7E LEARNING CYCLE MODEL IN TEACHING COMMUNITY DENTISTRY II

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ABSTRACT: *This quasi-experimental study aimed to determine the effect of 7E Learning Cycle Model as a strategy and approach in teaching Community Dentistry II. The respondents of this study were 80 sixth-year dental students in one of the private tertiary colleges in Iloilo City. Two intact Sections A and B were considered for the experiment. A toss coin was made to assign the experimental and control groups. A duly validated and reliability-tested 50-item multiple choice test measuring dentistry students' conceptual understanding of the coverage for the experimental period was utilized to gather data. Before the conduct of the intervention, both groups were pretested, which shows their level of performance in Community Dentistry II as "satisfactory" making them comparable. After the intervention, findings revealed that both groups have a "very satisfactory" level of performance. In addition, the experimental group has a higher mean score compared to the control group, in which it can be claimed that the 7E Learning Cycle Model increases students' performance in Community Dentistry II more compared to student's performance in the traditional method of teaching. Several inferential statistics were utilized to determine the significant differences in students' performance. The findings reveal a substantial difference in the pretest-posttest scores of students under the 7E Learning Cycle Model and the traditional method. There is a significant difference in the mean gain in students' performance, with the experimental group having a much higher mean gain. The 7E Learning Cycle Model has significantly contributed to students' Community Dentistry II performance. Teachers are recommended to include this teaching model as one way of developing student's conceptual understanding and increasing their level of performance in the course.*

Keywords: 7E learning cycle model, dental students, community dentistry

INTRODUCTION

Recently, the educational system has greatly evolved in terms of teaching and learning strategies. The 7E Learning Cycle Model is one of the innovations introduced to improve teaching. It involves several steps in the learning process to be incorporated into classroom activities. The outcome is expected to enhance teaching methods and increase learning.

Teachers, instructors, and professors are compelled to perform many roles and discharge many duties that may be considered supplementary. At the centre of the roles and duties is the actual practice of teaching. The fundamental purpose of this teaching practice is to promote student learning. Learning may be described as a transformation in behaviors, attitudes, or competencies. Effective teachers develop student learning, and pertinent instructional methods have been extensively reported in much educational research pieces of literature.

Traditional teaching includes lecture and discussion. However, these teaching strategies are designed as teacher-centered. These days, pedagogy evolved into an activity-based or student-centered teaching strategy. In this manner, learners are required to do more than just listening and studying. They are now committed to creating and storing knowledge for themselves. In a real collaborative environment, both the students and the teacher are learners. By recognizing the context of others, educators can teach in a more transformative way. A learning environment needs to be flexible and adaptable to promptly respond to the needs of the participants within it. This principle is encompassed in the philosophy of constructivism.

To help students learn better, many studies have been done on teaching methods [1–6], student preferences and readiness [7, 8], student motivation and attitude [9–12], teachers' skills, competencies, and challenges [13–16], assessment techniques and tools [17–20], and other factors [21–27]. However, not many studies have looked into what dental students think about teaching community dentistry using the 7E learning cycle model.

Notably , this specific research has evaluated the effect of 7E learning strategy .The research was to examine whether the students' mathematical understanding ability who learned using Learning Cycle 7E Model was better than those who learned using conventional learning. The population of this research was students in 7th grade, which consisted of 7A, 7B, and 7C in SMP PGRI 400 Tangerang, Indonesia. Findings reveal a positive effect of the learning cycle on students' achievement [28].

Given the above, the researcher felt that maybe something could be done with her classes in Community Dentistry – so that learning would be improved, to the students' and the teacher's satisfaction.

It is enhanced in studies conducted that the 7E learning cycle model is significantly effective, enabling students to actively participate in lessons and urging them to conduct research, promoting exchange of ideas and communication, and improving problem-solving skills [29]. This study aimed to enlighten educators, policymakers, and educational stakeholders in their efforts to promote effective teaching and learning practices that advance student success and commitment in educational settings. Also, the benefits of the 7E model of learning is an effective instructional approach for it uses the constructivist approach to facilitate teaching and learning [30].

