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GAMIFIED MOBILE COURSEWARE'S EFFECT ON STUDENTS' COGNITIVE & NON-COGNITIVE ABILITIES

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Abstract

The study used gamified mobile courseware in a Statistics and Probability class. A mixed-method design was employed to examine its effect on senior high school students' conceptual and procedural knowledge and engagement, motivation, self-regulation, and self-efficacy in learning mathematics. Of the 158 Grade 11 students, 104 participated and were divided into four groups. The students who used the gamified mobile courseware and self-learning modules for three weeks were randomly selected using a free random generator online. The respondents' midterm grades in General Mathematics and pretest scores were used to establish the comparability of the two groups. Results showed that the gamified mobile courseware in Statistics and Probability positively affected students' procedural knowledge and motivation in learning mathematics. Examining the effect of gamification elements on students' cognitive and non-cognitive abilities may be considered for future studies.

Keywords

Cognitive Abilities, Conceptual Knowledge, Gamified Mobile Courseware, Procedural Knowledge, Non-Cognitive Abilities

1. Introduction

One key factor to a successful teaching-learning process is the teacher's ability to select, develop, and use instructional material to suit the learners' academic needs. According to some studies, instructional materials used by teachers are essential because they can significantly increase students' achievement by supporting student learning. Ogaga et al. (2016) found that the teacher's choice of relevant instructional materials and ability to improvise an instructional material had a significant relationship in the teaching and learning process. On the other hand, Ajoke (2017) asserted that students' performance who were not taught using any instructional material was low. Instructional materials help the learning process by allowing the students to explore the new knowledge autonomously. Thus, teachers must determine which learning experiences using these instructional materials effectively promote learning.

In the meantime, the Covid-19 pandemic has affected many people's lives across the globe. One sector that has been dramatically affected by the said pandemic was the education sector. Almost all the usual activities that schools usually do were stopped because of the nationwide lockdown to minimize the virus's spread. The normal face-to-face classroom setups that were customary in most schools were instantly shifted to virtual classrooms. According to EducationWeek (2021), teachers have to adapt their usual teaching methods for classes that now occur online during this pandemic.

In the Philippines, the Filipinos, known for being resilient, did not falter to continue their fight to battle ignorance amidst the challenges brought about by the pandemic as the Education Secretary announced the beginning of classes for S. Y. 2020-2021 on October 5, 2020, in all public schools nationwide (DepEd, 2020). The Department of Education (DepEd) adopted flexible learning. It used alternative modes of instruction such as modular instructions, television and radio-based instructions, and blended and online instructions to deliver the lessons to the learners.

With the start of modern science and technology in the Philippines through the K-12 curriculum, mathematics became one of the points of emphasis in the Philippine educational system, as DepEd mentioned. And because Mathematics is learning by doing, the learners must be provided with enough learning activities to develop their skills even during these pandemic times. According to some studies conducted in the Philippines, the examples provided by the teacher and the self-learning modules (SLMs) used for the flexible learning modality were not enough to enhance the acquisition and development of mathematical concepts. In that regard, there should be instructional materials that would serve as supplementary materials to the alternative delivery mode of the DepEd.

1.1. Background of the Study

At present, the implementation of the Statistics and Probability course offered in the K-12 SHS curriculum has encountered a vast number of challenges since its first kick. Ocampo and Ocampo (2018) discovered a lack of competent teachers who can teach the Statistics and Probability course. On the other hand, Reston and Loquias (2018) specified that 68 percent of their teacher-respondents perceived a lack of confidence in teaching Statistics and Probability because they were the first batch who implement the new SHS curriculum.

Jaudinez (2019) indicated that the teachers had experienced problems in the availability of instructional materials. According to the researcher, the teachers stated that DepEd did not provide the textbooks in the Statistics and Probability course. The researcher also asserted that those textbooks in the market claimed to be K to 12 compliant were erroneous and inappropriate for an ordinary SHS student in terms of complexity, difficulty, and context.

