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Online Teaching in Physics Using Just-In-Time Teaching (JiTT), Academic Achievement, and Conceptual Understanding of Grade 9 Students

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ORIGINAL ARTICLE

ONLINE TEACHING IN PHYSICS USING JUST-IN-TIME TEACHING (JITT), ACADEMIC ACHIEVEMENT, AND CONCEPTUAL UNDERSTANDING OF GRADE 9 STUDENTS

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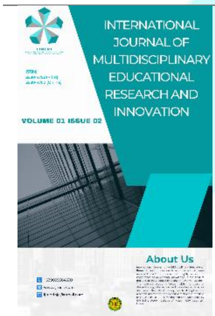

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ABSTRACT

This study determined the effect of online teaching in Physics using the Just-in-Time Teaching (JiTT) strategy on the academic achievement and conceptual understanding of Grade 9 students. One intact class was subjected to a single-group pretest/posttest pre-experimental research design. Purposive sampling was applied, and selected 48 Grade 9 students for this study. The data gathered were interpreted quantitatively from the validated physics achievement test (PAT) and from the adopted energy-momentum concept test (EMCT), while, the learning experiences survey responses were interpreted thematically. This study was conducted for a period of eight (8) weeks during the 4th quarter of the school year 2020-2021 at Junior High School in District II. The study's findings using descriptive and inferential statistics revealed a significant difference in the students' physics achievement mean scores and a significant difference in the students' energy-momentum mean scores before and after their exposure to online teaching in physics using the Just-in-Time Teaching (JiTT) strategy. The class average normalized gain (g) of the 48 respondents on the adopted Energy-Momentum Concept Test (EMCT) resulted in statistically "high" normalized gain (g) in their conceptual understanding before and after their exposure to online teaching in physics using the Just-in-Time Teaching (JiTT) strategy. Furthermore, the learning experiences survey responses revealed positive results and improvement on the students' learning experiences in JiTT's warm-up exercises. Hence, it was concluded that the online teaching in physics using the Just-in-Time Teaching (JiTT) as a teaching-learning strategy might significantly improve the students' academic achievement and conceptual understanding in grade 9 physics.

Keywords: *Academic achievement, Conceptual understanding, Just-in-Time Teaching (JiTT)*

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INTRODUCTION

The Covid-19 pandemic that hit the Philippines affected the field of education. The usual face-to-face learning process has turned into full online learning. The science curriculum was greatly affected during the pandemic, especially the Physics lessons, since most students struggled to understand the physical manipulative experimentation and concepts associated with it. Klein et al. (2021) stated that the pandemic has significantly affected the education system worldwide, which forced various physics courses, including lectures, tutorials, and laboratory courses, to transfer to online formats, resulting in a variety of simultaneous and mixed activities. The study by Haqiqi et al. (2020) showed that students were interested in taking physics lessons online during the pandemic because of many available online tools. It can infer that during distance learning, online-based physics lessons were used in place of face-to-face/offline learning. Moreover, students' assessment scores during distance learning were higher than offline learning (Mozer, 2016).

Previously, in the 2018-2019 MPS results of the grade 9 quarterly examination, science, especially in Physics garnered 54.41% MPS—fourth among the lowest-performing subject areas. In previous years, science displayed relatively poor performance in the National Achievement Test (NAT) in 2018, as released by the Division of City Schools of Muntinlupa-DepEd Bureau of Education Assessment. Among the six major subjects in Grade 6, science registered the lowest MPS with 33.71% in Muntinlupa, 33.06% in NCR, and 29.05% national. Likewise, in Grade 10 junior high school, science registered in the 2nd to the lowest MPS in Muntinlupa with 36.06%, in NCR with 39.23%, and in the national with 36.52%. This data shows that learners have low performance in science subject. Again, in the 2018 National Achievement Test (NAT) for grades 6, 10, and 12, as published by the Department of Education last May 24, 2019, science posted the lowest MPS with a 28.42% score. This further shows that the learners show low performance in science subject concepts (Cariño, 2018).

All this evidence is the basis for utilizing an alternative delivery modalities during the pandemic to continue the distance learning process that will guarantee the online science lessons, especially in physics, with quality and accessibility amid the health crisis. Blas and Fernández (2009) stated that online discussion in physics during distance learning modality mode creates a connection between teachers and learners where they can share knowledge and information through different kinds of supervised activities. Learner's academic achievement after the implementation of the distance learning modality mode using Modular Distance Learning (MDL) decreased (Dargo & Dimas, 2021). This indicates that face-to-face is more effective, efficient, convenient, favorable, and beneficial for the learners. It was also revealed that there were more adverse and harmful effects of a modular method than positive ones. On the contrary, according to Abude (2021), the distance learning modality mode in education is more effective than classroom-based instruction. Similarly, Bergeler and Read (2021) findings show that students in physics do equally well in both classroom-based instruction and the distance learning modality mode of the course. However, the fulfillment of the students is basically in favor of the online class. Nevertheless, the study by Faulconer et al. (2021) shows that the progressive expansion of the distance learning modality mode from classroom-based instructions caused problems for many teachers.

In learning physics, there are also crucial problems, one of which is the students' common conceptual understanding of the lessons during the distance learning modality mode. Students have a low conceptual understanding of the concepts in Physics lessons so they want to learn more about it even in the distance learning modality mode (Puspitasari et al., 2020). Apparently, not all students have the knowledge to understand the physics concept during the distance learning modality mode, which affects their performance during online discussion, resulting in low conceptual understanding causes them to take a remedial class in physics, especially in projectile motion (Defianti & Rohmi, 2021).

