higher Education*, *37*(4), 487-499.

Clift, R., Veal, M. L., Johnson, M., & Holland, P. (1990). Restructuring teacher education through collaborative *action research. Journal of Teacher Education*, *41*(2), 52–62. DOI: 10.1177/002248719004100207

Costa, A. L., &Kallick, B. (1993). Through the lens of a critical friend. *Educational Leadership*, *51*, 49-49.

Creswell, J. W. (2012). *Planning, conducting and evaluating qualitative and quantitative research*. Permissions Department.

Dahal, N., Luitel, B. C., and Pant, B. P., (2019). Understanding the use of questioning by mathematics teachers: Arevelation. *International Journal of Innovation, Creativity and Change.5*(1) 118-146. https://ijicc.net/images/Vol_5_iss_1_2019/Dahal_Nov_2019.pdf

Duran, L. B., and Duran, E. 2004. The 5E instructional model: A learning cycle approach for inquiry-based science teaching.*Science Education Review3*(2): 49-58.

Education Sciences. (2021). *In Wikipedia*. https://en.wikipedia.org/wiki/Pedagogy

ERO, (2018). *Report of National Assessment of Student Achievement 2018, Grade 5*.

ERO, (2019). *Report of National Assessment of Student Achievement 2018, Grade 10*.

Eroglu, A., &Okur, A. (2021). The effect of digital storytelling on digital literacy skills of the 7th graders at secondary school. *International Online Journal of Educational Sciences,13*(4), 1235-1253.

Fredricks, J. A., Blumenfeld, P. C., & Paris, A. H. (2004). School engagement: Potential of the concept, state of the evidence. *Review of Educational Research*, *74*(1), 59-109. Doi: 10.3102/00346543074001059

Freeman, M., &Burkette, G. (2019). Storytelling in the accounting classroom. *The Accounting Educators' Journal,29*(1), 29-39. https://bit.ly/3xVS2jg

Freire P. (2005). *Pedagogy of the oppressed*. The Continuum International Publishing Group.

Freire, P. (1970). *Pedagogy of the Oppressed*. Continuum International Publishing Group.

Gill, P., Stewart, K., Treasure, E., & Chadwick, B. (2008). Methods of data collection in qualitative research: interviews and focus groups. *British Dental Journal, 204*(6), 291-295.

Giri, S. (2021). Teaching learning mathematics in multi-cultural classroom. *Mangal Research Journal*, 27-36.

Godbole, A. Y. (1988). Storytelling; A way for developing child's personality. *SavitribaiPhule Pune University.*

Gok, T. (2017). Comparisons of the fractional gain in conceptual learning by using peer instruction. *Research Highlights in Education and Science 2017*, 81.

Grundy, S. (1987). *Curriculum: Product or praxis.* The Flamer Press

Guba, E. G. & Lincoln, Y. S. (1994). Competing paradigms in qualitative research. In N.K., Denzin, &Y.S., Lincoln,*Handbook of qualitative research*, (3rd Ed) (pp. 105 – 117). Sage.

Habermas, J. (1972). *Knowledge and human interests* (Jeremy, J. S. Trans.). Beacon Press.

Habermas, J. (2005). Knowledge, and human interests: A general perspective. In G. Gutting (Eds.), *Continental philosophy of science*(pp. 310–321). Blackwell.

Heaslip, G., Donovan, P., & Cullen, J. G. (2014). Student response systems and learner engagement in large classes. *Active Learning in Higher Education*, *15*(1), 11-24. DOI: 10.1177/1469787413514648

Ibarra, L., &Sommerstad, A. (2019). Notes from artists: Making the invisible visible and art as the bridge to science and interconnectedness. *Promoting Language and STEAM as Human Rights in Education: Science, Technology, Engineering, Arts and Mathematics*, 151-159.

IstenicStarčič, A., Cotic, M., Solomonides, I., & Volk, M. (2016). Engaging preservice primary and preprimary school-teachers in digital storytelling for the teaching and learning of mathematics. *British Journal of Educational Technology*, *47*(1), 29-50.

Jamil, F. M., Linder, S. M., &Stegelin, D. A. (2018). Early childhood teacher beliefs about STEAM education after a professional development conference. *Early Childhood Education Journal*, *46*, 409-417.

Kember, D., Ha, T. S., Lam, B. H., Lee, A., NG, S., Yan, L., & Yum, J. C. (1997). The diverse role of the critical friend in supporting educational action research projects. *Educational Action Research*, *5*(3), 463-481.

Kemmis, S., McTaggart, R., & Nixon, R. (2014). *The action research planner: Doing critical participatory action research.*Springer.

Khalil, M. K., &Elkhider, I. A. (2016). Applying learning theories and instructional design models for effective instruction. *Advances in Physiology Education*, *40*(2), 147-156.

Kincheloe, J. L., McLaren, P., & Steinberg, S. R. (2011). Critical pedagogy and qualitative research. In N. K., Denzin, & Y. S., Lincoln,. (Eds.). *The SAGE handbook of qualitative research*. Sage.

