Jurnal Pendidikan Matematika (Kudus)
P-ISSN 2615-3939 | E-ISSN 2723-1186
https://journal.iainkudus.ac.id/index.php/jmtk
DOI: http://dx.doi.org/10.21043/jpmk.v6i1.19405
Volume 6, Number 1, June 2023, pp. 1-18

Promoting Collaboration in InFleX Modality: A Case on Teaching History of Mathematics

Joneil Bariñan Medina[1*]
[1]Department of Science and Mathematics Education, College of Education, Mindanao State University – Iligan Institute of Technology, Iligan City, Philippines
**Correspondence: joneil.medina@g.msuiit.edu.ph*

Abstract

The goal of mathematics education in the Philippines is the development of critical thinking and problem-solving skills of the students. The pandemic, however, posed a serious challenge in implementing strategies that would promote 21st-century skills among unprepared students. This paper aimed to present the mathematics instructor's experience in promoting collaboration in the time of the pandemic among pre-service teachers, utilizing the innovative and flexible (InFleX) modality. As action research, this paper describes the implementation of modular collaboration projects and study groups to promote collaboration. Utilizing local research outputs on interdisciplinary contextualized project-based units, collaborative problem solving, and communication patterns, these mechanisms of implementing collaborative activities in online and distance learning modality was devised. Purposive sampling is employed in the collection of student data. Preliminary survey results of the student experiences yielded some types of students' mechanisms of decision-making and collaboration that are termed additive; goal-oriented and consultative. Students also expressed the role of the teacher in the collaboration activity and the challenges encountered. The implementation of the modular collab projects amidst the challenge of connectivity and the pandemic through the establishment of study groups and multiple communication channels encouraged students to achieve the module outcomes.

Keywords: Collaboration; Modular Collaboration Project; Online Distance Learning; Pandemic; Study Groups

Abstrak

Tujuan pendidikan matematika di Filipina adalah pengembangan kemampuan berpikir kritis dan pemecahan masalah para mahasiswa. Namun, pandemi menimbulkan tantangan serius dalam menerapkan strategi yang akan mempromosikan keterampilan abad ke-21 di kalangan mahasiswa yang tidak siap. Artikel ini bertujuan untuk menyajikan pengalaman instruktur matematika dalam mempromosikan kolaborasi di masa pandemi di antara calon guru, dengan

memanfaatkan modalitas inovatif dan fleksibel (InFleX). Sebagai penelitian tindakan, artikel ini menjelaskan implementasi proyek kolaborasi modular dan kelompok belajar untuk mempromosikan kolaborasi. Memanfaatkan hasil penelitian lokal pada unit berbasis proyek kontekstual interdisipliner, pemecahan masalah kolaboratif, dan pola komunikasi, mekanisme pelaksanaan kegiatan kolaboratif dalam modalitas pembelajaran online dan jarak jauh ini dirancang. *Purposive sampling* digunakan dalam pengumpulan data mahasiswa. Hasil survei awal dari pengalaman mahasiswa menghasilkan beberapa jenis mekanisme pengambilan keputusan dan kolaborasi mahasiswa yang disebut aditif; berorientasi pada tujuan dan konsultatif. Mahasiswa juga mengungkapkan peran guru dalam kegiatan kolaborasi dan tantangan yang dihadapi. Implementasi proyek kolaborasi modular di tengah tantangan konektivitas dan pandemi melalui pembentukan kelompok belajar dan berbagai saluran komunikasi mendorong mahasiswa untuk mencapai hasil modul.

Kata Kunci: Kelompok belajar; Kolaborasi; Pandemi; Pembelajaran Jarak Jauh Online; Proyek Kolaborasi Modular

Introduction

During the pandemic, a multitude of problems and obstacles arose, posing unprecedented challenges to traditional teaching methods across all levels of education. Inuki Sanchez Ciarrusta (2021) of the World Economic Forum pointed to the major challenges brought about by the pandemic, namely, translating traditional pedagogical models that do not translate to remote learning well; and the recalibration of the time teachers spend on teaching and engaging students and doing administrative tasks. However, SDG 4, which states, *ensure inclusive and equitable quality education and promote lifelong learning opportunities for all* still stands, and calls for action are known such that efforts should be made to sustain education (International Task Force on Teachers for Education 2030; 2020). In line with this challenge is to focus on the attainment of relevant 21st-century skills, as Partnership for 21st Century Skills claims: "To succeed in the 21st century, all students will need to perform to high standards and acquire mastery of rigorous core subject material. All students also will need to gain the cognitive and social skills that enable them to deal with the complex challenges of our age." (2011, p.11) Hence, with this being said, it is clear that educators should pursue the development of relevant skills such as Learning and Innovation Skills, Life and Career Skills, and ICT skills (Partnership for 21st Century Skills, 2009).

