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Computer-Based Instruction in Teaching Secondary Biology

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Abstract

This study investigates the effectiveness of Computer-Based Instruction (CBI) in teaching Biology to 7th graders of a secondary night school in Cebu City, Philippines. A pretest and posttest quasi-experimental design with a control group was utilized to two groups of students, of which one was exposed to CBI and the other to the conventional lecture method (CLM). An Instructional Materials Motivation Survey (IMMS) was used to assess its motivational characteristics. Data gathered were analyzed using descriptive statistics, frequency count and percentage, mean and standard deviation, t-test. Findings revealed that both groups had Fairly Satisfactory performance in the pretest, which implies that the students had low knowledge on the topic. The study also found that both groups had significantly increased their performances from the pretests to the posttests, implying the essence of CLM and CBI use. Ultimately, the study revealed that the use of CBI is more effective than CLM, as seen in the enhanced students' performance, signifying the effectiveness of the instruction using a computer in teaching Biology concepts. The students commended the CBI for being a user-friendly, autonomous, self-paced, and self-regulating instructional design that helped them enhance their performance in the least learned competencies. A contextualized CBI in Biology was crafted to serve as a guide for teachers and enable the students to pave the way for the mastery of the different competencies in Biology.

Keywords: *academic performance, biology education, computer-based instruction, conventional lecture method, instructional materials motivation survey*

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1. Introduction

The Philippines' current state of science education lags other countries worldwide based on the international standardized tests (Cabansag, 2014) and declining educational standards during the first decade of the 21st century (Macha et al., 2018). It ranked 76th out of 137 countries in math and science education in the Global Competitiveness Report (Schwab, 2017-2018) and 249 in science on Trends in International Mathematics and Science Study (TIMSS) (International Association for the Evaluation of Educational Achievement, 2019). In addition, in the report of Project Monitoring and Evaluation to meet Education Targets (MEET): An Undertaking for Constant Change Towards Progress (2017) of the Department of Education in Cebu City Division, the findings stated that District Central Schools and Night High Schools were the most significant contributors to Learners at Risk of Dropping out (LARDO) and Learners at Risk of Failing (LARF). The main factors of Filipino students' poor science performance are a lack of support for scientific culture, as seen by shortcomings in the school curriculum, ineffective teaching-learning process, a lack of teacher training (Magnanimous Science, 2014), and insufficient instructional materials (Torio, 2015).

The student's interest in science is a critical component of academic achievement and an essential element of motivation (Kahu & Nelson, 2018). It has been seen as a vital part of science and biology education (Renninger et al., 2015). Despite this goal, evidence suggests that biology education faces a unique challenge in building students' interest in biology content (Rowland et al., 2019), and the method of teaching is one of the factors contributing to the low interest in science and expressing the need to come up with alternative teaching strategy that could motivate students' interest and enhance their achievement (Ajaja, 2013). One of the strategies that can be addressed these challenges is computer-based instruction (CBI). CBI is a teaching material arranged systematically and designed with a programming language or software that uses strategic learning methods with materials, exercises, questions, and quizzes. Learning media that is packaged in a computer program aims to help understand the material to facilitate the teaching and learning process (Limbong et al., 2018)

Students must be faced directly with the real problems during the learning process at school, especially in science learning, which is always related to the surrounding natural environment. Natural sciences are concerned with deliberately acquiring information about the

natural environment, rather than accumulating knowledge in the form of concepts, facts, or principles and observing the subject of research (Tawar, 2016). An innovative teaching strategy is essential to improve the students' academic performance (Oyelekan et al., 2018). Understanding the Ecological Interaction at the secondary night school is vital since it is a piece of scientific knowledge that has been tested for the truth through the scientific method, with the characteristics of objective, methodical, systematic, universal, and tentative (Tuwuh, 2015). By using CBI, it plays a pivotal role in improving students' higher-order skills in the context of problem-based learning for Science, Technology, Engineering and Mathematics (STEM) education (Kim et al., 2018). The computer-based science and technology laboratory is becoming increasingly important in the educational curriculum due to the rapid pace of technological breakthroughs (Serin, 2011).