Meanwhile, the Covid-19 pandemic and nationwide lockdowns have affected the lives of teachers and students as face-to-face classrooms were transformed into virtual classrooms. And because the continuation of classes was pushed through, many challenges arose. Ferlazzo (2020) believed that there was a high possibility that students would not participate in a whole day of teaching no matter what instructional method was used because of the pandemic. Irfan et al. (2020) asserted that using learning management systems such as Google Classroom and Edmodo in online classes has limitations, especially in writing mathematical symbols.

In the Philippines, UNICEF (2020) indicated that children were bored, restless, and missed interacting with their friends and spent a lot of time playing online games. On the other hand, Gonzales (2020) reported that DepEd had monitored 41 errors in the SLMs used by students in remote learning. Moreover, ICT4ALS, FB Chat, Google Classroom, the Aral Muna app, and DepEd Commons were the most common technological interventions done in the Mindanao region during the quarantine period, as reported by Jorge (2020).

Since this pandemic has brought mathematics teachers opportunities to change how they teach the subject to the learners (Delgado, 2020), the study was thus conceptualized.

1.2. Literature Review

The review of related literature provided me with a solid background and factual data to support the necessity to produce alternative and innovative instructional materials in teaching Statistics and Probability for senior high school. It also served as a challenge and a solid motivation to improve students' mastery level by providing suitable instructional material that was carefully selected, designed, and developed to observe their cognitive and non-cognitive abilities.

1.2.1. Challenges In The Implementation Of Senior High School Mathematics Curriculum

Several studies in the Philippines have cited different challenges encountered during the implementation of the K-12 senior high school (SHS) mathematics curriculum. The earliest was the study of Chua (2015), who assessed the mathematics curriculum under the SHS modeling program and found that most of the challenges encountered by the teachers were directly related to the deficiency in curriculum support. Another study on the needs assessment of the 35 SHS mathematics teachers from 27 private and public secondary schools in the Second District of Oriental Mindoro was conducted by Aplaon (2017), who discovered that the teachers' content knowledge was below the needed level of mastery. Reston and Loquias (2018) indicated that most of the teachers who were pre-assessed said that they lack the confidence to teach the topics in the Statistics and Probability course, including random variables and probability distributions, normal distribution, sampling distribution, the Central Limit Theorem, estimation of parameters, and hypothesis testing. Jaudinez (2019) revealed that congestion of learning competencies and availability of instructional resources were the most compelling state of the teachers.

1.2.2. Courseware In Learning Mathematics

Many studies show that courseware in learning mathematics enables students to grasp the necessary knowledge and skills immediately and comprehensively. Salim and Tiawa (2015) used flash animations to determine the students' perception of learning mathematics and asserted that using flash animations helped students understand mathematical abstracts and concepts. Tran-Duong (2021) employed e-courseware to support fourth-grade students in self-study fractions and reported that it significantly increased the learning outcomes of fractions of the students. Banson and Arthur-Nyarko (2021) examined the benefits of using interactive courseware in teaching

Geometry on students' academic performance and learned that using the computer-based courseware in teaching Geometry increased the students' performance.

1.2.3. Effect Of Gamification And Mobile Courseware On Students' Cognitive And Non-Cognitive Abilities

Mobile courseware can accommodate diverse learning approaches, and one of those approaches is collaborative learning. Because of this fact, Fakomogbon and Bolaji (2017) examined the effects of collaborative learning styles on students' performance in a mobile learning environment. They found a significant gain in the students' pretest and posttest scores subjected to the mobile learning experience. A similar study was conducted by Fabian, Topping, & Barron (2018) about the effects of using mobile technologies in mathematics on students' attitudes and achievements using a quasi-experimental mixed-method design. They found that the experimental group performed better in their posttest than the controlled group, indicating that mobile technology in mathematics produced positive feedback from the students as to how they saw the mobile activities and how it helped them improve their performance.