To contextualize this issue, a review of the Philippine Basic Education Mathematics framework is necessary. *"The goal of mathematics education is to develop a mathematically empowered citizenry. For Filipino students, the goal of Mathematical Empowerment focuses on developing critical and analytical thinking skills among all Filipino students."* (SEI-DOST & MATHTED, 2011, p.6). This goal of

mathematical empowerment is translated into the Mathematics Curriculum Guide (2016) as the twin goals of mathematics education of developing Critical Thinking and Problem-Solving skills of the students. These skills are embedded in the Learning and Innovation Skills (Partnership for 21st Century Skills, 2009) and while distinctly identified are interrelated with the other key skills commonly known as the 4Cs namely Creativity, Critical Thinking, Collaboration, and Communication. As Partnership for 21st Century Skills would put it, "While the graphic represents each element distinctly for descriptive purposes, the Partnership views all the components as fully interconnected in the process of 21st-century teaching and learning" (2011, p.1). A good example of this claim is seen in the Intel® Education Transforming Learning: Digital Learning Fundamentals (2015) on the purposes of Digital Communication and Collaboration: (1) Student Achievement & 21st Century Skills; (2) Global Citizenship & Cross-Cultural Connections; (3) Learning as a Social Experience; (4) Deeper Content Understanding. While developing skills of communication and collaboration, one can also allow learners to have deeper engagement with content and use them critically to attain established goals as a group. Hence, it is not far to claim that targeting any of the skills to be developed inevitably touches upon the other skills. In short, while the pandemic posed several challenges to teaching and learning, it is still imperative to pursue and develop relevant 21st-century skills for learners.

This is the reason why educational institutions enacted different approaches to continue delivering quality education. Some of these strategies vary, depending on the context, capacity, infrastructure of the institution, and even the country. For example, Miao, Huang, Liu, & Zhuang, (2020) through UNESCO recognize distance learning modalities as some of the strategies that can address the challenge of ensuring quality teaching and learning. Accordingly, one of the roles of teachers in distance learning modality is "to deliver distance teaching, teachers should design activities to help learners actively explore and construct their understanding of a topic; plan flexible learning tasks and provide feedback so that learners can progress at their own pace; provide learners with opportunities to stay connected with peers, learn through discussion and communication, and feel empowered" (Miao, et. al., 2020, p.8). The roles of teachers, according to another framework, the #Openteach model of educator roles in online and distance learning, also emphasized the facilitator role is defined as a role to create student-centered learning environments; encourage student ownership of learning; and monitor and guide student interactions (Ní Shé, Farrell, Brunton, Costello, Donlon, Trevaskis, & Eccles, 2019). In addition to their facilitation role, they also exert other Managerial, Pedagogical, Social, Technical, Assessor, Content Expert, Instructional Designer, Researcher, and

Evaluator Roles (Ni She, et. al., 2019). As a response to the pandemic in the Philippines, among Higher Education Institutions; the Commission of Higher Education endorsed flexible learning modalities through their advisories and even issued memos that provide guidelines for such implementation (CHED, 2020a & CHED, 2020b). In turn, HEI's in the Philippines enacted various localized and contextualized adaptations of such learning modalities. As suggested by Yohannes, Juandi, Diana, and Sukma (2021), teachers should be given appropriate training to alleviate the challenges and difficulties they faced.

The Mindanao State University - Iligan Institute of Technology also adopted a framework of Innovative and Flexible Learning (InFleX) Teaching and Learning Modality (https://web.msuiit.edu.ph/institute-to-implement-inflex-modality-for-incoming-semester/). InFleX simply said, is the contextualized distance learning modality framework promulgated by MSU-IIT in response to the call of CHED (2020a, 2020b) to implement flexible learning modalities. It features the use of the Moodle-based learning management system, with print counterparts to cater to learners restricted by COVID-19 restrictions. The InFleX modality considers the learner's success as its core; done through the context of collaboration among the stakeholders to plan, implement, reflect, and revise practice to be able to deliver clear, holistic, relevant, engaging, and achievable learning experiences. Buan (2020) identified InFleX Teaching as the ability [of teachers] to tailor-fit synchronous & asynchronous learning activities, considering the students' varied access to technology and other relevant resources. Teachers therefore in the university are encouraged to collaborate with peers to plan, implement, reflect, and revise teaching and learning practices to deliver quality instruction with the learner's success in mind (see Figure 1).

