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Salmon's E-tivity Approach in Teaching Mathematical Concepts in Physics

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ABSTRACT

The study is a Quasi-Experimental research design employing Solomon's four-group method of comparing the performance of the experimental and control groups. It aimed to determine the impact of Salmon's E-tivity approach on students' Mathematical performance in Physics. E-tivities have five stages namely: access and motivation, online socialization, information exchange, knowledge construction and development. Relevant activities were derived from interactive simulations of Physics Education Technology (PHET) and a facebook group chat was created for the realization of the process. Seventy six (76) Grade 9 students of Subangdaku Technical Vocational School were randomly selected for the conduct of the study. The researcher adopted a validated questionnaire from DepEd to determine the performance level of the groups. The data were analyzed via dependent, independent t-tests, and ANOVA (single factor). Findings of the study showed that Salmon's e-tivity approach is more effective in improving students' Mathematical performance in Physics. The positive response of the approach was verified from experimental group's reflection of the entire stages. Thus, e-tivities fit the learners of today and can help address their difficulties in dealing with the mathematically challenged topics in Physics.

Keywords: *interactive simulations, salmon's e-tivity approach, solomon's four group design*

INTRODUCTION

The development of the educational system has been evolving to be able to compete globally which brings education as one of the country's priority. Even if education became one of the priorities, Philippines is still very low in Mathematics and Science according to the reports of World economic Forum (WEF) and Trends in International Mathematics and Science Study (TIMMS). As a matter of fact, Philippines ranked the third least competitive country among ten Southeast Asian Countries from the year 2013-2014. It means that the Filipino children stand at the bottom row in the global arena.

According to Rabino (2014), the National Achievement Tests (NAT) showed that science continues to be the most challenging field of study in the Philippine Basic Education. Students 'difficulty in Physics is associated with the problems of dealing Mathematical representations-such as formula manipulations which involves calculations (Erinosho, 2013). In a way, if students can fully understand and learn about Physics they can apply relevant topics from algebra to geometry to physics problems, according to Redish (1994).

Science education is a complex process which involves the teacher's instruction, students' learning, and the curriculum. The three have to go together and must agree to maximize learning. The use of Mathematics is required in dealing with Physics specifically in topics involving problem solving, graphical analysis and manipulation of formulas. Among the topics in Physics where students are having difficulties are Forces, Motion, and Energy, which difficulty of the contents increases as the year level increases. Once the students failed to absorb the basic concept intended in every grade level, they will surely have hard time dealing with the complex ones in the next level.

The spiral progression of Science in the K to 12 Curriculum has been challenging to teachers as well since it means there must be strategies that would fit the students of today without compromising the allotted time in every competency.

Another problem a Physics teacher is facing specially in teaching the subject is students of the necessary Mathematical concepts which are needed in understanding Physics. Redish (1994) validated that; "…we have problems understanding most of our students and they don't actually get us…" The characteristics of the 21st-century learners demand a teaching strategy that is augmented with technology. The usual conventional approaches in the past realistically do not fit the learners of today. The traditional instructional strategies such as discussions and illustrations obviously do not welcome learning. The adventurous personality of the students these days requires strategies that would satisfy curiosity through involving themselves and not limiting them to what they can possibly explore (Reif, 1985). The conventional teaching strategies cannot contain students to what they have to learn from the subject resulting to poor performance in Physics. Moreover, it will lead to an efficient teaching pedagogy since the teacher has to reteach the lesson just for the students to absorb them. Nowadays, there have been variety of strategies that the teacher can use in his or her class. However, it varies as well on the type of students and explorations of those approaches can be helpful yet crucial as well.

Salmon's e-tivity approach is a technology based approach which is an effective tool to communicate with learners and considered to have a wide-range of learning maximization. With the integration of interactive simulations that can be downloaded in the internet for free, this bridges the gap of learning especially in Physics that requires students to use Mathematics to understand further its concept.

E-tivities are frameworks which enable students to actively participate in online learning may it be done individually or by group. It employs essential, comprehensive principles and procedures of learning with the use of technology. Moreover, e-tivities focused on the learners who are collaborating with one another. It defies the idea of being dependent on the teacher's discussion to gain knowledge. Thus, the formation of knowledge was constructed from the learners themselves (Salmon, 2002).

The researcher aimed to determine the impact of Salmon's E-tivity approach in Teaching Mathematical Concepts in Physics among Grade 9 students of Subangdaku Technical Vocational School. Results of the study can assumingly help physics teachers teachers who are having difficulties in looking for strategies That the students easily understand the language of Mathematics which in turn help in the understanding of the concepts of Physics. What made this study more interactive is the integration of simulations found in Physics Education Technology (PHET) which served as the e-tivities for the students to manipulate.

Statement of the Problem

The study aims to determine the impact of Students' Mathematical performance using Salmon's E-tivity approach to Grade 9 students of Subangdaku Technical Vocational School.

Specifically, the study seeks to know the pre-post performance of the students in both control group (C1) and experimental group (E1). Moreover it wants to determine the significant difference in the pre-post performance of students in both the control group (C1) and the experimental group (E1). In addition, the researcher also needs to know the a significant pre-post mean gain in the students' performance both the control and experimental groups. To give best results of the study, the the study also check the significant mean gain difference of the students' performance between both the control and experimental groups. To assess further the effectiveness of E-tivities, the researcher asks the students about their experiences in stages of the e-tivities.

Conceptual Framework

This study focuses on Salmon's e-tivity approach in Teaching Mathematical Concepts in Physics anchored from Gilly Salmon's five-stage e-tivity model. It used free simulations online as main e-tivities reflected and were reflected on the lesson plan. Most of the attached simulations from the worksheets came from Physics Education Technology (PHET) of Colorado. Fig. 1 shows the schematic diagram of the theoretical-conceptual framework of the study.

The study was anchored from Professor Gilly Salmon's e-tivity approach applying the 5 stage steps to learn. The said steps are access and motivation, online socialization, information exchange, knowledge construction and development.

E-tivity approach describes a framework in facilitating active learning in an online environment.

E-tivities are quick and easy to reproduce, more comfortable and productive. An e-tivity involves the learners to interact with each other. The teacher serves as the e-moderator on the entire stages. One of those purposes of E-tivity approach is to challenge and motivate participants to critique, collaborate, review and accumulate ideas in a focused way. Moreover, it increases learner engagement towards a particular discussion (Salmon, 2015).