This study investigates the effectiveness of CBI in teaching Ecological Interactions to Grade 7 students in a secondary night school in Cebu City, Philippines. Specifically, it determined the pretest and posttest performances of those exposed in CBI and those exposed to CLM, determined whether there was a significant improvement in the performance of the students after the implementation of CBI and CLM, determined whether there was a significant difference between the mean gains of the two groups of students, and determined the level of student's Instructional Materials Motivation on CBI in terms of attention, relevance, confidence, and satisfaction.

2. Literature review

Science teachers were facing problems presenting concepts so that the student's knowledge and interest would increase. The issue of students' performance in biology has led to several proposals for enhancement. Unfortunately, those proposals revolve around unfitting teaching strategies and insufficient real-world exposure as the leading cause of students' poor performance in biology. Many students had difficulty in understanding the topics in biology (Castro & Morales, 2017; Mead et al., 2017). As computer technology evolves, the use of computers in education has become inevitable. Using technology in education provided students with a more conducive learning environment. Thus, it creates a conducive environment for the students (Bhushan et al., 2021; Hew & Kadir, 2016) and corrective feedback (Ai, 2017). Technological devices began to be used in instruction in education to develop audio-visual

materials such as animation and simulation as a representation of factual scenarios and processes, which resulted in the development of computer-based instruction techniques (Cavkaytar et al., 2017; Fuady & Mutalib, 2018; Wazeema, & Kareema, 2017)

Computer instructional program can be implemented in conjunction with traditional teaching methods to enhance the overall educational experience (Fotaris et al., 2016; Pappas, 2014). This provides a supplementary tool for instructional support in the classroom (Bulman & Fairlie, 2016; Shute & Rahimi, 2017). Using computer-based assessments, the students are assessed with the given performance standard within the learning sequence in each learning task determined by the learners' performance (Hoogland, & Tout, 2018; Muraina et al., 2011; Nguyen et al., 2017). The critical function of science education is to teach students science concepts in a meaningful way and enable them to learn how to use them in their daily lives. Anchored instruction promoted learning by making the context more significant, providing multiple ways of education, and making maximum use of experience and existing knowledge (Guzman, 2000; Srisawasdi, N., & Panjaburee, 2019). Students can proceed at their own pace, following a path through the curriculum as suited to their interests and talent (Achuonye, 2011).

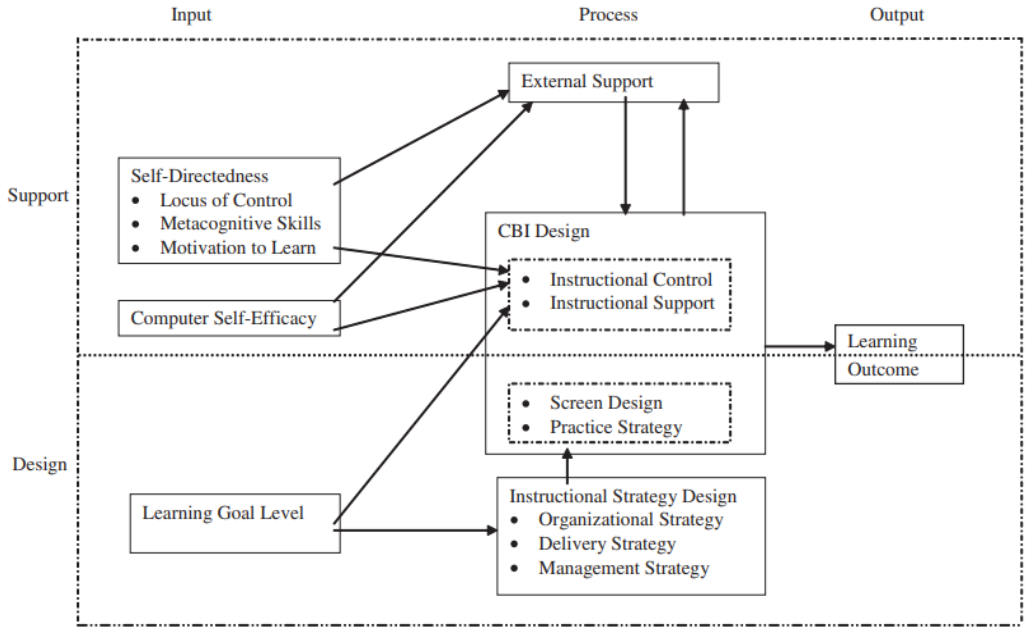
The CBI being effective in the delivery of instruction as literature revealed may benefit the students' performance in biology, particularly the least learned competencies in Ecological Interactions. However, this notwithstanding, a comparison would be made in this study between the students' performance using CBI and CLM.