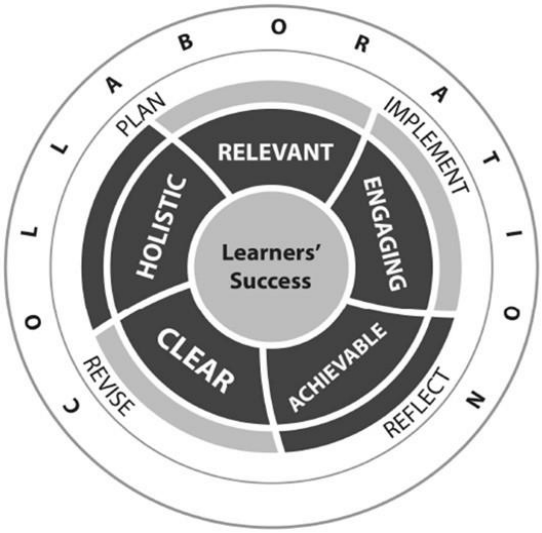


Figure 1. The Innovative and Flexible REACH Framework

However, the key to this framework is the understanding of the student's circumstances and capacities. In a survey conducted in June 2020 by one of the colleges of the university through the online survey; only a small fraction, only around 9% of the student population was able to take the survey; indicating that the majority of the students did not have access to the internet at the time of the survey; nor have access to the survey information (CED Survey Report as of June 5, 2020; CED Overview Student Population; accessed May 2021). While most of the respondents have smartphones (73.64%); laptops (43.41%) and some have Desktop PCs (13.95%) there are still those who only had basic cellular phones (30.32%). Looking at this demographic, it is clear that there is an obvious gap in student access to resources. Furthermore, most of the respondents (51.16%) use only mobile data as their main source of internet access; some have their own broadband connections at home (41.09%) and the rest have access to the internet only through other means. Apparently, there is a great challenge for the students to collaborate and even communicate with each other. Other studies such as that of Adnan, & Anwar (2020) and Toquero (2020) confirm the veracity of the apparent observation from the survey for both the teachers and students in higher education institutions; students were hesitant the online distance learning, have no confidence to finish group projects/activities (Adnan & Anwar, 2020) and the teachers are not prepared and unskilled in facilitating online classes (Toquero, 2020).

In line with the abovementioned literature, while there is a need to pursue quality teaching and learning, in line with the SDG 4 of Quality Education, the 21st Century skills, and the attainment of mathematical empowerment for the Philippine Basic Education, the pandemic serious challenges even for higher education institutions. Student circumstances taken into consideration, interventions are implemented to provide quality teaching and learning experiences for students during the pandemic. This paper aimed to present the mathematics education instructor's experience in promoting collaboration during the pandemic among pre-service teachers, utilizing the innovative and flexible (InFleX) modality. Specifically, this answers the following questions: (1) How is the course designed to provide flexible distance online learning? (2) How is collaboration promoted in the course? and (3) What are the students' experiences in the implementation of the course?

Method

Design. This paper is descriptive action research where the teacher records his experiences of addressing a problem in his classroom. Susman & Evered cited Kurt Lewin characterizing *"⋯ action research as comparative research on the conditions and effects of various forms of social action and research leading to social*

action" (1978, p. 6-7). According to Sagor (2000); there are 7 steps in doing action research: (1) Selecting a focus; (2) Clarifying theories; (3) Identifying research questions; (4) Collecting data; (5) Analyzing data; (6) Reporting results; and (7) Taking informed action. This action research focused on promoting collaboration in the course and the mechanisms surrounding its implementation.

Participants. The context of this research is on a teacher education program with a major in secondary mathematics education. Freshmen students in this program took a course on the History of Mathematics; on the 1st Innovative & Flexible teaching and learning modality term of the school year 2020-2021. The students in this class were coming from different backgrounds and different geographical locations; most students were unfamiliar with the university's existing Moodle-based Learning Management System called the MSU-IIT Online Learning Environment (MOLE). There were N=39 students in this course; with 11 Males and 28 Females. They also declared their student category, based on their resources and internet access, with C3 as the highest and C1 as the lowest capacity in terms of resources and access. This course had N=4 under C1 category, N=31 under C2 category, and N=4 under C3 category; these categories are based on the university's InFleX Modality Implementation Guidelines (MSU-IIT SO 0085, s.2020). C1 is characterized as having a minimum gadget requirement but having no access to online technology tools; C2 is characterized as having ample resources with limited access to online technology tools; and C3 is having ample resources with full access to online technology tools.

Data Collection. The data collection process is as follows: (1) the development of the course syllabus; (2) the designing of collaborative activities; and (3) the survey on students' experiences of the course. In the development of the course syllabus, considerations are given towards its format. The university is prescribed to compose a syllabus that is outcomes-based. This is further refined to fit the need of the remote teaching and learning modality. Some features are refined to fit the current need. Secondly, the designing of the collaborative activities is anchored on local research focused on promoting project-based learning and contextualization (Medina, Managing & Buan, 2018); collaborative problem solving (Medina, Buan, Mendoza, & Buan, 2019; Managing & Salazar, n.d.) and communication patterns in collaborative problem solving (San Pablo, n.d.) which are researched in local contexts. Elements from the research are derived to design the Modular Collaborative Projects that the students engaged in for one module in the course studied.

The course syllabus is evaluated through self-assessment and peer assessment, utilizing a checklist provided by the university. This checklist assesses

not only the syllabus itself but also the course materials that have been developed. The syllabus went through multiple revisions before receiving approval from the quality assurance team.

Analysis. The analysis techniques used in this action research were document analysis and thematic analysis. Document analysis were employed to investigate the records of the students' performances during the course and thematic analysis was used to derive meaningful themes from their perceptions and answers to the open-ended questions.