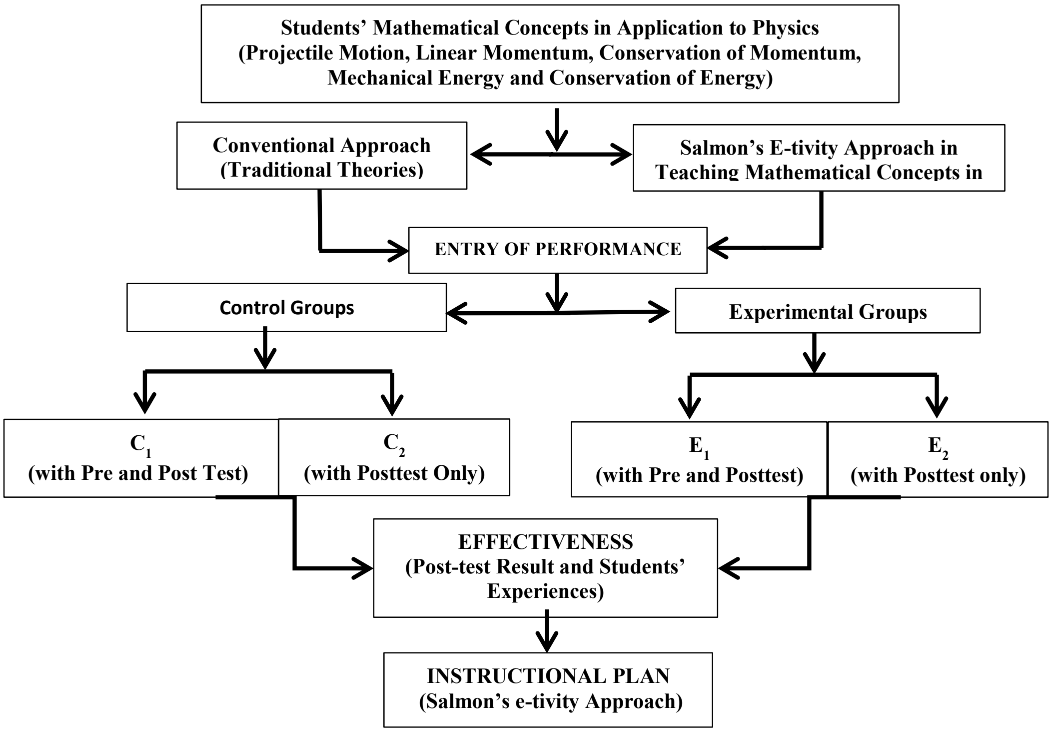

Figure 1. Schematic Diagram of the Theoretical-Conceptual Framework of the study

The above framework describes the flow of the study and the data needed to achieve research goals. Controlled groups were employed with the traditional approach while the experimental groups were applied with Salmon's e-tivity approach. The performance of the groups were determined through pre-posttest. Results of the post-test and their narrative experiences determine the effectiveness of the approach. Moreover, the output of the research is the application of Salmon's e-tivity approach and is reflected in the teachers' instructional plan.

Review of Related Literature

Mathematical processes are also used in Physics. It is not only the "language" of Physics, but it also determines a huge extent pertaining to the content and meaning of physical concepts and theories themselves. These Physical concepts, Mathematical arguments and critical thinking are also used in Mathematics. Thus, Physics not only more into problems solving but it also gives ideas, methods and concepts that are crucial for the formation and development of new mathematical concepts, methods and theories, (Tzanakis, 2001).

According to Tzanakis (2001), from the history there were three ways in which Mathematics and Physics are interrelated. First, theories in Physics and relevant Mathematical framework are parallel with each other. Second, Mathematical theories, process or procedures were formulated to solve physical related problems, or to give a well-founded methods and concepts of Physics. Formulation of a mathematical theory is derived from its applications to phenomenon. Its use is often constructed depending on its level of importance in order for physical problems to be solved.

Saul, Wittmann, Steinberg, & Redish (2005) had observed a number of failures with regards to relating symbols to measurement or even failure to understand variable relationships. According to Lederman (1992), conceptual similarities between mathematics and physics subjects should also have an effect for teaching and learning the subject. For instance, how theoretical physicists use mathematical applications is also an essential factor of the nature of physics. The importance of applying mathematical concepts in physics education is also supported by research results which are related to learning. Mathematical knowledge into physics domain cannot be expected to happen instantly. On the other hand, Mathematics related concepts cannot be easily transferred to physics as the application of it varies also in Physics. The use of Mathematics as a language in physics differs in many ways depending on its need to be applied.

The problems and difficulties of the students with the use of mathematical concepts in physics education must not be ignored. The application of formulas and related calculations that made students find it difficult to understand physical related concepts, procedures of computations which still bring to Mathematical difficulties in application to Physics has to be taken seriously. Though such problems rooted from the use of Mathematics in Physics teaching.

A closer analysis of the connections of Mathematics to Physics varies on the technical and structural role. Technical role refers to the tool-like use of the subject while the structural role refers to the close connection of the subjects- Physics and Mathematics such as the use of Mathematical equations to understand Physical phenomenon. In classroom setting the technical role seems to prevail which allow a meaningful application of mathematics. Moreover, the structural role of mathematics to physics is more relevant especially for deeper investigation of relationships among variables.

E-tivities are useful in the online related interactions. Using this may arouse interest of the learners in Physics despite the fact of applying Mathematical concepts on it. However, todays' trend is more on virtual related learning. E-tivities are designed for time related constraints in learning the subject not only in Physics, however, they are reusable. Teachers can always improve them whenever needed. This can be helpful to students who are bored of the printed worksheets and point-based homeworks. These can create a classroom where students collaborate and other interactions related to learning and teaching methods (Salmon, 2002).

Various research in mathematics education show the students have difficulties in applying Mathematical concepts in Physics. Studies such as of Akinsola (1994, 1997), Popoola (2002) revealed that delivery of instruction is very important in acquainting mathematical concepts. According to Brown (1997), effective instruction requires the teacher to step outside the concept of personal experience unto what the learners need. The learners must be engaged in an activity in order for learning to take place. The learner must commit to learn. Simulation-game like instructional strategy might be the solution to the problem.

Randel, Morris, Wetzel and Whitehill (1992) agreed that since students enjoy playing games, it is important to consider if this play aspect can be combined with teaching instruction to enhance learning. Mathematics plays an important role in learning physics. There are various studies and publications dealt with philosophical aspects, attempts to model use of Math in Physics and studies focusing on the students' attitude and misconception towards Mathematics or Physics.

Physics education has to be focused. The many reactions pertaining to the application of formulas and calculations which hinder to understand it better lead to the traditional routines and meaningless computing activities and brings additional mathematical struggles with it, has to be put into consideration. Skemp (1976), who is a pioneer in mathematics educational research, pointed out the difference between instrumental and relational understanding. By focusing on the necessary skills like usual manipulations of formula related and learning strategies, it is impossible to achieve a deeper understanding of the Mathematical concepts. For knowledge to take place a relational understanding of the concepts has to be focused through applying techniques to solve the said problems. Therefore, it is really important in physics the elaboration of the concepts in order to develop a kind of understanding of the relationship between physical behavior and mathematics. Using the common can just make it worse.

For this possibility of combining the e-tivities and the interactive simulations, the concept might make a difference in students' performance towards Physics despite the application of Mathematics.

METHODOLOGY

Research Method. Since the study intends to compare the conventional method with e-tivity approach in teaching Mathematical concepts in Physics, the Solomon four-group experimental design was used. This is done to minimize the possibility of recall in the post-test. The dependent variable is the students' performance towards projectile motion using the interactive simulations. The independent variable of the study is Salmon's e-tivity approach. Variables such as academic and length of time are controlled. Moreover, groupings of the students pertaining to the intended activity are also controlled. Meanwhile, variables such as time schedule of the classes on both groups, the set-up of the classroom, the age bracket of the respondents, the socio-economic standing of the respondents will not be considered in the study. This design is used in summative judgments to establish significant difference among groups of subjects through critical analysis on the basis of the criterion measure, and to ascertain empirical data through experimentation using the design that eliminate effects maturation, attrition, and other intervening factors, that would result to a guaranteed valid research finding outcomes

Sample and Sampling Technique. The sample of 76 was randomly selected form a population of 100 students.

Research Subjects and Respondent. The subjects of the study were the 76 grade 9 students of Subangdaku Technical Vocational School S. Y. 2015-2016 who were randomly selected for the conduct of the study.

Research Environment. This study was conducted at Subangdaku Technical Vocational School, which is the only pilot school of Senior High School under K to 12 curriculum in Mandaue City Division. The school has more than 600 students and known for its quality teaching and practices when it comes to Technical Vocational related fields particularly in garments, food and beverage, shielded metal arc welding, beauty care, electricity and internet computing fundamentals (ICF). It has been producing 100% of NCII passers. Moreover, it has internet connection directly proportional to 61 individual units of LCD monitor. It is situated at M. Logarta St. Subangdaku, Mandaue City and has been founded in 1997. Currently, the school is preparing for the full blast implementation of k to 12 and is now focusing on what technology has to offer to 21st century learners just like considering computer laboratory as an important facility in learning all subjects.

