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Numeracy Enhancement Tool (NET): Offline Mobile Game Application for Mathematics Classes

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ABSTRACT

Numeracy skills are necessary for the students to cope with senior high school mathematics subject wherein lessons are advanced and need mastery of lower mathematics. These skills are highly required for grade 11 students wherein their academic performance based on mean percentage score (MPS) in the Mathematics examination was below average. In this study, offline mobile game application (Numeracy Enhancement Tool) in the form of quiz was utilized to increase the numeracy skills of the students. In particular, the study aimed to determine the effectiveness of the said mobile app through experiment. This study used practical action research with a pilot testing through pre-test-post-test design for two sections from grade 11 and roll-out in all grade 11 students. A selection of the sections for pilot testing was based on the sections with lowest first grading MPS in mathematics and simple random sampling was used to determine the control and the experimental groups. Using paired sample t-test, it was found out that the mobile app helped the students to increase their numeracy skills based on the pre-test and post-test scores. It was revealed that there is a significant difference between the pre-test and post-test results and between the control and the experimental groups. Moreover, semi-structured interviews were conducted on the experiences and suggestions of the students to improve the mobile app. The study pursued its implementation for the whole grade level in senior high school. All grade 11 students were encouraged to use the mobile app for three months during the third grading period. Their academic performance in the periodical test was considered. It was found out that there was an increase in the mean percentage score which indicates that the use of mobile app has a positive effect on the numeracy skills of the students. It means using mobile phone in learning mathematics concepts may increase not only the passion of the students in mathematics, but also the student's computational and conceptual skills. However, it is suggested to conduct similar studies in other schools to verify the findings of this study.

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1. Introduction

Number sense is an attempt to emphasize the notion that teachers can facilitate the learning process in convergence even with highly diverse learners. It is aligned on the curriculum goal of the National Competency Based Teaching Standard (NCBTS). Every teacher recognizes the demands of numeracy across the curriculum. It involves skills that are not always taught in the classroom. Mathematical knowledge and skills can be transferred even outside the classroom. These opportunities help students recognize the knowledge in different learning areas are interconnected in nature and in the wider world, and give them an opportunity to use their mathematical skills widely.

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In the wider sense, numeracy is not merely the ability to manipulate numbers nor to perform basic operations. It is composed of knowledge, skills, behaviors and attitude that students need to utilize mathematics in a wide application in different situations. It comprises of students recognizing and understanding the role of mathematics in the real world scenario and having the right attitude and capacities to make use of mathematical knowledge and skills fruitfully (Shomos & Forbes, 2014). To make these possible, students need to be able to think, communicate and act mathematically (Wichelt, 2009). Likewise, they can make use of data, understand patterns and practicalities, and make use mathematical reasoning to different situations where problems arise (NCTM, 2017). Thus, numeracy skills can enable them to live more confidently in a complex modern world. That is why mathematics teachers' main duty is to make sure that the students possess numeracy skills regardless of what grade level they belong.

Numeracy as part of integrative learning, can also encourage teachers to be more creative and flexible to cater the different methods of effective teaching. Numeracy is vital in dealing with higher mathematics where complex operations and concepts come inculcated with the mathematical problem (Venkat & Winter, 2015). If the students have low numeracy skills, they were not able to understand the higher mathematics which may cause frustration on the part of the students. Eventually, student may feel fear of dealing with mathematics concepts or studying mathematics as school subject. Seemingly, the students lost their interest in the subject matter despite of different encouragement and strategies used by their teachers.

Based on a sociocultural perspective, numeracy is similar to other social and cultural practices evolves from interactions among people as they try to communicate ideas, organize events, distribute resources, provide equitable exchanges, settle disputes, and reach agreements (Cole & Engestrom, 2003). The meaning found in these social transactions are converted and internalized to give the means necessary for Higher-Order thinking skills (HOTS). But thinking itself, it is intervened and changed by the various technologies that are employed to assist the student's performance (Cole & Engestrom, 2003). Technologies convert both the activity and the human person, build forms of social practice, and of particular relevance and a new version of numeracy. Numeracy, as a part of social practice, is part of an active system that is stretched across the context, the activity, the meditational tools, and the individual-in-interaction (Cole & Engestrom, 2003). From this perspective, this study was anchored on technology based teaching where mobile app was used in improving the numeracy skills of the students as they interact with each other using mobile phones.

In past years, educational setting transformed from a traditional school setting wherein classroom environment is almost structured, teacher-centered and with limited sources of knowledge to a more open setting with distance education inclusion, highlighted with Information and Communication Technology (ICT) based teaching integration. With challenges that come along with a fast change going to the manner of people transact and learn about life situations, mobile phones become more popular tools, especially for the millennial. Eventually mobile phones become the center as such highly digital learning environment. This brings birth to the approval of mobile phones as a new and flexible tools of learning in the 21st century (Fetaji, 2008). Adding the interest of the students on using mobile phones, these devices may be used as tools for learning since the students' lesson and activities are found in their devices.