To describe the collaboration of students, a collaboration peer rating rubric with its descriptors was adopted (rubistar.4teachers.org) as follows: (1) *Contribution* – 'Routinely provides useful ideas when participating in the group and classroom discussion. A definite leader who contributes a lot of effort, (2) *Quality of Work* – 'Provides work of the highest quality', (3) *Monitoring Group Effectiveness* – 'Routinely monitors the effectiveness of the group, and makes suggestions to make it more effective', (4) *Working with Others* – 'Almost always listens to, shares with, and supports the efforts of others. Tries to keep people working well together, and (5) *Focus on Task* – 'Consistently stays focused on the task and what needs to be done. Very self-directed'. This rubric was adopted from Rubistar.com. The Cronbach alpha = 0.97 indicated that the rubric was reliable.

The analysis paper was rated according to the following criterion: (1) *Content (50%)*– The content was complete and comprehensive as detailed in the guides. Each element was thoroughly discussed in relation to the assigned civilization. There were 1-2 samples for the rules to serve as an illustration that the concept was properly understood. There were no obvious flaws in the understanding and application of rules. (2) *Formatting and Articulation (36.67%)* – The paper follows the prescribed template. There were minimal grammatical and formatting errors. The discussion of the concepts could be well understood. (3) *Timeliness (13.33%)* – The group submitted the work on or before the deadline. The analysis paper had a maximum score of 30 points. The rubric was made by teachers and constructively aligned to the outcomes. The reliability index could not be established with only one rater.

The concept map was rated according to the following criterion: (1) Concept – Most concepts and all significant concepts were selected, and they clearly relate to the topic. The arrangement of the concepts demonstrated a complete and insightful understanding of the relationship between them. Relationships make logical sense, with few errors. (2) *Structure* – Most or all concepts were connected in a hierarchical structure leading from more complex to less complex, and on to specific concepts.

(3) *Linkages* – Most or all relationships were indicated by connecting lines. All lines are labeled with linking words. Most of all linking words are accurate and varied. And (4) *Cross-links* – Cross-links showed complex relationships between two or more distinct segments of the concept map. All criteria had the same weight, with a maximum score of 10 pts. The Module score was simply the sum of the Analysis Paper score and the Concept Map score. This rubric was adopted from Hilary McLeod (2001) and retrieved from https://www.slideshare.net/funwithchemistry/rubrics-for-concept-mapping. The reliability index cannot be established with only one rater.

Results and Discussion

Course and Activity Design

The course syllabus and design were based upon the recommended format from the Policies, Standards, and Guidelines for the Bachelor of Secondary Education Programs (BSEd) issued by the Philippine Commission on Higher Education (CMO No. 75, s. 2017), revised with additional features to fit the remote teaching and learning modality (MSU-IIT SO 0085, s. 2020). The new format was termed 'OBE-RTL' Syllabus format (see Figure 2), meaning outcomes-based education remote teaching and learning format. In this format, there were a few features added for this course, namely the Teaching and Learning Activities had provisions for online and offline learning. A variety of learning resources were also provided to the students with a clear articulation of the assessment tasks, tools, and evidence of the outcome. The learning activities reflected in the syllabus were also how the students see the learning activities through the university learning management system.

DURATION / EFFORT	TOPIC	ILO	TEACHING AND LEARNING ACTIVITIES (TLA)	LEARNING RESOURCES	ASSESSMENT TASKS (ATs); STRATEGIES & TOOLS	EVIDENCE OF OUTCOME & DUE
Week 2	Module 1: The Emergence of Mathematics	Present a text analysis of the select texts on the historical emergence of mathematics.	a. Read the text on the emergence of mathematics **Early Number Systems and Symbols**, by Brunton, D. (2011) p.1-5 **(Asynchronous)** b. Using the template on text analysis, create a text analysis on the given **Civilization's Number System**. **(Asynchronous)** i. Babylonian ii. Egyptian iii. Phoenician & Syrian iv. Hebrew v. Greek vi. Early Arabs vii. Romans viii. Peruvian & North American Knot Records ix. Aztecs x. Mayan xi. Chinese & Japanese xii. Hindu-Arabic c. Discussion on the emergence of mathematics **(Synchronous)** d. Quiz on the required reading **(Asynchronous)**	Burton, D. (2011). The History of Mathematics An Introduction. The McGraw-Hill Companies, Inc. https://bit.ly/3dcExxC Accessed: June 16, 2020 Video: A Brief History of Numbers (TED-Ed) https://youtu.be/cZH0YnFpjwU	- Text Analysis (individual) (S) - Text Analysis Template & Rubric - Discussion (F) - Quiz (F)	- Submits Text Analysis in MOLE Assignment **(40 Points - Individual)**

Figure 2. Sample Syllabus for the Course Design

The activity, collaborative analysis, was designed from the results of local research, namely that of promoting project-based learning and interdisciplinary contextualization (Medina, Managing & Buan, 2018); collaborative problem solving (Medina, Buan, Mendoza, & Liwanag, 2019; Managing, Buan, Lahoylahoy & Salazar, n.d.) and communication patterns in collaborative problem solving (San Pablo, Buan, et. al., n.d.). The following Figure 3 summarized how the Modular Collaboration Projects were developed.

