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# Development of Study Guides for Asynchronous E-Learning Strategies in Business Mathematics

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**Abstract.** This study investigated the effectiveness of asynchronous e-learning strategies—specifically video-based lessons and collaborative online activities—in improving academic achievement and independent learning skills among Grade 11 Business Mathematics students. Using a quasi-experimental design, 78 students were divided into two asynchronous groups (Async A and Async B). Both groups participated in video lessons and online collaborative activities. Pre- and post-tests, along with math journals, were used to assess outcomes. There was no significant difference in post-test scores or self-regulated learning skills between the two groups, indicating both asynchronous strategies were equally effective. Asynchronous e-learning can effectively support learner autonomy and achievement in mathematics. Its continued use is recommended, especially in flexible or remote learning settings.

**Keywords**: asynchronous learning, independent learning, business mathematics, study guides, online education

## 1. Introduction

The COVID-19 pandemic has accelerated the adoption of alternative learning modalities, including asynchronous e-learning, in the Philippines (DepEd, 2020). Asynchronous e-learning, which allows students to access materials and complete activities on their own schedules, has shown promise for fostering independent and critical thinking skills (Malkin, Rehfeldt, & Shayter, 2016). Asynchronous e-learning has been shown to support mathematics learning by enabling flexible pacing and repeated exposure to complex concepts (Martin & Bolliger, 2018).

In mathematics education, these approaches may help students develop self-regulation and problem-solving abilities necessary for academic success (Danso, 2017). Also, research indicates that self-regulated learning strategies, often fostered in asynchronous environments, are positively correlated with mathematics achievement (Sun, Xie, & Anderman, 2018).

Other studies have found that video-based instruction can improve conceptual understanding and retention in mathematics (Kay, 2012; Mayer, 2021). Collaborative asynchronous activities, such as online discussions and group problem-solving, can enhance critical thinking and engagement in mathematical topics (Borba et al., 2016; Soon & Choon, 2019).

This study evaluates the effectiveness of asynchronous e-learning strategies, specifically video lessons and collaborative online activities, in supporting achievement and independent learning among Grade 11 Business Mathematics students.

For these reasons, the researcher conducted this study aimed at giving continuity to the applications of asynchronous e-learning strategies in Business Mathematics, as guided by the results of the studies reviewed with similar characteristics. The present study used an online learning approach through asynchronous e-learning strategies in an online classroom with video lessons and activities as an instructional model to help the students become independent learners through the utilization of technology.

Conceptual Framework. The twin goals of the K-12 program in the Philippines are critical thinking and problem solving skills (DepEd, 2012). Critical thinking (CT) is recognized as an essential skill for students to master in the 21st century. Previous studies have indicated that teaching CT through asynchronous online discussions may be one of the successful ways to equip students in educational settings to develop 21st skills (Soon & Choon, 2019). In the present study, asynchronous e-learning strategies with video lessons and activities via online classroom will be used by the researcher to help learners improve their achievement levels and develop their independent learning skills, and eventually lead them to think critically and solve problems on their own