On the other hand, the focus of teaching Physics leans toward the mathematical side and ideas. New principles are usually taught through a mathematical interpretation instead of a conceptual idea. Most learners will not be able to make a strong relationship between this equation and the physical condition connected with it. Moreover, the information and concepts are not presented in any sort of rational and logical structure that will help the learners tie all ideas together. Students are infrequently given a foundation and structure of basic conceptual understanding in physics to construct the rest of their knowledge. They are given individual details and then left to discover the big picture independently (Ojose, 2008). Hence, students have a low understanding of the physics concept. It occurs because the

conceptual understanding of physics courses of the students is shallow, thus resulting in a low student capacity to think deeply (Dewi et al., 2019).
The said concerns led the researcher to consider a strategy where teaching physics online could involve learners' and teachers' interactions which specifically would allow the learners to invest time in the reading outside the class hours. The strategy Just-in-Time Teaching (JiTT) came up as a strategy used for this research to sustain the interest of the students and to continue the learning process through online teaching that would surely increase and help the students to attain positive academic achievement and positive conceptual understanding through web-based exercises from the different web tools like Chat box, Google Meet, and Google forms. Simkins and Maier (2004) described JiTT as an activity technique that uses web-based exercises that promote active student learning and participation. So, Brame (2020) agreed that Just-in-Time Teaching (JiTT) is a beneficial strategy online in the distance learning modality mode that is designed to promote the effective use of class time for more active learning.

This strategy banks on the idea that academic achievement and conceptual understanding of the learners are possibly gotten through presetting the learning climate and drawing from the learners an anticipatory attitude towards learning new concepts. Since this strategy is conducted online before the class meeting, and may require the use of web-based questions and exercises online, the learners have time to study the lessons and questions in advance.

Lastly, while online learning and teaching have been an active issue of research exploration and discourse during the pandemic days, the start of the pandemic has unexpectedly created an imminence on such means of course delivery. Traditional methods of synchronous content dissemination and distribution are currently being compelled to be brought online due to this gap and tightness regarding successful, effective, and engaging content delivery. Consequently, with the Department of Education continuously adapting to the new landscape of teaching and learning, this study hopes to adhere to its learning continuity plan (LCP) that stipulates that students do not have to be inside a classroom in the new normal (Department of Education, 2020). Also, it does not mean that teachers and learners will undergo traditional classroom instruction.

For this reason, the researcher investigated the incorporation of online teaching in physics using Just-in-Time Teaching (JiTT) strategy to improve the academic achievement and conceptual understanding of the students amidst the pandemic in the distance learning modality mode.

Research Questions

This study assessed the online teaching in physics using Just-in-Time Teaching (JiTT), academic achievement, and conceptual understanding of grade 9 students in the 4th Quarter Physics 9 concepts, SY 2020-2021.
Specifically, it aimed to answer the following questions:

1. What are the student's achievement test scores in Physics 9 before and after using Online teaching in Physics using the Just-in-Time Teaching (JiTT) strategy?
2. Is there a significant difference between the pretest and posttest mean scores of the students in the Physics Achievement Test (PAT)?
3. What is the students' energy-momentum concept test scores before and after the use of the Online teaching in Physics using the Just-in-Time Teaching (JiTT) strategy?
4. Is there a significant difference between the pre-test and post-test mean scores of the students in the Energy-Momentum Concept Test (EMCT) before and after their exposure to Online teaching in Physics using the Just-in-Time Teaching (JiTT) strategy?
5. What are the students' learning experiences on the use of Online teaching in Physics using the Just-in-Time Teaching (JiTT) strategy?

REVIEW OF RELATED LITERATURE

Constructivism

This research was anchored on the theory of "Constructivism" by Jean Piaget (1896–1980). This theory promotes the building of new knowledge from their existing experiences. When individuals integrate, they incorporate and integrate the new understanding and experience into an already existing framework without moving it.

For David (1994), constructivism theory is a misconstrued learning theory that obliges the students to "reinvent the wheel." Furthermore, constructivist learning and teaching perspectives represent a shift from viewing learners as responding to the external stimuli and seeing them as "active in building their knowledge" because constructivism asserts that "social connections are important in knowledge construction (Bruning et al. 2004)."

Thus, the core assumption is that each learner must "construct" knowledge and skills independently (Huitt 2009). Furthermore, constructivism as an educational theory guides teachers to consider what their students know and build on it as they put it into practice. Student-centered learning (SCL) may well be the most important contribution of constructivism because its central idea is the construction of human learning to build new knowledge based on previous learning (McLeod, 2019).

Since then, constructivism learning theory has been implicitly incorporated into the learning process whenever teachers apply their creative aid as a facilitator for the students to gain their conclusions. It removes the focus from the teacher and lecture and puts it upon the student and their learning creating a curriculum allowing each student to solve problems. It assists educators to encouraging their students to improve and learn by actively constructing their knowledge through their experiences as a learner (Western Governors University, 2022). In this digital learning age, constructivist learning is innovated with technology and online learning tools such as Just-In-Time Teaching (JiTT).

Just-In-Time Teaching

Just-in-Time Teaching (JiTT) is designed to stimulate the use of class time for the more active learning environment. Established by Gregor Novak and coworkers (1999), JiTT offers structured opportunities for learners to enthusiastically build new knowledge and information from previous knowledge. Students' over-all responses to JiTT questions/exercises make gaps in their learning visible to the teacher before class, allowing them to address learning gaps and capabilities since the material is still new in students' minds. This makes the learning "Just-in-Time" (Simkins, 2009).