In a study to determine the effects of gamification elements on primary and college students' motivation and learning, Papp (2017) discovered that students expressed increased motivation and engagement at both the primary and college level and improved knowledge. The finding has been supported by Chen (2019), who studied the effect of mobile augmented reality on learning performance, motivation, and math anxiety in a math course and found that the AR group had higher motivation based on Keller's ARCS (attention-relevance-confidence-satisfaction) model compared to the non-AR group. His findings also showed that the AR group performed better than the non-AR group. A quasi-experimental study examined the ability of gamified modules in a statistics course to have positive impacts on learning and attitudes towards statistics, Smith (2017) revealed that the attitudes of cognitive competence, affect, value, and perceived difficulty were all positively impacted after completing the gamified exercises, and the experimental group also had significant effects of test performance one semester after completing the course. Lastly, Game-based learning and gamification have been used as teaching innovations to improve students' learning, especially enhancing students' motivation and intention to learn. With this thought in mind, Hasan et al. (2017) conducted a study to improve students' motivation to learn through gamification and found out that gamification can improve students' learning and increase their motivation and interest in the subject.

1.3. Research Objectives

The study aimed to examine the effect of using gamified mobile courseware in Statistics and Probability on Senior High School STEM and Non-STEM students' cognitive and non-cognitive abilities as instructional material in the flexible learning modality. Specifically, the study aimed to:

1. Determine the effect of the gamified mobile courseware on students' cognitive and non-cognitive abilities
    - 1.1 Cognitive abilities
        - 1.1.1 conceptual knowledge
        - 1.1.2 procedural knowledge
    - 1.2 Non-cognitive abilities
        - 1.2.1 engagement in learning mathematics
        - 1.2.2 motivation in learning mathematics
        - 1.2.3 self-regulation in learning mathematics
        - 1.2.4 self-efficacy in learning mathematics
2. Determine the students' perceptions on the use of gamified mobile courseware in learning mathematics through a focus group interview.

2. Methodology

This section describes the research design used, the respondents of the study, the research instruments, the process of validation of the research instruments, the sampling technique used, the selection process of the respondents, and the data analysis tools.

The study used the mixed-method experimental (intervention) design by Creswell & Creswell (2018) to attain its objectives. The quantitative data from the STEM & Non-STEM groups before and after the experiments were collected through the pre and post-tests. These were then compared to determine the gamified mobile courseware's effect on the students' cognitive and non-cognitive abilities. The qualitative data was collected through focus group interviews after the post-test to solicit feedback on using gamified mobile courseware for further improvement.

2.1. Respondents of The Study

The Grade 11 students of the City of Mandaluyong Science High School (CMSHS) in Mandaluyong City, Metro Manila, Philippines, served as the study population. The researcher considered only four sections in the study where 126 of 158 volunteered to participate: one set per STEM and Non-STEM strands for the control and experimental groups. A list of students currently enrolled for the second semester of S.Y. 2021-2022 was obtained from the senior high school coordinator for the consideration of sample size computation. The statistical power used in determining the sample size was 80%, a non-inferiority margin of 2.508, and a desired minimum detectable effect of 1.5%. The sample size was determined using a free online statistical power and sample size determination calculator. Table 1 displays the distribution of the respondents in the control and experimental groups.

Table 1: *Distribution of the Respondents in the Control & Experimental Groups*

Strand	Group	Total Enrolees	No. of Enrolled Students	Recommended Sample Size	Sample Size per Group
Non-STEM	Control Group 1	63	31	52	26
	Experimental Group 1		32		26
STEM	Control Group 2	63	31	52	26
	Experimental Group 2		32		26
	Grand Total	126		104	

(Source: *Self)*

Of the 126 enrolled, both the non-STEM and STEM strands have 63 enrolled students, of which 31 were assigned for control groups 1 and 2 while 32 students for experimental groups 1 and 2. The table also showed that 104 students were the recommended sample size for the study, of which each strand has 52 students and 26 students per group.

The researcher determined the respondents through the simple random sampling technique in deciding which class would be subjected to the control and experimental groups. The selection was done by the researcher using a random number generator software. Because the final grade was not yet available, the respondents' midterm grades in General Mathematics and their pretest scores served as bases for comparability. The Shapiro Wilk's W was used to establish their normality.