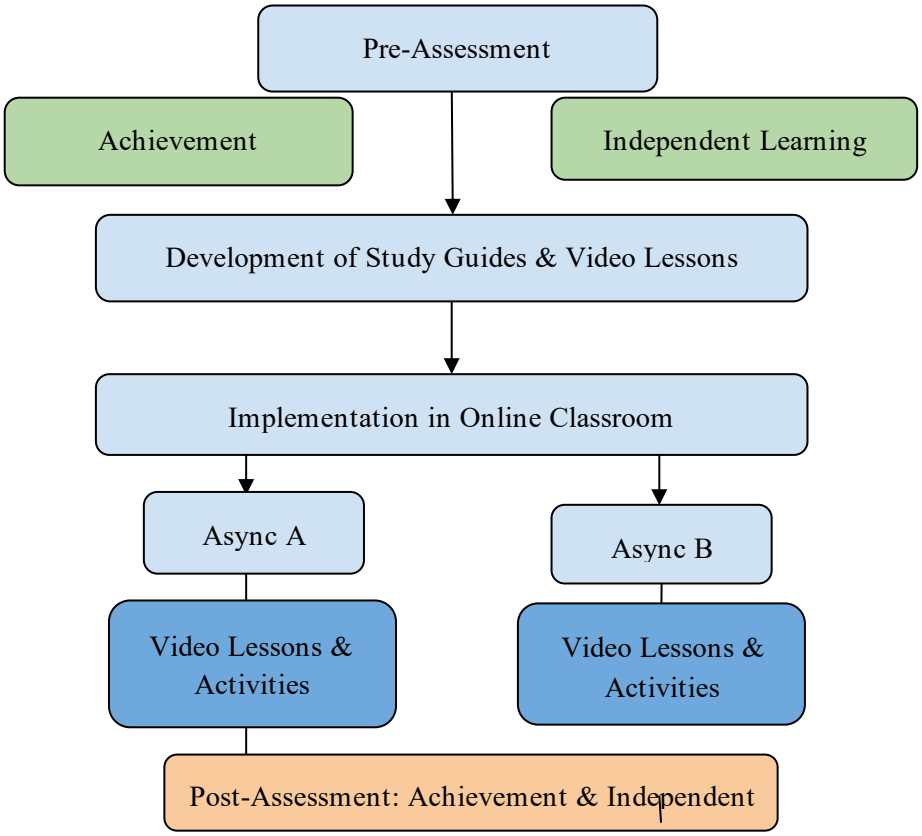


*Figure 1 Conceptual Framework Paradigm*

Figure 1 shows the conceptual framework used in this study. The researcher started by gathering the achievement level and independent learning skills of the learners. The process of the study includes the development of the study guides of the asynchronous classroom which were used in an online classroom during the duration of the study. The asynchronous classrooms were Async A and Async B. The two classrooms, Asynchronous A and Asynchronous B were then implemented at the classroom level. This was done to

determine the improved conceptual understanding and developed independent learning skills of the respondents.

This study contributes to the ongoing discourse on flexible learning methods, providing practical insights into how asynchronous strategies can bridge learning gaps in mathematics education, particularly in resource-constrained settings.

## 2. Methodology

This quasi-experimental study was conducted among 78 Grade 11 students from a private school in Iligan City, Philippines, during the 2020-2021 school year. The students were divided into two groups (Async A and Async B), both receiving asynchronous e-learning interventions via an online classroom platform (Google Classroom). The e-learning interventions used are Video lessons, Collaborative activities and supplementary materials. Video Lessons: Four video lessons (10–15 minutes each) on simple and compound interest, aligned with K-12 standards, were developed and validated by subject experts. Collaborative Activities: Students engaged in group-based problem-solving activities designed to foster critical thinking and collaboration, with submissions and peer feedback completed online. Supplementary Materials: Additional resources, such as YouTube videos and handouts, were provided. The core intervention in this study was the implementation of asynchronous e-learning through video lessons and online collaborative activities. Students accessed video-based instruction and participated in group activities via an online classroom, enabling flexible, self-regulated learning and fostering critical thinking and problem-solving skills in business mathematics.

The quantitative data were obtained from pre- and post-tests measured academic achievement. The qualitative data obtained from mathematics journals were analyzed for evidence of independent learning skills. This study used different types of instruments like Researcher-made achievement tests, journal prompts, and activity rubrics (based on 21st CLD). Achievement and independent learning scores were compared using paired and independent t-tests. Qualitative data were coded and analyzed thematically.

To determine the performance level of the respondents, pretest and posttest were administered and the results were tallied and compared. The transmutation and interpretation of scores were based on the DepEd's norm of assigning the lowest possible mark (i.e., zero) as equivalent the lowest possible grade in the student's report card (i.e., 60).

Table 1 *Interpretation of Learners Achievement Scores*

| Score | Interpretation |
|---|---|
| 24.01 – 30.00 | Advanced |
| 18.01 – 24.00 | Proficient |
| 12.01 – 18.00 | Approaching Proficiency |
| 6.01 – 12.00 | Developing |
| 0.00 – 6.00 | Beginning |

To test the statistical significance in the achievement test and develop independent learning skills, T-test was used.

For easier processing of data needed for analysis, qualitative data were coded. Each respondent was systematically assigned to a corresponding symbol.