2.1. Theoretical framework

The present study is anchored on Lowe and Holton's Theory of Computer-Based Instruction for Adults (2005) that provides a framework for research to explain or predict effective learning by adults using a desktop computer. It plays an essential role for self-directedness and computer self-efficacy of adults in designing CBI for adults. It is intended to be interwoven with the units of self-directedness, computer self-efficacy, learning goal level, instructional design, and external support. The learning goal level affects instructional design strategy and the instructional control component of CBI design. External help and instructional support are needed to provide a positive CBI experience, and the theory draws together the isolated variables researchers consider essential in the adult learning process and aligns them to provide effective CBI.

Figure 1

Theory of Computer-Based Instruction for Adults



Source: Lowe & Holton (2005)

3. Methodology

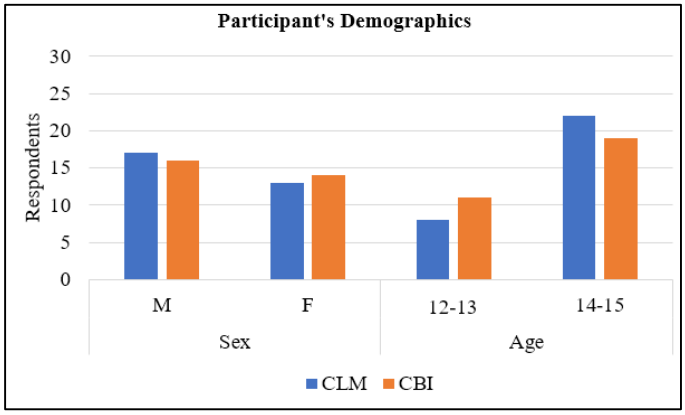
3.1 Research Design, Environment and Respondents

The study employed two pedagogies: CLM for the control group and CBI for the experimental group. CLM infused teacher-directed lecture format. Lectures constituted classroom discussion and problem-solving. The study utilized the quasi-comparative research design in which pretest and posttest with control group design were employed to determine the effectiveness of CBI in teaching ecological interactions concepts in night high school students. Two groups of 30 randomly selected 7th-grade students from a public secondary night school in Cebu City, Philippines, participated in the study. These participants were selected through fish-bowl method randomization. Figure 2 shows the demographic profile of the respondents in terms of age and sex.

A total of 60 students from two groups participated in the study. For both group, most of the participants were males, CLM (57%) and CBI (53%), and their ages ranges from 12 to 15 years old with a mean of 13.70 for CLM and 13.60 for CBI.

Figure 2

Respondents' Demographics according to age range and proportion of male and female



3.2 Research Pedagogies and Research Instruments

The study utilized the conventional lecture method (CLM) for one group of students and the Computer-Based Instruction (CBI) for the other group. CLM used lectures constituted of classroom discussion. In CBI, students accessed web pages with detailed lecture notes supplemented with graphics, animations, and hyperlinks. The teacher first identified the target of instruction and operationalized it to be observable and measurable. Then, baseline data were collected appropriately for the targeted skill. Next, technology support personnel were identified in the school/program building. The teacher did the check of computer availability schedules in the computer laboratory and developed a plan for the learner's use of available computers. The ratio of students to the computer was 1:1. Appropriate software, graphics, animations, and hyperlinks were identified and selected. Orientation and filling out of demographics by the respondents were done. As the students navigated the computer, the teacher provided minimal support and intervention.