The Shapiro Wilk test indicated that the midterm grades of the respondents in the non-STEM [$W(26)=.933$, $p=.092$ and $W(26)=.963$, $p=.463$, respectively] and STEM groups [$W(26)=.930$, $p=.077$ and $W(26)=.923$, $p=.052$, respectively] did not significantly depart from normality. Also, the non-STEM [Conceptual Knowledge: $W(26)=.963$, $p=.459$, $W(26)=.957$, $p=.343$, respectively and Procedural Knowledge: $W(26)=.952$, $p=.262$, $W(26)=.970$, $p=.633$, respectively] and STEM groups' [Conceptual Knowledge: W(26)=.971, p=.643; W(26)=.923, p=.052, respectively and Procedural Knowledge: W(26)=.963, p=.445; W(26)=.932, p=.087, respectively] pretest scores in the CAMT did not show a significant departure from normality.

Moreover, Barlett's test for homogeneity of variance was used to establish the comparability for the respondents' midterm grades and pretest scores in the CAMT because they were normally distributed. Results showed that the variances of the midterm grades for the STEM and non-STEM groups were not significantly different, B(1)=.080, p=.780 and B(1)=2.527, p=.115, respectively. Also, the non-STEM and STEM groups' pretest scores in the CAMT confirmed that their pretest scores' variances were not significantly different [M=3.621, p=.325] and (M=2.299, p=.532), respectively.

Lastly, the Independent t-test was used to establish the sample independence of their midterm grades and pretest scores. The results asserted no significant difference in the non-STEM group's midterm grades, $t(50)=-.581$, $p=.564$, although the Experimental Group 1 (M = 92.19, SD = 2.593) attained higher midterm grades than the Control Group 1 (M = 91.81, SD = 2.698). Similarly, there was no significant difference in the STEM group's midterm grades, $t(50)=.598$, $p=.552$, although the Control Group 2 (M = 90.04, SD = 2.919) gained higher midterm grades than the Experimental Group 2 (M = 89.62, SD = 2.118).

Also, no significant difference in the non-STEM group's pretest scores, $t(50)=-.170$, $p=.866$ for the conceptual knowledge and $t(50)=.159$, $p=.874$ for procedural knowledge were found. Likewise, no significant difference in the STEM group's pretest scores, $t(50)=-.726$, $p=.471$ for the conceptual knowledge and $t(50)=-.467$, $p=.642$ for the procedural knowledge were found.

The results proved that the randomly selected respondents for the non-STEM and STEM groups were comparable using their midterm grades and pretest scores.

2.2. Data Collection Instruments

The research instruments used in the study undergo content validity and internal consistency. As evaluated by three math experts, most of the Cognitive Abilities in Mathematics Test (CAMT) items have an I-CVI of 1.00 and a K coefficient of 1.00. It has been pilot tested on 180 volunteer Grade 11 students (STEM & Non-STEM) who have already taken the Statistics and Probability course. The reliability analysis attested that the 46 items retained have excellent internal consistency as established by its Cronbach's alpha coefficient of .88 using KR-20.

Meanwhile, the Non-Cognitive Abilities in Mathematics Questionnaire (NCAMQ) was content validated by five licensed psychometricians. The content validity analysis suggested that it has an I-CVI of .76 and a K coefficient of .69. The reliability analysis divulged that the retained 21 items have good internal consistency, as affirmed by its Cronbach's alpha coefficient of .718. Moreover, it has been pilot-tested on 308 volunteer Grade 11 students (STEM and Non-STEM) who have already taken the Statistics and Probability course and demonstrated good internal consistency, as indicated by its Cronbach alpha value of .854.

Lastly, two language teachers and one journalism teacher evaluated the researcher's interview guide before using it in the focus group discussion. There were 11 questions in total for the interview guide, in which one question was allotted for the beginning part, eight questions for the probe part, and two questions for the exit part. The interview guide's I-CVI is 1.00, interpreted as "relevant," and the Cohen's Kappa was 1.00, construed as "effective." Its Cronbach's alpha coefficient was .737, interpreted as "acceptable."

The research instruments were administered during the respondents' scheduled asynchronous learning through Google Forms and were set to necessary restrictions, especially the CAMT.