Asynchronous A students - $A_{S1}$, $A_{S2}$, $A_{S3}$ and so on.
Asynchronous B students - $B_{S1}$, $B_{S2}$, $B_{S3}$ and so on.

## 3. Results and Discussions

### *3.1 Development Process of Asynchronous Lesson on Business Mathematics*

The researcher used the ADDIE model in developing the study's video lessons and activities. It is an instructional design which aims to produce more efficient and effective instruction and learning consisting of five phases.

In the Analysis Phase, the learner's resources for their asynchronous learning were gathered through conducting a survey. This was done in order to set learning objectives for the asynchronous lesson and activities. The table 2 shows the result of the devices used by the learners in asynchronous learning. Most of the learners, specifically 38, used their smartphones as their primary device for e-learning. Followed by a tablet in which 32 of the learners use it. And the least devices that learners used are laptop (5) and desktop (3).

*Table 2 Devices used by the learners*

| **Devices** | **Smartphone** | **Tablet** | **Laptop** | **Desktop** |
|---|---|---|---|---|
| **No.of Students** | 38 | 32 | 5 | 3 |

The table 3 shows the result of the internet access by the learners during their asynchronous learning. Data shows that 42 of the learners used mobile data as their means of internet connectivity during their asynchronous learning.

*Table 3 Internet Connectivity used by the learners*

| Internet Connectivity | Mobile Data | Wireless Connection | Cable TV Modem | Fiber Optic | DSL | Don't Know |
|---|---|---|---|---|---|---|
| No.of Students | 42 | 17 | 1 | 5 | 8 | 5 |

The table 3 shows the result of the performance level in Async A and Async B before the implementation of the study. There was no significant difference in the achievement test scores of Async A (M=12.77, SD=5.039) compared to Async B (M=10.92, SD= 4.226), t = 1.973, p > 0.05. This implies that the two groups are equivalent in terms of content prior to the implementation.

**Table 4** *Pretest: Learners' Performance levels in Async A and Async B*

| | ***Async A*** | | ***Async B*** |
|---|---|---|---|
| ***Advanced*** | *2* | | *0* |
| ***Proficient*** | *3* | | *3* |
| ***Approaching Proficiency*** | *15* | | *8* |
| ***Developing*** | *13* | | *25* |
| ***Beginning*** | *6* | | *3* |
| ***Mean*** | *12.77* | | *10.92* |
| ***SD*** | *5.039* | | *4.226* |
| ***t-value*** | | *1.973* | |
| ***p-value*** | | *0.056* | |

The table 5 shows the result of the independent learning skills in Async A and Async B before the implementation of the study. There was no significant difference in the independent learning skills Async A (M=3.51, SD=0.17) compared to Async B (M=3.47, SD= 0.26), t = 0.99, p > 0.05.

**Table 5** *Pre survey: Independent Learning Skills in Async A and Async B*

| Groups | Async A | | Async B |
|---|---|---|---|
| Collaboration | 3.415385 | | 3.333333 |
| Effectuve Participant | 3.403846 | | 3.352564 |
| Self-Management | 3.602564 | | 3.647436 |
| Thinking Skills | 3.348718 | | 3.179487 |
| Self-regulation | 3.769231 | | 3.820513 |
| Mean | 3.507949 | | 3.46667 |
| SD | 0.174628 | | 0.260362 |
| t-value | | 0.999 | |
| p-value | | 0.3741 | |

The Design Phase. From the gathered information in the analysis phase, the learners' performance in Business Mathematics and their developed independent learning skills through the use of asynchronous e-learning strategies – the researcher designed collaborative lesson activities. Also, researcher developed video lessons that were also implemented. This is done in order to improve the learners' low-performance level during the pretest and to implement the 21st Century skills to the learners which is part of the goal of the K-12 Basic Education Program.