7E consists of the following phases: elicitation, engagement, exploration, explanation, elaboration, expansion and extension. Each phase has a specific function and contributes to the teacher's coherent instruction and the learner's formulation of a better understanding of scientific and

technological knowledge, attitudes, and skills. The explanation for each phase is the following: Elicitation, this stage aims at motivating learners and enhancing their curiosity about learning the concept.

The teacher motivates students creates the element of curiosity among them and encourages prediction. Engagement: this stage aims at satisfying the learners' curiosity by providing them with necessary experiences and aid. Exploration: this stage aims at explaining the concept as well as the terms, the teacher directs the students towards the concept construction and identifies it cooperatively by emphasizing certain sides of the activities that they practised in the previous stage. Explanation, also called the application stage, aims at the discovery of new applications for the concept, in this stage, learners use their acquired experiences about the concept and apply them to new situations and problems to expand their comprehension. Elaboration: This stage aims at clarifying the concepts presented, the teacher helps students recognize the relationship of other concepts being presented. Expansion, this stage aims at exchanging experiences and ideas, or changing them, where the teacher encourages the students' cooperation. In extension, the teacher in this stage evaluates the students' learning of the concept and provides them with suitable feedback [31].

Studying the Relationship of the 7E Learning Cycle Model of Inquiry-Based Instruction on Student Science Achievement. Understanding scientific concepts is becoming increasingly difficult for young students, particularly in primary schools. The difficulty stems from the science teachers' teaching methods. Teachers typically use the traditional teaching approach, known as lecturing, due to its ease of use and a lack of knowledge of alternative teaching approaches. This study aimed to compare the 7E learning cycle model to the traditional lecture method [32].

Probably, if lessons in Community Dentistry can be taught using this strategy, this can spell the difference in the student's performance.

Although there were studies that have been made regarding 7E learning cycle, exploring the learning achievements, involving science process skills, it appears that no studies were mentioned yet using the application of 7E learning in Community Dentistry. This particularly, has inspired the researcher to see if such teaching strategy would be applicable in the field of Community Dentistry.

Such pedagogical strategies should, in the end, motivate these students to rethink their options regarding their academic performance. The 7E learning model should awaken curiosity, help change negative attitudes and raise levels of abilities along the higher order thinking skills.

1. MATERIALS AND METHODS

The study was conducted at Iloilo Doctors' College - College of Dentistry, where the researcher is currently a faculty handling the subject Community Dentistry II. The school is located at Timawa Avenue, Molo, Iloilo City. The researcher sought approval from the IERC to conduct the study.

The researcher included the following topics in the preparations of the traditional lesson plans and Pedagogical Plan Using the 7E Learning Cycle Model: Level of Disease Prevention, Administration of Fluoride, Pit and Fissure Sealants, Glass Ionomer Restorative Materials Healthcare Delivery Systems, Atraumatic Restorative Treatment, Plaque Control, and Oral Health and Nutrition.

A researcher gathered a 50-item self-made questionnaire to collect data and ensure comprehensive coverage of the student's conceptual understanding of the topics under Community Dentistry II. The table of specifications containing the content, outline, learning competencies, and the number of items, along with the distribution of the questions, was submitted to the experts.

The respondents of the pilot test were 4th-year dental students of the same college who had already finished the subject and were not participants in the experiment.

A total of 80 sixth-year students of Iloilo Doctors' College, who are enrolled in Community Dentistry II on the first semester of 2017- 2018 formed the sample. 40 students in one group were taught with the use of the 7E learning cycle. The second group (40 students) studied the same content using the traditional method.