2.3. Data Analysis Tools

For the quantitative data, the One-way MANOVA was used to compare the STEM and non-STEM groups' cognitive and non-cognitive abilities. The One-way ANCOVA was used if a significant difference was found in their cognitive and non-cognitive abilities to verify whether their pretest scores caused the significant difference. For the qualitative data, the semantic thematic analysis was used to develop themes. The analysis was done using a subscription version of SPSS and MAXQDA.

3. Results and Discussion

This section presents the salient findings of the study on the research questions about the effect of gamified mobile courseware on students' cognitive abilities in terms of conceptual and procedural knowledge, non-cognitive abilities in terms of engagement, motivation, self-regulation, and self-efficacy in learning mathematics, and the feedback of the students on the use of said courseware. The primary sources of data from which the analyses in Tables 2 to 4 were derived from the results obtained from the Cognitive Abilities in Mathematics Test, Non-Cognitive

Abilities in Mathematics Questionnaire, and the transcription from the focus group discussion after the experiment.

3.1. Effect of the Gamified Mobile Courseware on Students' Cognitive Abilities

Table 2 illustrates the one-way MANOVA analysis of the STEM and Non-STEM groups' cognitive abilities in mathematics in terms of conceptual and procedural knowledge after the experiment. The assumptions on using one-way MANOVA for the two domains were first analyzed and satisfied, such as the Shapiro-Wilk's normality test, Box's test of equality of variance matrices, and Levene's test of equality of error variance based on the mean.

Table 2: *One-Way MANOVA Analysis of the STEM & Non-STEM Groups' Cognitive Abilities after the Experiment*

Group	Wilk's Λ	F	$df_{Hyp.}$	$df_{Er.}$	Sig.	Decision	Partial η^2	Effect Size
Non-STEM	.973	.673	2	49	.515	Failed to Reject H_o	.027	Small
STEM	.717	9.662	2	49	.000	Reject H_o	.283	Very Large

Legend: $df_{Hyp.}$ – Hypothesis degrees of freedom; $df_{Er.}$ – Error degrees of freedom(* **Source*: Self)*
***Significant at .05 level (2-tailed)*

The one-way MANOVA analysis in Table 2 indicates that although Experimental Group 1 has a higher conceptual knowledge (Mean=17.96, SD=3.789) and procedural knowledge (Mean=18.58, SD=2.817) than the Control Group 1 (Mean=17.35, SD=3.577 & Mean=17.58, SD=3.557, respectively), there was no significant difference and the effect was small among the Non-STEM group's mean scores in the CAMT after the experiment, Wilk's Λ=.973, F(2, 49)=.673, p=.515. The multivariate η^2=.027 indicates that approximately 2.7% of the multivariate variance of the dependent variables (conceptual and procedural knowledge) is associated with the group factor.

Table 2 also asserts a significant difference, and the effect size was very large among the STEM group's mean scores in the CAMT after the experiment, Wilk's Λ=.717, F(2, 49)=9.662, p<.001. The multivariate η^2=.283 indicates that approximately 28% of the multivariate variance of the dependent variables (conceptual and procedural knowledge) is associated with the group factor.

In particular, there was no significant difference between the STEM group's conceptual knowledge [F(1, 50)=2.771, p=.102, η2=.053], despite the fact that the Experimental Group 2 obtained a higher mean score for the conceptual knowledge (Mean=20.69, SD=1.490) than the Control Group 2 (Mean=19.81, SD=2.263) . In contrast,a significant difference and very large effect size was indicated between the STEM group's procedural knowledge [F(1, 50)=19.699, p<.001, η2=.283] after the experiment.

To remove the influences from the pretest, I used the One-way Analysis of Variance (ANCOVA). It was used to examine the effect of gamified mobile courseware in Statistics and Probability on the respondents' procedural knowledge. The homogeneity of the regression test suggests that the assumptions have been met to proceed with the use of ANCOVA (F = .963, p = .329). The ANCOVA result is shown in Table 3.