A researcher-made pretest and posttest questionnaire was structured based on Bloom's Taxonomy framework and went through validity by the panel of experts and reliability test of Cronbach's alpha value of 0.84. An Instructional Materials Motivation Survey (IMMS) survey instrument adapted from Keller (2016) was utilized to assess the motivational characteristics of instructional material using the Attention, Relevance, Confidence, and Satisfaction (ARCS) model of motivation, and rated in five-point Likert scale ranging from "*not evident*" to "*highly evident*."

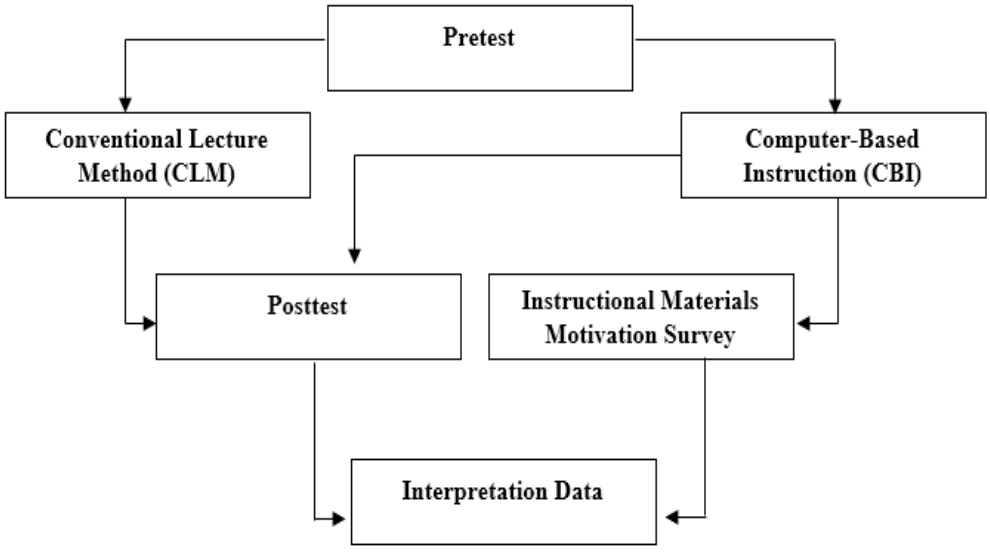
3.3 Data Gathering Procedures and Data Analysis

A permit from the Schools Division Superintendent and the school principal was secured before the conduct of the study. Upon approval, the pretest tool was administered to the two groups. After pretesting, the two groups of Grade 7 students underwent the experimentation phase. The first group was exposed to CLM, while the other was exposed to CBI. After two weeks of experimentation, the two groups were given the posttest. The CBI group was given the IMMS survey to assess the motivational characteristics of the instructional material.

To analyze the data obtained from the assessment tool, a t-test for single and small samples were employed. To determine whether there is a significant difference between the pretest and posttest performances, a t-test for correlated samples was used. Lastly, to know the difference between the mean gains of the two groups, a t-test for two independent samples was utilized. All tests were used at a level of significance, $\alpha=0.05$. Figure 3 shows the data collection process.

Figure 3

Data Collection Procedure



3.4 Ethical Consideration

Research permission was sought from the Schools Division Superintendent and school principal before the conduct of the study. An informed consent was given to the respondents with the considerations as to freedom to participate in the study. All names remained anonymous while data obtained from the study were kept private and confidential.

4 Findings and Discussion

4.1 Performance Level of the Students in Biology in Pretest and Posttest

The performance level in Ecological Interactions from both CLM and CBI groups is significantly lower than the standard set by the Department of Education (Table 1). This low performance implies that the students had low knowledge of the topics as shown in the pretest, understandably because the lesson on Ecological Interactions was not yet introduced.