Lassance, L., Filgueiras, L. V. L., Dessus, P., Guntz, T., & Crowley, J. (2022). *video lecture design and student engagement: Analysis of visual attention, affect, satisfaction, and learning outcomes*.video-lecture-version-open.pdf

Lehman, D. W., O'Connor, K., Kovács, B., & Newman, G. E. (2019). Authenticity. *Academy of Management Annals*, *13*(1), 1-42.

Lewin, K. (1946). Action research and minority problems. *Journal of Social Issues*, *2*(4), 34-46.

Luitel, B. C., &Dahal, N. (2020). Conceptualising transformative praxis. *Journal of Transformative Praxis*, *1*(1), 1-8.

Luitel, B. C., & Taylor, P. C. (11-15 April 2005). *Overcoming culturally dislocated curricula in a transitional society: An autoethnographic journey towards pragmatic wisdom*. [Paper presentation]. Annual Meeting of the American Educational Research Association (AERA), SIG: Self-Study of Teacher Education Practices Montreal.

Luitel, B. C., & Taylor, P. C. (2019). Introduction: Research as transformative learning for sustainable futures. In P. C. Taylor & B. C. Luitel (Eds.), *Research as transformative learning for sustainable futures: Glocal voices and visions* (pp. 1-16). Brill-Sense.

Luitel, B. C., Dahal, N., & Pant, B. P. (2022). Critical pedagogy: Future and hope. *Journal of Transformative Praxis*, *3*(1), 1-8.

Luitel, L. (2019). Nature of mathematics and pedagogical practices. *Proceeding of 10th International Mathematics Education and Society Conference*.MES_proceeding_Laxman_Luitel-libre.pdf (d1wqtxts1xzle7.cloudfront.net)

Maseko, P. N. (2018). Transformative praxis through critical consciousness: A conceptual exploration of a decolonial access with success agenda. *Educational Research for Social Change*, 7, 78-90.

McNiff, J. (1995). *Action research for professional development*. Hyde.

Mehta, R., Keenan, S., Henriksen, D., & Mishra, P. (2019). Developing a rhetoric of aesthetics: The (often) forgotten link between art and STEM. In M. S. Khine, S. Areepattamannil (Eds.), *STEAM Education* (pp- 117- 141). Springer.

Messiou, K. (2018). *Facilitating inclusion in schools through collaborative action research.*University of Southampton Institutional Repository.

Mishra, P., & Koehler, M. J. (2006). Technological pedagogical content knowledge: A framework for teacher knowledge. *Teachers' College Record*, *108*(6), 1017-1054.

Morra, S. (2013). An Educational uses of digital storytelling.*Great digital storytelling.* http://digitalstorytelling.coe.uh.edu/page.cfm?id=23.

Muntomimah, S., &Wijayanti, R. (2021, April). The importance of STEAM loose part learning effectiveness in early childhood cognitive learning. *2nd Annual Conference on Social Science and Humanities* (ANCOSH 2020) (pp. 47-52). Atlantis Press.

Noor, M. S. A. M., &Shafee, A. (2021). The role of critical friends in action research: A framework for design and implementation. *Practitioner Research*, *3*, 1-33.

Normann, A. (2011). *Digital storytelling in second language learning.*https://www.semanticscholar.org/paper/Digital-storytelling-in-second-language-learning%3A-A-Norman

Oja, S.N. and Smulyan, L. (1989) *Collaborative action research: A developmental perspective.* Falmer

Pant, B. P. (2015). *Pondering on my beliefs and practices on mathematics, pedagogy, curriculum and assessment*. [Unpublished MPhil's dissertation]. Kathmandu University.

Pant, B. P. (2017). Doing, teaching, learning and thinking about mathematics–On becoming a transformative teacher. *Journal of Education and Research*, 7(1), 11-24.

Pant, B. P., Luitel, B. C., & Shrestha, I. M. (2020, January). Incorporating STEAM pedagogy in teaching mathematics. *Proceedings of the Eight International Conference to Review Research in Science, Technology and Mathematics Education* (episteme 8), HomiBhabha Centre for Science Education. https://episteme8.hbcse.tifr.res.in/proceedings.

Pant, S. K., Luitel, B. C., & Pant, B. P. (2020, December). STEAM pedagogy as an approach for teacher professional development. *In Mathematics Education Forum Chitwan. 5(*5), 28-33.

Poondej, C., &Lerdpornkulrat, T. (2016). The development of gamified learning activities to increase student engagement in learning. *Australian Educational Computing*, *31*(2).

Porteous, J., & Lindsay, A. (May 13–17, 2019). Protagonist vs antagonist proviant: Narrative generation as counter planning. *In Proceedings of the 18th International Conference on Autonomous Agents and MultiAgent Systems* (pp.