On the other side, the use of mobile phones has been a portion of people's activities specifically, the youth. These popular devices lessen the efficiency of any school rules and policies that prohibit them in school which leads employing its applications to enhance teaching and learning with ease. Richtel (2010) said that prohibiting the use of mobile phones in schools seems like the means to trespass the students' world and limiting to educate in their technological area. It is believed that using mobile devices produces more learning in an environment where the students love and enjoy what they are doing and multi- tasking is not new to them. Moreover, students find the joy of learning when interesting and challenging activities are introduced and exploring experiential learning take place. The young generation becomes more attached to mobile phones as common and available tools for

effective learning (Kafyulilo, 2012). So, ignoring mobile phones as the entertaining educational tools that students most likely and using it at all times is not reasonable (Kolb, 2008).

Mobile phones become part of the students' daily life. They now become their friendly tools through which learning makes interesting in the eyes of the students who are inactive and not engaged enough in traditional class activities. This is true with Fisher and Baird (2007) findings that mobile technology produces an active learning atmosphere. Based on their study, one characteristic that mobile phones, especially those smart phones, is the ability to convert learning from within the classroom to the open world via the access of the internet. Moreover, Al-Shehri (2011) as cited in Khrisat and Mahmoud (2013) said that the extended students' experiences to be achieved in learing as a whole is not merely related to their instant learning needs. Lots of new knowledge can be accessible to learners using mobile phones. Knowing the reality that these devices can be utilized to both developed and developing countries which help alleviate the gap between them. In line with this, Topolewski, Annie, Shubo, and Pallacholla (2013) believed that mobile learning implementation will gain more involvement by parents and teachers, who act a vital role in the education of their children. This is true, especially in K to 12 which the researcher believes that it is necessary to have a better education for students through the utilization of mobile devices.

It is better to utilize mobile phones in teaching-learning process as learners have access to educational technology aside from the fact that mobile phones are carried around everywhere they go. Most importantly mobile devices are available and are being used by almost students in the present time (Junior & Coutinho, 2008). Two dimensions of the importance were added to the availability of mobile phones. The first one is the timely-needed access to materials and other resources, where learners can easily access to the sources of knowledge (Shiliang & Hongtao, 2013). The researcher perceives that this leads to give an opportunity to the learner to rely on mobile phones as a tool to satisfy his or her own learning needs as long as there is proper utilization of these gadgets. Strengthening the learner-centeredness and providing the learners' knowing in a significant real-life context will give an opportunity on how the learning take places in the digital world. Second, frequent use of mobile phones eradicates the technology alienation that teachers usually experienced when using new devices (Pollara & Broussard, 2011).

At the present time, the common trend in education is generally focusing in utilizing mobile technology and even if the concrete application in the classroom is not highly observed. The stakeholders' attitude toward utilization of technology is positive. Pedagogically, mobile learning happens anytime, anywhere with learners having mobile phone have the full responsibility of their learning. On the other hand, this learning process makes it hard to assist or measure if learning really takes place due to the mobility use of mobile learning technology. From a psychological perspective, students are not completely used to mobile phones as learning tools, but for entertainment or communication purposes only. However, technical challenges on using mobile phones as pointed out by Shudong and Higgins (2006) are the issues of small screens, smaller memory sizes, compatibility, and so forth. But the researcher of the current study believes that these are no longer issues at the present time due to the increase of screen dimensions, memory sizes, and platforms that work with mobile devices.

Dede (2000) and Bereister (2002) revealed that educational theorists advocated that classroom experiences must reflect the complexity of society in order to unfold collaboration skills, gain proficiency in operation with incomplete information and concepts, formulate decision making, and construct new knowledge—part of being an achieving member of society. They looked for technology integration into the teaching of content of the lesson, as students become more productive in using different technologies. The utilization of technology to dig problems and formulate solutions enhanced their comprehension on the process and also the content (Klopfer, Yoon, & Rivas, 2004). With this in mind, teachers believe that mobile technology provides a key to engage students through the utilization of video and audio that goes beyond reading a reference material. The use of mobile phones gives chances for all sensory perceptions—auditory, visual, and kinesthetic—to be involved

during the learning process (Saylor 2004). These new technologies may improve the learning process if properly utilized.

There are many online games for mathematics which are available to be utilized as re-enforcement material for teaching. However, one of the common problems in using online games is the access on the internet which is the reason why few schools use this intervention. However, the students' interest in using mobile devices will give birth to educational gaming in schools. According to Shin, Norris, and Soloway (2011), mobile gaming produces an individualized learning situation that allows students to traverse their own learning track based on their previous knowledge and learning preferences. This flexible route linked to prior knowledge that leads to fruitful learning with ease because they are free to play it anytime and anywhere. Hence, there are school trials that demonstrate benefits in using learning through mobile devices. However, their wide-range effective application in schools has not yet been studied (Milrad et al., 2013; Rushby, 2012; Selwyn, 2010).