In the posttest, the CLM group had Satisfactory performance while the CBI group had very satisfactory performance. This performance was supported by De Witte et al. (2015) that higher exposure to the utilization of computers in learning leads to higher test outcomes and given the participation to computer-assisted learning program doing more exercises leads to higher test results and working this toll seems therefore effective.

Table 1

Performance Levels of the Students in Biology

Test	Group	MeanSD	p-value	Description*
Pretest	CLM	15.40±4.93	.000	Fairly Satisfactory
	CBI	15.90±6.92	.000	Fairly Satisfactory
Posttest	CLM	25.13±6.10	.000	Satisfactory
	CBI	29.97±5.00	.000	Very Satisfactory

**Legend: Below 9 (Did Not Expectation); 9-16 (Fairly Satisfactory);17-24 (Satisfactory); 25-32 (Very Satisfactory); 33-40 (Outstanding)*

4.2 Mean Improvement of the Students' Performances in Biology from Pretest and Posttest

The mean improvement of the students' performance in Biology from pretest and posttest is presented in Table 2. Both groups had significantly higher posttest scores than the pretest scores, thus, gaining significant improvement in their performance. These significant mean improvements were due to students' acquiring concepts and skills about the Ecological Interactions brought about by exposure to CLM and CBI. CLM has helped the students to attain enhanced learning due to the active involvement of the teacher, which made students understand the concept. In the study of Gupta (2014), students consider the CLM beneficial for learning because they can interact and connect with the teacher and their classmates. The ability to ask questions and receive rapid responses from the teacher is essential for those who learn best through cooperative activities and group work.

The use of CBI resulted in significant improvement because the students were peer-taught than self-taught during the learning exercises they had during the study. This supported the study of Birgin et al. (2015) and Serin (2011), who reported that significant improvement was caused by computer instruction compared to traditional instruction.

Table 2

Mean improvement of students' performances from pretest to posttest

Group	Pretest Mean	Posttest Mean	Difference	p-value
CLM	15.40	25.13	9.73	.000
CBI	15.90	29.97	14.07	.000

4.3 Comparison of the Mean Gains in Biology between CLM and CBI Groups

As compared in Table 3, there was a highly significant difference between the mean gains of CLM and CBI groups. The use of CBI was more effective in improving students' performance in biology than the students who were taught using the lecture method. This denoted that peer tutors and their tutees were directly involved in an active, friendly, and individualized learning process, as they supplemented what the teacher taught them.

These results supported Dubovi's (2018) studies that students have higher learning gains for computer-designed instruction than alternative learning approaches. The number of time students was engaged in learning with simulations was significantly associated with learning gains scores.

Table 3

Differences between the mean gains of CLM and CBI groups

Group	Mean Gain	Difference between Means	p-value
CLM	9.73	4.34	.002
CBI	14.07		

4.4 Level of students' Instructional Material Motivation on CBI

The level of students' instructional material motivation on the CBI in terms of attention, relevance, confidence, and satisfaction, which were the steps in promoting and sustaining the learners' motivation, was summarized in Table 4 with a verbal interpretation of Mostly Evident. It showed a positive perception of the students towards using CBI in the lesson Ecological Interactions.

The students commended the CBI for being a user-friendly, autonomous, self-paced, and self-regulating instructional design that helped them enhance their performance in the least learned competencies. The result showed that a good instructional design could improve the learning and implementation of the students and supported the study of Wang & Hsu (2014) that learners with higher flow experience in a computer-based instruction environment exhibited superior learning performance and satisfaction during learning.

Table 4

Summary of the Level of students' Instructional Material Motivation on CBI

Dimension	MeanSD	Interpretation
Attention	3.89±0.91	Mostly Evident
Relevance	3.92±0.90	Mostly Evident
Confidence	3.84±0.89	Mostly Evident
Satisfaction	3.82±0.87	Mostly Evident

4.5 Comments and Feedback on the Use of CBI

Students have positive feedback and comments on the use of CBI as they found it relevant in the learning Biology. It helped them understood the topics very well because of the interactive discussion. One of the students named Jane (*not the real name*) gave a positive comment regarding on the use CBI as an intervention tool in learning Biology.