1069-1077).https://aamas.csc.liv.ac.uk/Proceedings/aamas2019/pdfs/p1069.pdf

Rawat, S. S., Luitel, B. C., &Belbase, S. (2021). Lived experience of pedagogical boomerang in mathematics teaching-learning. *Journal of Education and Learning* (EduLearn), *15*(1), 104-118.

Reeve, J., & Tseng, C. M. (2011). Agency as a fourth aspect of students' engagement during learning activities. *Contemporary Educational Psychology, 36*(4), 257-267.

Riel, M. (2019). Understanding collaborative action research. *Turkish Online Journal of Qualitative Inquiry, 2*(2). 7-16.

Robin, B. R. (2006). *The educational uses of digital storytelling. in society for ınformation* [Conference Presentation]. Technology & Teacher Education International Conference.

Robin, B. R. (2016). The power of digital storytelling to support teaching and learning. *Digital Education Review, 30,* 17-29.

Robin, B. R. (2017). Digital storytelling: A powerful technology tool for the 21st century classroom digital. *Taylor and Francis Online, 47*(3). https://doi.org/10.1080/00405840802153916

Roulston, K. (2010). Considering quality in qualitative interviewing. *Qualitative Research*, *10*(2), 199-228.

Sagor, R. (1993). *How to conduct collaborative action research*. Association for Supervision and Curriculum Development.

Saldana, J. (2021). *The coding manual for qualitative researchers*. Sage.

Saripudin, D., Komalasari, K., &Anggraini, D. N. (2021). Value-Based digital storytelling learning media to foster student character. *International Journal of Instruction, 14*(2), 369-384.

Saritepeci, M. (2021). Students' and parents' opinions on the use of digital storytelling in science education. *Technology, Knowledge and Learning*, *26*(1), 193-213.

Shrestha, I. M. (2021). *Exploring mathematics pedagogy through the lenses of Habermas' knowledge-constitutive interests* [Unpublished Doctoral Thesis]. Kathmandu University.

Shrestha, I. M., Luitel, B. C., & Pant, B. P. (2020). Exploring transformative pedagogy in teaching mathematics. *Mathematics Education Forum Chitwan*, *5*(5), 9–16. https://doi.org/10.3126/mefc.v5i5.34752

meda, N., Dakich, E., & Sharda, N. (2012) Transforming Pedagogies through Digital Storytelling: Framework and Methodology. *Proceeding of 2nd Annual International Conference on Education & e-Learning (EeL 2012).*https://www.researchgate.net/profile/Nalin-Sharda/publication/268459343

Smeda, N., Dakich, E., & Sharda, N. (2014). The effectiveness of digital storytelling in the classrooms: A comprehensive study. *Smart Learning Environments*, *1*, 1-21.

Sulyman, H. T., &Oladoye, E. O. (2022). COVID 19 Pandemic era: a shift in pedagogical approach as a means of improving children's learning in today's classroom. *International Journal of Education* (KIJE), *4*(1), 231-243.

Tabiin, A. (2019). Implementation of STEAM method for early childhood developing in kinder garden. *Early Childhood Research Journal*, *02*, 36-49.

Tajeri, M., Syal, P., &Marzban, S. (2017). Enhancing vocabulary and writing skills through digital storytelling in higher education. *Journal of Educational Technology*, *14*(3), 40-48.

Taylor, P. C. (2015). *Constructivism*. Springer Netherlands.

Taylor, P. C., & Medina, M. (2011). Educational research paradigms: From positivism to pluralism. *College Research Journal*, *1*(1), 1-16.

Taylor, P. C., Taylor, E., & Luitel, B. C. (2012). Multi-paradigmatic transformative research as/for teacher education: *An Integral Perspective. Second International Handbook of Science Education*, 373-387.

Vygotsky, L. S., & Cole, M. (1978). *Mind in society: Development of higher psychological processes.* Harvard university press.

Wu, J., & Chen, D. T. V. (2020). A systematic review of educational digital storytelling. *Computers & Education*, *147*, 103-786.

Yuliani, S., & Hartanto, D. (2021). Designing digital storytelling in English online learning. *International Journal of Educational Management and Innovation*, 2(3), 309-321.

APPENDICES

Appendix 1: Action plan of the study

The tentative implemented timeline for Collaborative action research (CAR) study is shown in the following table