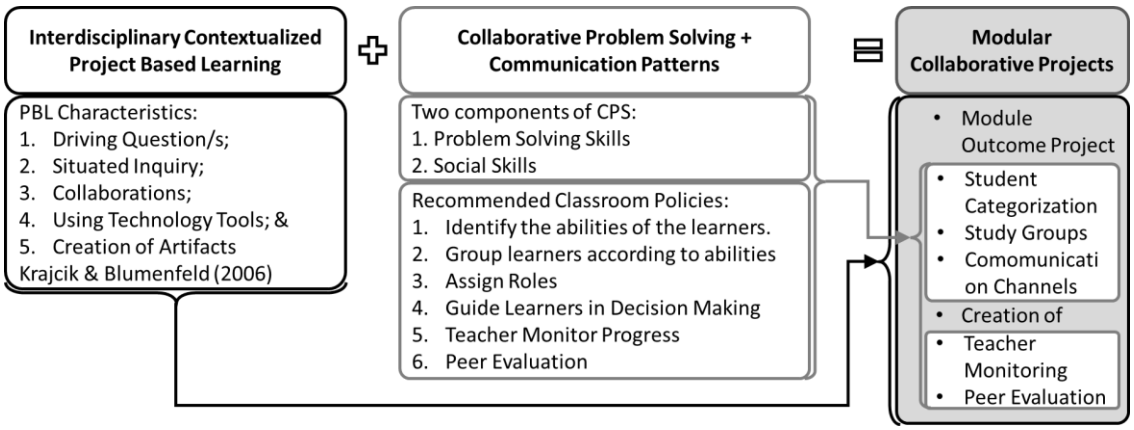


Figure 3. Basis and Process for Modular Collaborative Projects

The rationale for adopting elements from interdisciplinary contextualized problem-based learning was also based on the Department of Science and Technology - Science Education Institute (DOST-SEI) ongoing professional development training that yielded significant results among teacher trainers in the region, of which this approach in teaching was one of the key training competencies (Buan, Medina, & Liwanag, 2021) and had been found to have good effects in engaging students according to action research conducted on grade 8 students (Medina, Managing & Buan, 2019). Collaborative problem solving is also one of the key skills of the 21st century where both problem-solving skills and social skills are needed (Medina, et. al., 2019; Managing, et. al., n.d.) this is also reinforced by the findings of San Pablo, et. al., (n.d.) on her thesis on the effectiveness of collaborative problem-solving activities on students' achievement of learning outcomes and recommended classroom policies supporting collaboration among learners.

Elements from contextualized project-based learning, such as *driving questions; collaboration,* and the *creation of artifacts* were adopted into the *modular collaborative project* design. This was coupled with mechanisms adopted from CPS and the recommendations of San Pablo et. al. (n.d.) such as *student categorizations; establishing study groups and communication channels* with *teacher monitoring* and *peer evaluation*. These elements and mechanisms were translated into the parts of the learning guides and the establishment of study groups and communication

channels. Caldi, Jafri, and Guo (2021) confirm that combining synchronous groupings (e.g., Zoom breakout rooms) and informal social media groupings is deemed most effective.

The learning guides were integrated into the learning management system (LMS) and into digital modules (PDF) for the student to access. To ensure participation and engagement, students were purposely grouped into *study groups* that can be described as support teams that are composed of students with diverse backgrounds and categories, in terms of resources and internet connectivity. The communication channels were opened not just one communication channel, but at least four; namely email, short messaging (SMS); FB Messenger, and LMS. Sometimes, some students communicated through Discord and FB.

Student Experiences

Student Outputs. In the first module, the unit outcome was "At the end of this module, the students would present a text analysis and a concept map (& its application) of the select texts on the historical emergence of mathematics." Ultimately, the students needed to submit a text analysis; and a concept map on the emergence of a number system assigned to their group. With a perfect mark of 40 pts, the students' scores ranged from 30 to 34.5 pts. (See Table 1).