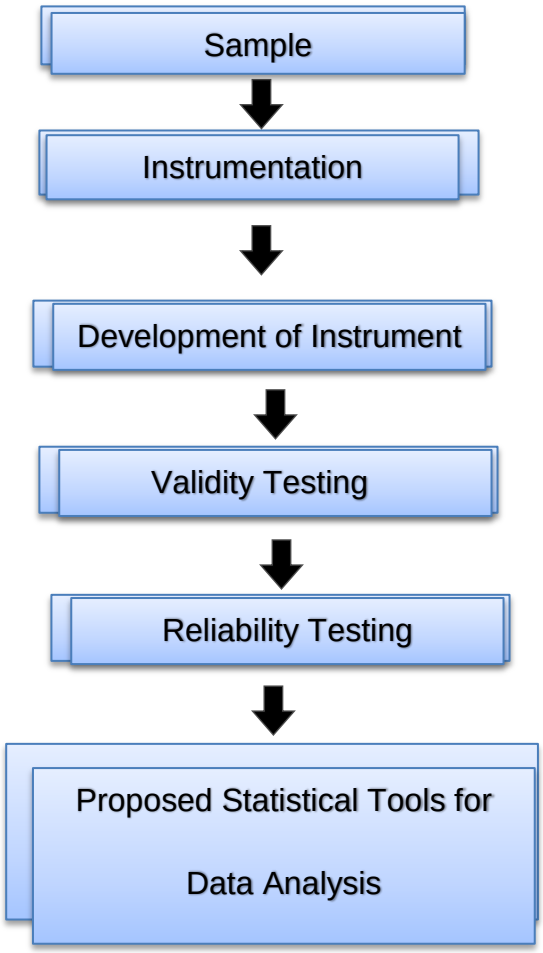
The gathered data were processed using the Statistical Packages for the Social Sciences (SPSS) Software.

Table 1; A Five-point scale in Determining the Level of Students' Performance in the 50-item Conceptual Understanding *Test*

Scale	Descriptive Rating	Description
40.00 – 50.00	Outstanding	The group answered correctly 80% to 100% of the items.
30.00 – 39.00	Very Satisfactory	The group answered correctly 60% but less than 80% of the items.
20.00 – 29.00	Satisfactory	The group answered correctly 40% but less than 60% of the items.
10.00 – 19.00	Fairly	The group answered correctly Satisfactory 20% but less than 40% of the items.
0.00 – 9.00	Poor	The group answered correctly below 20% of it

The gathered data were treated using descriptive statistics such as the mean, standard deviation, and t-test for dependent and independent samples.

The result was then submitted to the statistician for a reliability test to measure the constancy of the conceptual test in order to achieve the purpose of this study.



Flow Chart of Research Procedure

2. RESULTS AND DISCUSSIONS

Table 2. Level of Performance of the Students after 7E and Traditional Strategy

Groups	Posttest			
	n	SD	Mean	Description
Experimental	40	3.21	36.23	Very Satisfactory
Traditional	40	2.02	31.63	Very Satisfactory

Legend: 0.00-9.00(Poor); 10-19.00 (Fairly Satisfactory);20.00-29.00(Satisfactory); 30.00-39.00 (Very satisfactory); 40.00-50.00 (Outstanding)

Descriptive Data Analyses

The descriptive data analyses made use of the mean and standard deviation to describe the level of academic performance of the students before and after the 7E strategy and the traditional strategy.

Level of Performance of the Students before the 7E and the Traditional Way of Teaching. In determining the level of performance of the students before the experiment, the mean and the standard deviation were used with the descriptive rating provided. It can be seen in Table 2 that the level of performance of the students before 7E was "satisfactory" (M = 25.18, SD = 3.89). Regarding the same table, the level of performance of the students before having the traditional strategy was

"satisfactory" (M = 22.58, SD = 2.83). The results indicate that the students. It is safe as well to say that both groups of students were performing at about the same level of performance.

Table 3. Level of Performance of the Students after 7E and Traditional Strategy

Groups	Pretest Mean	Posttest Mean	Mean Gain
7E	25.18	36.23	11.05
Traditional	22.58	31.63	9.05

Legend: 0.00-9.99 (Poor); 10-19.99 (Fairly Satisfactory);20.00-29.99 (Satisfactory); 30.00-39.99 (Very satisfactory); 40.00-50.00 (Outstanding)

Level of Performance of the Students after the 7E and the Traditional Way of Teaching.

In determining the level of performance of the students after the experiment, the mean and the standard deviation were also used with the descriptive rating provided. It can be seen in Table 3 that the level of performance in the experimental group was "very satisfactory" (M = 36.23, SD = 3.21). Considering the same table it can be seen that the level of performance of the students in the control group was "very satisfactory" (*M* = 31.63, *SD* = 2.02). The results show that the level of performance of the students as revealed by their mean scores after being exposed to 7E is higher than the students in the traditional group. It can also be stated that the learners having 7E outperformed the students having the traditional way of teaching. Moreover, the students' performance in the post-test is very satisfactory which means that they were able to answer 30 to 40 of the items correctly or more or less 60% to 80% correct answers. Both group's mean scores met the 75 percent required mastery of all learning competencies for the lesson's coverage and they all showed a substantial improvement in the post-test scores in comparison to their pre-test scores.