> Jane: *"Maglisud man ko ug English pero sa CBI kay sayonan ko kay simple ang words nga gigamit. Lipay kaayo ko magtan-aw kay interactive ang discussion."* (I have difficulty with English language but with the use of CBI I find the words simple. I am happy watching the interactive discussion.)

Another student commented that:

> Joshua: *"Ganahan kaayo ko sa mga activity kay dali ra mahimo ug sayon sundon bisan ug walay teacher nga mo guide kay simple ang iyang mga steps ug kadiyot ra mahuman*."
>
> (I like the activity because it is easy to follow even if the teacher is not around to guide me since the steps are simple and doable.)

All the respondents satisfied and approved the use of CBI in learning Science and Mathematics concepts like earthquakes, simplifying rationale expression. The simulations and interactive discussion were very relevant to their understanding of the lesson.

> Claire: *"Ganahan ko sa discussion sa lesson sa computer kay naay mga simulations ug mas nakasabot ko sa lesson sa science. Na appreciate naku ang interactive discussion."* (I like the discussion of the lesson in the CBI because of the simulation and I understand the lessons more in science. I appreciate the interactive discussion).

Another respondent also added that easy activity makes the lesson interesting to do.

> Joseph: *"Gisayunan raku sa mga activity gamit ang computer ug mahibaw-an dayun nimu ang results sa activity."* (I find it easy to answer the activity with the use of computer and I can immediately see the results of the activity.)

All the comments and feedback by the students can be supported in the study of Rachmadtullah et al., (2019) positing that learning using interactive computer-based interactive applications more effectively in comparison with conventional media. This is because learning

using interactive multimedia computer-based, students can control the learning activities and students determine the speed of learning and choose the sequence of learning activities in accordance with needs. Conclusively, the CBI was perceived by the students positively and the appropriate to the topic and understanding of the students. CBI holds a promise for student learning and good news for teachers who plan to utilize the CBI in teaching Biology.

5 Conclusion

The use of Computer-Based Instruction was an effective tool for the seventh-grade students at a night school as seen in the change of students' performance from Fairly Satisfactory to Very Satisfactory, significant improvement of the student's performance levels after the intervention, and the significantly higher mean gain among the students than those who were exposed to the conventional lecture method. Therefore, the students exposed to CBI manifested a more enhanced performance in learning the Ecological Interactions. Lowe & Holton's theory predicts effective learning using computer instruction interwoven with the units of computer self-efficacy, learning goal level, self-directedness, instructional design, and external support. A contextualized CBI in Biology was crafted to serve as a guide for teachers and enable the students to pave the way the mastery of the different competencies in Biology.

The study recommended that teachers use computer-based instruction as a form of instruction in teaching biology that Biology teachers utilize CBI and other strategies already employed in teaching. It is also recommended that the teachers handling science subjects undergo seminars and training for effective implementation of computer-based instruction to empower more specific student-centered learning experiences and environment to the students and that further studies on CBI be conducted using a large number of students as subjects in other science disciplines.

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References

Abimbade, O., Akinyemi, A., Bello, L., & Mohammed, H. (2017). Comparative Effects of an Individualized Computer-Based Instruction and a Modified Conventional Strategy on Students' Academic Achievement in Organic Chemistry. *Journal of Positive Psychology and Counseling*, *1*(2), 1-19.

Ai, H. (2017). Providing graduated corrective feedback in an intelligent computer-assisted language learning environment. *ReCALL*, *29*(3), 313-334.

Ajaja, O. P. (2013). Which way do we go in biology teaching? Lecturing, Concept mapping, Cooperative learning or Learning cycle? *The Electronic Journal for Research in Science & Mathematics Education*, *17*(1)

Achuonye, A. (2011). Using computer in science class: The interactive effect of gender. *Journal of African studies and development*, *3*(7), 131-134.