Title	Work in detail	Tentative time
Overview of CAR Study (Whole plan)	• Experience collection, interaction • Plan Implementation, Reflection and text/data collection • Data/text collection, Reflection, feedback collection from co-researcher/critical friends • Interpretation, meaning-making and conclusion	30 days (From may17 to June 16, 30 Days)
Pre-plan for the CAR	• Pre-interview with participants and co-researcher • Literature collection • DS preparation • Plan making for CAR	From April 10 to May 15, 2022
Cycle 1	• Interaction and experience collection of learners (engagement and content) • Plan implementation in mathematics classroom • Collection of data/text, reflection and feedback (Self	30 days (May and June 2022)

	and co-researcher/critical friends) • Assessment of cycle 1	
Cycle 2	• Evaluation of cycle 1 • Making plan for next implementation • Creating new digital stories • Improve and implement plan in class • Collection of data/text, reflection and feedback (Self, co-researchers/critical friends) • Assessment of cycle 2	15 days (after 1st cycle June, and July, 2022)
Final stage	• Collect data/text collection through interview, focused group discussion, Observation, Diary and logbook • Analysis, Interpretation, and meaning making • Sharing final interpretation and meaning making with critical friends and participants for further improvement • Finalize the interpretation conclusion • Wrapping up the entire plan	5 days (4th week of July)
Report	• Report writing • Submition	2 month (August and September)

Appendix 2: Sample of lesson plan

Digital storytelling lesson plan (5E inst. model)

Date 5 June 2022 Name Puskar Singh Bohara

Class- Ten No of students: 50

Subjects: Mathematics

Unit: Compound Interest (CI) Proposed time: 40 minutes

Objectives: At the end of the class students will be able to:

a. Describe basic concepts of interest system.

b. Identify problems and probable solution related to the interest system

c. Understand the integration of other disciplines in the story

d. Identify the skills used by students during the DST

Materials used: Digital story, Laptop, projector and Smart board.

Learning Theory used: Vygotsky's Social constructivism

- Learners are not passive recipients of information (knowledge cannot be received passively), but they actively construct their knowledge through social interaction.
- Teacher will facilitate students discussions and activities, encourage multiple awareness, challenge students' thinking

Steps	**Teaching learning activities**		**Integrated activities**		**Time**
	Teacher's role	**Student's role**	**Materials**	**Key functions**	
ENGAGE:	-Group division of	-Will think and	Textbook, notebook,	Group division,	mi

The activities in this section will stimulate their thinking and help them access prior knowledge	students (4 group) Pose brainstorming questions about picture of the DST (What is the picture about? Guess the story form the picture) -Present the initial condition of the story 1. -Discuss about their prior knowledge related to the story contents	observe different objects in the DS. - Try to give probable answer		responsibility, discussion	nutes
EXPLORE	-Let students their answer of the	-Will discuss in a group	DST, laptop, smart board	Observe the story and work	0 mi

In this section students will be given time to think, plan, investigate and organize collected information)	discussion questions -Present story 1, pause the story and discuss with groups of students.	-Try to answer the questions arises during the discussion -Pose question about the situation		in the group through collaboration, communication	nutes
EXPLAIN In this section, students will be involved in an	-Let the students discuss in the group to finalize their understanding - Facilitate and explain some questions posed	-Discuss within the group to finalize their understanding, describe understanding, and pose the question -Present	DST, laptop, smart board	Observe and listen the content and situation on the story group discussion, knowledge construction regarding	0 minutes

analysis of their explorati on. Their understan ding is clarified and modified.	by students.	the ideas they learn in a class -Collect feedback from other groups and discussion		simple interest, preparation for appropriate answer in class	
ELABO RATE T his section will allow students to expand and solidify their understan ding of the concept	-Present the story one and discuss with the group of students -Let some students explain about what they learned from other groups -Remind them and explain the content in the	-Present the knowledge they got previously. -Discuss concepts of interest - finalize group work (ppt. slide or chart paper) -Final view on arrangement and	DST, laptop, smart board	Listen other's answer and try to create new solution of the problems Observ e and listen the content and situation on the story Prepare , present, and collect the final understanding of the story	5 mi nut es

and/or apply it to a real-world situation	story.	designing concept		regarding content, skills, and integration of the disciplines	
EVALUATION This section will provide opportunities for concept check test items and answer keys that are aligned to the learning	-Allow students for final answer - Evaluate students and give feedback -Will observe understanding and skills used by students, - Evaluate every stage of the class	-Give feedback and comment to the other group -Prepare final understanding to the content, skills, and disciplines		Observation, Individual presentation, participation and understanding about contents Evaluation of the story Content discussion, integration, skills and conclusion	ontinuously in whole class

objectives, content, and performance standard					

Appendix 3: Plan used to create stories

Story	Problem	ettin g	Cha racters	Plot (Situation)	Sol ution
1.	➢ What is interest? ➢ Terms used in simple interest and notation ➢ Ethical connection	illag e, poor situa tion	➢Rich merchant ➢Poor farmer ➢Son of farmer ➢Teacher	• Borrow some money from merchant • Every year pays some money but remains the borrow money • Observed by son of farmer and asked to the farmer • Meet the teacher to know more about interest system, discussed with merchant	Far mer tell the interest system in village Te acher tell the terms used in interest system s'g } lglZrt /sdlglZrt ;dodflglZrt Jofhb/ cg';f/ k|fKtx'g] cltl/St /sd g} Aofhxf] . M ore interest rate leads to pay more money in interest
2.	➢ Basic concepts of compound interest ➢ Ware about the interest system	orpo rativ e insti tutio n in villa ge	➢Farmers, ➢manager ➢Trainer ➢students	• Farmers borrows some loan from institution • Interest was varying • Not satisfied with behavior of manager • Conduct training • Students teaches other people in village	Interest on interest is CI Cu mulate if not pay in fixed time
	➢ Compound interest increased loan	illag e	➢Lazy farmer (Govind)	• Govind has 3 hector land but donot want to	He worked hard in his