The same results were revealed by the study using the 7E learning cycle model among immediate and delayed achievement and retention among preparatory year students enrolled at a university in Saudi Arabia. Results showed that the 7E learning cycle was an effective teaching strategy and had a positive longitudinal effect on retention with the 35 subjects of the first group. The traditional method did not have a similar effect on the 38 that comprised the 2nd group [33].

Table 4. Paired t-test results on the Significant Difference in the pretest and posttest scores of the Experimental Group

Category	n	Mean	t	df	p-value
Pretest Scores	40	25.1750	-15.709**	39	.000
Posttest Scores	40	36.2250			

**highly significant, $p < 0.01$

Mean Gain Students' Performance after 7E and Traditional Strategy.

The mean gain after 7E refers to the differences in the average scores of the students in their pretest and posttest. It can be seen in Table 4 that the mean students' performance after 7E indicates a positive mean gain therefore students scored higher in their mean posttest scores than in their mean pretest scores (M = 11.05). Looking at the same table, it can be seen that the mean gain in students' performance after the traditional way of teaching indicates also a positive mean gain which shows an increase in the student's mean scores from the pretest to the posttest (M = 9.05). Based on the results, those students under 7E have a higher mean gain (M = 11.05) compared to students under the traditional strategy (M = 9.05). The results also show that after the intervention, students who had 7E as a strategy increased more in their performance compared to students who were not exposed to 7E.

Inferential Data Analyses

The inferential data analyses made use of paired samples t-test and independent samples t-test. The paired sample t-test was used to determine if there was a significant difference in the level of performance of each group before and after the experiment. The independent samples t-test is used to determine the significant difference in the level of performance of the experimental and control groups before and after the experiment.

Table 5. Paired t-test results on the Significant Difference in the pretest and posttest scores of the Experimental Group

Category	n	Mean	t	df	p-value
Pretest Scores	40	25.1750	-15.709**	39	.000
Posttest Scores	40	36.2250			

**highly significant, $p < 0.01$

Differences in Students' Performance before and after the Experiment. A paired samples t-test was conducted to determine the effect of having 7E as a strategy in teaching Dentistry. The results indicate that there is a difference in the level of performance before the exposure and after the exposure to the 7E Learning cycle model from "satisfactory" (M = 25.18, SD = 3.89) to "very satisfactory" (M = 36.23, SD = 3.21), showing a highly significant difference in the paired sample t-test result [t(39) = -15.709, p = 0.000] at 0.05 level of significance.

Table 6. t-Test results on the Significant Difference in the pretest and posttest scores of the Traditional Group

Category	n	Mean	t	df	p-value
Pretest Scores	40	22.5750	-17.361**	39	.000
Posttest Scores	40	31.6250			

**highly significant, $p < 0.01$

Differences in Students' Performance before and after the Traditional Learning Strategy. A paired samples t-test was also used to determine the effect of having the usual teaching strategy on students' conceptual understanding in Dentistry. The results also indicate a significant difference in the level of performance before and after the traditional strategy from "satisfactory" (M = 22.58, SD = 2.83) to "very satisfactory" (M = 31.63, SD = 2.02), showing a highly significant difference in the paired sample t-test result [t(39) = -17.361, p = 0.000] at 0.05 level of significance. Based on the results, traditional teaching strategy contributes significantly to students' performance in Dentistry subjects. This indicates that the traditional methods still contribute to students' conceptual understanding. It can be inferred based on the results that the traditional method of teaching as well as 7E involves processes and products that both boost students' achievement.

Similarly, a study in Turkey showed a positive effect of the 7E learning cycle model on students' conceptual learning, self–efficacy, perceptions and attitudes but not on their comprehension of Physics in computer assisted instruction. [34].

Likewise, a meta-analysis study on the effect of 7E learning cycle model on learning in science teaching was conducted by Balta & Sarac, in two universities in Turkey. The result of the investigation was positive for increasing student achievement in science [35].