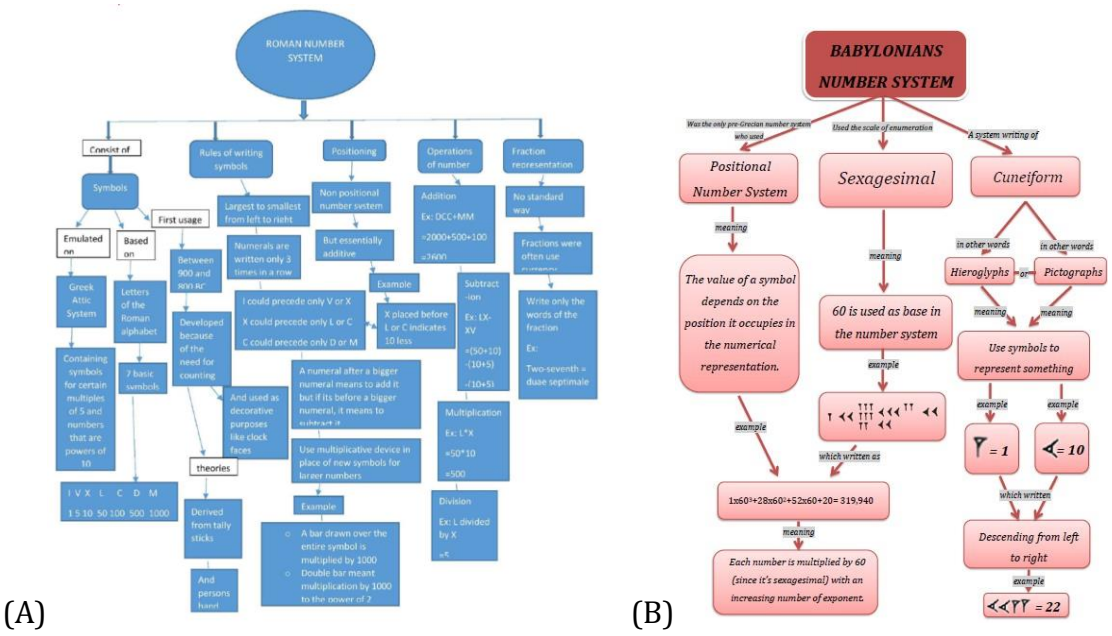
The peer rating score of 10 pts with scores ranging from 6.125 to 10 pts. (See Figure 7). The students had successfully attained the unit outcome of creating a text analysis and concept map.

Table 1. Students' Score by Group

Group	Analysis Paper Score	Concept Map Score	Module Outcome Score	Module Outcome Score (%)	Description
1	27	6	33	82.5	Satisfactory
2	28	5.5	33.5	83.75	Satisfactory
3	28	6.5	34.5	86.25	Very Satisfactory
4	28	6	34	85	Very Satisfactory
5	26	7.5	33	82.5	Satisfactory
6	24	6	30	75	Fairly Satisfactory
7	27	5.5	32.5	81.25	Satisfactory
8	27	5.5	32.5	81.25	Satisfactory

Two groups of students got 'very satisfactory' marks; five groups got 'Satisfactory' marks and only one group got a 'Fairly Satisfactory' mark. These

descriptions are adopted from the 2020 Department of Education official Transmutation Tables (Llego, 2020).



(A) (B)

Figure 4. Sample low (A) and medium (B) student outputs on concept mapping

The concept map, the visual representation of the key concepts, from the students' analysis papers showcased the extent of students' understanding of the concepts. Sample (A) scored at 5.5/10 indicating a low-quality output, it had a very simplistic cascading hierarchy with almost no linking words connecting one concept to another. However, in contrast, sample (B) scored at 7.5/10 indicating a medium-quality output, had a well-structured hierarchy with select illustrations of key concepts (see Figure 4). Furthermore, the usage of brief articulation of concepts rather than sentences was also observed with all linking lines labeled well with connecting words.

Table 2. Peer Rating Summary

Category	Descriptor	Mean Score	Standard Deviation
Contribution	Routinely provided useful ideas when participating in the group and classroom discussions. A definite leader who contributed a lot of effort'	1.795	0.293
Quality of Work	Provided work of the highest quality	1.758	0.280
Monitoring Group Effectiveness	Routinely monitored the effectiveness of the group, and made suggestions to make it more effective	1.761	0.283
Working with Others	Almost always listened to, shared with, and supported the efforts of others. Tried to keep people working well together	1.792	0.281
Focus on Task	Consistently focused on the task and what needed to be done. Very self-directed	1.786	0.279
	Total	**8.892**	**1.364**

The peer rating reflected that there was a student who was notably 'unreachable' and 'cannot collaborate'. While the rest of the class could get above 50% peer rating scores (Table 2). The above-mentioned data showed that the students were most successful in attaining the unit outcome, which was to collaboratively compose an analysis paper and create a concept map on emerging number systems. Furthermore, peer ratings showed that they can fairly *contribute to the group work; provide quality work; monitor group effectiveness; work with others* and *focus on tasks*.

Student Experiences of Collaboration. Initial survey results right after the unit was given to the students and students who volunteered in answering their experiences of collaboration. They briefly shared how they communicate in their Study Groups; how they made decisions as a group; how they perceived the role of the teacher in the unit and their challenges and impressions in the said unit. From their brief answers to the open-ended questionnaire administered to the students, the following impressions were made as to how the students make decisions as a group.

There were cases observed in their answers of "*How does your group make decisions"?* The first case, termed *additive*, highlights almost an independently created output characterized by simply adding each member's assigned 'part'. There was no mention of evaluating as a group how the whole output might be presented.