Research Instrument. To determine the effectiveness in applying Salmon's E-tivity approach in teaching Mathematical concepts in Physics, the researcher adopted a validated questionnaire from DepEd. The performance test is a 29-item test which was used to measure the respondents' pre-test and post-test achievement on force, motion and energy. The test questions were fitted to the table of specifications that measured proportionally to the skills of knowledge, comprehension, application, analysis, synthesis and evaluation. The table of specification is found in Appendix C. Rubrics parameters and indicators are based from the competencies in learning force, motion, and energy through interactive simulations.

Moreover, the students were given a format of the journal which they wrote their experiences and reflection as they manipulate their worksheets using their Facebook group chat account. The format of the mentioned journal can be found in Appendix F.

Data Gathering Procedure. The researcher asked the permission of the Schools Division Superintendent and the school principal of Subangdaku Technical Vocational School for the conduct of the study to the students of Grade 9-Chastity and Patience who are enrolled to S.Y.

2015-2016. The researcher also prepared two lesson plans focusing on the mathematical concepts of force, motion and energy related topics. The said lesson plans were of the same objective but of different strategy-Salmon's e-tivity approach and the conventional (lecture discussion approach).

With the blessing of the school principal, the researcher grouped the students of into two, comprising of 17 in each group. The groupings were done randomly. Such groups were the assigned groups for the control and experimental. To determine further how far the students had gone through the mathematical concepts of force, motion and energy, the pre-assessment was conducted. The pre-assessment were given to all the students involve in the study and served as the basis of the researcher's determination of the pursuance of the study. After the needed materials and venue for the experimentation were finalized, the focus of this study was experimented to the target respondents. The other groups of grade 9 Chastity (C1) and the other group of grade 9 Patience (C2) were the control groups who were exposed to the conventional method. On the other hand, the other groups of grade 9 Chastity (E1) and other group of grade 9 Patience (E2) was the experimental groups and were treated using Salmon's e-tivity approach.Those respondents from the control group were taught using the conventional approach, the usual lecture-discussion with a short demonstration on force, motion and energy. Exercises were done orally and through board work. Assignments pertaining to projectile motion were given to the respondents. Meanwhile, those who were part of the experimental group were taught with the concepts of force, motion and energy and were manipulating the e-tivities through the interactive simulations. Before they took place as the respondents, they were oriented with how the e-tivities worked. The manipulation of the e-tivities was based on the PHET worksheet. The researcher had to create another Facebook account which served as the group chat outlet while doing the interactions regarding the e-tivity. The researcher then added the Facebook account of those students to the group she created. Instructions were relayed carefully to the respondents including the do's and don'ts of the computer laboratory which served as the venue of the e-tivity for the experimental groups. Right after the e-tivity, concerns pertaining to equations and solutions related to example problems in force, motion and energy had taken up in a separate manner, since the focus of the e-tivity is to emphasize the mathematical concepts of physics particularly in force, motion and energy topics. The role of the researcher is as e-moderator and the facilitator. Questions pertaining to the activities both on experimental and conventional were done by the researcher. At the same time, it is the role of the researcher to check the outputs of the students. More emphasis on the mathematical concepts of force, motion and energy were done through various example problems that involve e-tivities related to mathematics in physics.

All four groups were subjected into posttest and comparison between and among them were established. The results of the posttests then, were interpreted and analyzed for the research report.

Statistical Treatment of Data

Parametric and non-parametric treatments were used in the processing and analyzing of data. In order to determine the students` performance in dealing with the mathematical concepts in Physics, the t-test for one sample was used. To determine whether there is a significant mean difference and significant mean-gain difference between the students` mathematics performance treated with E-tivity Approach and conventional instruction, the t-test of mean difference was used. Moreover, to determine whether there is a significant pre-post mean gain of the learning performance of students in Projectile Motion, Linear Momentum, Conservation of Momentum, Mechanical Energy and Conservation of Energy, the t-test for pre-post mean gain was used. Furthermore, to determine the significant difference in the post-test performance of the students among the four groups, the one-way analysis of variance (ANOVA) was used.

A 0.05 level with a two-tailed test of statistical significance for rejecting or accepting the hypotheses is used in this study.

RESULTS AND DISCUSSIONS

Level of Performance in Learning Mathematical Concepts in Physics through E-tivity Approach

The students level of performance in the Mathematical Concepts of Projectile Motion, Linear Momentum, Conservation of Momentum, Mechanical Energy and Conservation of Energy of the control groups and experimental groups were determined based on the results of their pre-test and post-test. It was administered before and after introducing the concepts and recalling the tools necessary in dealing with those concepts. The total score of the prepared summative test is 29, with equal number of total points. The respondents of the study were expected to get a mean score of 17.4 which is 60% of the total score. Moreover, for Projectile Motion, the students were expected to get 6, for Linear Momentum, they were expected to get 3.6, for Conservation of Momentum they need to get 2.4, Mechanical Energy, 3.6 and 1.8 for Conservation of Energy respectively. It was hypothesized that, at 0.05 level with a two-tailed test of statistical significance, each treatment would have no significant difference in their actual mean and hypothetical mean both before and after the conduct of the experiment.

Table 1. Students Performance of the Control Group in the Pretest

Topics	Points	H.M.	A.M.	SD	t_{cv}	DESC.
Projectile Motion	10	6	2.84	1.39	9.94	BA
Linear Momentum	6	3.6	1.11	0.66	16.53	BA
Conservation of Momentum	4	2.4	0.37	0.60	14.83	BA
Mechanical Energy	6	3.6	1.42	0.84	11.34	BA
Conservation of Energy	3	1.8	0.68	0.58	8.35	BA
TOTALITY	**29**	**17.4**	**6.42**	**2.01**	**23.82**	**BA**

Significant when t_{cv}> 2.101 at 0.05 level (2-tailed); N=19

The table above shows students' low performance in Projectile Motion, Linear Momentum, Conservation of Momentum, Mechanical Energy and Conservation of energy. One primary reason was the students' problems in dealing with the Mathematical related foundations which serve as the language in those topics in Physics. The spiral progression of the K to 12 curriculum in Science does not show strong connections from the topics in grade 8 to grade 9 which is also a factor which contributes to the level of difficulty to learn Physics concepts found in grade 9. Mathematics is extensively used in Physics to communicate concepts. Some students are having poor performance in Physics due to their poor Mathematical background (Njru & Karuku, 2015). Students need further help in understanding further the Physics topics especially those that require Mathematical concepts. These can be used in understanding physical phenomena based on graphical representation, constructing graphs and apply formulas to solve what is asked in the problem, and understanding the quantities which are involved in the graph (Alimen, 2008).

The table below is the experimental group's pre-test performance on the topics pertaining to projectile motion, linear momentum, conservation of momentum, mechanical energy and conservation of energy. This has to be done to determine whether the selection of samples in the experimental group coincides with the control group. Results were analyzed using the t-test for one sample.

Table 2. Experimental Group's Pre-test Performance

Topics	Points	HM	AM	SD	t_{cv}	DESC
Projectile Motion	10	6	3.47	1.39	7.93	BA
Linear Momentum	6	3.6	1.84	1.26	6.09	BA
Conservation of Momentum	4	2.4	1.21	0.92	5.65	BA
Mechanical Energy	6	3.6	1.58	1.02	8.66	BA
Conservation of Energy	3	1.8	0.95	0.62	5.98	BA
TOTALITY	**29**	**17.4**	**9.05**	**2.59**	**14.04**	**BA**

Significant when t_{cv}>2.101 at 0.05 level (2-tailed), N=19

Based on the data above, it was found out that the students who belong to the experimental group have below average performance in projectile motion, linear momentum, conservation of momentum, mechanical energy and conservation of energy, which means that this group had a hard time dealing with the Mathematical concepts of the mentioned topics. The low performance of the students implies that the students have low foundation in the mathematical related applications. This means that they need help in understanding the concepts better despite the difficulty of their Mathematical related foundations. Recalling the past lessons in Math which can be applied in Physics takes time and might hinder in achieving 100% covered competencies. Thus, the teacher has to find a better strategy that would address this difficulty. This is why Salmon's e-tivity approach was used as a strategy for the experimental group. Another problem that this group encountered was the effect of the spiral progression of K to 12 curriculum wherein realistically, some competencies from prior level doesn't connect the competencies in grade 9 Science particularly in Physics. Furthermore, there is no prior knowledge of those topics. Prior knowledge is a basic requirement for students to comprehend higher skills. Knowing spiral progression of K to 12 curriculum, it is necessary that the students had learned the basic skills from their lower years. Prior knowledge about a topic has a major impact on what a student learns from a particular instructional exchange (Ip, 2003). Many students could not solve worded problem because they could not translate the unknown into mathematical expression and formulate mathematical equation that expresses the relation of the variable in the problem (Panez, 2005).