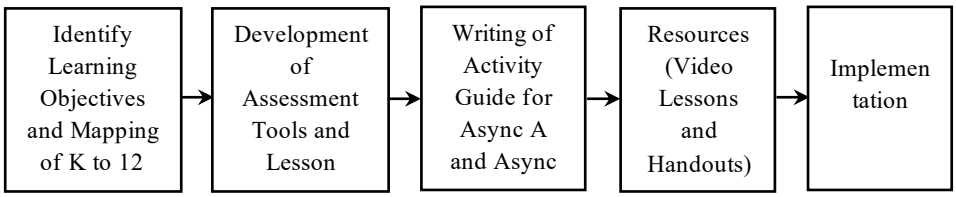


*Figure 2* Process of Development of Asynchronous Lesson Activities

The process of development of asynchronous lesson activities was based on the study of Jackaria, P. et al (2019). The development started with mapping of topics based on the K to 12 Curriculum Guide in mathematics. This was followed by the selection of appropriate learning activities among the many strategies and assessment tools to be used in both the asynchronous e-learning strategies. Developed lesson activities were based on the set objectives and tools. Then the writing of the activity guide was based on the identified objectives and tools. The resources such as video lessons and detailed handouts were uploaded in the online classroom. Afterward, the asynchronous lessons were implemented at the online classroom level.

Table 6 shows the mapping of the K-12 standards to the learning objectives and developed activities to ensure alignment to the educational goals of the Department of Education.

**Table 6** *Curriculum Guide from K-12 Standards its Objectives and Activities*

| PERFORMANCE STANDARDS | Learning Competency | Lesson Objectives | Real World Problem Solving Tasks |
|---|---|---|---|
| The learner is able to investigate, analyze and solve problems involving | The learner illustrates simple and compound interests and distinguishes between simple and compound interests. | Illustrates simple and compound interests and distinguishes between simple and compound interests. | Compare the different rates from the different banks. |
| | | Apply the formula in solving the simple interest.<br>Solve real-world problems involving simple interest. | Solving the real world problem involving simple interest. |

| | | | |
|---|---|---|---|
| simple and compound interests and simple and general annuities using appropriate business and financial instruments.. | The learner computes interest, maturity value, future value, and present value in simple interest and compound interest environment.<br><br>The learner solves problems involving simple and compound interests. | Apply the formula in solving the compound interest.<br>Solve real-world problems involving compound interest. | Solving the real world problem involving Compound Interest |

Based on the standards and objectives, the researcher outlined and developed the asynchronous e-learning activity in business mathematics. An authentic activity was designed that would best allow learners to demonstrate what they have learned in business mathematics, considering that they asynchronously accessed them. A panel of evaluators helped with the improvement of the activity. The researcher adopted the rubrics from 21st CLD in assessing the activity.

The **Development Phase** is when the researcher constructs and accumulates the content assets that were considered in the Analyze and Design phases. Video lessons and lesson activities were generated in this phase.

- Online classroom is the online platform that was used by the researcher in the study. This is where the asynchronous learning happens; the instructional materials needed during this learning were posted in the online classroom. This is where the teacher interacts with their learners by monitoring the online presence of them and supplying them with continuous feedback (El-Soud & et.al, 2014).
- Video lessons in business mathematics were based on the MELCs from the DepEd which is 60% of the second quarter topic which is the primary material for this study. The unit was composed of 4 video lessons which use a PowerPoint presentation in delivering the lesson. Two are under the topic of simple interest and the other two videos are under the topic of compound interest. Two video lessons were intended for a week session. Each video was composed of a 10-15 minutes video and the asynchronous schedule for each session is 3 hours. It was evaluated by the school principal, department head and mathematics teacher in terms of content and two technical experts in the technicality of the video using an adopted rubric. The teacher upload multimedia content such as video and audio related to the course (Koutsabasis & Stavrakis, 2011).
- Lesson Activities designed by the researcher to provide learners to collaborate more deeply and to think critically. Learners' activities that involve collaboration, thinking skills and real-world problems were rated through 21st CLD rubric (see Appendix I). There were four activities developed in this study that involve collaboration, thinking skills and real-world problems. Each group was asked to turn-in all their activities in the Google classroom. To accomplish the task, the learner needs to collaborate with their group, solve a real-world problem and make feedback among their group. Teachers provide several types of asynchronous communication so that appropriate means are available for different learning activities (Hrastinski, 2008).
- Supplementary materials such as related videos in YouTube about the topics and detailed handouts were prepared.