3.	➢ Lazyness ➢ https://www.youtube.com/watch?v=hYhLY3m4-D0	arm	➢ His wife ➢ God of wealth (Laxmi)	work in his farm, used to sleep whole day • Took loan from bank, compounded interest • Loan amount increases every year, become worried • One day, he went to his farm, but slept under the shadow of tree • Meet laxmi, you have a wonderful farm, produce 5% of grain would be of gold. Every year it increase by its double rate.	farm and produce a lots of grains He sold extra amount of grains Payed some loan every year, interest decreased Finalize the loan and realize that, those extra grains are gold and working had will produce gold.
4.	➢ Types of interest used ➢ Interest rate	chool and Bank	➢ Bank manager ➢ Teacher ➢ students	• Teacher wants to give an idea about interest system to his students by visiting bank manager in near bank • There was confusion about the interest rate	Bank manager explains the interest system in bank SI and CI Teacher explain the meaning of interest rate If the interest of rs.100 in a year is Rs.12 then we call R=12%
5.	➢ Comparison of Simple interest	illage	➢ Two students of grade	• Two farmers borrows same amounts of	Teacher explain

	and compound interest		10, their father were farmers ➢ Two bank having simple and compound interest system	money from two different bank for agriculture purpose • After 3 years they wants to return • But both bank ask different amount of money • They return village and ask the teachers	simple and compound system For the same time compound interest might be greater than simple interest
6.	➢ Derivation of formula for CI	lassroom	➢ Teacher and students	• How can we derive formula for CI	Discussion and interaction between teacher-students. Teacher facilitate to derive formula for CI, and students derive formula for CI
7.	➢ Calculation of compound interest without using formula	lassroom	➢ Teacher ➢ Students	• How can calculate CI? • How can calculate CI without using formula? • Use of formula in calculating CI	• Teacher explains two ways of calculating compound interest • Without using formulae • Use of formula to calculate CI
8.	➢ Calculation of compound interest without using formula	lassroom	➢ Teacher ➢ Students	• How can calculate CI? • How can calculate CI without using	• Teacher explains two ways of calculati

				formula? • Use of formula in calculating CI	ng compound interest • Without using formulae • Use of formula to calculate CI
9.	➢ Calculation of compound interest using formula	lassroom	➢Teacher ➢Students	• Use of formula in calculating CI	• Teacher revised the ways of calculating compound interest without using formula • Use of formula to calculate CI
10.	➢ Half yearly and yearly compound interest	raining hall	➢Villagers ➢Students ➢Facilitators	• Villagers and students were excited to participate training organized by microfinance • To facilitate the training, external expert were invited	Expert discussed about half yearly and yearly CI How they can calculate.

Appendix 4: Class observation guidelines (Semi-structured)

. N.	**Observation aspect**	**Specification**	**Observed situation/events**
.	Classroom environment	• No. of students • Sitting arrangement	

		• Materials in classroom • Initial classroom environment	
.	Starting condition of class	• How class started? • What was student's expectation? • What was response of students?	
.	Behavior of students	• Listening and observing DS • Note taking and questioning • Interaction and views • Effort and contribution • Curiosity and attention	
.	Emotion of students (Reaction of students)	• Enjoyment, happiness • Feeling through words • Body language • Connection of felling with content	
.	Cognitive activities of students	• Depth knowledge • Self-regulation • Creativity • Understanding and meaning-making	

		• Ways of problem solving	
.	Other activities	Which behavior did you observed mostly during DST? How can we use DST for better learning and more interactive activities? Are students relate other subjects? What types of skills did you observed in DST class? What is your feeling? Your feedback?	

Observer:

Name: Date:

Signature: Time:

Appendix-5: Classroom reflection sample

Day three; 26 May 2022

Today, I planned to present 3rd digital story in the class in which I improved the story with the help of critical friends. The school was running the morning shift from 6:15 to 11:30 AM. It was the fourth period (about 9:15 AM) of the regular class of the school and was leisure time for students. I entered the class of grade ten with my critical friend Mr. Damber sir. When we entered the class, most students were feeling happy. I think; why they are being happy? I asked them; why are you being happy? The most student said, "*Because today is also story day sir…… we will enjoy today*!" After the event, I realized that students were feeling happy, joyful, and eager to see DST in the class.

Some questions arosein my mind; why they were not feeling happy, and joyful in their usual classroom? How can I improve my pedagogy so that all students get a joyful environment in the classroom? From the scenario of the classroom, it was easy to say, there is a problem in our conventional pedagogy, and in our usual classroom activities.