The total performance of the students in the pre-test from the experimental group was below average. The group got a mean score of 9.05, which is less than the target of 17.4. The t-test results from the data showed that the difference was significant. This means that the group was not yet exposed to the subjects. Furthermore, it was found out that the control and the experimental groups' level of performance in the pre-test were below average. To determine whether the difference of the groups' performance in the pre-test was not significant, the t-test for mean difference was conducted. The result is presented in table 3.

Table 3. Significant Difference in the Performance of the Pre-test Control and Experimental Group in learning the Mathematical Concepts of Physics through E-tivity

Topics	Group	µ	SD	tCV	Remarks
Projectile Motion	Control	2.84	1.39	1.34	AcceptH0
	Experimental	3.47	1.39		
Linear Momentum	Control	1.11	0.66	2.35	RejectHo
	Experimental	1.84	1.26		
Conservation of Momentum	Control	0.37	0.60	4.80	Reject Ho
	Experimental	1.21	0.92		
Mechanical Energy	Control	1.42	0.84	0.55	Accept Ho
	Experimental	1.58	1.02		
Conservation of Energy	Control	0.68	0.58	1.32	Accept Ho
	Experimental	0.95	0.62		
TOTALITY	**Control**	**6.42**	**2.01**	**3.62**	**RejectHo**
	Experimental	**9.05**	**2.59**		

Significant when t_{cv}> 2.101 at 0.05 level (two-tailed) Control group (C1), N=19, Experimental group (E1), N=19

To sum up, table 3 shows that the performance of both groups was comparable. The data from the table reflects students' difficulties in dealing with those Physics topics which are mathematically related. Thus, this shows how students really find the topics difficult. During the time when it was not yet spiral progression, these Physics topics were encountered in fourth year. It's also on the same year where students take up trigonometry to understand some illustrations and computations of motion. Moreover, the students can really focus on Physics alone since it's the only science they have to study. According to Snider (2004), spiral progression approach avoids inconsistency between levels of schooling, it enable learners to learn topics and skills appropriate to their developmental/cognitive stages, and caters strong retention and mastery of topics and skills just like the Mathematical concepts in Physics. Realistically, students have a hard time in absorbing those concepts especially with the chosen topics due to the limited time. Teachers found the performance of students truly alarming. This is one reason why e-tivity has to be tried to find out if it helps the learners understand the concepts of these topics despite the limited time due to spiral progression approach. Moreover, the general performance of the students in this group with the computed t-test of 3.62 which is greater than the tabulated t-test value of 2.101 at 0.05 level of significance (two-tailed) shows that both groups are handled by one teacher and that the said groups are not yet exposed to the subjects. The performance of the group has significant difference in terms of dealing with the concepts pertaining to the said topics. Rejecting the null hypothesis does not mean that the performance of both groups are quiet far apart from each other. It is shown from the table that the means of the groups have slight differences which made them comparable. The groups are on the same level of knowledge and skills towards the subjects.

After giving intervention, the four groups were given the posttest. This was done to determine which among these groups have obtained the highest level of performance in dealing with the Mathematical Concepts in Physics. Through the posttest, the researcher will be able to find out whether the control or experimental group is better. Table 4 shows the level of performance of the control pre-test group in the post-test.

Table 4. Level of Performance of the Control Group (C1) in the Post- test

Topics	Points	HM	AM	SD	tcv	DESC
Projectile Motion	10	6	4.21	1.48	5.29	BA
Linear Momentum	6	3.6	2.84	0.96	3.45	BA
Conservation of Momentum	4	2.4	1.42	0.96	4.44	BA
Mechanical Energy	6	3.6	1.89	1.05	7.09	BA
Conservation of Energy	3	1.8	0.68	0.67	7.25	BA
TOTALITY	**29**	**17.4**	**11.05**	**2.53**	**10.95**	**BA**

Significant when tcv >2.101 at 0.05 level (2-tailed), N=19

It is evident from the table above that the posttest of this group reflects a below average performance. Projectile motion and the rest of the topics in Physics are difficult for the students to comprehend. Using the traditional approach of teaching the specified topics, students have a hard time to understand the concepts in every topic due to poor visualization problems. In Physics or even in Mathematics, illustrations are among one of the common traditional way of teaching the subjects. Despite the teachers' ways of delivering those topics in a conventional way, still the students have a hard time understanding illustrations that are confusing. One primary reason is that, the teacher did all the talk and the students just have to imagine or visualize the meaning of the illustrations. Though imagining can be a powerful approach to provide different thinking ways about mathematics for mathematics students but it is not enough for them to understand the concepts. The use of this traditional approach just cater the various opinions of the students which can be too abstract of they may view the concept on a different perspective (Konyalioglu et al.2005).These topics of Physics require mathematical foundations to understand further and to manipulate the problem solving side. It was mentioned already how important prior knowledge is and if students do not have one, then they will surely have a hard time connecting the current topics to the previous ones. With the result of the control group in the post-test, it shows that conventional approach is no longer effective. There are various seminars that have been conducted by the Department of Education just to update teaching strategies in various subjects however, due to unavailability of the resources. Some limited themselves on whatever is available but do not answer the needs of the students. This result shows how important it is for a teacher to use strategies that will fit the learners' characteristics so that best results are expected in their performance. Studies have shown that the success of the students towards their subjects can be linked to the effectiveness of teachers (Rivkin, Hanushek, & Kain, 2005; Rockoff, Jacob, Kane, & Staiger, 2008). Thus, teaching strategies matter in students' performance. Many physics teachers nowadays are disappointed from teaching the subject since assessments of learning show majority of them have not learned. Mathematical structures may later serve as a framework for students to better understand the subject with the appropriate knowledge which they have to learn (Redish & Steinberg, 1999). Students can manipulate mathematical operations correctly in the context of a math problem, but cannot manipulate the same operations in the context of a physics problem. Students often have less appreciation for or understanding of the rich meaning carried by a symbol in either Math or Physics (Redish et.al, 1996). Moreover, these topics are also new to the students. In comparison with the topics in the lower years, there is no basic foundation of these topics that will connect to the difficulty level of the current Physics concepts that the students have to learn.

The totality performance of the students in this group is below average. One primary contribution of the students' low performance is the lecture-demonstration method strategy by the teacher. The use of illustrations or even discussions pertaining to those mathematical sides of Physics is not enough to make them understand the topics. They still fail to absorb the concepts leading them to a poor performance on the said topics. Demonstration method is a type of teaching method in which the teacher is the principal actor while the learners are just the audience in which students just observe and can't put their shoe on what the teacher is saying. In the course of employing the method, the teacher dominates the teaching with less interaction on the part of the learners (Daluba, 2013). Such mentioned method is not all effective in today's characteristics of learners.