Hao et al. (2018) conducted evaluative study of mobile app for middle school students who were struggling with English vocabulary. Participants were ten grade seven students who were performing significantly below as compared to other students in their English as a Foreign Language (ELF) classroom. They found out, that the use of the mobile app enhanced EFL learning. Also, it enhanced their confidence in learning through the use of app. They concluded that the design of the app was an effective tool for mobile instruction. However, student suggested modifying the interface design to be more adaptive and attractive to them. The findings confirmed the possibility of use of the app's instructional design and may be used as evidence-based learning materials to cater EFL learning.

Bano et al. (2018) conducted a systematic review of empirical evidence on mobile learning for science and mathematics school education. The systematic literature review resulted in the detailed analysis of 49 studies (60 papers) published during 2003 – 2016 using content and thematic analysis. The most repeatedly stated subject discussion of the studies are effectiveness of using app, design of the app and technology implementation. They found out that fifty-nine percent of the studies investigated the use of self-developed apps and forty-one percent investigated the use of 3rd party apps which were available in the market. The trend of investigation on technology used was specifically self-developed apps in science; however in mathematics more generic online apps were utilized in the studies. In addition, there are many studies on mobile learning, but there are few studies on mobile game-based research (Liu et al, 2014). It implies that less mobile apps were produced for mathematics lessons. This calls for new apps which are not available in the market but are useful for mathematics' lessons which help both teachers and students in academic matter.

At present, the San Pedro Relocation Center National High School (SPRCNHS) – Main Campus in the city of San Pedro, Laguna is now being challenged to improve the Mathematics skills of the students due to the fact that Mathematics obtained the lowest mean percentage score (MPS) 34.42% in the National Achievement Test (NAT) in 2015. Considering the first grading period of Grade 11 school year 2017 – 2018, it was found out that the Mathematics MPS was 53.53%. This was far from the target MPS which is 75% as an indicator of mastery of the subject matter. Moreover, two sections from this grade level have low mastery level which calls the attention of the mathematics teachers.

The mastery of mathematical skills is necessary to cope and deal with the Senior High School Mathematics where topics were taken from higher branches of Mathematics. These skills greatly affect the students' academic performance in Mathematics as seen from the NAT result. If this problem cannot be addressed, more problems will arise and thus create misconception of the mathematical knowledge of the students. To address this issue, initial interviews were conducted to the mathematics teachers and students to understand what was going on and why this problem occurred. Similarly, classroom observations were carried out to verify the data collected through initial interviews with the permission of the head teacher.

Based on the data collected, it was revealed that the main reason why the students found difficulty in dealing with Mathematics is the low mastery level of the pre-requisite skills which were supposed to

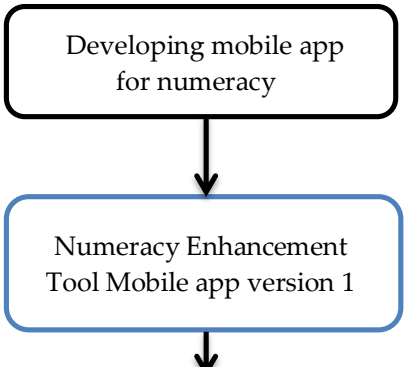
be acquired from the lessons on previous years or grade levels. These skills are pertaining to the basic mathematical skills – numeracy. Moreover, they like doing activities using their phones. So, the researcher concluded that the intervention to improve the pre-requisite skills must be on the interest of the students, easy to access to the topic or lesson, efficient, at hand and focus on numeracy. Considering the attitude and the interest of the millennials towards the utilization of technology devices in their daily activities, the use of mobile phones is sound interesting and economical for them. Hence, their attentions are in focused of using mobile phones. The researcher saw the usefulness of these devices. Thus, a mobile game application was utilized.

An initial survey was conducted to determine the number of students with a mobile phone and it was found out that the majority of the students from SPRCNHS were from the underprivileged families who have less capabilities on materials provisions. However, the use of smartphones is merely typical activity for them. It was revealed that sixty-nine percent of the Grade 11 students have smartphones. These are being used for communication, entertainment, and leisure of the students. Through these data, mobile phones can be used as additional tools in delivering the lesson or assessing the students learning. Moreover, considering the Mathematics Framework of K to 12 wherein mathematical tools that can be used in delivering the lessons are smartphones, a researcher came up with mobile game android application called NET which means Numeracy Enhancement Tool. This application aims to increase the numeracy skills of the students which served as the pre-requisite skills needed in Grade 11 Mathematics.