After talking a few times, students were divided into six groups. After that, I started with a slide presentation of a story on a smart board. The story was about the "teaching style of Ramlal sir". He was an experienced mathematics teacher who tries to teach his students by different methods and using technologies. In the story, Ramlal brings his students to the nearby bank to discuss a simple and compound interest along with the different aspects of interest systems. In the story, they find solutions to questions from the manager of the bank. I started the story as a picture along with brainstorming questions.

I observed that most of the participant students were enjoying answering those brainstorming questions.Why students became active in the mathematics classroom? How I made such an environment in the mathematics classroom? It might be the effect of contextual DS in the classroom. It was really good for me as a researcher, because most students were emotionally and behaviorally engaged in the classroom.

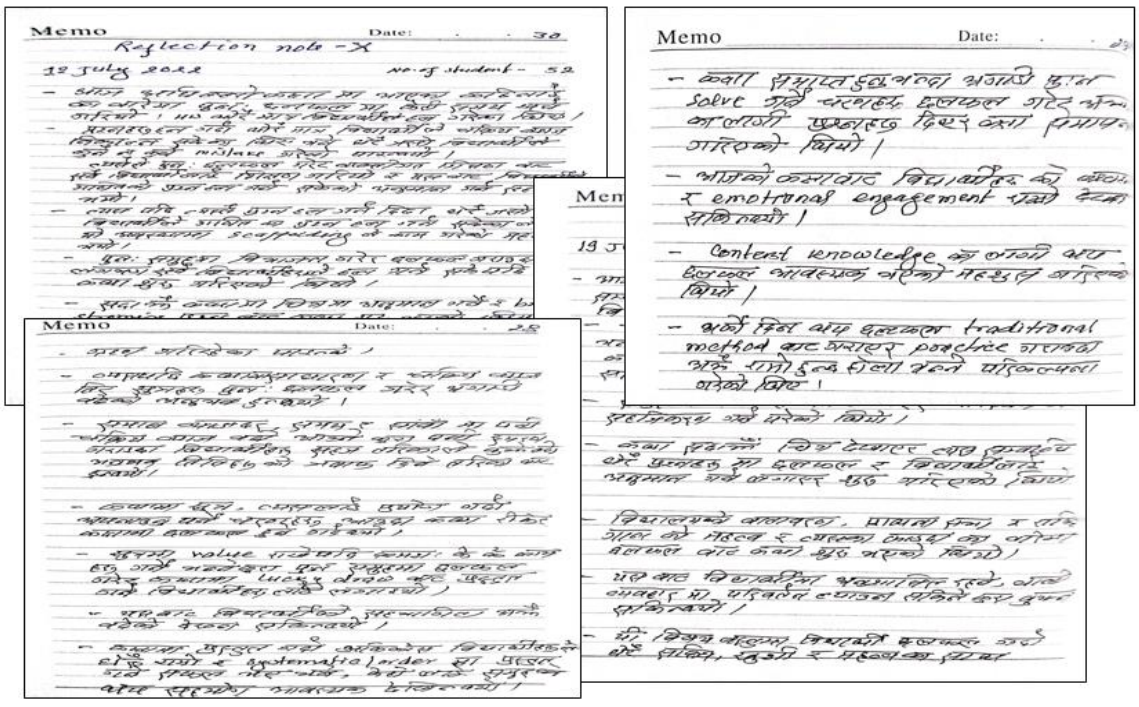
In every slide of the story, I started with a picture followed by brainstorming questions for discussion. Students were discussing themselves in their groups during answering the questions. They were trying to give subjective answers to each of the questions, joking about others' answers, concluding, and trying to collaborate in the group. From this, I realize that they were in the position of enjoying, expressing their feelings, and developing their behavior towards socialization.

When the manager of the bank told about simple and compound interest in the story, most students were listening and observed each event. On the other hand, students were taking notes on mathematical content that appears in the story and trying to solve related problems during the discussions. During the discussion time, I observed that they had made a clear understanding of simple and compound interest, types of compound interest, profit in using the interest system in society, and things to be aware.

At the end of the story, we discussed the contents included in this from different disciplines, and feedback to improve the story. My critical friend Mr. Damber sir suggested presentinga story through slides and concluding the discussion in each step of the story to make better learning. Lastly, I end the discussion by thanking all of them. From the use of digital storytelling in class, I found that students were engaged emotionally, behaviorally, and cognitively. I found the scenario of

students' engagement and integration of other disciplines by using digital storytelling in mathematics class.

After the classroom, Mr. Damber sir said that "*it was an excellent class, it was joyful for all. All students were actively engaged in classroom activities.*" From his statement, I felt better.He also raised the question, "*is it enough to engage in mathematics learning?*" We discussed the possible ways to improve our class. We concluded that an actively engaged, and joyful environment might not enough for cognitive engagement in mathematics learning.Our activities should focus on cognitive engagement. After that, I made a plan to provide more time for interaction, note-taking, and practice in the group of students during DST in the mathematics classroom from the next classes.