Bhushan, M., Sinha, A., Sinha, M., & Kumari, S. (2021). Use of Technology in Creating Conducive Learning Environment in Higher Education.

Birgin, O., Bozkurt, E., Gürel, R., & Duru, A. (2015). The effect of computer-assisted instruction on 7th grade students' achievement and attitudes toward mathematics: The case of the topic "Vertical Circular Cylinder". *Croatian Journal of Education: Hrvatski časopis za odgoj i obrazovanje*, *17*(3), 783-813.

Bulman, G., & Fairlie, R. W. (2016). Technology and education: Computers, software, and the internet. In *Handbook of the Economics of Education* (Vol. 5, pp. 239-280). Elsevier.

Cabansag, M. G. S. (2014). Impact statements on the K-12 science program in the enhanced basic education curriculum in provincial schools. *Researchers World*, *5*(2), 29. Department of Education (2016). K to 12 Basic Education Curriculum.

Castro, J. A. F., & Morales, M. P. E. (2017). "Yin" in a Guided Inquiry Biology Classroom–Exploring Student Challenges and Difficulties. *Journal of Turkish Science Education*, *14*(4), 48-65.

Cavkaytar, A., Acungil, A. T., & Tomris, G. (2017). Effectiveness of teaching café waitering to adults with intellectual disability through audio-visual technologies. *Education and Training in Autism and Developmental Disabilities*, *52*(1), 77-90.

De Witte, K., Haelermans, C., & Rogge, N. (2015). The effectiveness of a computer-assisted math learning program. *Journal of Computer Assisted Learning*, *31*(4), 314-329.

Dubovi, I. (2018). Designing for online computer-based clinical simulations: Evaluation of instructional approaches. *Nurse Education Today*, *69*, 67-73.

Fotaris, P., Mastoras, T., Leinfellner, R., & Rosunally, Y. (2016). Climbing up the leaderboard: An empirical study of applying gamification techniques to a computer programming class. *Electronic Journal of e-learning*, *14*(2), 94-110.

Fuady, R., & Mutalib, A. A. (2018). Audio-visual media in learning. *Journal of K6 Education and Management*, *1*(2), 1-6.

Gupta, Swati (2014). Traditional Vs. Modern Teaching Methodology. Pioneer Institute of Professional studies, Indore

Guzman, N. (2000). Applications of adult learning theories to constructivist learning environments. *Retrieved August*, *12*, 2003.

Hew, T. S., & Kadir, S. L. S. A. (2016). Predicting the acceptance of cloud-based virtual learning environment: The roles of Self Determination and Channel Expansion Theory. *Telematics and Informatics*, *33*(4), 990-1013.

Hoogland, K., & Tout, D. (2018). Computer-based assessment of mathematics into the twenty-first century: pressures and tensions. *ZDM*, *50*(4), 675-686.

International Association for the Evaluation of Educational Achievement (IEA) 2019. Trends in International Mathematics and Science Study (TIMSS)

Kahu, E. R., & Nelson, K. (2018). Student engagement in the educational interface: understanding the mechanisms of student success. *Higher education research & development*, *37*(1), 58-71.

Keller, J.M. (2010). *Motivational Design for Learning and Performance: The ARCS Model Approach.* New York, NY: Springer.

Kim, N. J., Belland, B. R., & Walker, A. E. (2018). Effectiveness of computer-based scaffolding in the context of problem-based learning for STEM education: Bayesian meta-analysis. *Educational Psychology Review*, *30*(2), 397-429.

Limbong, T., Simarmata, J., Tambunan, A. R. S., Siagian, P., Panjaitan, J., Siagian, L., ... & Lumbanbatu, K. (2018, September). The implementation of computer based instruction model on Gost Algorithm Cryptography Learning. In *IOP Conference Series: Materials Science and Engineering* (Vol. 420, No. 1, p. 012094). IOP Publishing.

Lowe, J. S., & Holton III, E. F. (2005). A theory of effective computer-based instruction for adults. *Human Resource Development Review*, *4*(2), 159-188.