This mobile game app was developed through the help of an alumnus named Efrai Vyxen M. Rivera of the said school. Items or questions were taken from the Numeracy Inventory Tools for Laguna Learners (NIT2L) developed and validated by the Mathematics teachers of Laguna which are intended to assess and evaluate the numeracy of the students. Little twist was put in the app to make it interesting game for the students. The first version of the app was pilot testing to the grade 10 students for one week to ensure its usefulness. The second version was pilot testing to grade 12 students for one week. Their inputs on enhancing the mobile app were considered for the third version. After two weeks of a pilot testing in grade 10 and 12, the third version was developed for another two weeks. Suggestions from Mathematics teachers and students were considered until the third version of the app was materialized.

Developing a mobile app for numeracy skills of the students will help the mathematics teachers to develop the pre-requisite skills of the students through meaningful and fun activities with little guidance. Moreover, this study may help the teachers to be opened on the integration of Information and Communication Technology (ICT) based teaching standard in the teaching-learning process specifically the mobile phone and consequently change their negative perspective on the gadget use by their students. Similarly, it may help future researchers to conduct similar studies on the use of mobile phone. Pedagogically, this may inspire them to finish their research regarding the usefulness of mobile devices in a school setting.

The study used the pre-test and post-test scores for pilot testing of the third version of mobile app to determine if this may increase the numeracy skills of the students. This mobile app maybe used by the students anywhere even without internet connection. Basic numeracy skills such as number sense and basic operations were tested in this offline mobile app throgh quiz game which was considered vital in coping Senior High School Mathematics.