Table 3: *ANCOVA Analysis of Students' Procedural Knowledge for the STEM Groups After the Experiment*

Domain	*Group*	*Adjusted Means*	*F-stat.*	*Sig.*	*Decision*	*Partial Eta Squared*	*Relative Size*
Procedural Knowledge	Gamified Mobile Courseware	19.69**	7.828	.006	Reject H_o	.073	Medium
	Self-Learning Modules	18.24**					

Note: Significant at .05 level (2-tailed) (**Source** *: Self*)

The ANCOVA result asserted that the difference between the procedural knowledge of the students who used the gamified mobile courseware in Statistics and Probability was statistically significant and the relative size of the difference was medium after considering the pretest scores of the students (F = 7.828, p = .006, η^2 = .073). Results imply that gamified mobile courseware significantly improved the students' procedural knowledge and positively enhanced their procedural knowledge in the Statistics and Probability course. The development was supported by Zulnaidi's and Zamri's (2016) study, who also reported a significant difference in the procedural knowledge of their students who were taught using the conventional approach and GeoGebra software after his experiment. Responses in the focus group interview also support the quantitative result. One student said, "*If you have attained four or five stars in one quiz, it means that you already have mastered that particular lesson*." Another student noted, "*The app does not allow you to proceed to the next lesson/chapter unless you meet the required number of stars*."

3.2. Effect of The Gamified Mobile Courseware On Students' Non-Cognitive Abilities

Table 4 displays the one-way MANOVA analysis of the STEM and Non-STEM groups' non-cognitive abilities in mathematics in the four domains after the experiment. The researcher satiated the assumptions by using One-way MANOVA for the engagement, motivation, self-regulation, and self-efficacy mean scores first similar to their cognitive abilities.

Table 4: *One-Way MANOVA Analysis of the STEM & Non-STEM Groups' Non-Cognitive Abilities after the Experiment*

Group	Wilk's Λ	F	$df_{Hyp.}$	$df_{Er.}$	Sig.	Decision	Partial η^2	Effect Size
Non-STEM	.851	2.061	4	47	.101	Failed to Reject H_o	.149	Very Large
STEM	.815	2.2667	4	47	.044	Reject H_o	.185	Very Large

Legend: $df_{Hyp.}$ – Hypothesis degrees of freedom; $df_{Er.}$ – Error degrees of freedom (Source** : Self)*
***Significant at .05 level (2-tailed)*

The result from the One-way MANOVA asserts that although the effect size was very large, there was no significant difference between the two group's non-cognitive abilities in learning mathematics (engagement, motivation, self-regulation, and self-efficacy), Wilk's Λ=.827, F(4, 47)=2.464, p=.058. This was despite the fact that the level of non-cognitive abilities in learning mathematics of the Experimental Group 1 was higher in engagement (Mean=21.19, SD=2.546), motivation (Mean=17.19, SD=1.896), self-regulation (Mean=21.92, SD=2.171), and self-efficacy (Mean=28.54, SD=3.818) than the Control Group 1's engagement (Mean=20.46, SD=2.213), motivation (Mean=15.65, SD=1.896), self-regulation (Mean=20.69, SD=2.936), and self-efficacy (Mean=27.42, SD=3.546) after the experiment. The multivariate η^2=.149 indicates that approximately 14.9% of the dependent variables' multivariate variance is associated with the group factor.

Table 5: *ANCOVA Analysis of Students' Motivation Level for the Non-STEM Groups After the Experiment*

Domain	*Group*	*Adjusted Means*	*F-stat.*	*Sig.*	*Decision*	*Partial Eta Squared*	*Relative Size*
Motivation	Gamified Mobile Courseware	19.62**	6.086	.015	Reject H_o	.058	Medium
	Self-Learning Modules	18.30**					

Note: Significant at .05 level (2-tailed) (**Source** : Self)

Specifically, there was a significant difference and a large effect size between the Non-STEM Group's motivation level [F(1, 50)=7.852, p=.007, η^2=.136], but no significant differences in their engagement level [F(1, 50)=1.220, p=.275, η^2=.024], self-regulation level [F(1, 50)=2.953, p=.092, η^2=.056], and self-efficacy level [F(1, 50)=1.191, p=.280, η^2=.023] were found.