Technically, Just-in-Time Teaching (JiTT) blends web-based technologies and tools used to prepare the learners with active learning environment to provide necessary skills and deliver immediate response on an example task based on real-life situations (Novak & Beatty, 2016). For this reason, McGee, et al., (2016) used JiTT exercises with web-based questions to students based on previously viewed material. Naturally, Internet-based questions or exercises are constructed to elicit and show common problems in concept understanding among the students, so the teachers can assist them with "Just-in-Time Teaching" to address these misunderstandings immediately before the next class. Similarly, Kurt S. (2019) emphasized JiTT as an advance approach and strategy to education that integrates real-life situations and virtual instruction efficacy. As a result, JiTT fostered active student engagement, commitment, and improved learning by purposefully linking out-of-class and in-class activities. After the students submitted their accomplished small set of web-based questions online a few hours before class begins, the teachers developed in-class active-learning exercises as they review their submitted answers targeting the learning gaps identified in the JiTT responses.

Indeed, JiTT is favorable approach for both teachers and students in an online class. For instance, Hinojo, et al., (2019) discovered the JiTT blended learning technique consists of sending assignment to the learners before the class. Students studied the topics, solved problems, or replied to questions before the class. It allows educators to get feedback from students before class so that they can adjust the lesson flow and prepare techniques and activities to address student weaknesses.

Moreover, the JiTT strategy strengthens learners and teachers' interactions because it allows the learners to invest time in reading beyond the class hours. In terms of its form, the JiTT can be a blend of multiple-choice and short answer/essay exercises which are mostly effective when used as reading comprehension or analysis assessment. It is best achieved when asking open-ended and thought-provoking questions/exercises. The key advantage of JiTT is critically helping student analyze the questions beyond choosing the best answer in a multiple-choice test. Usually, the questions in JiTT exercises refer to the concepts understanding that have not yet been included in the program, requiring students to process their prior knowledge to develop information or apply the gathered concepts in the most applicable way.

In the current study, the exercises utilized have multiple choices with short answer/essays. The JiTT strategy was used in this research to sustain the interest of the students and to continue the learning process that would surely increase and help the students to attain positive academic achievement and positive conceptual understanding through different web-based questions using different web tools.

Academic Achievement

Academic achievement is an interesting area of students' progress and outcome especially in understanding their respective subject difficulties. In science, academic achievement is related to how students learn and perceive science. Some students learn by reading and others by listening; others learn better when given opportunities to manipulate objects or see concepts and ideas represented visually.

Physics teachers' role is contributory to the students' academic achievement. Shavelson and Ruiz-Primo (2008) recognize that teachers have a special role in developing the students' understanding; they must go beyond the idea and understanding that proportional knowledge is just a set of facts and concepts that the students need to acquire.

On the other hand, physics students' behaviors, attitudes, and interests are better predictors of their success in physics. This was proven by Lumintac (2014) when found out that the learners, who have a negative academic achievement toward the physics subject, have fair or low performance since there was significant relationship between the students' attitude toward physics subject and their academic achievement. Hence, students' negative views to physics influenced the low academic achievement. This was also the findings of Edmund et al., (2021) that low achieving students in physics were affected by their different learning strategy or method in learning the subject. Thus, it was recommended and suggested that physics teachers should adopt the use of different learning strategy or methods in their discussions to enhance students' academic achievement in physics subject.
Meanwhile, siddiqui and Khan (2016) in their study since physics achievement was positively correlated with the students' self-concepts given that better self-concept would give higher achievement in physics. The results revealed the important element to consider in the interpretation of student success in physics which was the intellectual self-concept.

Consequently, academic achievement covers the specified level of attainment, understanding, and proficiency in academic work as assessed by the teachers using standardized tests, outcome-based assessments, or combination of both. Ideally, every student wants a good academic achievement to be better and successful in their life. Indeed, academic achievement represents the performance outcomes of students, which indicate the extent of their specific accomplished goals. The student's grade is regarded as the primary indicator of academic achievement and is often measured by an exam or a series of continual assessments (Mansour, et al., 2017).

Conceptual Understanding

The integration and functional grasp of mathematical ideas of learners is regarded as conceptual understanding. Studies on perceptive, concept development and conceptual understanding among learners convincingly established that there is possibly of no period during development when the learner is a 'blank mind.' They display high quality of knowledge and understanding about a diversity of concept, including number, physics, and social phenomena. Although this knowledge can serve as a solid foundation for formal instruction, some early knowledge may conflict with the material covered in literary and scientific domains because the conceptual understanding needed to understand these subjects does not correspond to real-world knowledge and experience (Bullock, 2001).

In physics, students' understanding of concept is challenging. Taqwa, et al. (2016) found out that students have problems in understanding the concept in almost all topics of physics such as mechanics, optics, electricity, and thermodynamics. They emphasized that the students' conceptual understanding was one of the important purposes in teaching physics, but the common constraint was how to achieve the student's conceptual understanding based on the appropriate scientific principle. Certain problems remained as hindrances in achieving it such as the predicament of students with difficulties aside from the challenges posed by the students' preconceptions.

Apparently, the weak conceptual understanding of students in physics can be addressed if the science teacher knows his/her students most common problems in conceptual understanding. Teachers' interventions can likely increase their students' science knowledge (Kola, 2017). For this reason, Moser and Chen (2016) suggest that science teachers should facilitate conceptual understanding rather than memorization. In this way, they are aiming and providing students with the capacity to succeed in the near future. Thus, if the science teachers provide a rational and accessible basis for conceptual understanding, it gives opportunity for students' prior knowledge to be tapped and then create lessons that can shape their understanding instead of memorizing. According to literature, conceptual understanding has now expanded and has included the influence of the individual's motivation for learning which has further implications to teaching science. This means that the teacher must not merely present a rationale for change in conceptual understanding, but also increase the quality of the engagement which can result in a better conceptual understanding for students.

RESEARCH METHODOLOGY

Research Design

The focus of the research study was to assess the Online Teaching in Physics using the Just-in-Time Teaching (JiTT), academic achievement, and conceptual understanding of grade 9 students. This study utilized the pre-experimental research design using the single-group pretest and posttest, wherein a single intact class was given pretest and posttest to determine the effect of Online teaching in Physics using the Just-in-Time Teaching (JiTT) on the students' academic achievement and conceptual understanding.