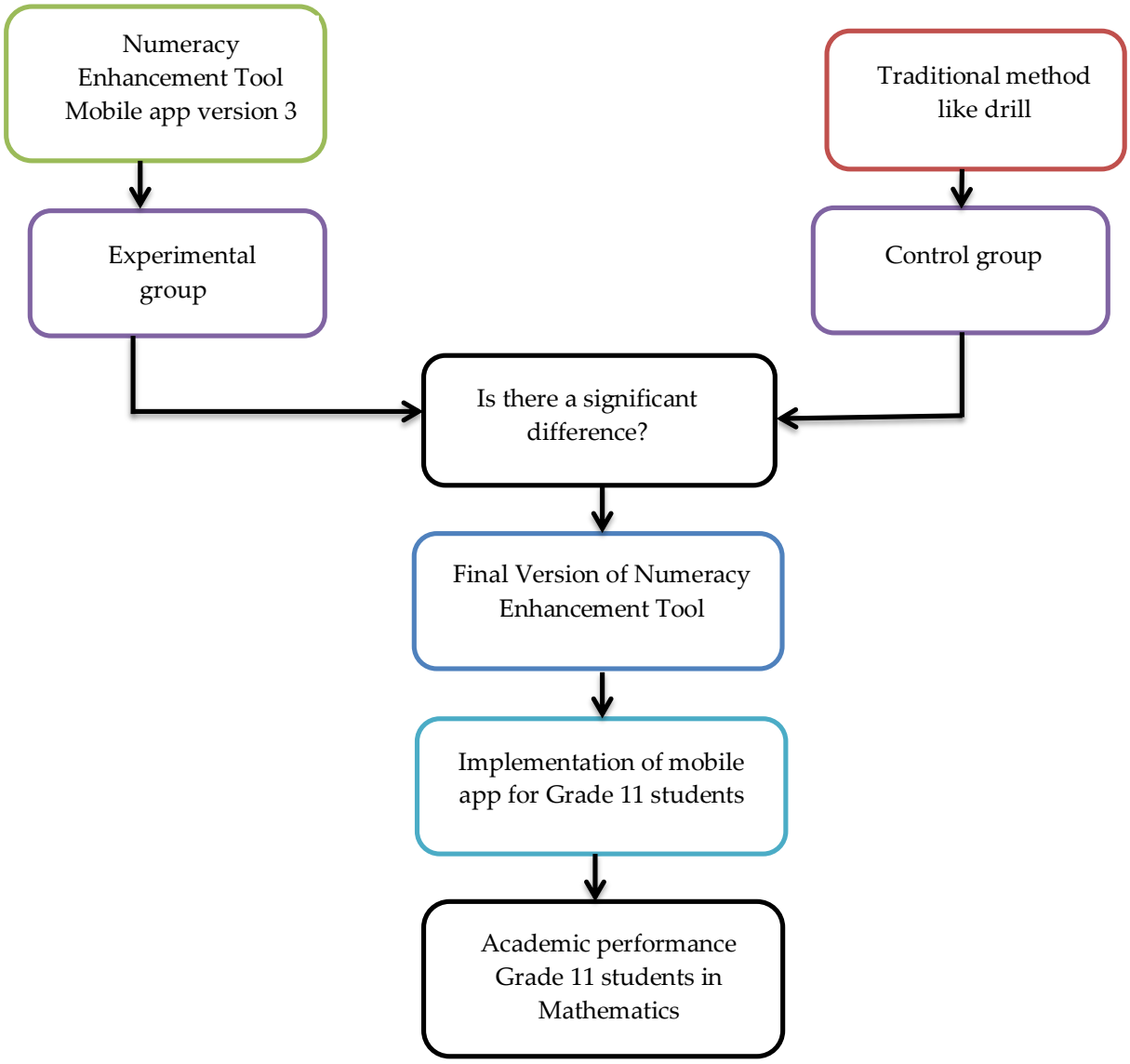


Figure 1. Conceptual paradigm

The figure above shows the flow of study. Four versions of the mobile app were developed until the third version was pilot tested in one section of grade 11 students. A significance difference of the pre-test and post-test scores was utilized to determine if there is a significant result in the academic performance of the students after the use of mobile app. Then, suggestions of the students to improve the final version were taken into considerations. The implementation of the final version of mobile app used for all grade 11 students for three months was utilized to enhance the numeracy skills of the students and perform better in Mathematics subject.

This study aimed to determine the effectiveness of the Numeracy Enhancement Tool (NET) as the means of increasing the numeracy skills of the students through the use of an android cell phone for school year 2017 - 2018. Specifically, it sought to answer the following questions: 1. What are the levels of performance in the pre-test and the post-test of the experimental group and the control group in pilot-testing? 2. Is there a significant difference between the scores of two groups in the pre-test and

post-test? 3. What are the suggestions of the students in pilot testing to improve the Numeracy Enhancement Tool? 4. How effective is the offline mobile app in increasing the academic performance of the Grade 11 students in General Mathematics?

2. Methodology

2.1 Research design

This study was practical action research using mobile app for android phones to address the low performance of the students in grade 11 Mathematics. The study used mobile game app called Numeracy Enhancement Tool (NET). The NET is just an android mobile game application which can be played inside or outside the school to measure and enhance the students' numeracy skills through answering the mathematical question one at a time in every level of a chosen category. It can be used even without internet connection. The students play this app first by reading the instruction on the interface and click button at the left hand corner. The installed questions are in the quiz form with three levels - easy, average and difficult; and four categories such as whole numbers, rational numbers, integers, and decimals. Each level has five-item multiple choice to be answered one at a time out of fifteen installed questions. Items were automatically displayed and no item will be repeated in a single play in the final version of mobile app. After each level, the score will be displayed and the student must get at least four correct items before he/she can proceed to the next level or else repeat the same level with differnt set of questions. In case the student has no mobile phone, he/ she may borrow mobile phone from the class anytime and play the game anywhere in school. The scores of the students will be recorded daily by the class president for monitioring and basis of giving additional points to their writen work. However, quasi-experimental design where pre-test and post-test scores were utilized between the control and the experimental groups for pilot testing of the third version of the app.