Table 5. Level of Performance of the Experimental Group (E1) in the Post-test

Topics	Points	HM	AM	SD	tcv	DESC
Projectile Motion	10	6	7.63	1.67	4.25	AA
Linear Momentum	6	3.6	3.68	1.25	0.29	A
Conservation of Momentum	4	2.4	3.05	0.97	2.93	AA
Mechanical Energy	6	3.6	3.53	1.68	0.19	A
Conservation of Energy	3	1.8	2.05	0.62	1.77	A
TOTALITY	**29**	**17.4**	**19.94**	**3.54**	**3.14**	**AA**

Significant when tcv > 2.101 at 0.05 level (2-tailed), N=19

Students' performance in projectile motion, conservation of momentum, and conservation of energy, got more than the 60 % of the correct answer as shown in table 5. Students show mastery in topics using the e-tivity approach. However, students' performance in linear momentum, mechanical energy and conservation of energy got an average score which has a slight difference from the expected 60%. After the E-tivity approach was employed to this group they had improved in their performance comparing it from the pre-test. Some of the topics such as projectile motion and conservation of momentum got above average performance however the topics pertaining to linear momentum, mechanical energy and conservation of energy because students got so interested on the different simulations of those topics. Many found it so playful where they can use not only one example of objects but more than enough to make them understand the concepts. Thus, not bad at all compared to the student performance during the conventional approach. In response to this average performance of the students, they might have a little problem in dealing with those topics. Others are still adjusting on the use of the simulations since they are not just manipulating it but also learning those intended topics from the e-tivities. Students have difficulty in understanding the basic principles related to energy and momentum and in applying them in physical situations (Singh & Rosengrant, 2016). Introductory physics students have difficulty in understanding why and when to use the energy and momentum concepts, and most especially in the conservation laws (GrimelliniTomasini, Pecori-Balandi, Pacca, & Villani, 1993; Lawson & McDermott, 1987). This can be an essential hindrance to learning, because energy and momentum are fundamental concepts in physics, it has to be absorbed by the students to further know its application. These applications such as conservation laws in solving problems and gaining deeper understanding are also significant in learning and doing physics.

The overall performance of the students belonging to this group is average because the new approach was implemented. Everyone love to post and comment on those posts about the manipulated simulations. Upon sharing while manipulating the simulation, they find the topics interesting. They also understood the relationship of variables that are very important in understanding the concepts. Simulations enable students to apply theory and encourage critical skillsIt is convenient for teachers for it provides relief from the daily tasks of reading and preparing the class.

Table 6. Level of Performance of the Control Group (C_2) in the Post-test

Topics	Points	HM	AM	SD	tcv	DESC
Projectile Motion	10	6	3.26	1.48	8.03	BA
Linear Momentum	6	3.6	2.37	0.83	6.46	BA
Conservation of Momentum	4	2.4	2.32	1.20	0.30	A
Mechanical Energy	6	3.6	1.95	0.97	7.42	BA
Conservation of Energy	3	1.8	1.47	0.51	2.77	BA
TOTALITY	**29**	**17.4**	**11.37**	**1.18**	**22.27**	**BA**

Significant when tcv >2.101 at 0.05 level (2-tailed), N=19

Table 6 showed the posttest performance of controlled group C_2. It is visible in the table that the students got below average performance in projectile motion, linear momentum, mechanical energy and conservation of energy. However, the group got an average performance on conservation of energy. It shows that after the illustrations and demonstrations about those topics, only conservation of energy got an average score but still not the 60% of the entire points for such topic. Despite the absence of experience of this group for pre-test, still their performance towards those topics after the discussion is below the expected 60%. It was mentioned that these students have no background on the said topics and that they have low mathematical foundations that will serve as their tool in dealing with the topics. In the teaching of physics, it is typically used to demonstrate physical phenomena, to present derivations; and to show examples of how to solve problems. The use of lecture time to present derivations is typically ineffective. A derivation presented on the blackboard is less useful to the student than the same derivation presented in the textbook, where it can be traced through repeatedly at the student's leisure (Freedman, 1996). Such performance gave the researcher an idea that these students have not much knowledge in those topics after the conventional approach in teaching. Some students are having hard time dealing with the relationship of variables found in those involve topics partly because of their low foundation in mathematics. One fear of students in the cited topics is the derivations of equations which they will be dealing as they go through applications. Physics is considered as the most difficult area within the branches of science, and it traditionally has less number of students than chemistry and biology (Rivard &Straw, 2000).This attitude towards learning Physics hinders them to understand the concepts. Checking on prior knowledge in Mathematics, this group fails the expected. The idea of this conventional approach leads to students' misconceptions toward those topics in Physics. Such misconceptions mislead the students to appropriate concepts.

Table 7. Level of Performance of the Experimental Group (E_2) in the Post-test

Topics	Points	HM	AM	SD	t_{cv}	DESC
Projectile Motion	10	6	7.00	1.29	3.38	AA
Linear Momentum	6	3.6	3.11	1.33	1.62	A
Conservation of Momentum	4	2.4	3.63	1.30	4.13	AA
Mechanical Energy	6	3.6	3.53	0.96	0.33	A
Conservation of Energy	3	1.8	1.68	0.48	1.06	A
TOTALITY	**29**	**17.4**	**18.95**	**1.31**	**5.14**	**AA**

Significant when tcv > 2.101 at 0.05 level (2-tailed), N=19

In using the e-tivity approach in teaching the mathematical concepts in those topics involve, table 7 outlines the performance of the students in the experimental group (E_2) posttest. The group has not experienced the pre-test but went through the items of posttest after manipulating the e-tivities. The table shows the above average performance of the students in projectile motion and conservation of momentum which means that they have learning after the e-tivities. Aside from it, the students got average performance on the topics such as linear momentum, mechanical energy, and conservation of energy. Despite the no pre-test, this group had performed well in those topics however, for the performance which shows average, the means show almost approaching to the hypothesized mean, thus not a bad performance. One catchy observation was, students were so engaged in the discussions which would eventually confirm concepts that are true and reject those that are not. They found the e-tivities so engaging where their opinions matter. Aside from that they are free to share what they found out about their e-tivities. Active-learning instructional methods are similar to other instructional methods in which they allow students to experience doing physics to develop a strong conceptual foundation in physics, and to aid them to explain effectively and succeed at problem-solving tasks (Meltzer & Thornton, 2011). Results show the general performance of above average from this group despite a no pre-test experience. Students have enjoyed a lot in manipulating the simulations through the e-tivity approach. One more factor that catches the interest of the students is the sharing for ideas and facts on their Facebook group. They gained confidence in sharing and most of the time the students are not hesitant to express themselves. The thrill and challenging task which were shared in the group chat served as students' source of confirming and gaining further knowledge related to e-tivities. This kind of instruction activity actively involves students during classes since they will focus on what the group will be discovering from the e-tivities. Thus, making learning fun while discovering themselves the essence of the subject or topic. Unlike the common practice of motivation where the teacher usually ask informal questions and it even continues during a lecture is conducted, which typically bores students and can make them passive in the class (Crouch & Mazur, 2001). Moreover, this performance of the no pre-test confirms the effectiveness of the approach with regards to mathematical concepts in Physics. Unlike the performance of the no pre-test control group, this group got almost of the same performance with the pre-test experimental group.