Pilot testing was conducted to test the efficacy of the video lessons and activities and to identify the components that are important to observe during implementation. This stage also helped the researcher in determining the length of time the lesson was to be

implemented. It was conducted in one of the private schools in Iligan City and the pilot testing lasted for two weeks. The try-out respondents were composed of 38 learners, 19 in Async A and 19 in Async B who were heterogeneous in composition. The results in the item analysis during the pilot testing imply that revisions of the test items were essential and it helps the researcher to make video lessons that focus on the identified difficult topic.

During the **Implementation Phase**, the teacher-researcher ensures that the instructional materials such as video lessons, activities, supplementary videos and handouts were all posted in the online classroom. The activity guide was also posted in the online classroom.

In asynchronous learning, the teacher facilitates the online discussion activities (Cheung & Hew, 2010). The implementation of asynchronous e-learning strategies took more than two weeks to finish. The teacher-researcher made the asynchronous activity guide to make sure that the learners were guided on what to do on a daily basis.

Lesson activities in Business Mathematics were developed to measure learners' ability based on what they have learned from the lessons in Business Mathematics. The learners performed activities that involve collaboration and problem solving skills in business mathematics. These activities were done asynchronously through a Facebook group or group chat they created in Facebook messenger to avoid face-to-face interactions. The activities were submitted in the online classroom by their group leader and were graded. The teacher-researcher made sure that the activities developed gave the learners opportunities to collaborate among their group mates with the use of Facebook groups in a way that they can participate through discussions in the form of comments in the posts.

**The Evaluation Phase.** This phase measures the effectiveness of the instruction and developed activities. This actually happens during the entire instructional design phases: - within phases, between phases, and after implementation. Pretest and posttest were administered and compared to determine the overall efficacy of the instruction. In order to change teaching and learning practices to enhance learner' performance, formative evaluation was also performed by the teacher-researcher during the learning process.

There were five evaluators who helped to improve the video lessons and lesson activities. In designing the activities, the researcher followed the 21st CLD rubrics to determine the level of collaboration, knowledge construction, problem-solving, and self-regulation which were accordingly rated by the three evaluators. Three content evaluators and two technical experts assessed the designed and created video lessons for the study with the use of an adopted rubric. Comments and suggestions were acknowledged and accepted for revision and enhancement of the activities such as specifying the roles of each learner for the given activity.

Table 3.6 shows the ratings of panels on the developed activity. The 21st Century skills that were focused for the learners to acquire gained an excellent rating.

**Table 3.6**

*Evaluation of the Developed Lesson Activities*

| 21st Century Skills | E1 | E2 | E3 | Mean Rating | Description | Interpretation |
|---|---|---|---|---|---|---|
| ***Collaboration*** | 5 | 5 | 5 | 5 | Excellent | Students are sharing responsibility fairly, and they are making substantive decisions together, and their work product is interdependent |
| ***Knowledge Construction*** | 5 | 5 | 5 | 5 | Excellent | Students are required to apply their knowledge in a new context and knowledge construction is the main requirement. The knowledge construction should be interdisciplinary and the activity does have learning goals in more than one subject. |

| | | | | | | |
|---|---|---|---|---|---|---|
| ***Real-world Problem Solving*** | 4 | 4 | 4 | 4 | Very Satisfactory | The student's main effort was problem-solving, and the solution did address a real-world problem and the solution was successful, and the student did innovate. He or she did implement a solution in the real world. |
| ***Self-regulation*** | 4 | 4 | 4 | 4 | Very Satisfactory | Students do have learning goals and associated success criteria in advance of completing their work. Students do have the opportunity to plan their own work and to revise their work based on feedback. |

The ratings of the content experts for the instructional videos produced are shown in Table 3.7. The expert reviews indicate an excellent rating with a perfect score with the content scale and included supplemental materials. Table 3.8 also displays the technical experts' assessment of the established video lessons after a series of revision of the PowerPoint presentation based on the comments and suggestions of the experts. The video lessons garnered an overall rating of the technical production as excellent.