The research design is illustrated below:

Figure 1. Single-group pretest and posttest design

O1 X O2

Where:	O1-	=	pretest (PAT & EMCT)
	X	=	JiTT strategy (Warm-Up exercises)
	O2	=	posttest (PAT & EMCT)

Figure 1 shows the pretest and posttest research design used in the study. O1 is the pretest before the implementation of online teaching in physics using the Just-in-Time Teaching (JiTT) strategy which was X and O2 indicates as posttest after the implementation of the strategy.

Research Respondents

The study employed a quantitative pre-experimental research design that used a purposive sampling technique to assess the online teaching in physics using the Just-in-Time Teaching (JiTT) strategy, academic achievement, and conceptual understanding of grade 9 students. The study involved two observers: the Science Department Head II and Master Teacher from the Science Department. The study was conducted at Junior High School - District II and has initially involved Grade 9 first cluster composed of six (6) sections which totaled to three hundred thirty (330) students. However, only one (1) section, the grade 9 – Bronze completed the JiTT strategy online and became the official participants of the study. The grade 9 – Bronze class was composed of forty-eight (48) heterogeneous students with 23 females and 25 males who were selected using purposive sampling. The students in this section have stable Internet connectivity and technological gadgets during the conduct of the online class. This section experienced the online teaching in physics using the Just-in-Time Teaching (JiTT) strategy with warm-up exercises.

Research Instrument

This study used the following instruments to collect data: (1) Physics achievement test (PAT) to measure the achievement level of the students; (2) Energy-momentum concept test (EMCT) to measure students' conceptual understanding; (3) The JiTT's warm-up exercises via Google forms; (4) Daily lesson log (DLL); (5) Rubric for warm-up exercises; and (6) Student's learning experience survey questionnaire on JiTT. Three of the research instruments were adopted and the remaining three were researcher-made instruments.

Data Analysis

This research study used the quantitative pre-experimental research design using a single-group pretest and post-test to present the tables and described the findings and analyze quantitatively. The technique used in the research study was the purposive sampling technique. The achievement of the students was measured using the Physics Achievement Test (PAT) that was administered using Google forms. The students' scores were collected and generated once the test was submitted. The mean, standard deviation, and highest and lowest scores were described and compared analytically. Consequently, the data obtained from PAT were compared and described using descriptive statistics and a paired t-test to know the significant difference between the pretest and post-test within the group. The mean scores of the students' pretest and posttest were calculated by adding the scores and dividing them by the total number of the items (35 items). In addition, statistics such as percentages, mean values, mean difference, and standard deviation were used to assess how respondents agreed or disagreed with the items of the research questionnaire. The energy-momentum concept test (EMCT) was also administered before and after the implementation of the strategy as a pretest and post-test to measure students' conceptual understanding of the energy-momentum lessons. The energy-momentum concept test was also compared and described using descriptive statistics and paired t-test to know the significant difference between the energy-momentum pretest and post-test within the group.

Normalized gain (g) was used to compare each student's learning gains on the concept inventory in the energy-momentum concept test. The normalized gain (g) was calculated by collecting the number of students with the correct answer for every item in the energy-momentum concept test (pretest and post-test) using the formula: g = (posttest score – pretest score)/ (100 – pretest score) to get the gain of students every item in the test. Once normalized gain (g) was figured for all students in the 25-item energy-momentum concept test (pretest and post-test), the class average gain scores were calculated to know the learning gain for the entire class on average. The result of normalized gain can be presented in both percentage and decimals to easily analyze the result of data. The normalized gain (g) result was converted into normalized gain criteria: Interpretation of normalized gain (g), 0.70 < (g) High, 0.30 < (g) < 0.70 Medium, and (g) < 0.30 Low, (Hake R. R. 1999).

On the other hand, the learning experience survey form was also used to determine the student's learning experiences and interest in physics lessons after being exposed to online teaching in physics using the Just-in-Time Teaching (JiTT) strategy. This survey form consists of three questions which were mainly focused on thought-provoking and open-ended questions that were used to gather students' learning experiences in learning Physics with JiTT using warm-up exercises. The students' responses were analyzed thematically to generate common ideas and information about their learning experiences in physics.

RESEARCH FINDINGS AND DISCUSSION

Students' Achievement in Physics (PAT) Before and After Their Exposure to Online Teaching in Physics using Just-in-Time Teaching (JiTT) Strategy

Pretest and post-test scores are the basis for determining students' achievement in Physics (PAT) before and after their exposure to online teaching in physics using Just-in-Time Teaching (JiTT) strategy. The descriptive data based on the students' responses to the pretest and post-test are summarized in Table 1.

Table 1
Pretest and Posttest Scores of the Students in the Physics Achievement Test (PAT) (n = 48)

Test	Highest Score	Lowest Score	Mean	Mean Difference	SD
Posttest	35	27	31.85	4.52	1.70
Pretest	31	14	27.33		3.86

Table 1 shows the highest and the lowest score, mean score, mean difference, and standard deviation in the post-test and pretest in the physics achievement test (PAT). It shows that the highest score attained in the post-test is 35 and the lowest score is 27, at the same time the highest and the lowest score obtained in the pretest is 31 and 14. It also shows that the post-test has a mean score of M = 31.85, while the pretest has a mean score of M = 27.33. The mean difference between the post-test and the PAT is MD = 4.52. It shows an increase in the scores of the students suggesting that the students performed better after their exposure to the online teaching in physics using the JiTT strategy. The standard deviation of 1.70 in the post-test is lower than the pretest with 3.86, signifying that the posttest scores are more clustered around the mean than the pretest scores. This result conforms to the findings of Egenti (2017), that the achievement grades of students taught using the JITT method online are greater than those taught using the lecture method. Majority of the students agree that the warm-up exercises helped their learning by making them think critically about the material before going to class and become keener on the topics that would be discussed.