Table 7. t-Test results on the Significant Difference in the pretest scores between the Experimental and Control Group

Category	n	Mean	t	df	p-value
Experimental	40	25.1750	3.60	78	.000
Traditional	40	22.5750			

**highly significant, $p < 0.01$

Differences in Students' Level of Conceptual Understanding in Dentistry Before 7E Learning Cycle Method and Traditional Method. An independent sample t-test was utilized to determine the student's performance in the 50-item conceptual understanding test before the conduct of the study. The result indicates that there is a highly significant difference in the student's level of performance before 7E and the traditional method [t(39) = 3.60, p = 0.001] at 0.05 level of significance. The level of performance is both "satisfactory" (M = 25.18, SD = 3.89) for the experimental group and "satisfactory" (M = 22.58, SD = 2.83) for the control group with the experimental group already higher in mean score because both are in-tacked sections with the experimental group being Section 1 with higher academic standing.

Table 8. t-Test results on the Significant Difference in the post-test scores between the Experimental and Control Group

Category	n	Mean	t	df	p-value
Experimental	40	36.2250	7.675	78	.000
Traditional	40	31.6250			

**highly significant, $p < 0.01$

Table 9. t-Test results on the Significant Difference in the pretest and posttest scores of the Traditional Group

Category	n	Mean	t	p-value
7E	40	11.05	2.284*	0.025
Traditional	40	9.05		

*$p > .05$.

Differences in Students' Performance in Dentistry Subject after 7E Learning Cycle Model and Traditional Method. An independent t-test was conducted to determine the students' conceptual understanding of Dentistry after the conduct of the study. The results indicate that there is a highly significant difference in the student's level of performance after 7E and the traditional method. The level of performance are both "very satisfactory" (M = 36.23, SD = 3.21) for the experimental group and control group, "very satisfactory" (M = 31.63, SD = 2.02), thereby showing a highly significant result in the independent t-test [t(39) = 7.675, p = 0.000] at 0.05 level of significance. Despite the highly significant result, students after exposure to the 7E learning cycle model have higher mean performance scores compared to those exposed to the traditional method.

In connection, results match the result above which shows that students in Thailand gained more analytical thinking, science learning achievement and attitude towards chemistry learning compared to traditional teaching strategies [36].

Although both are 'very satisfactory 'however t-test results proved that there is a significant difference with 7E having a much higher mean gain value. It is shown in the previous table that given the scale for a 'very satisfactory' interpretation, the 7E mean gain is much closer to the upper value while that of the traditional method's mean gain is nearer the lower value of the interval making the gap between two mean gains significantly different.

3. CONCLUSIONS AND RECOMMENDATION:

The conclusion drawn based on the results of the study is that the 7E learning cycle model improves students' performance in Community Dentistry II. Based on the findings and conclusions of the study, the following recommendations are advanced:

For the Students. The 7E learning cycle model contributes to an increase in the student's performance in Community Dentistry II, thus the researcher recommends that students must be exposed to this learning model for their conceptual understanding of the subject to be enhanced.

For Dentistry Teachers. Teachers must be encouraged to teach using the 7E learning cycle model so that more skills of learning are activated among Dentistry students. With the changes in the way teachers teach, more engaging and constructivists-based teaching strategies are encouraged for teachers to explore. This could be a good help in increasing students' interest in the course as well as increasing their chances of passing the Dentistry board examination.

For the Commission of Higher Education (CHED). As planners and implementers of the curriculum, the said authorities can organize training and workshops for Dentistry teachers on how to effectively execute the 7E Learning Cycle Model. This can equip Dentistry teachers with more constructivist methods of teaching that can be added to their repertoire of teaching methods making their teaching more interesting, exciting and engaging for their students.

For Other Researchers. It is suggested that future researchers may conduct similar studies to determine the effect of the 7E learning cycle model on two equated groups of Dentistry students. Moreover, similar studies can be conducted considering variables like other subjects aside from Community Dentistry II, different subject matter, time duration of the intervention, schedule of classes, and students' course level. Also, researchers may conduct a similar study focusing on students' level of confidence in clinical performance. Interested researchers may also conduct qualitative studies to further verify and explain the results of this study.