**Table 3.7**
*Content Evaluation of the Developed Video Lessons*

| | Mean Rating | | | Overall Rating | Interpretation |
|---|---|---|---|---|---|
| | CE1 | CE2 | CE3 | | |
| **Intsructional Video** | | | | 4.9683 | Excellent |
| **Content** | 5 | 5 | 5 | 5 | Excellent |
| **Instructional Plan** | 4.8571 | 4.8571 | 5 | 4.904762 | Excellent |
| **Included Supplemental Materials** | 5 | 5 | 5 | 5 | Excellent |

*Legend:1-1.8=Poor, 1.81-2.40 =Fair, 2.41-3.40=Good, 3.41-4.20=Very good, 4.21-5.00=Excellent*

**Table 3.8**
*Technical Evaluation of the Developed Video Lessons*

| | Mean Rating | | Overall Rating | Interpretation |
|---|---|---|---|---|
| | TE1 | TE2 | | |
| **Technical Production** | | | 4.3125 | Excellent |
| **General Video Design** | 5 | 4 | 4.50 | Excellent |
| **Focused on Intended Content** | 5 | 4.50 | 4.75 | Excellent |
| **Visual Quality** | 4 | 3.50 | 3.75 | Very Good |
| **Audio Quality** | 5 | 3.50 | 4.25 | Excellent |
| **Audio-Visual Relationship** | 5 | 4 | 4.50 | Excellent |

*Legend:1-1.8=Poor, 1.81-2.40 =Fair, 2.41-3.40=Good, 3.41-4.20=Very good, 4.21-5.00=Excellent*

### *3.2 Learners' Performance in the Async A and Async B*

**Table 3.9**
*Comparison of Achievement test of the two groups: Async A and Async B*

| | ***Async A*** | | ***Async B*** |
|---|---|---|---|
| ***Advanced*** | *7* | | *3* |
| ***Proficient*** | *11* | | *4* |
| ***Approaching Proficiency*** | *7* | | *11* |
| ***Developing*** | *13* | | *18* |
| ***Beginning*** | *1* | | *3* |
| ***Mean*** | *16.62* | | *13.436* |
| ***SD*** | *7.224* | | *5.757* |
| ***t-value*** | | *1.897* | |
| ***p-value*** | | *0.065* | |

*Significant at $\alpha<0.05$*

Table 3.9 shows the Comparison of Achievement test of the two groups: Async A and Async B in the posttest. The results indicate that there are a significant number of learners who belong to the proficient and advance levels compared to the Async B. Moreover, there was no significant difference in the achievement test scores in the posttest of the Async A (M=16.62, SD=7.224) compared to Async B (M=13.436, SD= 5.757), t = 1.897, p > 0.05. This indicates that both groups made similar improvements in terms of posttest mean scores using the asynchronous e-learning strategies. This supports the study of Malkin, Rehfeldt & Shayter (2016), the results of which indicated much greater group mean performance for learners who were required to be involved in asynchronous e-learning discussion as an instruction. Also, the outcome shows relevant results in the study of Ejubović, A. & Puška, A. (2019) & North (2019) in which self-regulated learning has a significant influence on satisfaction and academic performance of the students.

### *3.3 Independent Learning Skills in Async A and Async B*

**Table 3.10**

*Comparison of Learners' Independent learning skills in Async A and Async B*

| ILS | Group | Mean | SD | T value | P value |
|---|---|---|---|---|---|
| Collaboration | Async A | 3.610 | 0.955 | 1.477 | 0.148 |
| | Async B | 3.308 | 0.915 | | |
| Effective Participant | Async A | 3.577 | 0.845 | 0.240 | 0.812 |
| | Async B | 3.532 | 0.728 | | |
| Self-management | Async A | 3.763 | 0.856 | 0.436 | 0.665 |
| | Async B | 3.686 | 0.630 | | |
| Thinking Skills | Async A | 3.354 | 0.745 | 0.559 | 0.579 |
| | Async B | 3.261 | 0.623 | | |
| Self-regulation | Async A | 3.853 | 0.864 | 0 | 1.000 |
| | Async B | 3.853 | 0.756 | | |

*Significant at α<0.05*

Table 3.10 shows the comparison of learners' independent learning skills in Async A and Async B. With the independent learning skills survey at a significant level of 0.05, the result indicates no significant difference in their developed independent learning skills in each scale.

On the collaboration component, learners in the Async A obtained a mean (M) of 3.610, Standard Deviation (SD) of 0.955, while in the Async B the mean is 3.308, Standard Deviation of 0.915 with a p-value of 0.148. This suggests that students were confident in working with a group and were able to take leadership roles when doing some activities with their classmates.