Picture: Sample of class reflections

Appendix 6: Data/text collection Plan

Data/text collection tools used in CAR	How?	Why?	Where?	When?
Unstructured Interview	1. initial One by one (One day each: 45 minutes-1hour) with co-researchers 2.Short interview with critical friends to collect reflection (15 minutes after each class observed by critical friends) 3. Telephone and video call 4. code-category-themes-interpreting themes based on thematic and theoretical framework	1. To find disengaged condition in mathematics classroom 2. To collect feeling, emotion, contextual knowledge from digital story (DS) and improvement in DS 3. To clarify concept, interpret and make meaning	1. Face to face interview at School 2. After, before or at school time	1. One-two days Initially 2. One week alternative days with co-researchers (Students +Teachers) 3.
Focus group discussion	1. Invite focus group students and critical friends	To collect evidences for students' engagement in mathematics classroom through DST	1. At face-to-face at school	3 days in beginning, middle, and end of the study
Observation	1. Observation of self, peer of students and critical friends	1. To observe students' engagement during and after DS presentation 2. To collect the behavior during classroom discussion, test and assignment in classroom	Clasroom	Every DST classroom in mathematics
Diary	Use personal research diary and critical friends' diary	1. To take field Note/ Observation Note (Important		1. Every day during and after

		activities of the classroom) 2. To update Reflective Journal (my reflections) 3. To collect reflection and suggestion of critical friends for improvement of classroom activities and DS 4. To collect appropriate points during interview, informal discussion		implementation of plan.
Reflecting Critically	1. Reflect upon content, process and assumptions 2. Reflecting upon each step of action procedure 3. Reflection for future actions (deciding whether to stop intervention or think about new action cycle)	1. To collect reflection on students' engagements 2. Reflect upon each of the steps		1. Continuously (during and after interview and classroom interaction) 2. After monitoring the effect of intervention
Report Writing				Two months after implementation of all stage of CAR

Appendix 7: Interview guidelines for teachers

- Informal and Informational discussion before recording
- Recording will be taken by taking consent of the participants

Opening section (Greeting and rapport building)

1. **Greeting:**Namaskar/Good morning/afternoon/Evening. How are you? What are you doing now days? Can you tell me about your teaching experiences?
2. **Inform about use of interview:** consent and confidentiality
3. **Information about study:** I am doing study about students' behaviour in classroom. So now we will talk about the same topic, use of art in teaching-learning, story and digital stories (DS) in teaching learning, how can DS will be helpful? How can we use DS to enhance students' engagement?

Body Section (Content for interview with teachers/co-researchers)

1. **Classroom behaviour of students**

   Sir you have long experience in teaching field, Can you tell about some behaviour of students?

   What types of learning activities do you feel in classroom? I mean some students shows disengaging behaviour, did you feel this types of situation ever?

2. **Learning achievement:**

   What is your view about Low achievement of mathematics in secondary level government school?

   In your opinion, what are some Factors affecting low achievement?

Can Pedagogical improvement enhance learning achievement? How?

3. **Less interest of students:** What is our general Pedagogy of mathematics teaching? Students' interest on our pedagogy? , classroom environment, group of students
4. **Knowledge construction:**

   What types of learning environment in classroom? How student are learning mathematics?

   How we use interaction/ discussion in classroom?

   How can we allows opportunities for Students' views in learning mathematics?
5. **Art-based pedagogy:**

   How can we use arts in mathematics?

   How can we use storytelling, storytelling in mathematics teaching?

   How can DS effect the learning?

   How can teacher use DS in classroom so that class will become more interactive?
6. **Types of engagement and DS (For co-researcher teacher):**

   How can DS change the behaviour, emotion and cognitive level of learner?

   How to use and present DS to enhance engagement of learners?

   What are precautions we have to consider during presentation of DS so that learner will engage in interaction?

   Is there any other ways to use DS for interactive classroom activities?

Is DST relates other disciplines? Science, Technology, Social, Ethical and values.

How can we integrate other disciplines in DST in mathematics class?

Did you feel DST is helpful for interactive classroom?

How can we make more interactive class by using DST?

How can we improve DST in classroom?

7. **Experience of students (For students Only)**

Did you feel DS is being more helpful in mathematics class? How?

What difference you feel in DST and traditional classroom?

What was your/others feeling during DST?

What types of activities of other students you observed?

How much it is useful for discussion and make meaning?

How can you learn mathematics from DS?

What things did you learnt from DST related to other subjects?