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4. REFERENCES:

[1] Gayeta, N. E. & Caballes, D. G. (2017). Measuring conceptual change on stoichiometry using mental models and ill-structured problems in a flipped classroom environment. *Asia Pacific Journal of Multidisciplinary Research*, *5*(2), 104-113.

[2] Guiao, C. D., & Caballes, D. G (2023). Teachers' perception on integrating historical vignettes in teaching science concepts. *International Journal of Innovative Science and Research Technology, 8*(1), 1985-1990.

[3] Narca, M. L, & Caballes, D. G. (2021). Exploring students' mental constructs on evolution towards proposed pedagogical interventions. *International Journal of Science and Research, 10*(8), 857-862.

[4] Caballes, D. G., Panol, R. F., Vasquez, A. G., & Valdez, M. R. (2022). Offline modular learning in a public school system: its perceived effects on school operations. *International Journal of Research in Engineering and Science, 10*(3), 21-26.

[5] Ucang, J. & Tan, D.A. (2013). Students' Beliefs and Mathematics Performance in a Process-Oriented Guided-

Inquiry Learning (POGIL) Environment. *CMU Journal of Science*. 17 (2013), 141-157.

[6] Florungco, J. K. E. & Caballes, D. G. (2021). A narrative study of science teaching methods and techniques in the new normal. *International Journal of Asian Education, 2*(3), 296-303.

[7] Ong, A. K. S., Prasetyo, Y. T., Chuenyindeedobla, T., Young, M. N., Doma, B. T., Caballes, D. G., Centeno, R. S., Morfe, A. S., & Bautista,C. S. (2022). Preference analysis on the online learning attributes among senior high school students during the COVID-19 pandemic: a conjoint analysis approach. *Evaluation and Program Planning, 102100*.

[8] Caballes, D. G., & Tabang, M. P. (2022). Grade 10 students' online learning readiness and e-learning engagement in a science high school during pandemic. *Journal of Humanities and Education Development, 4*(3), 237-241.

[9] Narca, M. L., & Caballes, D. G. (2021). Learning motivation: strategies to increase students' engagement in online learning at San Sebastian College-Recoletos, Manila. *International Journal of Asian Education, 2*(4), 573-580.

[10] Aguanta, E. & Tan, D.A. (2018). Effects of Dyad Cooperative Learning Strategy on Mathematics Performance and Attitude of Students Towards Mathematics, *International Journal of English and Education*, 7(3), 303-313.

[11] Ciubal-Fulgencio, N., & Tan, D. (2018). Effects of mathematics communication strategies on attitude and performance of grade 8 students, *Asian Academic Research Journal of Multi-disciplinary*, Volume 5, Issue 2, 44-53, February 2018.

[12] Cordova, C., & Tan, DA. (2018). Mathematics Proficiency, Attitude and Performance of Grade 9 Students in Private High School in Bukidnon, Philippines‖. *Asian Academic Research Journal of Social Sciences and Humanities*, vol. 5, issue 2, pp. 103-116, February 2018.

[13] Caballes, D. G., & Tiria, R. A. (2020). The digital skills of secondary school teachers in Manila. *CiiT International Journal of Software Engineering and Technology*, *12*(3), 33-37.

[14] Doblada, J. C. L. & Caballes, D. G., (2021). Relationship of teachers' technology skills and selected profile: basis for redesigning training for online distance learning modality. *Instabright International Journal of Multidisciplinary Research, 3*(1), 17-22.

[15] Caballes, D. G., Panol, R. F., Vasquez, A. G., & Valdez, M. R. (2021). Competency level of science teachers in teaching evolution: basis for training design. *Global Journal of Advanced Research, 8*(8), 235-243.

[16] Herrera, M. B., & Caballes, D. G. (2022). Challenges of teachers amidst sustained global health crisis. Journal of Humanities and Education Development 4 (3), 142-149, *4*(3), 142-149.

[17] Cordova, C., Pagtulon-an, EA., & Tan, DA. (2018). No Assignment Policy: A Boon or A Bane?‖. *International Journal of English and Education*, 8(1), 144-160, January 2019.

[18] Cordova C., Tan D. and Ucang J. (2018). Take Home Assignment and Performance of Grade 11 Students. *International Journal of Scientific and Technology Researches*, 7(12), 57-61, December 2018.