Table 8. Significant Difference in the Performance of Control (C1) and Experimental (E1) Groups in the Post-test

Topics	Group	Mean	SD	T test	Remarks
Projectile Motion	Control	4.21	1.48	5.91	Reject Ho
	Experimental	7.63	1.67		
Linear Momentum	Control	2.84	0.96	2.19	Reject Ho
	Experimental	3.68	1.25		
Conservation of Momentum	Control	1.42	0.96	4.34	Reject Ho
	Experimental	3.05	0.97		
Mechanical Energy	Control	1.89	1.05	3.45	Reject Ho
	Experimental	3.53	1.68		
Conservation of Energy	Control	0.68	0.67	6.66	Reject Ho
	Experimental	2.05	0.62		
TOTALITY	**Control**	**11.05**	**2.53**	**7.08**	**Reject Ho**
	Experimental	**19.95**	**3.54**		

Significant when t > 2.101 at 0.05 level (2-tailed);
Pre-test Control Group (C_1) =19; Pre-test Experimental Group (E_1)=19

Table 8 shows the significant difference in the performance of control group C1 and experimental group E1 in the posttest. The data above describes the performance of both groups as significant. Considering the value of their means, the experimental group performed well in the post-test in comparison to the control group. This means to say that the students in the control group were learning the concepts of projectile motion, linear momentum, conservation of momentum, mechanical energy and conservation of energy. One primary reason why the experimental group performed best than the control group was the use of the E-tivity approach where students can gain knowledge of what is the focus of those cited topics through the manipulations of the interactive simulations. After such, they are free to discuss towards each other on what they had learned on those manipulated simulations which is one great help of developing students' self-esteem. The use of technology fits the teaching practice not only in science but also in other areas offering students opportunities for active learning, contextualized instruction, and the use of visualizations to clarify difficult concepts (Plass, J. L. et. al, 2012). Using the students' Facebook, they can share, like and comment on what was posted. This made these students feel that their comments are welcome and that others are free to interact about it. Facebook is a social media site where users can interact in a virtual community. Students usually spend their time on reading at friends' posts and liking them or show reactions on those posts. Usually named as social networking site, Facebook is an online community of allowing users to build a virtual nation where they can create an account in order to connect and interact with people who are part of their social network (Boyd & Ellison, 2007). Likewise, McCarthy (2012) reported positive attitudes from students in using Facebook can be an academic tool, which the teacher can use as a virtual classroom for students to chat showing their interactions on the topics involved. It is a platform very common to students which can be used to access academic information on a system that they are constantly interacting with. Meanwhile, the control group which was exposed to conventional approaches in teaching the said topics got low scores in the post-test. As mentioned in the previous tables, students from this group still had a hard time understanding the concepts. One reason of such is the strategy that was employed to the students. Obviously, the data showed the effectiveness of the interactive simulations in teaching the mathematical concepts in those specified topics. Furthermore, the above data simply speaks that interactive simulations must be used as a strategy in teaching. Nowadays, the treat of producing competent learners is compulsory. Teachers play such vital role in teaching and learning. If the teachings are there yet learning is not working, there might a problem with the strategy that one is using. Thus, the data can convince a teacher on the effectiveness of the said approach.

Table 9. Significant Difference in the Performance of the Control Group (C_2) and Experimental Group (E_2)

Topics	Group	Mean	SD	Ttest	Remarks
Projectile Motion	Control	3.26	1.48	8.53	Reject Ho
	Experimental	7.00	1.29		
Linear Momentum	Control	2.37	0.83	1.83	Accept Ho
	Experimental	3.11	1.33		
Conservation of Momentum	Control	2.32	1.20	4.44	Reject Ho
	Experimental	3.63	1.30		
Mechanical Energy	Control	1.95	0.97	5.88	Reject Ho
	Experimental	3.53	0.96		
Conservation of Energy	Control	1.47	0.51	1.17	Accept Ho
	Experimental	1.68	0.48		
TOTALITY	**Control**	**11.37**	**1.83**	**16.68**	**Reject Ho**
	Experimental	**18.95**	**1.31**		

Significant when t > 2.042 at 0.05 level (2-tailed); Pre-test Control Group (C_2) =19; Pre-test Experimental Group (E_2)=19

Table 9 describes the significant difference of the students' performance from the control group C2 and experimental group E2. Both groups were not able to undergo pretest, only the posttest. The data shows significant performance in projectile motion. After the conventional method such as demonstration on the said topic, students gain knowledge in projectile motion. Despite the teacher's attempts to discuss thoroughly the concepts through the usual illustrations, still the students had hard time comprehending the topics. Just like the other control group (C1), which also has problems in visualizing the concepts through illustrations alone. They have hard time predicting the possible results of motion in Projectile. Moreover, for the topics such as linear momentum, formulae discussions and giving sample problems with their solutions were not enough to employ knowledge. Students seek more examples even up to the ninth times which contradict the allotted time for the particular topics. Comparing their performance with the experimental group E2, after the e-tivity, students were able to learn a lot in projectile motion, in conservation of momentum, and mechanical energy but do not perform their best on linear momentum, and conservation of energy. In those topics where the students performed best through e-tivities, one main reason was the students' enthusiasm towards learning which is why a student finds it hard to understand the topics. The e-tivities motivate them to focus and to learn. They wanted to manipulate and so eager to share and respond to posts. In projectile motion and also in those topics were the experimental group got high scores, interactive simulations are not limited to only one object unlike in those topics such as momentum. In linear momentum, students only manipulate balls in which they crave for more objects. The topic from both group showed a significant performance. However, for linear momentum, students' performance was not significant. For topics such as conservation of momentum and mechanical energy, students' performance was significant. For conservation of energy, students' performance was not significant. Looking at the data, the experimental group performs better compared to those in the controlled group. The differences in means suggest that those students from the experimental group had gained the expected knowledge in those topics from the table which require mathematical concepts to be fully understood and applied. Many schools nowadays are turning up the web world and teaching students online which has changed the entire spectrum of teaching methods. The Education/Tools that e-learning provides surpass all other forms of learning methods. This medium of e-learning has made studying very easy. E-learning is an essential tool for learning mathematics in the 21st century, and all schools must ensure that all their students have access to technology. Effective teachers maximize the potential of e-learning to develop students' understanding, stimulate their interest, and increase their proficiency in mathematics (Kavitha & Sundharavadivel, 2012). The overall performance of the data shows that the performance of both groups was significant. This implies the effectiveness of the interactive simulations even in the no pre-test experimental group. The data suggests unbiased performance of the effectiveness of the Approach in teaching mathematical concepts in Physics.

Table 10. Significant Mean Gain in the Performance of the Control Group

Topics	Group	Mean	SD	M_G	SD_G	Ttest	Remarks
Projectile Motion	Pre	2.84	1.39	1.37	0.09	3.06	Reject Ho
	Post	4.21	1.48				
Linear Momentum	Pre	1.11	0.66				Reject Ho
	Post	2.84	0.96	1.74	1.02	7.24	
Conservation of Momentum	Pre	0.37	0.60				
	Post	1.42	0.22	1.05	0.89	5.04	Reject Ho
Mechanical Energy	Pre	1.42	0.84				Accept Ho
	Post	1.89	1.05	0.48	1.53	1.31	
Conservation of Energy	Pre	0.68	0.58	0.0	0.73	0	Accept Ho
	Post	0.68	0.67				
TOTALITY	**Pre**	**8.58**	**3.13**	**6.68**	**1.43**	**5.96**	**Reject Ho**
	Post	**15.26**	**3.81**				

Significant when t > 1.734 at 0.05 level (1-tailed)

Table 10 summarizes the mean gain performance of the control group's pretest and posttest. From the data above, the topics pertaining to mechanical energy and conservation of energy got the insignificant mean gain performance. However, the topics such as projectile motion, linear momentum, and conservation of momentum are significant. Considering the differences in means, the posttest had better performance compared to the pretest. This is because the students got an idea of the topics already. Moreover, the means show that students got difficulties in energy topics compared to other topics. Aside from it, the performance of the students both in pre and posttest despite the improvement is not enough to sustain the standard target of 60%.Teaching and learning mathematics are complex tasks. With this performance of the pre-test and post-test of the control group where their mean difference is quiet small implies that despite the approach employed to this group, the increment in students' performance is not the expected. As stated, the strategies which are considered conventional employed to this group are proven not effective. The reasons for such were cited already from the previous tables. Usually, the poor academic achievement of the majority of the students in Physics has been associated to ineffective teaching to impart what are expected to his/her students (Adunola, 2011). It is difficult to expect students to learn especially if the teachers' strategies are limited to himself/herself. There has to be a consideration to the type of learners they are facing. Thus, as teachers seek to enhance their teaching strategies by changing their instructional practices, they should carefully consider the teaching context, giving special consideration to the types of students they teach (Grouws & Cebulla, 2000).