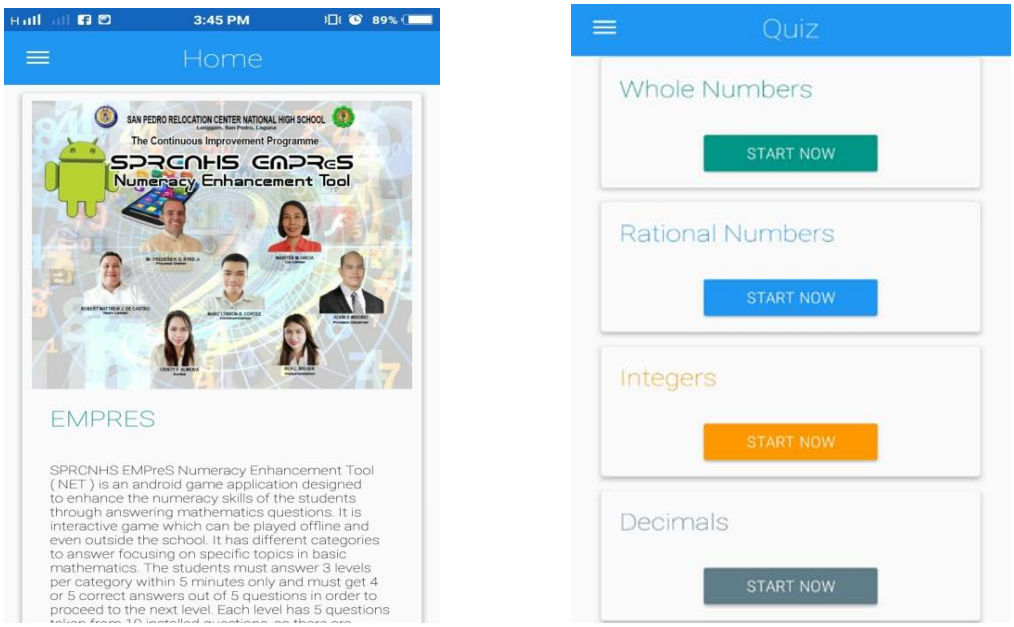


Figure 2. The interface of the offline mobile game app

The figure shows the interface of the final version of mobile app with the faces of school head, mathematics head teacher and teachers in grade 11. Short description was written on the interface as instruction to users. The item questions were installed into categories such as whole numbers, rational numbers, integers and decimals where the student may choose the topic he/she wants to play at a time. This is a game in the sense that the students are enjoying each item in answering to get a passing score at the end of each level and category until they already played all categories. This challenged the mathematical ability of the students particularly the numeracy skills which considered as pre-requisite skills for senior high school mathematics.

2.2 Respondents and Sampling Method

In pilot testing of the third version of the app, the selection of the two sections in grade 11 was determined based on the lowest MPS in the first grading mathematics examination. Simple random sampling was used to determine which group was the control or the experimental. Forty students in each group were considered to make paired comparison of the results. The experimental group was exposed to the use of mobile app for two months in the second grading period to review and enhance their numeracy skills while the control group was exposed to the traditional way of reviewing numeracy skills like drill using flash cards.

In roll-out, fourteen sections for grade 11 of SPRCNHS with the total of 740 students were used as subjects of the study. The mobile app was share to all students with android phone to install the app and make use it for three months. Sharing of phones was allowed and the class president was assigned to monitor and record their daily scores and time played based on the screen shot. For ethical consideration, informed consent and assent were given to the students and their parents to elicit their permission. Hence, identity of students was not revealed to protect the subjects of study because most of them were minors. Moreover, data were treated with utmost confidentiality as part of the protocol.

2.3 Research Instruments

The study used test material to measure the numeracy skills of the two groups for pre-test and post-test. The test material was utilized as assessment tool because the students are familiar in this method of assessing their mathematical ability. The items of test material were taken from Numeracy Enhancement Tool for Laguna Learners which was created to measure the numeracy skills of the students in the province of Laguna, Philippines and it was validated by the head teacher in Mathematics. There are four topics in the test material such as whole numbers, rational numbers, integers and decimals with ten items each, a total of 40 item test with no choices to avoid guessing of answers. This tested their acquired numeracy skills obtained by playing the mobile app. The test questions started with the easy item like performing operations on whole numbers going to difficult item like problem solving as application of mathematical concepts. The students may write their solution and answer in any piece of paper for one-hour examination without the use of any gadget. However, for the roll-out, the periodical test result was used to determine if the use of mobile app helped the students to perform better in Mathematics subject. The periodical test was constructed by other mathematics teacher of grade 11 to avoid bias and administered simultaneously by the class advisers.

2.4 Data Collection and Analysis

A letter of permission was secured addressed to the school head and noted by the head teacher. After the permission was granted, the orientation for the mathematics teachers and students was conducted. Parents were also informed about the mobile app through consent and accent form so that they did not prohibit their children on using a mobile phone. The first version of the mobile app was pilot tested to forty grade 10 students and they were asked about their experiences and suggestions to improve the app. The second version was pilot tested to forty grade 12 students and they also asked about their experiences and suggestions to improve the app. The third version was pilot tested to one section of grade 11 students as the experimental group for two months. Pre-test was administered to the experimental and the control group prior to the use of app. The result was set aside for comparison on the post-test result. After two months, a post-test was administered. The scores from examination were checked by Mathematics teachers and kept confidential. Through this, the comparisons between the results of before and after treatment; and between the two groups were utilized in order to determine the effectiveness of the mobile app through t-test. Moreover, semi-structured interviews were conducted on the experimental group about their experiences and suggestions to improve the mobile app. After the result of comparisons, the findings were communicated to the school head to ask permission to roll-out intervention to all sections of grade 11.

The mathematics teachers motivated all grade 11 students to use the final version of mobile app for three months during the third grading period by giving additional points on their quizzes. If the student completely answered all levels and categories, they must have a screen shot of their scores to gain additional points in their quiz as proof of using the app. The teachers give one point for every screen shot score per day. Student's score and time played were recorded by class president daily and monitor by mathematics teachers. Moreover, a quiz bee on using mobile app was conducted after three months of using the mobile app and everyone was invited. Similarly, scores from third periodical test were considered and analyzed statistically to determine the effect of using mobile app after the implementation. Quantitative data were treated statistically using percentage, mean and t-test independent and paired samples under Statistical Package for Social Sciences (SPSS) version 20 while qualitative data treated thematically.

3. Results

The data were treated using some statistical treatment to determine its meaning. Below is one-sample Kolmogorov-Smirnov test to determine the normality of scores.