Significant Difference Between Students' Pretest and Posttest Mean Scores in Physics Achievement Test (PAT) Using Paired t-test.

The paired t-test is used to see whether there is a statistically significant difference between the pretest and post-test mean scores on the physics achievement test (PAT). The test's results are presented in table 2.

Table 2
Paired t-test: Pretest and Posttest Mean Scores in the Physics Achievement Test (PAT) (n =48)

Test	Mean	Standard Deviation	df	*t*-value	*p*-value	Remark
Posttest	31.85	1.70	47	8.06	.001	Significant
Pretest	27.33	3.86				

$p < 0.05$

The post-test means score (M = 31.85) is higher than the pretest mean score (M = 27.33), and the standard deviation of the posttest (SD = 1.70) is lower than the pretest (SD = 3.86). Since the computed p-value (p = .001) is less than the level of significance ($p < 0.05$), it means that the online teaching in physics using Just-in-Time Teaching (JiTT) strategy has a significant effect on increasing the students' achievement in physics for grade 9. The results reveal that there is a significant difference between the pretest and post-test mean scores of the students in the PAT. This result conforms with the findings of Ayu, et al., (2021) after following the JITT stages, students' understanding changes. The results show that there is a significant increase in the students' mastery of concepts, which shows that JITT strategy has had a high effect on students' understanding.

Students' Energy-Momentum Concept Test Before and After Their Exposure to Online Teaching in Physics using the Just-in-Time Teaching (JiTT) Strategy

The pretest and post-test scores in the energy-momentum concept test are the basis for determining students' conceptual understanding of the physics 9 lessons before and after their exposure to online teaching in physics using JiTT strategy**.** Table 3 summarizes the descriptive statistics based on the students' responses to the pretest and post-tests of the Energy-Momentum Concept Test (EMCT).

Table 3
Pretest and Posttest Scores of the Students in the Energy-Momentum Concept Test (n = 48)

Test	Highest Score	Lowest Score	Mean	Mean Difference	SD
Posttest	25	10	21.77	10.31	3.42
Pretest	16	3	11.46		3.26

The data in Table 3 shows the highest and the lowest score, mean score, mean difference, and standard deviation in the pretest and posttest in the EMCT. It shows that the highest score attained in the post-test is 25 and the lowest score is 10, while the highest and the lowest score obtained in the pretest is 16 and 3. It shows that the posttest has a mean score of *M* = 21.77, while the pretest has a mean score of *M* = 11.46. The mean difference between the post-test and the pretest in the EMCT is 10.31. It shows an increase in the scores of the students in the EMCT suggesting that the students perform better in the Physics 9 lessons after their exposure to online teaching in physics using the JiTT strategy. Moreover, the standard deviation of *SD* = 3.42 in the post-test is higher than the pretest with *SD* = 3.26, signifying that the posttest scores are more scattered around the mean compared to the pretest scores. This result supports Formica, et al.'s (2010), investigation, whether teaching an introductory physics course with a traditional lecture style or with JiTT will help the students. Overall, based on the study, the gains favor the JiTT method compared to the traditional lecture classes. The study shows that students in courses that are taught using the JiTT strategy better understand the concept of physics after instruction than students in traditional lecture courses.

Significant Difference Between Students' Pretest and Posttest Mean Scores in Energy-Momentum Concept Test (EMCT) Using the Paired t-test

The paired t-test is also used in this data to see whether there is a statistically significant difference between the pretest and post-test mean scores on the EMCT.

Table 4
Paired t-test: Pretest and Posttest Mean Scores in Energy-Momentum Concept Test (n =48)

Test	Mean	Standard Deviation	Df	*t*-value	*p*-value	Remark
Posttest	21.77	3.42	47	7.42	.001	Significant
Pretest	11.46	3.26				

$p < 0.05$

Table 4 shows that the post-test mean score (*M* = 21.77) is higher than the pretest means score (*M* = 11.46), and the standard deviation of the posttest (*SD* = 3.42) is higher than the pretest (*SD* = 3.26). Since the computed *p*-value (*p* = .001) is less than the level of significance ($p < 0.05$), it means that the online teaching in physics using the JiTT has a significant effect on increasing the students' understanding of the Energy-Momentum Concept. The results reveal that there is a significant difference between the pretest and post-test mean scores of the students in the EMCT before and after their exposure to the JiTT strategy. Simkins and Maier (2004) also observe that JiTT has significantly provided a positive impact on the students' learning as measured by exam scores.

Class Average Normalized Gain (g) Mean Score
Table 5 summarizes the average scores of normalized gains (g) of the entire class based on the data result of the Energy-Momentum Concept Test. The calculation result of normalized gain is converted into normalized gain criteria: Normalized gain interpretation, 0.70 < (g) High, 0.30 < (g) < 0.70 Medium, and (g) < 0.30 Low, (Hake, 1999). The data is presented in percentage and decimal values to easily know the percentage class average normalized gain (g).