Table 11. Significant Mean-Gain in the Performance of the Experimental Group

Topics	Group	Mean	SD	M_G	SD_G	Ttest	Remarks
Projectile Motion	Pre	3.47	1.39	4.16	2.50	7.25	Reject Ho
	Post	7.63	1.67				
Linear Momentum	Pre	1.84	1.26	1.84	1.30	6.17	Reject Ho
	Post	3.68	1.25				
Conservation of Momentum	Pre	1.25	0.92	1.84	1.26	6.38	Reject Ho
	Post	3.05	0.97				
Mechanical Energy	Pre	1.58	1.02	1.95	1.87	4.54	Reject Ho
	Post	0.94	1.68				
Conservation of Energy	Pre	0.94	0.62	1.11	0.94	5.14	Reject Ho
	Post	2.05	0.62				
TOTALITY	**Pre**	**9.05**	**2.59**	**10.89**	**4.38**	**10.83**	**Reject Ho**
	Post	**19.93**	**3.54**				

Significant when t > 1.734 at 0.05 level (1-tailed)

The table above shows the significant mean-gain performance of the experimental group in the pre and posttest in all the topics in physics which require mathematical concepts to understand. Furthermore, the means vary from the pretest to the post test. It was indeed visible how students from this group obtained remarkable performance after the e-tivity approach was applied. Moreover, the students from this group obviously enjoyed the activity as shown in the table. Holley (2002) found out that students who are involved in online/ E-Learning achieved better grades than students who preferred to study using conventional approach. As a result of this findings E- learning is growing very fast and become popular and that is why many higher educational institutions are adopting to virtual learning system. According to Malone (1980), instructional designers should try to create an educational environment that would motivate students to engage themselves in an effortless and engaging way. Computer games, in particular, which become an outlet to students anywhere can be integrated to make learning fun in Physics. The simulations which serve as the e-tivities in the study are game-like activities which are made easier for students to manipulate yet too much motivating to resist. No wonder the performance of this group shows good results after the approach was applied.

Table 12. Significant Difference in Pre-Post Mean-Gain of the Control and the Experimental Groups

Topics	Group	Mean Gain	Mean Diff	tCV	Remarks
Projectile Motion	Control	1.37	2.79	3.41	Reject Ho
	Experimental	4.16			
Linear Momentum	Control	1.74	1.11	0.31	Accept Ho
	Experimental	1.84			
Conservation of Momentum	Control	1.05	0.79	1.84	Accept Ho
	Experimental	1.84			
Mechanical Energy	Control	0.48	1.47	2.66	Reject Ho
	Experimental	1.95			
Conservation of Energy	Control	0	1.11	4.19	Reject Ho
	Experimental	1.11			
TOTALITY	**Control**	**6.68**	**4.21**	**2.54**	**Reject Ho**
	Experimental	**10.90**			

Significant when t > 2.179 at 0.05 level (2-tailed); Pre-test Control Group (C_1) = 19; Pre-test Experimental Group (E_1)=19

At 0.05 level of significance, the pre-post mean gain performance of the controlled group and experimental group show insignificant in the topics pertaining to linear momentum and conservation of energy. However, the rest of the topics such as projectile motion, mechanical energy and conservation of energy are significant. Checking on their means, the experimental group got higher means showing good result of using e-tivity approach in teaching mathematical concepts in Physics. While the traditional/ conventional way of teaching mathematical concepts in physics shows not an acceptable result in the students' performance. Thus, based on the transparency of the data above, the e-tivity approach shows positive results in students' performance. As per observation of the students while doing either the conventional approach or the e-tivity, students who are from the controlled group found the procedure of learning about Forces, Motion and Energy very procedural making them felt bored about every step. Whereas the experimental group, found the steps so rewarding for they seem like playing every step of the e-tivity. As they conquer every step, they were filled with the knowledge they deserve to learn about those topics in forces, motion and energy. Simulations can give learners with virtual representations of interactive theoretical entities that which can't be visualized through a static environment such as science textbook (Ardac & Akaygun, 2004; Honey & Hilton, 2011). In engaging students with simulations, it will help them develop scientific processes which are essential for knowledge construction and retention. As a result, simulations have the ability to involve learners enthusiastically for them to understand scientific processes and develop critical thinking skills which is very important in learning the mathematics side of physics.

Table 13. Significant Mean Difference in the Post-Test Performance of the Students in the Four Groups ANOVA: Single Factor

SUMMARY					**LSD**	**1.579218**			**FINAL RESULT**	
					HSD	**2.09335**			**F ratio**	**72.66**
Groups	**Count**	**Sum**	**Average**	**Variance**	**Scheffe**	**5.55514**			F_{CV}	2.74
C1	19	210	11.05	6.39	**Post Hoc**	**C1**	**E1**	**C2**	**Pvalue**	0
E1	19	379	19.95	12.50	E1	8.89			**Decision**	**Reject H_0**
C2	19	216	11.37	3.25	C2	0.32	8.58			
E2	19	360	18.95	1.72	E2	7.89	1.00	7.58	**Interpretation**	**Significant**

It was reflected from the data above that the significant difference between the groups' post-test was evident. As shown in table 13, the computed F-value (ANOVA) of 72.66 was greater than the tabled value (critical value) of 2.74 and a p-value of 0 which was less than 0.05 (level of significance). There was a significant difference in the level of performance of the four groups in the post tests. The experimental groups showed a higher difference of means than the control groups which evaluates the effectiveness of the e-tivity approach. Moreover, there is only a slight difference in the performances of the control groups so as the experimental group. Nonetheless, comparing the means of control and experimental groups, the data concluded that there are big differences in means which impulses that the students who are into the experience of e-tivity had more learning in terms of the mathematical concepts pertaining to those topics in physics.

Table 13 also shows the Post Hoc Analysis of the performance of the four groups. Results of the analysis show that,

C_1 and E_2 have significant mean differences

C_2 and E_2 have significant mean differences

C_1 and E_1 have significant mean differences

C_2 and E_1 have significant mean differences

These differences were confirmed in the previous tables. Tables 4, 5, 6, and 7 show that there was a significant difference between the performance of the students in the control group and experimental group. Most of the students in the experimental group were able to answer the items from the test after the e-tivity approach was implemented. Observing the differences in means of the different groups, the control groups either with pre-test group or none, has big differences in terms of mean from the experimental groups which means to say that it further confirms the effectiveness of the approach towards teaching Mathematical concepts in Physics.

Experiences in the use of E-tivity Approach in Learning the Mathematical Concepts in Physics (Journal-Patterned)

The students in the experimental groups were given t-model template which served as their journal in every e-tivity. The t-model summarizes about "what-they-see", "what-they-think" and "what they-wonder" pertaining to the different topics in Physics that involves Mathematical concepts to be understood. Below is the summary of the students' experiences in exploring e-tivities of those cited topics in Forces, Motion and Energy.

What do you see?	What do you think?
▪ a game where you need to hit the bull's eye. ▪ I see how to compute momentum using the formula m x v which helps me know the amount of momentum in the simulations. ▪ I see a skate park which you can play as a skater and manipulate the differences of kinetic and potential energy.	• if the mass is bigger, the speed will be slow and when the mass is smaller the speed will be fast. • it can help me compute the momentum. • E-tivities on conservation of momentum helps me more about understanding what the topic is and when it will be conserved.

What do you wonder?
▪ I wonder how the mass affects the speed of an object and how the mass affects its distance. ▪ if it's position changes, will momentum be changed? And if Ball 1 is bigger than ball 2, is it continuously moving? ▪ how is momentum change if there is no "after collision" or "before collision"? ▪ I wonder how the games work and how to relate it in our daily lives experiences.