This may be characterized as the lowest kind of 'collaboration'. The second case, termed *goal-oriented* on another hand, is characterized by starting correctly with a negotiated goal with a conscious consideration of a member's resources as the tasks are assigned. While there is the same idea from the first case of *adding together* what each member did, there is an element of group evaluation and revision before the final output is submitted. Finally in the third case, dubbed as *consultative* at every turn of the activity, each one of the members consults the whole group from time to time up until the final revision and submission of outputs. These observations confirm the findings of Medina, et. al. (2019) of some of the behavioral descriptors of Collaborative Problem-Solving Skills namely *Participation; Perspective Taking,* and *Social Regulation.*

Challenges Encountered and Impressions on the Unit. The students also expressed their difficulties and challenges encountered during the Modular Collaborative Projects. As synchronous classes seemed to perform better than asynchronous ones (Libasin, Azudin, Idris, Rahman & Umar, 2021), the following challenges affirm this finding to some degree namely Learning Management, Internet Connectivity, Scheduling, and Negotiating the common challenges.

> *Also, we encountered a problem with submitting the file because the website and also the app used for submission somehow crashed or there is something wrong with the server but after a while, it was finally fixed and we were able to pass our collaborative analysis. S1 (LMS Challenge)*

> *Poor connections, a sudden brownout, and not enough gadgets are important, especially laptops. Though these challenges were really hard for them. S4 (Internet Connectivity)*

> *The challenge we encountered while making the activity is that we aren't the same when it comes in internet connectivity and it's hard to communicate every time… S6 (Internet Connectivity)*

> *The main challenge we encountered is our difference in schedule or free time, some of the members aren't on time or is not there when were brainstorming. S2 (Scheduling)*

> *Virtual groups are fun actually but it is very difficult particularly when you send your message since it might be misunderstood by the reader especially if it doesn't have commas and punctuation, this is very crucial when dealing with virtual groups. S8 (Negotiating)*

> *… not all of us being online at the same time is one of the challenges that we've encountered, so to solve this, we just leave our ideas in our group chat and wait until our other group mates approve them. S9 (Scheduling & Negotiating)*

Amid the challenges, the students are still able to learn from each other. In their answers to the impressions on the unit; some claimed to have attained a *deeper understanding of the content individually or from their peers:*

> *... The collaborative task affected my learning somehow in a positive way because I was able to* ***learn the lessons independently****, without a teacher's discussion and* ***I gained more knowledge from the topic*** *that was given to us. S1*

> *It affects my learning in a good way because there are* ***ideas shared by other members of the group that I don't know or think about.*** *It is also an advantage to collaborating because the more ideas shared among the members of the group, the easiest and faster we finish the output. S7*

Students also claimed to have experienced *learning in a social context:*

> *I think the collaborative task went well than I expected,* ***all of us are new to each other, and we don't know the attitude of each other, but … this task went very well****. I learned that it doesn't matter if you didn't personally know someone, you can do a great job if you will be understanding and kind. S2*

> *I thought that collaborative task is difficult when it comes to online classes because we had no allocated time in discussing our ideas in regard to the output.* ***But, we cooperated well and I realized that teamwork is really important because it can motivate one another to boost confidence.*** *S3*

> *I thought that it would be very difficult but it turns to be not so. It was amazing since I witnessed the different ideas that my group mates are sharing.* ***In this way, maybe they can share their ideas compared face-to-face since they are not shy to express what or she thinks.*** *S8*

There are also students who find it awkward to work with people whom they do not know personally; but nevertheless, they are still able to work it out at the end:

> *Our collaborative task is* ***quite awkward****, especially, when you are grouped to strangers or someone that don't have the same culture of the school as yourself and you are not really used to it. ... S5*

While there are obvious limitations brought about by the sudden shift to a remote teaching and learning modality, the students' experiences of collaborative

learning through modular collaborative projects proved to show evidence that collaborative learning can be successfully implemented. While there is no direct conclusive evidence of the development of collaboration skills; students' experiences and observations of the class show that the students are going in that direction.

Conclusion

This descriptive action research aimed to describe the process of developing a remote teaching and learning activity that is geared towards promoting collaboration. The course was designed using the REACH Framework of the MSU-IIT InFleX Modality, guided by the principles of OBE and local research outputs produced *Modular Collab Projects* as the main vehicle for course implementation and achievement of one of the course outcomes of the history of mathematics course. The implementation of the *Modular Collab Projects* amidst the challenge of connectivity and the pandemic through the establishment of Study Groups along with multiple communication channels encouraged students to achieve the module outcomes collaboratively. There is evidence of students' performance on the collaborative outcomes expected from them and they perceive that they performed quite satisfactorily in the collaborative activity by looking at their peer ratings.

While there is not yet conclusive and strong evidence of the development of collaboration & communication skills, based only on this single module, there is evidence that students are fostering the right attitude towards it based on the shared experiences of the students. The results of this action research are greatly limited in their generalizability due to the nature of the research design, as the teacher-researcher is susceptible to bias. However, the given narrative provides evidence that it is still possible to pursue the development of the 21st-century skills of collaboration and communication, despite the challenges experienced by both the students and the teacher. Finally, this paper can provide a basis for improving content delivery in distance and online learning.

References

Adnan, M., & Anwar, K. (2020). Online Learning amid the COVID-19 Pandemic: Students' Perspectives. Online Submission, 2(1), 45-51.