Table 5
Class Average Normalized gain (g) Mean Score of the Students in the Energy-Momentum Concept Test. (n = 48)

	Pre	Pre%	Post	Post%	Gain	Remarks

Count	48	48	48	48	48	
St. Dev.	3.26	13	3.42	14	21	
ClassAv. Mean	11.46	46	21.77	87	g = 0.78 = 78%	High

Table 5 presents the normalized gain (g) average in the pretest and post-test results of the EMCT. It shows that the class average mean of pretest and standard deviation (*M* = 11.46 = 46%, SD 3.26 = 13%) are lower than the post-test mean score and standard deviation (*M* = 21.77 = 87%, SD 3.42 = 14%). The standard deviation in gain is equal to 21 and the normalized gain (g) mean class average score is 0.78 equivalent to 78% which is based on the normalized gain interpretation of 0.70 < 0. 78 (g) which has "high gain" in concept understanding; therefore, the 48 students, who took the pretests and post-test EMCT, have statistically "high" normalized gain (g) in conceptual understanding in their physics 9 lessons. This result proves that online teaching in physics using the JiTT strategy has a high positive impact on the students' conceptual understanding.

This result conforms with the findings of Gavalcante, et al., (2016) that gains in understanding concepts tended to be greatest for the lessons, which provide mental structures to support conceptual understanding. In addition, Mazzolini (2017) believes that testing conceptual understanding in physics will help promote more effective teaching and better evaluation on the effectiveness of physics courses in teaching basic physics concepts. These findings indicate that a course structure involving concept-based questions/exercises using a JiTT strategy is an effective technique for promoting learning and understanding of concept.

Students' Responses to the Learning Experiences Survey Questionnaire

For further validation of the quantitative analysis results, the students' learning experience survey is administered to all the student-participants immediately after the implementation of the strategy. The survey contains three thought-provoking and open-ended questions that are used to gather the student-participant's responses.

Data gathered from the students' responses to the learning experiences survey questionnaire are analyzed and presented thematically using Creswell (2013) and Saldana's (2013) framework. The transcripts are read and re-read to decontextualize information from primary data. The themes and codes of the open-ended questions are derived from the answers that have the same concepts and ideas with Creswell (2013) and Saldana (2013).

Table 6

Thematic Analysis of the Open-ended Questions (Learning Experiences Survey)

Main Themes	Codes
JiTT on student's learning using Warm-Up Exercises	Boost confidence
	Develop background knowledge
	Develop advance learning
	Develop interest
	Improve conceptual understanding
Problems encountered during the Online implementation of JiTT strategy	Internet connection
	unsearchable answer
JiTT strategy improves students' performance and conceptual understanding	Improve knowledge for future purposes
	Improve conceptual understanding and performance
	Makes study easier
	Improve participation
	Poor internet connection
	Builds knowledge and understanding of the lesson

Improve preparedness before the class

The students learning experiences in online teaching in physics using the Just-in-Time Teaching (JiTT) strategy developed background knowledge, and improved conceptual understanding and performance. However, the slow/poor Internet connection was a problem during the online teaching. These findings lead to the recommendation that future online offerings should require mandatory online participation. Overall, the learning experience survey results showed that the online teaching in physics using JiTT strategy improved the academic achievement and conceptual understanding of the Grade 9 students.

CONCLUSION

Based on the summary of findings the following conclusions were drawn.

1. The online teaching in physics using the Just-in-Time Teaching (JiTT) strategy increased the students' academic achievement in Grade 9 Physics.
2. The online teaching in physics using the Just-in-Time Teaching (JiTT) strategy improved the students' conceptual understanding in learning Grade 9 Physics based on normalized gain.
3. The following themes were generated based on the learning experiences survey of the students with the JiTT strategy:
   a. Developed background knowledge
   b. Improved conceptual understanding and performance
   c. Poor internet connection.

REFERENCES

Abude, A. J., (2021). The effectiveness of modular distance learning modality to the academic performance of students: A literature review. Himalayan Journal of Education and Literature, 2(6). DOI: https://doi.org/10.47310/Hjel. 2021.v02i06.008.

Montgomery, J. J. (2022). Assessing the Digital Technology Competencies of Certified Public Accountants: A Gaze into Ilokano Workplace Context. Universal Journal of Educational Research. 1(2), 26-36. https://doi.org/10.5281/zenodo.6937848.

Ayu, H. D., Sagita, U., & Jufriadi, A. (2019). The effect of just in time teaching (JiTT) learning model on the concept mastery of students learning motivation. Journal pengajaran MIPA, 24. https://ejournal.upi.edu/index.php/jpmipa/index.

Ayu, H. D., Jufriadi, A., & Andinisari, R. (2021). High impact on students' understanding of atomics radius on crystals geometry concept through implementation of JITT with 3D animation. Momentum: Physics Education Journal, 5(2), 153-160. https://doi.org/10.21067/mpej.v5i2.5557.

Bergeler, E. & Read, M.F. (2021). Comparing learning outcomes and satisfaction of an online algebra-based physics course with a face-to-face course. J Sci Educ Technol 30, 97–111. https://doi.org/10.1007/s10956-020-09878-w.

Blas T. M. & Fernández A. S. (2009). The role of new technologies in the learning process: Moodle as a teaching tool in Physics. Computers and Education, 52(1), 35-44. https://doi.org/10.1016/j.compedu.2008.06.005.

Brame C. (2013). Just-in-time teaching (JiTT). Vanderbilt University Center for Teaching. https://cft.vanderbilt.edu/guides-sub-pages/just-in-time-teaching-jitt/.

Bullock, M. (2001). Cognitive development: Child education. International Encyclopedia of the Social & Behavioral Sciences, pages 2094-2098. https://doi.org/10.1016/B0-08-043076-7/02321-4.

Cariño, E. L. (2019). 2018 national achievement test (NAT) 6, 10 & 12 results and analysis. Department of Educantion Regional Office. http://region2.deped.gov.ph/urm-s-20192018-national-achievement-test-nat-610-12-results-and-analysis/.

Creswell, J. W. (2013). Qualitative inquiry and research design: Choosing among five approaches (3rd ed). Library of Congress Cataloging-in-Publication Data. http://www.ceil-conicet.gov.ar/wp-content/uploads/2018/04/CRESWELLQualitative-Inquary-and-Research-Design-Creswell.pdf.