I also used ANCOVA to verify whether the difference in the motivation level of the two groups was not affected by their pretest scores. Levene's Test of Equality of Error Variances indicates that I can proceed with the use of ANCOVA because the assumptions were met (F = 1.345, p = 1.249). Table 6 highlights the ANCOVA analysis of students' motivation level for the two groups after the experiment.

It can be seen clearly from the table that there was a significant difference between the students' motivation level after the experiment, as evidenced by the ANCOVA result after considering the pretest scores (F = 6.086, p = .015). The result also indicates that the relative size of the difference was medium (η^2 = .058). This only proves that using gamified mobile courseware in Statistics and Probability positively improved students' motivation in learning mathematics. The numerical result was also supported by the students' responses in the focus group interview, of which one student said, "*The app did not only entertain and educate students. What happened is that we were enjoying more the lessons and the exercises because it was not the way of direct teaching.*" Another student mentioned, "*Because of that star, users were intrigued, like me, because I'm pushed to get five stars. After all, I wouldn't say I like it incomplete. I'm more motivated to get a perfect score on a given test.*"

The result of this study contradicts what has been reported by Alsultanny et al. (2014) in their study, who reported no significant differences between their control and experimental groups in terms of motivation using simulations in e-learning programs in the Environmental Education course.

Also, the result from Table 3.2 confirms a significant difference and a very large effect size in the non-cognitive abilities between the STEM group, Wilk's Λ=.815, F(4, 47)=2.667, p=.044. The multivariate η^2=.185 indicates that approximately 18.5% of the dependent variables' multivariate variance is associated with the group factor.

Particularly, the ANOVA of the STEM group's self-efficacy domain [F(1, 50)=2.995, p=.090, η^2=.057] was significant to the adjusted p-value, although the effect size was small. The result also indicates that the ANOVAs of the engagement [F(1, 50)=.898, p=.348, η^2=.018], motivation [F(1, 50)=1.633, p=.207, η^2=.032], and self-regulation [F(1, 50)=2.219, p=.143, η^2=.043] domains were not significant to the adjusted p-value, despite the fact that the engagement

(Mean=20.85, SD=2.213) and self-regulation (Mean=20.65, SD=2.936) levels of the Control Group 2 was higher than that of the Experimental Group 2 (Mean=20.15, SD=2.546 & Mean=19.46, SD=2.171, respectively), but lower motivation level (Mean=15.96, SD=1.896) than the Experimental Group 2 (Mean=16.69, SD=2.059) after the experiment.

The One-way ANCOVA analysis asserts that there was no significant effect and the effect size was small between the STEM group's self-efficacy level after controlling for three covariates, $F(1, 46)=1.817$, $p=.184$, $\eta^2 = .037$, although the self-efficacy level (Mean=28.38, SD=3.546) of the Control Group 2 was higher than that of Experimental Group 2 (Mean=26.46, SD=3.818) after the experiment.

The study was supported by Uzunboylu et al. (2020), who determined the effects of an authentic learning approach Moodle LMS based on mathematics achievement and online authentic learning self-efficacy. Their findings indicated no significant difference between the Control Group and the Experimental Group's self-efficacy post-test grades.

3.3. Students' Perceptions Of The Use Of Gamified Mobile Courseware

To solicit feedback from the students who used the gamified mobile courseware, I conducted a focus group interview (FGI) through Google Meet at a time most convenient to the participants. Ten students volunteered to participate in the said activity. The participants' feedback was categorized as content presentation, information, learning assessments, usability, functionality, aesthetics, engagement, and self-regulation.

The emerged themes for each category were as follows: simplicity and clarity of contents, logical organization of ideas, coverage of the course content, appropriateness of the learning content, adequacy of learned concepts/skills, pacing, scoring mechanism, and diversity of the assessment tasks, availability of learning resources, monitoring system, user-convenience, user-friendliness, user-interactivity, ease of use, visual layout, user customization settings, mastering the learning contents, recall of learned knowledge/skill, reward system, user-motivation and interest, and persistency in learning math, respectively. The major themes from their feedback include cohesiveness of the learning contents, effective assessment approaches, user efficiency, mobile app features, and a fun learning experience.