Table 1. One-Sample Kolmogorov-Smirnov Test for normality of scores

Statistics		Pre-test	Post-test
N		80	80
Normal Parameters[a,b]	Mean	11.812	34.942
	Std. Deviation	3.573	4.881
Most Extreme Differences	Absolute	.143	.110
	Positive	.086	.102
	Negative	-.143	-.110
Test Statistic		.729	.984
Asymp. Sig. (2-tailed)		.076	.288

The table above shows the test used to determine if the collected scores were normally distributed to allow the use of parametric test for significant difference. It could be noted on the table that the scores obtained from pre-test and post-test were normally distributed. Furthermore, the researcher is allowed to use t-test to determine the significant difference before and after treatment since parametric tests requires normally distributed scores for numerical data.

Table 2. Comparison of score in pre-test and post-test of the two groups

	Group	$\bar{X}$	SD	Std. Error Mean
Pre-test	EG	11.850	3.570	.564
	CG	11.775	3.605	.570
Post-test	EG	28.850	2.852	.451
	CG	21.025	2.939	.465

The table 2 presents an increase of scores in both groups from pre-test to post-test. The mean scores of the two groups from pre-test were closer to each other which revealed that the two groups are comparable. However, scores of the experimental group increased to 17 points, while the control group increase to 9.26. Moreover, the experimental group obtained the higher mean score than the control group in post-test. This data intensifies the use of NET mobile app wherein the students can use the application everywhere with convenience in reviewing and enhancing numeracy skills.

Table 3. t-test for independent samples for significant difference

		t-test for Equality of Means				
		t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference
Pre-	Equal variances assumed	.093	78	.926	.07500	.80227

test	Equal variances not assumed	.093	77.992	.926	.07500	.80227
Post-test	Equal variances assumed	12.085	78	.000	7.82500	.64752
	Equal variances not assumed	12.085	77.928	.000	7.82500	.64752

It is revealed from the table 3 that the computed t-value of the comparison of pre-test scores of the experimental and the control groups was .093 with p-value of .926. It shows that there is no significant difference between the scores in the start of the experimentation. This is good indicator for the experiment to be conducted because two groups performed the same in pre-test. On the other hand, the computed t-value of the comparison of post-test scores of experimental and control group was 12.085 with p-value of .000. It means that there is a significant difference between the scores in the end of the experimentation. Considering the mean difference of the post-test, it was around 8 points which farther than pre-test. It means there was an increase score in post-test.

Table 4. Paired sample t-test for a significant difference between the pre-test and post-test scores

		Paired Differences				t	df	Sig. (2-tailed)
		$\bar{X}$	SD	Std. Mean	Error			
EG	Pre-test & Post-test	27.000	4.212	.666		40.539	39	.000
CG	Pre-test & Post-test	19.250	4.856	.767		25.074	39	.000

It can be gleaned from the table 4 that the computed t-value of the comparison of pre-test and post-test scores of students in the experimental group was 40.539 with p-value of .000. It shows that there is a significant difference between the pre-test and post-test of the students in the experimental group. The same with the control group obtaining 25.074 for t-value with .000 p-value. It also shows that there is a significant difference between pre-test and post-test of the control group. Both sets of students obtained the difference but comparing the average, the experimental group obtained the highest mean than the control group. It means that the experimental group performed better than the control group. It implies that the use of mobile app in reviewing and enhancing the numeracy skills of the students was effective. This finding gives confidence to the researcher to pursue roll-out the use of mobile app and considering the suggestions from the students to improve the final version of mobile app before the full implementation.