Buan, A. T., Medina, J. B., & Liwanag, G. P. (2021, March). Capacity Building in Teaching Mathematics through Problem Solving. In Journal of Physics: Conference Series (Vol. 1835, No. 1, p. 012090). IOP Publishing.

Calder, N., Jafri, M., & Guo, L. (2021). Mathematics education students' experiences

during lockdown: Managing collaboration in elearning. Education Sciences, 11(4), 191.

Ciarrusta, I.S. (2021). 4 lessons from remote learning during COVID-19, study. World Economic Forum.

Commission on Higher Education (2017). CMO No. 75, s. 2017 - Policies, Standards and Guidelines for Bachelor of Education (BSEd).

Commission on Higher Education (2021). CMO No. 4, s. 2020 - Guidelines on the Implementation of Flexible Learning.

Commission on Higher Education (2020). Guidelines for the Prevention, Control and Mitigation of the Spread of Coronavirus Disease 2019 (COVID-19) in Higher Education Institutions (HEIs) : CHED Advisory No.6.

Department of Education (2016) K to 12 Curriculum Guide - Mathematics (Grade 1 - 10). Department of Education.

Intel® Corporation (2015). Intel® Education Transforming Learning: Digital Learning Fundamentals.

International Task Force on Teachers for Education 2030 (27 March 2020). Response to the COVID-19 Outbreak Call for Action on Teachers.

Libasin, Z., Azudin, A. R., Idris, N. A., Rahman, M. S. A., & Umar, N. (2021). Comparison of Students' Academic Performance in Mathematics Course with Synchronous and Asynchronous Online Learning Environments during COVID-19 Crisis. International Journal of Academic Research in Progressive Education and Development, 10(2), 492−501.

Llego, M.A. (2020, October 29). DepEd K to 12 Grading System Steps for Computing Grades.

Managing, R., Buan, A., Lahoylahoy, M. & Salazar, D. (n.d.). Problem-Solving Models: Effects on the problem-solving skills among grade 8 students. Master's Thesis (Unpublished) Mindanao State University - Iligan Institute of Technology, College of Education

Medina, J. B., Buan, A. T., Mendoza, J. V. D., & Liwanag, G. P. (2019, October). Development of Mathematics Collaborative Problem-Solving Skills Scale. In Journal of Physics: Conference Series (Vol. 1340, No. 1, p. 012058). IOP Publishing.

Medina, J., Buan, A. & Managing, R.J. (2018). Trash to math: Integrating environmental education in teaching grade 8 mathematics. In M. Inprashitha, S. Rerkjaree, N. Luanganggoon, P. Saenna, W. Patham & P. Janta (Eds.), 11th International Conference on Educational Research: Innovations for Capacity Building and Networking (pp. 157-172). Thailand: Faculty of Education, Khon Kaen University.

Miao, F., Huang, R., Liu, D., & Zhuang, R. (2020). Ensuring effective distance learning during COVID-19 disruption: Guidance for teachers. United Nations Educational, Scientific and Cultural Organization, France. Unit for Technology and AI in Education Sector UNESCO.

Mindanao State University - Iligan Institute of Technology (2020). SO No. 0085-IIT, s.2020 - Implementation of the Proposed Guidelines for Enrollment and Class Management for the First Semester of AY 2020-2021 at the Mindanao State

University - Iligan Institute of Technology.

Ní Shé, C., Farrell, O., Brunton, J., Costello, E., Donlon, E., Trevaskis, S., & Eccles, S. (2019). Teaching online is different: critical perspectives from the literature. Dublin: Dublin City University. Doi: 10.5281/zenodo.3479402 Partnership for 21st Century Skills. (2009). P21 framework definitions. ERIC Clearinghouse.

Partnership for 21st Century Skills. (2009). P21 Framework Definitions. ERIC Clearinghouse.

Partnership for 21st Century Skills. (2011). P21 Common Core Toolkit: A Guide to Aligning the Common Core State Standards with the Framework for 21st Century Skills. ERIC Clearinghouse.

Sagor, R. (2000). Guiding School Improvement with Action Research: ASCD. Ascd. Retrieved from: http://www.ascd.org/publications/books/100047/chapters/What-Is-Action-Research%C2%A2.aspx

San Pablo, G., Buan, A., et. al. (n.d.). Communication Patterns in a Collaborative Problem-Solving Mathematics Classroom. Master's Thesis (Unpublished) Mindanao State University - Iligan Institute of Technology, College of Education

SEI-DOST & MATHTED (2011). Mathematics framework for Philippine basic education. Manila: Science Education Institute, Department of Science and Technology (SEI-DOST) & Philippine Council of Mathematics Teacher Educators (MATHTED), Inc.

Toquero, C. M. (2020). Challenges and Opportunities for Higher Education Amid the COVID-19 Pandemic: The Philippine Context. Pedagogical Research, 5(4).

Yohannes, Y., Juandi, D., Diana, N., & Sukma, Y. (2021). Mathematics teachers' difficulties in implementing online learning during the COVID-19 Pandemic. Journal of Hunan University Natural Sciences, 48(5).

This page is intentionally left blank