Cruz, M. R. (2019). Worst PH ranking in math, science, reading prompts DepEd review. Philippine Daily Inquirer. https://newsinfo.inquirer.net/1198208/.

Dargo, J. & Dimas, M. (2021). Modular distance learning: Its effect in the academic performance of learners in the new normal. Journal of Education, Teaching and Learning, 6(2), 204-208. https://www.learntechlib.org/p/220456/.

Defianti A. & Rohmi, P. (2021). Undergraduate student's misconception about projectile motion after learning physics during the Covid-19 pandemic era. In Journal of Physics: Conference Series (Vol. 2098, No. 1, p. 012026). IOP Publishing. DOI https://10.1088/1742-6596/2098/1/012026.

Department of Education (2020). Official statement. Republic of the Philippines, Department of Education www.deped.gov.ph/2020/05/06/official-statement-2/.

Dewi, F. H., Samsudin, A., & Nugraha M. G. (2019). An investigation of students' conceptual understanding levels on fluid dynamics using four-tier test. In Journal of Physics: Conference Series (Vol. 1280, No. 5, p. 052037). IOP Publishing. DOI https://10.1088/1742-6596/1280/5/052037.

Division of City Schools of Muntinlupa (2018). National Achievement Test (NAT) for grades 10 and 6, 2017-2018. SDO Muntinlupa. DepEd-Bureau of Education Assessment. https://deped-muntinlupa.com/.

Egenti, U. P. (2017). Comparative effects of just-in-time teaching and lecture method on academic achievement of guidance and counselling students: implications for improved ICT in schools. Journal of Emerging Trends in Educational Research and Policy Studies, 8(5), 285-290. https://hdl.handle.net/10520/EJC-e5f9db722.

Formica, S. P., Easley, J. L., & Spraker, M. C. (2010). Transforming common-sense beliefs into Newtonian thinking through Just-In-Time Teaching. Physical Review Special Topics-Physics Education Research, 6(2), 020106. DOI: https://doi.org/10.1103/PhysRevSTPER.6.020106.

Gavalcante, P. S., Newton, D. P. & Newton, L. D. (2016). The effect of various kinds of lesson on conceptual understanding in science. Research in Science & Technological Education, 15(2),185-193. DOI: https://doi.org/10.1080/0263514970150205.

Gavrin A. (2006). Just in time Teaching. Department of Physics, IUPUI. Retrieved from https://journals.iupui.edu/index.php/muj/article/view/20284/19877.

Gavrin, A., Watt, J. X., Marrs, K., & Blake Jr, R. E. (2004). Just-in-time teaching (JITT): Using the web to enhance classroom learning. Computers in education journal, 14(2), 51-60. http://webphysics.iupui.edu/iupui_me/asee_paper.pdf.

Gerodias, D. (2023). A Focus on the Contextualized Learning Activity Sheets. International Journal of Multidisciplinary Educational Research and Innovation. 1(1), 1-13. https://doi.org/10.5281/zenodo.7377366.

Montgomery, J. J. (2022). Assessing the Digital Technology Competencies of Certified Public Accountants: A Gaze into Ilokano Workplace Context. Universal Journal of Educational Research. 1(2), 26-36. https://doi.org/10.5281/zenodo.6937848.

Hake, R. R. (2002, August). Relationship of individual student normalized learning gains in mechanics with gender, high-school physics, and pretest scores on mathematics and spatial visualization. In Physics education research conference (Vol. 8, No. 1, pp. 1-14). https://web.physics.indiana.edu/sdi/AnalyzingChange-Gain.pdf.

Haqiqi, K. T., Hariyono, E., & Lestari N. A. (2020). The effectiveness of online based physics learning in the covid-19 pandemic period on the material of work and energy. PENDIPA Journal of Science Education, 5(3), 451-458. https://doi.org/10.33369/pendipa.5.3.451-458.

Hinojo-Lucena, F. J., Aznar-Díaz, I., Cáceres-Reche, M. P., & Romero-Rodríguez, J. M. (2019). Artificial intelligence in higher education: A bibliometric study on its impact in the scientific literature. Education Sciences, 9(1), 51. https://doi.org/10.3390/educsci9010051.

Klein P., Ivanjek L., Dahlkemper M. N., Jeličić K., M.-A. Geyer, S. Küchemann, & A. Susac (2021). Studying physics during the COVID-19 pandemic: Student assessments of learning achievement, perceived effectiveness of online recitations, and online laboratories. Physical review physics education research, 17(1), 010117. https://doi.org/10.1103/PhysRevPhysEducRes.17.010117.

Kola, A. J. (2017). Investigating the conceptual understanding of physics through an interactive lecture-engagement. Cumhuriyet International Journal of Education, 6(1), 82. https://www.researchgate.net/profile/JacobAina/publication/315841723_Investigating_the_Conceptual_Understanding_of_Physics_through_an_Interactive_Lecture_Engagement/links/58eb7f914585153b60c96054/Investigating-the-Conceptual-Understanding-of-Physics-through-an-Interactive-Lecture-Engagement.pdf.

Kurt, S. (2019). Just-in-time teaching (JiTT)," in educational technology. New Directions for Teaching and Learning, 2011(128), 63-73. https://educationaltechnology.net/just-in-time-teaching-jitt/.

Liberatore, M. W., Morrish, R. M., & Vestal, C. R. (2017). Effectiveness of just in time teaching on student achievement in an introductory thermodynamics course. Advances in Engineering Education, 6. https://eric.ed.gov/?id=EJ1138854.

Lumintac, M. Q. (2014). Students' negative attitude to physics influences low academic achievement. IAMURE International Journal of Education, 12(1), 1-1. https://ejournals.ph/article.php?id=3422.