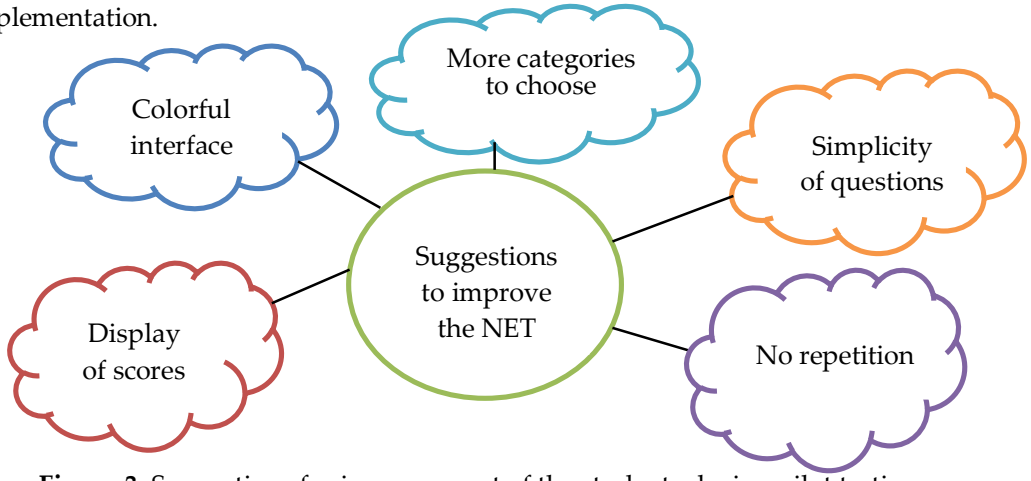


Figure 3. Suggestions for improvement of the students during pilot testing

The figure 3 shows the themes arrived from the transcript of the interviews. The students suggested to make the interface colorful, but simple to add attraction to them, making questions simple as possible wherein no repetition of items display and more categories or levels to choose from. They also want a display of scores obtained in each level and categories at the end of the game so that they can recall which categories they failed to get the correct answer. These suggestions were considered to re-program the final version of the mobile app NET and utilized for the roll-out in all grade 11 students.

The figure below shows the result of the three months implementation of the mobile app in grade 11 students with 14 sections and three strands in Senior High School during the third grading period compared with the previous grading periods.

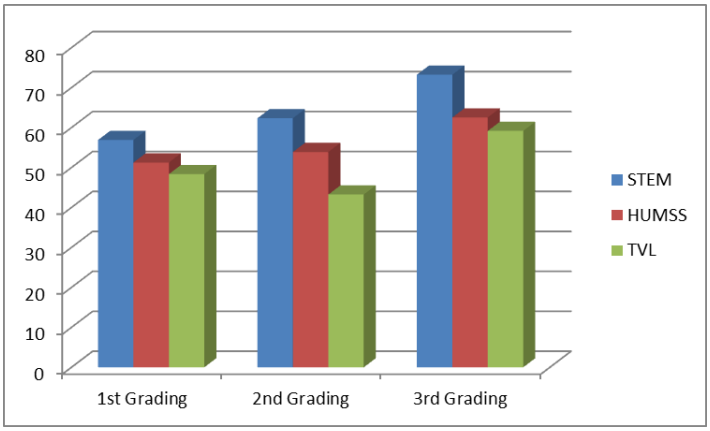


Figure 4. Mean Percentage Score (MPS) in Mathematics of grade 11 students

It can be gleaned from the figure 4 the mean percentage score of grade 11 students increased from first grading to the third grading period. There was 15.82 increase from second to the third grading which indicates the effect of the use of mobile app. After three months of roll-out use of mobile app, the students' performance in examination improved.

4. Discussion

NET mobile game app helps the students to engage in learning while they are playing or having fun. This may lessen the work of the mathematics teachers in reviewing the numeracy skills of the students. Based on the findings, scores in pre-test of the selected students in pilot testing of the third version of mobile app were the same which is ideal for experimentation. Using t-test, there is no significant difference between scores in the start of experimentation. On the other hand, there is a significant difference between the post-test scores in the end of experimentation. It means that the intervention used during experimentation was effective. Moreover, there were some students who performed better in post-test they came from the experimental group.

During three months of roll-out, students were motivated to use the mobile app to make sure they utilized it. This enabled the students to perform better in mathematics during the third periodical exam. It means their conceptual and computational skills were enhanced. This was because of the routine of the students in playing mobile app which changes their experiences towards learning mathematics. These changes experienced by students toward learning mathematics were because they used mobile devices to support their learning. Likewise, using mobile phones everyday whether inside or outside the classroom helped them to perform better academically (Daher, 2011). The increase in scores on their examination manifest that learning happens among the students through the use of mobile app. This finding is similar in the study of Hao et al. (2018) who found out that mobile app enhanced learning. Since students nowadays are technologically inclined, using smart phones may help teachers to get the students' interest in learning the subject matter. Teachers may use mobile phones as an innovation to cope up with the needs of the highly diverse learners.

This study intensified the usage of NET mobile application in reviewing basic concepts in mathematics. The students can conveniently use the mobile app everywhere and anytime they want. This study believes that NET mobile app can replicate the traditional teaching of the teachers while reviewing and enhancing the numeracy skills in senior high school Mathematics. It is more convenient for both teacher and students to use the mobile app where the students can use with ease. This application follows differentiated learning, where the students can answer questions in their own pace.

This is study is limited to one grade level and one school for ten months' duration including the planning stage up to the writing stage. Moreover, the mobile app used was intended only for Mathematics classes in grade 11 catering the numeracy skills of the students. However, it adds to the existing literature about the benefits of mobile devices in teaching and learning. More studies are needed to substantiate the findings of this study to be conducted by future researchers.

Replication of the mobile app is recommended in other subjects to determine if a mobile app really increase the academic performance of the students. Still NET can be improved by providing teacher editing facilities and by redesigning its interface. A qualitative research should follow after this research to confirm the experiences of the students to this application to enrich the findings of this study. Moreover, similar study may be conducted by other schools to validate its effectiveness and to gather more suggestions for improvement of the mobile app.

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APPENDIX

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