Among the common experiences of the students based on "what they see" was, they saw a "Game-Like" activity. They love to manipulate the simulations at the same time they were enjoying the fun environment of the e-tivities. In todays' digital trend, where the 21st century learners are into online activities, this new experience made them feel like they are involved and that their participation had helped build further knowledge on those concepts mentioned. One student wrote ....*"Wow! These simulations are fun! They're like games I played in Yahoo. I cannot wait for the next e-tivities!"*......The features of the simulations and their impact to learning had blended into a strategy that would fit the characteristics of the 21st century learners. These learners appreciate the "trial and error" approach in learning concepts and they also like to learn by doing. Thus, this new approach of learning definitely strikes the interest of the students to learn. Numerous scholars (Chan & Lin, 2000; Jiang, 2008; Kuo, 2008; Robinson, 1960; Zheng, 2008) have pointed out that games are useful for children involved in the learning of English since games can strengthen students" motivation and self-confidence. According to Skinner's theory, playing can be presented as a kind of prize after learning which allows teachers to motivate learners to step forward (Pound, 2005). Chen (2007) is of the same opinion, showing that games are workable because they can easily attract the attention of students, thus influencing student motivation. Since it has been a quest for teachers to motivate students towards learning, such response of the experimental group shows that they are indeed motivated to learn the intended concepts in Forces, Motion and Energy as the simulations from the e-tivities suit the learners' characteristics.

Another student from the experimental group said that ....*" I see a Skate park which I can play!"* The skate park activity was from the e-tivity on Energy both from conservation and mechanical. Students indeed can relate about what they had experienced in the simulations. They knew it was like something they had played since the situation was familiar and that they wanted to explore and play with it online. The relevance of this to learning is that, the said students have been more interested to manipulate the said e-tivities. There and then, it made learning possible since the students have been so interested and are motivated to follow instruction and see themselves where the e-tivities will lead them after playing with the skate park. Using games, according to the same study, also maintains high levels of attentiveness as any basic understanding of human nature might suggest probable. To continue with the idea of human nature leads us to the biological approach, where, it is argued, playing is vital to the development of the flexible and adaptable human brain because children's imagination and creativity are enhanced by playing (Pound, 2005). Also, Atake (2003) made the following statement in her research, arguing that "students are challenged to think and use certain target vocabulary expressions . . . but in games it becomes easier for students to memorize because students are impressed by competing or interacting with classmates" (p.13). Upon reading those words and phrases of the students from their journal, the game-like nature of the simulations gave an impact into learning the mathematical concepts in Physics the way students find it fun and interactive.

Meanwhile, on "what do you think" part, they thought that e-tivities are "informative" probably because they were amazed of the variations of learning through the traditional way and this new approach. From the mentioned "game-like activities" on the previous paragraphs, students have not thought they could learn through this approach. When they did the manipulations, their childish attitude came out since they were like playing but they were surprised on how the play became concepts and how those concepts turned into new knowledge pertaining to the mentioned topics. This informative description of the students regarding the implementation of e-tivities had been developed when students share and interact through their Facebook group chat. The further development of building knowledge does not end in merely manipulating but also on the rest of the stages of Salmon's e-tivity approach which affirms the effectiveness of the said approach. A student from the experimental groups said, "*The simulations about projectile motion are very helpful in understanding variable relationships. I tried to use a Buick and fired it; the motion was different with firing a bullet. It makes sense"*. In other words, the students' see a new experience, a new way to understand the concepts about projectile motion, mechanical energy, conservation of energy, linear momentum and conservation of momentum. Comparing it to the traditional experienced, students have difficulty of analyzing variable relationships which lead them to a poor performance in applying it to problem solving. Unlike the use of these e-tivities, such experiences of the students had shown how the understood the realm of some mathematical concepts involved in the e-tivities. Instructional simulations have the potential to engage students in "deep learning" that empowers understanding as opposed to "surface learning" that requires only memorization. Students are able to learn scientific methods including the relationships among variables in a model or models. Simulation allows students to change parameter values and see what happens. Students develop a feel for what variables are important and the significance of magnitude changes in parameters (Bruckner, Monica et.al, 2015).

Considering the "informative" description of the students from such group, a student also wrote, *"It helps me compute the momentum"*. Computations are very essential in physics since it is one application of the concept. However, many students found the difficulty of applying some equations involved in Physics for they do not fully understand the mathematical concepts behind it and when to use or what appropriate formula to use in a particular situations. This experience of the student was not about mere computations but digging into the deeper understanding of the concepts before they will apply on problem solving exercises. Before e-tivities, students do manipulations of the variables through paper and pen. This atmosphere of e-tivities made them appreciates the computation nature of the subject because they are motivated to learn and explore. Students using interactive simulations can reflect on and extend knowledge on understanding and refining their own thought processes. Simulations are engaging. Students can manipulate (and isolate) the input parameters to explore their effects (Perkins et al., 2006). Through this, they understand the deeper sense of the topics.

Furthermore, on "what they wonder", students made their own "predictions" and see themselves if their predictions are right. They wanted to learn more and explore more the e-tivities and are surprised of what the simulations can offer. Students can observe processes that are otherwise unobservable. Scaled visual models allow students to "watch" processes they can't actually see in real time and space and it made them curious enough that they have their own conclusions of what might happen next. A student mentioned, *"I wonder how the mass affects the speed of an object and how the mass affects its distance"*. And other one also said, *"If its position changes, will momentum be changed? And if Ball 1 is bigger than ball 2, is it continuously moving?"* This curiosity of the students gave more justifications of how the e-tivities made them wonder on those real experiences they encounter upon dwelling with the simulations.

Such questions lead to predictions while they manipulate the e-tivities which is a great indication that learning is taking place. The interactive simulations use a constructivist approach, rather than guiding learners step-by-step. Students are encouraged to make predictions, and to explain their predictions, prior to exploring the simulation to test their predictions. This approach is more effective than a prescriptive one for overcoming alternative conceptions (Windschitl and Andre, 1998). Scientifically, after the explorations, students will then conclude whether their hypotheses are correct or not. After such, the sharing and posting on the facebook group chat started to fire the conversation based on their findings about predictions which could lead others to compare their experiences as well as their predictions. Simulations provide minimal guidance, to facilitate open-ended exploration. This can take the form of one or two "driving questions," questions about the challenging underlying concepts illustrated by the simulation. Students given these open-ended conceptual questions explore simulations much the way scientists explore: posing and answering questions to themselves, driven by their own curiosity, to make sense of the phenomenon being simulated. When more guidance is given, in the form of directions to explore specific features or variables, students actually explore less, stopping as soon as they have answered the specific questions in the "guided inquiry" activity (Adams et al., 2007).

The effectiveness of the study is derived from how the students learn important concepts using the e-tivity approach. The responses of the students pertaining on how they learn from the e-tivities have made this study effective. Thus, with e-tivities, students show interest to learn, they are eager to learn more and they develop a sense of confidence to share, to elaborate more and learned pertaining to those topics in Physics. Educational games and simulations have been found to be effective in motivating students to learn (Ke, 2008; Papastergiou, 2009; Tüzün, Yilmaz-Soylu, Karakus, Inal, & Kizilkaya, 2009).

CONCLUSION

Salmon's E-tivity Approach is another strategy in teaching Mathematical Concepts in Physics due to its emphasized steps which can boast students' enthusiasm to learn. The interactive simulations made the experience of the students more meaningful. As reflected on the increment of students' performance pertaining to mentioned topics in Physics, it shows how the strategy made a difference to learning. This approach fits today's digital learners. Thus, it bridges the gap that hinders learning in the spiral progression of K to 12 curriculum not only in the discipline of Mathematics but also in other subject areas.

RECOMMENDATION

This study recommends the use of Salmon's e-tivity approach in teaching. Though the context of the study is the Mathematical concepts in Physics, this approach can also be used to other subject areas. Moreover, the study made use of Physics Education Technology's interactive simulations which can be accessed online and offline to make learning fun and interactive. The use of Facebook group chat can be optional. Teachers can find means to replace facebook group chatting to other means of conceptualizing an online classroom such as Edmodo.

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