> *"The best part of this activity is the trust that my block mates gave to me. I am so thankful that they trust me to lead them. I feel great and I motivate myself to do more, to do better for our group to do well on our activity."* $A_{S1}$
>
> *"My experience during our group work is that I am the leader of this group activity. I tell them to help each other and we cooperate to solve the problem and we also shared ideas about the given questions of the topic."* $B_{S1}$
>
> While in the area of effective participant, learners in the Async A acquired the following, (M=3.577, SD=0.845), whereas, the Async B has (M=3.531, SD=0.728); p=0.812. The results show that students in both groups have the same improvements in terms of becoming an effective participator. This demonstrates that students were able to think of ways and means to support their group to solve problems or achieve their goals.
>
> *"The lesson I learn in this activity is that I know what is simple and compound interest it and I know how to solve some of them and i did my best to share my ideas with my group accomplish with them."* $A_{S2}$

*"Based on my experience during our group work, not all my classmates cooperated to the activity but I'm so happy that we're able to pass it with the help of my other teammates. Even though there are times that our answers were not the same, we collaborate our answers to make it right."* $B_{S2}$

Moreover, learners in the Async A group obtained the following: (M=3.763, SD=0.856) on the aspect of self-management skill, while in the Async B students, they acquired this: (M=3.686, SD=0.630); p=0.665. It shows that students in both groups were able to organize their time and complete all classwork on time. Students also show that they were able to reflect on their work to know what skills they must develop.

*"I finalize our work and submit to google classroom. I have a deep realizations and it's amazing to think that in the near future I could possibly apply this real – life problem involving Compound Interest."* $A_{S3}$

*"What I experienced during our group work is that some of my group members were not that cooperative, some are busy at work. But in the end we still continue and study the topic so that we can accomplish it and get it done well."* $B_{S3}$

Regarding the component of thinking skills, learners in Async A acquired this: (M=3.354, SD=0.7447), while in Async B had this: (M=3.261, SD=0.6226); p=0.579. The data reveals that they were able to link original and new ideas to complete a task. Students in both groups also show that they were able to decide on what information is useful when completing tasks.

*"This activity becomes easy for us because we manage everything well, it is because of the previous activities. My block mates also learn and I am grateful that together we learned a lot!"* $A_{S4}$

*"As what I've noticed, it is difficult for me to understand each topics and lessons. I should observe that how it works, to solve and to find a solution to each problem. I also learned that in order to solve the problem I should use the past lessons to acquire the solution to the problem."* $B_{S4}$

On the last component of independent learning skills which is self-regulation, learners in the Async A obtained the following: (M=3.853, SD=0.864), while in the Async B (M=3.853, SD=0.756); p=1.000. The findings pointed out that both groups made similar improvements in being self-regulated. This suggests that they were able to plan out class works that they want to complete. Also, students were able to do something even when things were not going well.

*"To achieve my goal, I will write down important details from the hand-outs, particularly the examples so I will be familiarized how it was done. I will watch the videos to fully understand the topic."* $A_{S5}$

*"To be honest I'm not so good on math, I don't know if my answer is correct or not but I did my best to know that topic. Even the topic is difficult and even I'm not good in math, I study hard to achieve and to know what is the point in the topic."* $B_{S5}$

This leads to the fact that after the asynchronous e-learning strategies implementation, the developed skills of the learners in the two groups, Async A and Async B have made no significant difference. In addition, it also indicates that both groups are equivalent in terms of their developed independent learning skills after the implementation of asynchronous e-learning strategies. This supports the study of Danso (2017) that assessment techniques and tasks/activities implemented suggests to have a strong potential in enhancing the development of learners' independent skills and have helped them become more engaged in mathematics lessons. He also stated that the rate at which these skills were developed was found to vary among individual learners and other factors such as the type of technique implemented. In addition, Wong (2013) study confirms the potential of an online learning environment to develop independent learning skills

effectively, if appropriate support systems were provided to familiarize learners with various learning technologies.