Marrs, K. A., Blake, R. E., Gavrin, A. D., & Marss, K. A. (2003). Use of warm up exercises in just-in-time teaching to determine students' prior knowledge and misconceptions in biology, chemistry, and physics. J Coll Sci Teach, 33, 42-47. https://serc.carleton.edu/resources/14234.html.

Mansour, E. A., El-Araby M., Pandaan I. N., & Gemeay G. E., (2017). Hemispherical brain dominance and academic achievement among nursing students. IOSR Journal of Nursing and Health Science, 6(3), 32-36. DOI: https://10.9790/1959-0603083236.

Mazzolini, A. (2017). Testing conceptual understanding in physics using a browser-based computer managed system. School of Biophysical Sciences and Electrical Engineering. https://openjournals.library.sydney.edu.au/index.php/CAL/article/view/6151.

McGee, M., Stokes, L., & Nadolsky, P. (2016). Just-in-time teaching in statistics classrooms. Journal of Statistics Education, 24(1), 16-26. https://doi.org/10.1080/10691898.2016.1158023.

McLeod, S. (2019). Constructivism as a theory for teaching and learning. SymplyPsychology. https://www.simplypsychology.org/constructivism.html.

Montuori, L., Alcázar Ortega, M., Bastida Molina, P., & Vargas Salgado, C. A. (2021). Application of Artificial intelligence to high education: empowerment of flipped classroom with just-in-time teaching. In Proceedings INNODOCT/20. International Conference on Innovation, Documentation and Education (pp. 223-231). Editorial Universitat Politècnica de València. DOI: https://10.4995/INN2020.2020.11896.

Moser, T. & Chen, V. (2016). What is Conceptual Understanding. Getting Smart. https://www.gettingsmart.com/2016/08/what-is-conceptual understanding/.

Mozer, Lisa F., (2016). A comparison of online and face-to-face achievement in physical science. https://digitalcommons.kennesaw.edu/cgi/viewcontent.cgi?article=1005&context=instruceddoc_etd.

National School Board Association (2014). Center of public education.https://www.nsba.org/Services/Center-for-Public-Education.

Novak, G. M., & Beatty, B. J. (2016). Designing just-in-time instruction. In Instructional-Design Theories and Models, Volume IV (pp. 415-448). Routledge. https://doi.org/10.4324/9781315795478.

Novak, G. M., Patterson, E. T., Gavrin, A. D., & Christian, W. (1999). Just-in-time teaching: Blending active learning with web technology. New Jersey: Prentice-Hall. Center for Innovation in Teaching & Learning. https://citl.illinois.edu/citl-101/teaching-learning/resources/teaching-strategies/just-in-time-teaching.

Oducado, R. M. (2020). Survey instrument validation rating scale. Available at SSRN 3789575. https://www.researchgate.net/publication/330958308_Survey_Instrument_Validation_Rating_Scale.

Ojose, B. (2008). Applying Piaget's theory of cognitive development to mathematics instruction. The Mathematics Educator, 18(1), 26–30. https://eric.ed.gov/?id=EJ841568.

Puspitasari, R., & Mufit, F. (2021, April). Conditions of learning physics and students' understanding of the concept of motion during the covid-19 pandemic. In Journal of Physics: Conference Series (Vol. 1876, No. 1, p. 012045). IOP Publishing. DOI: https://10.1088/1742-6596/1876/1/012045.

Saldaña, J. (2021). The coding manual for qualitative researchers. The coding manual for qualitative researchers, 1-440. https://www.torrossa.com/en/resources/an/5018667.

Shavelson, R. J., & Ruiz-Primo, M. A. (2008). On the assessment of science achievement conceptual underpinnings for the design of performance assessments. National Center for Research on Evaluation. https://cresst.org/wp-content/uploads/TECH491.pdf.

Siddiqui, M. A., & Khan, M. (2016). Study of achievement in physics, study habits and self-concept among senior secondary school students. Journal Homepage: http://www. ijmra. us, 6(9). https://www.researchgate.net/publication/308365577_Study_of_Achievement_in_Physics_Study_Habits_and_Self_Concept_among_Senior_Secondary_School_Students_Introduction.

Simkins, S., & Maier, M. (2010). Just-in-time teaching: Across the disciplines, across the academy. Stylus Publishing, LLC. https://styluspub.presswarehouse.com/browse/book/9781579222932/Just-in-Time-Teaching.

Simkins, S., & Maier, M. (2004). Using just-in-time teaching techniques in the principles of economics course. Social Science Computer Review, 22(4), 444-456. https://journals.sagepub.com/doi/abs/10.1177/0894439304268643.

Singh, C. & Rosengrant, D. (2003). Multiple-choice test of energy and momentum concepts. American Journal of Physics, 71(6), 607-617. DOI: https://10.1119/1.1571832.

Taqwa, M. R. A., Hidayat, A., & Sutopo S. (2016). Recitation program based on multi representation needed to increase the kinematics conceptual understanding. Journal of Physics Education Innovation and Its Integration, 1(2). https://www.researchgate.net/profile/Atina-Rizanatul-Fahriyah/publication/328231886_The_MetaAnalysis_of_Effectiveness_Science_Technology_Society_STS_Approach_Toward_The_Learning_Achievement/links/5bc036ba458515a7a9e2a69a/The-Meta-Analysis-of-Effectiveness-Science-Technology-Society-STS-Approach-Toward-The-Learning-Achievement.pdf#page=66.

Western Governors University (2022, May 27). What is constructivism?, Western Governors University. www.wgu.edu/blog/what-constructivism2005.html#close.

White, J. D. (2020). Teaching general physics in a COVID-19 environment: insights from Taiwan. Physics Education, 55(6), 065027. DOI: https://10.1088/1361-6552/abb347.