When asked about their favorite feature of the app, one student said, "*What I like the most was the built-in lessons because I don't need to search for them on Google. I can just read the lessons provided by the app*." Another student said, "*I think what's good in the app was the* *"number of stars. It's like playing video games to which you can get a high score*." One student also noted, *"I enjoyed the part that there was an overview of the lesson to know the lesson's coverage that I needed to answer*."

The researcher's intention in developing the gamified mobile courseware was confirmed when asked how the app could be beneficial in studying their subject. Some student responses were, "*I think it was the practice test where the app tests our active recall regarding the subject Statistics; that I think contributes to our learning*." "*For me, the idea is that you cannot proceed to the next level unless you attain the required number of stars for each lesson*." "*The part where the app does not give the correct answer. I feel challenged on how to do it*." The Mastery-Based Learning Theory used in the app's development was validated with all these responses.

On the part where the researcher intended to incorporate gamification in their course, some participants responded, "*The students are enjoying more answering the tests because there was an incentive to prove. It's like a game where you need a certain number of stars to proceed to another lesson. It's a different approach to allowing students to learn*." "*The app did not only entertain and educate students. What happened is that we were enjoying more the lessons and the exercises because it was not the way of direct teaching, but it integrates entertainment, which is fun and exciting to students because we earn something in return, which is the stars*. These responses also supported the Game-Based Learning Theory in the app's development.

Moreover, the Self-Paced Curriculum Learning Model (*Since it's pandemic, there were many free times because we're at home most of the time. If you feel lazy, you can turn to your phone or tablet where the app is installed, and you will learn right away*.) and Mobile Learning Theory (*We can also view our lessons without the internet, and because it's on our cell phones already, we learn everywhere anytime*.) were confirmed by the participants' responses.

The result only implies that the gamified mobile courseware in Statistics and Probability served its purpose: to build the user's mastery of the learning contents in the said subject, to learn the intended curriculum for their grade level in their own time and at their own pace anywhere while enjoying it as if they were only playing games.

4. Conclusion

The use of gamified mobile courseware in Statistics and Probability did not significantly improve the students' cognitive abilities (conceptual and procedural knowledge) in Non-STEM

Experimental Group 1 compared to the students in Non-STEM Control Group 1 (Non-STEM) who used the self-learning modules. On the other hand, it significantly improved the students' procedural knowledge in STEM Experimental Group 2 compared to those in STEM Control Group 2 who used the self-learning modules. Also, the gamified mobile courseware increased the motivation level of the students in Non-STEM Experimental Group 1 after the experiment compared to those in Non-STEM Control Group 1 who used the self-learning modules. Meanwhile, the significant difference between the STEM group's self-efficacy level occurred only by chance after the scores had been adjusted. Thus, the gamified mobile courseware in Statistics and Probability positively affected students' procedural knowledge and motivation levels and can be a valuable instructional material in the flexible learning modality.

The conduct of the study is limited only to three weeks. Because of this, the result in the non-cognitive abilities could have been better as these could take longer to manifest. Also, the study was conducted in an online setting, that's why the result in the cognitive knowledge of the students was affected as well; as the internet provides a vast library of references that students can easily access, which in turn may contribute to the increase of conceptual knowledge of the students. Lastly, the study only focused on the effect of gamification on the students' cognitive and non-cognitive abilities, not its elements.

Based on the findings drawn from this study, the developed gamified mobile courseware may be enhanced by improving the visual layout, user-customization settings, reward system, and ease of use based on the students' recommendations. Future developers may improve the monitoring scheme when the app is used at home to ensure that the students are using the app. Also, making the examples more interactive and adding more game elements are recommended to safeguard and improve user engagement. Lastly, a study about the effects of gamification elements on students' conceptual and procedural knowledge in mathematics and engagement, motivation, self-regulation, and self-efficacy in learning mathematics may be explored by future researchers for future work.

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