***3.4 Insights from the asynchronous classroom implementation***

The researcher used a Math journal writing for the Asynchronous A and writing a weekly summary for the Asynchronous B , as additional activity, to help the learners monitor their asynchronous learning. The following data shows the insights drawn from the asynchronous classroom implementation.

Their responses seem to suggest that the biggest challenge for learners is the coordination between their group mates.

> *"There was so many best part that I'd like to share but for me the best is the teamwork what we did because sometimes lack of communications with them is our main problem but at least we made it."* $A_{S6}$
> *"My experience during our group work is that not all my classmates respond our group chat. I always remind them to participate as a group but no one is willing to reply."* $B_{S6}$

Some learners also mentioned their engagement on making the learning activities, as we quote:

*"The best part is I was able to answer the activity and to help my group if their answer is wrong. To improve our work everyone should be cooperative and do it as a team."* $A_{S7}$
*"What I learned in group work is that not all cooperated, but there are few of our members who talks about the activities and it's fun. We all help each other to finish our activity. ."* $B_{S7}$

Furthermore, some learners also mentioned their collaboration in answering the activities.

> *"The lesson I learn in this activity is that I know what is simple and compound interest is and I know how to solve some of them and i did my best to share my ideas with my group to accomplish with them."* $A_{S8}$
> *"I experienced during our group work is that we cooperate each other and we shared ideas about the given activity."*$B_{S8}$

Data also indicates that some of the learners had some difficulties in doing the activities and lessons, so that they intended to give more time to understand the lesson.

> *"On this week, I am having trouble coping up with the tasks and especially the lesson, so I dedicated my extra time to give more time on the subject so that I can cope up with the lesson."* $A_{S9}$
> *"My experience with this week's lesson is challenging, I am able to learn about different types of interests and I don't know that there are many of them. It's so challenging memorizing all of them but I enjoy learning and I want to learn more."* $B_{S9}$

Many learners also said that they were happy that their group mates chose them as leaders.

> *"The best part of this activity is the trust that my block mates gave to me. I am so thankful that they trust me to lead them. I feel great and I motivate myself to do more, to do better for our group to do well on our activity."* $A_{S10}$

*"I felt comfortable with them as a group leader and they are friendly too and helpful even though some other group members did not cooperate but we still fight to get it done before the deadline."* $B_{S10}$

The above responses as insights drawn from the learners in Asynchronous A and Asynchronous B as they underwent the activities in the study support the finding that after the implementation of the asynchronous e-learning strategies learners in both groups made similar improvements in their developed independent learning skills.

## 4. CONCLUSIONS AND RECOMMENDATIONS

The panel of evaluators rated the developed study guides as 'Excellent' indicating the appropriateness and usability of the developed asynchronous lessons integrating video lessons in teaching business mathematics. The results of the study show no significant difference in the posttest between Async A and Async B. This implies that both groups made similar improvements in terms of posttest scores using the asynchronous e-learning strategies. Data also indicates no significant difference in their developed independent learning skills in each scale in both the Async A and Async B. This indicates that both groups are equivalent in terms of their developed independent learning skills after the implementation of asynchronous e-learning strategies. Moreover, the insights drawn from the asynchronous classroom implementation confirms that there was no significant difference in their developed independent learning skills.

This study recommends that: (1) Since all learners made improvements irrespective of their academic abilities, mathematics teachers may use the developed asynchronous lessons and activities in business mathematics as a device in promoting and enhancing learning, especially during this COVID-19 pandemic, depending on the teacher's focus on what to develop either content or life skills among the learners; (2) The ratings of the developed video lessons and activities were excellent, future researchers should consider independent experts who will rate the said instructional materials from other universities/schools different from the school site/respondent of the research; (3) The results show that the series of activities and Math Journal Writing developed by the researcher helped the learners improve their independent learning skills. Thus, teachers may adapt and integrate these series of activities and math journal writing in a Mathematics classroom for the learners to develop their independent learning skills and problem solving abilities; (4) It will be useful to further continue this form of research to better understand how innovations such as mobile devices or time monitoring apps can help learners develop independent learning skills such as self-regulation, time management or efforts to minimize or eliminate distractions and remain on-task; (5) While the study confirms the potential of asynchronous strategies in fostering independent learning, future research should explore long-term impacts and scalability across diverse educational contexts.

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