Macha, W., Mackie, C., & Magaziner, J. (2018). Education in the Philippines. Retrieved at https://wenr.wes.org/2018/03/education-in-the-philippines

Magnanimous Science (2014). Poor Science Education in the Philippines: Causes, Solutions, and Suggestions. Retrieved from: https://magnanamousscience.wordpress.com

Mead, R., Curnow, R. N., & Hasted, A. M. (2017). *Statistical methods in agriculture and experimental biology*. Chapman and Hall/CRC.

Muraina, I. O., Adeleke, I. A., & Rahman, M. A. (2011). Computer assisted instruction for teaching/learning process and its effects on students performance in tertiary institutions. *International Journal of Computer Trends and Technology*, *2*(1), 15-19.

Nguyen, Q., Rienties, B., Toetenel, L., Ferguson, R., & Whitelock, D. (2017). Examining the designs of computer-based assessment and its impact on student engagement, satisfaction, and pass rates. *Computers in Human Behavior*, *76*, 703-714.

Oyelekan, O. S., Igbokwe, E. F., & Olorundare, A. S. (2018). Science teachers' utilisation of innovative strategies for teaching senior school science in ilorin, nigeria. *MOJES: Malaysian Online Journal of Educational Sciences*, *5*(2), 49-65.

Pappas, Christopher (2014). Instructional Design Models and Theories: Computer-Based Instruction Theory. Retrieved from: https://elearningindustry.com/computer-based-instruction-theory

Project Monitoring and Evaluation to meet Education Targets (MEET): An Undertaking for Constant Change Towards Progress (2017). Department of Education, Cebu City Division.

Rachmadtullah, R., Zulela, M. S., & Sumantri, M. S. (2019, March). Computer-based interactive multimedia: a study on the effectiveness of integrative thematic learning in elementary schools. In *Journal of Physics: Conference Series* (Vol. 1175, No. 1, p. 012028). IOP Publishing.

Renninger, K. A., & Hidi, S. E. (2015). *The power of interest for motivation and engagement*. Routledge.

Rowland, A. A., Knekta, E., Eddy, S., & Corwin, L. A. (2019). Defining and measuring students' interest in biology: An analysis of the biology education literature. *CBE—Life Sciences Education*, *18*(3), ar34.

Schwab, Klaus (2017-2018). Global Competitiveness Report.

Serin, O. (2011). The Effects of the Computer-Based Instruction on the Achievement and Problem-Solving Skills of the Science and Technology Students. *Turkish Online Journal of Educational Technology-TOJET, 10*(1), 183-201.

Shute, V. J., & Rahimi, S. (2017). Review of computer-based assessment for learning in elementary and secondary education. *Journal of Computer Assisted Learning*, *33*(1), 1-19.

Srisawasdi, N., & Panjaburee, P. (2019). Implementation of game-transformed inquiry-based learning to promote the understanding of and motivation to learn chemistry. *Journal of Science Education and Technology*, *28*(2), 152-164.

Tawar (2016). Peningkatan Prestasi Belajar IPA Melalui Pendekatan Lingkungan Alam Sekitar Pada Siswatunagrahita Kelas 7. Jurnal Rehabilitasi dan Remediasi Vol. 25 No. 01 Hlm. 19-24

Torio, M. Z. C. (2015). Development of instructional material using algebra as a tool in problem solving. *International journal of education and research*, *2*(1), 569-586.

Tuwuh Waluya (2015). Peningkatan Aktivitas dan Hasil Belajar IPA Materi Pewarisan Sifat Dengan Media Kartu Dogen. JPK UNNES Vol. 1 No. 1 Hlm. 18-28

Wang, C. C., & Hsu, M. C. (2014). An exploratory study using inexpensive electroencephalography (EEG) to understand flow experience in computer-based instruction. *Information & Management*, *51*(7), 912-923.

Wazeema, T. M. F., & Kareema, M. I. F. (2017). Implication of multimedia audio-visual aids in the English language classroom. South Eastern University of Sri Lanka, University Park, Oluvil, Sri Lanka. 433-442.