[19] Pagtulon-an, E. & Tan D. (2018). Students' Mathematics Performance and Self-efficacy Beliefs in a Rich Assessment Tasks Environment. *Asian Academic Research Journal of Multidisciplinary*. 5(2), 54-64.

[20] Tan, D.A., Cordova, C.C., Saligumba, I.P.B., Segumpan, L.L.B. (2019). Development of Valid and Reliable Teacher-made Tests for Grade 10 Mathematics. *International Journal of English and Education*, 8(1), January 2019, 62-83.

[21] Jackaria, P. M., & Caballes, D. G. (2022). Equipping teachers to adapt: a look into teachers' professional development experiences in times of COVID-19 pandemic. *Journal of Humanities and Education Development, 4*(4), 18-22.

[22] Panol, R. F., Vasquez, A. G., Valdez, M. R., & Caballes, D. G., (2021). Parental involvement on students' completion of learning tasks in science. *International Journal of Scientific Research in Multidisciplinary Studies*, *7*(5), 1-7.

[23] Tan, D. A., & Balasico, C. L. (2018). Students' Academic Performance, Aptitude and Occupational Interest in the National Career Assessment Examination. *PUPIL: International Journal of Teaching, Education and Learning*, 2(3), 01-21.

[24] Tan, D.A. (2018). Mathematical Problem Solving Heuristics and Solution Strategies of Senior High School Students, *International Journal of English and Education*, 7(3), July 2018, 1-17.

[25] Duque, C. & Tan, D. (2018). Students' Mathematics Attitudes and Metacognitive Processes in Mathematical Problem Solving. *European Journal of Education Studies*, 4(11), 1-25.

[26] Balasico, C.L., & Tan, D.A., (2020). Predictors of Performance of Central Mindanao University Laboratory High School Students, *PEOPLE: International Journal of Social Sciences*, 6(2), 1-21.

[27] Caballes, D. G., & Sapad, R. P. (2022). Initiation of professional development program for science instructional leaders within the technological pedagogical content knowledge (TPACK) framework. *The Palawan Scientist, 14*(1), 75-83.

[28] Jaya, D. P., Sulistiawati, N., & Arifin, S. (2023). The impact of the 7E learning cycle model on students' capacity for Understanding mathematics. AIP Conference Proceedings.

[29] Iqbal, M., Noreen, Z., & Hayat, K. (2024). Impact of 7E Model on Students' Academic Achievement: A Comprehensive analysis in educational settings. Journal of Education and Social Studies, 5(1), 154–167.

[30] Rahman, S. & Chavhan, R. (2022). 7E model: An effective instructional approach for teaching learning. Epra International Journal of Multidisciplinary Research, 8(1).

[31] Sornsakda, S., Suksringarm, P. & Singseewo, A. (2009).

Effect of learning environmental education using 7E learning cycle with metacognitive techniques and teachers hand book approaches on learning achievement, integrated science process skills and critical thinking of Mathayomsuksa 5 students with different learning achievement. Pakistan Journal of Social Science, 6(5), 297-303.

[32] Gyampoh, A.O., Aidoo, B., Nyagblormase G.A., Kofi3, M. Amoako, S.K. (2020). Investigating the Effect of 7E Learning Cycle Model of Inquiry-Based Instruction on Students' Achievement in Science.

[33] Khashan, K. (2016). The Effectiveness of Using the 7E's Learning Cycle Strategy on the Immediate and Delayed \ Mathematics Achievement and the Longitudinal Impact of Learning among Preparatory Year Students at King Saud University (KSU). Journal of Education and sPractice, 7(36), 40–52.

[34] Kocaya, G., & Kocaya, S. (2010) Analysis of Turkish high-school physics-examination questions according to Bloom's taxonomy. Asia-Pacific Forum on Science Learning and Teaching, Volume 11, Issue 1, Article 9, p.1.

[35] Balta, N., & Sarac, H. (2016). The Effect of 7E Learning Cycle on Learning in Science Teaching: A Meta-\ Analysis Study. European Journal of Educational Research, 5, 61-72.

[36] Siribunnam, R., & Tayraukham, S. (2009b). Effects of 7E KWL and Conventional Instruction on Analytical Thinking,Learning Achievement and Attitudes toward Chemistry Learning. Journal of Social Sciences, 5(4), 279–282.