Closing of interview

1. **Summarization of interview:** Today we talk about……., Anything to add,
2. **Wrap-up:** We will discuss letter, Thank you for your support

Appendix 8: Interview guidelines for students-Participants

- Informal and Informational discussion before recording
- Recording will be taken by taking consent of the participants

Opening section (Greeting and rapport building)

4. **Greeting:**Namaskar/Good morning/afternoon/Evening.
5. **Inform about use of interview:** consent and confidentiality
6. **Information about study:** I am doing study about students' behaviour in classroom. So now we will talk about the same topic, use of art in teaching-learning, story and digital stories (DS) in teaching learning, how can DS will be helpful? How can we use DS to enhance students' engagement?
7. **Introduction and rapport building**

    Your introduction?

    How are you? How are you spending your time now days?

    Can you tell me, how much years you read in this school?

    How is the environment of school?

Body Section (Content for interview with teachers/co-researchers)

8. **Classroom behaviour of students**

    Which subject do you like most? Why?

    Which subject likes your friend?

    What about mathematics?

    What is your friend's feeling about mathematics?

    Can you tell about some behaviour of students in mathematics class?

What types of learning activities do you feel in classroom? I mean some students shows disengaging behaviour, did you feel this types of situation ever?

9. **Learning achievement:**

Most of students know/ understand or not? What is your experience?

What is your view about Low achievement of mathematics in secondary level government school?

In your opinion, what are some Factors affecting low achievement?

Can Pedagogical improvement enhance learning achievement? How?

10. **Less interest of students:**

What is your teacher's general Pedagogy of mathematics teaching?

Students' interest on that pedagogy? , classroom environment, group of students

11. **Knowledge construction:**

What types of learning activities did in classroom?

How student are learning mathematics?

How your teacher use interaction/ discussion in classroom?

How teacher can allows opportunities for Students' views in learning mathematics?

12. **Art-based pedagogy:**

Can you remember any interesting mathematics class?

What types of activities was in that class?

Have you ever experience the any kinds of art (Song, poem, story) in mathematics teaching or any other subject?

Have you any experience storytelling?

Storytelling through smart board?

13. Types of engagement and DS :

Emotion

What did you feel when studying mathematics from DST?

Did you feel happiness/sadness? When?

Which types of word did students used during happy?

What types of body language used by students?

Behaviour

What was the behaviour of students during DST?

How they are participating in group discussion?

How they are trying to answer in group/individually?

All students were trying to answer the questions from DST even if they were silent in other classes why?

Cognitive

What mathematical content did you learnt from story?

How do you understand mathematical concepts?

What were content of other subjects in story?

In what aspect the process is differ from traditional teaching mathematics?

14. Experience of students (For students Only)

Did you feel DS is being more joyble in mathematics class? How?

What difference you feel in DST and traditional classroom?

What was your/others feeling during DST?

What types of activities of other students you observed?

How much it is useful for discussion and make meaning?

How can you learn mathematics from DS?

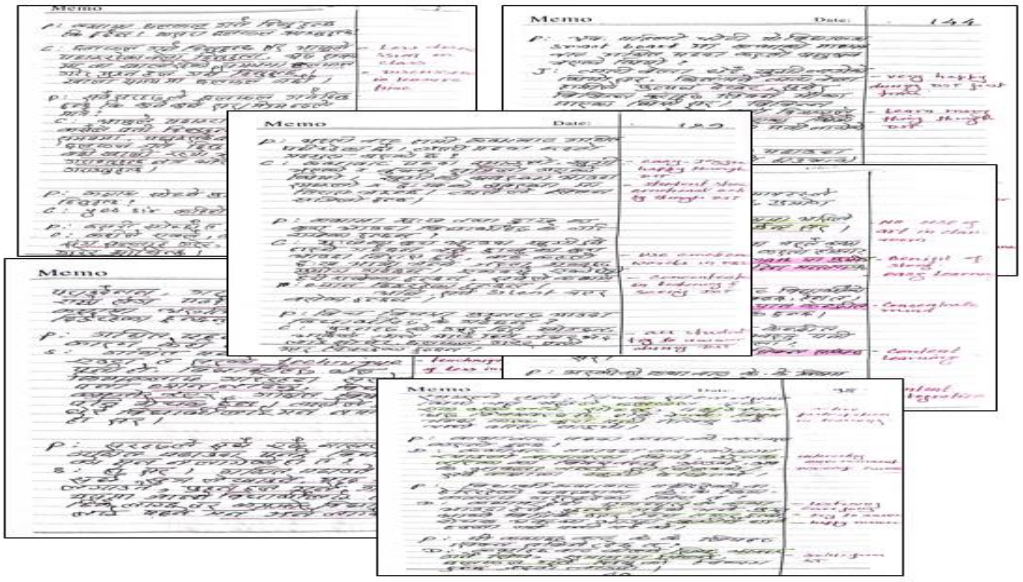
What types of skills did you observed in other students during DST?

What things did you learnt from DST related to other subjects?

Closing of interview

3. **Summarization of interview:** Today we talk about……., Anything to add,
4. **Wrap-up:** We will discuss letter, Thank you for your support

Appendix 9: Interview Transcript and Coding Samples



Appendix 10: Sample of digital story