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Students' Engagement And Academic Achievement in Science Through Computer Simulations in A Collaborative Learning Environment

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Abstract

This study focused on the use of computer simulations as an instructional tool in a collaborative learning environment. It assessed the engagement and academic achievement in science of Grade 10 students in a collaborative learning environment at Central Mindanao University Laboratory High School. It aimed to: a) ascertain the level of students' engagement in science when exposed to CSCLE and those in non-CSCLE in terms of (i) cognitive, (ii) behavioral, (iii) emotional, and (iv) social engagement; (b) determine the level of the academic achievement of students when exposed to computer simulations in a collaborative learning environment (CSCLE) and those in non-CSCLE; c) find out the engagement of students in science when exposed to CSCLE and those in non-CSCLE and (d) compare the academic achievement of students when exposed to CSCLE and those in non-CSCLE. This research used quasi-experimental research design. Results were analyzed using independent t-test to examine if there is a significant difference in the students' engagement in science when exposed to CSCLE and those in non-CSCLE and Analysis of Covariance (ANCOVA) to investigate if there is a significant difference in the students' academic achievement in science when exposed to CSCLE and those in non-CSCLE. The results indicate that computer simulation in a collaborative learning environment serves as a dynamic tool in improving the progress of the learning environment by encouraging engagement, collaboration, participation and communication among students which strengthened their knowledge skills and increased their performance outcomes. The results exhibited students' engagement in the domains; cognitive, behavioral, emotional and social engagement with a high engagement level when exposed to CSCLE. Students' academic achievement when exposed to CSCLE was in average level on their posttest from a very low level on their pretest. Significant difference was also observed which indicates that there is a significant difference in the engagement level of students' when exposed to CSCLE and those in non-CSCLE. By the results shown, it is observed that as the engagement of the students rises, their academic achievement also progresses. With this, it is recommended to utilize computer simulation as an instructional tool in a collaborative learning environment.

Keywords: academic achievement, engagement, science, computer simulations, collaborative learning environment.

1. Introduction

Teaching in the twenty-first century has created a novel and engaging atmosphere for students' growth and development. Students have numerous challenges in science education because of this. Research has revealed a fundamental connection between student academic performance and access to resources. Insufficient resources may lead to diminished productivity among students. Students with insufficient instructional and learning resources performed worse than their counterparts in schools with appropriate resources (Sadera et al., 2020). The deficiency of classroom resources, sufficient textbooks, and the education of science educators are merely a few impediments in science instruction (Anderman & Sinatra, 2012).

The Department of Education said that local and international assessments conducted on December 3, 2019, under the Programme for International Student Assessment (PISA) indicated that the Philippines scored below the average of all participating nations (DepEd). Secretary Leonor Briones additionally remarked that the performance of Filipino children on the National Achievement Test (NAT) is generally subpar, especially in science, mathematics, and english (Year-End Report, 2019).

Nevertheless, substantial additional challenges emerged because of the COVID-19 pandemic, especially within the academic sector. UNESCO said that schools in more than one hundred countries had been closed as of June 2020. The method of physical learning has evolved since that time. In response to the problems of the educational landscape, schools globally have transitioned from in-person instruction to flexible learning (Ali, 2020). Teachers must be more innovative and possess the skills to modify instructional strategies to enhance students' academic performance and increase their involvement in science, considering these and other challenges.

Students can be introduced to scientific subjects in numerous ways, one of which is utilizing computer simulations as an instructional tool. This will include students in the educational process and stimulate their active participation in class. The integration of computer simulations has enhanced students' academic performance and attitudes (Hu et al., 2012). A review of the pertinent literature revealed that computer simulations positively influenced learners' development (Rutten et al., 2012).

Collaborative learning is a critical competency for 21st-century learners. Collaboration simulation enables several students to engage in collective problem-solving activities inside a shared environment (Chang et al., 2017), fostering innovation, idea exchange, and active participation in discussions (Laal, 2012).

Student engagement is associated with learner involvement and active participation in activities (Slavin, 2019). Science participation represents enjoyment and fervor in the discipline. Conversely, Hampden-Thompson and Bennett (2013) utilized motivation, enjoyment of science, and prospective pathways to deduce student engagement in science.

The primary objective of this research is to examine how computer simulations within a collaborative learning environment may enhance students' academic performance and enthusiasm in science. The findings of this study will provide a basis for curriculum change and development by curriculum designers, school administrators, and educators to address the global challenges of 21st-century scientific education.

2. Materials and Methods

The study utilized a quasi-experimental research design with two (2) intact sections of Grade 10 students. One class was exposed to CSCLE, the experimental group, and the other class was exposed to non-CSCLE, the control group.

The two sections covered the same topics (Plate Tectonics and Continental Drift; Earth’s Interior; Plate

Boundaries and Plate Movement; and Mountain Building) that will be discussed for five (6) weeks. Students in the experimental group were exposed to computer simulations in a collaborative learning environment (CSCLE), while the control group will be exposed to non-CSCLE.

The instrument used for students' academic achievement was a standardized test from Central Mindanao University Laboratory High School (CMULHS) Science Department. A one-hundred (100) item exam guided by a table of specifications (TOS) set by the Department of Education (DepEd) Curriculum Guide for K to 12 Grade 10 Science with Cronbach's alpha 0.82 covers the following topics: Plate Tectonics and Continental Drift, Earth's Interior, Mountain Building, Ocean Floor and Ocean Water and Ocean Life.

A one-hundred (100) item exam was in multiple-choice test type. Items were scored one (1) for every correct answer and zero (0) if otherwise. To measure the academic achievement of the students, CMULHS Revised Transmutation Table 2021 (Table 1) scale was used in interpreting the data.

A survey questionnaire adapted from Wang et al. (2016) with Cronbach's alpha in general engagement (0.93), cognitive engagement (0.75), behavioural engagement (0.82), emotional engagement (0.89), and social engagement (0.74) was used in gathering the data on students' engagement in science via CSCLE and non-CSCLE. The questionnaire consists of eight (8) Cognitive engagement questions, eight (8) behavioral engagement questions, ten (10) emotional engagement questions, and seven (7) social engagement questions. A reverse scoring procedure is done for negative statements.

3. Results

The mean of science students' engagement in the cognitive domain (Table 3) exposed in CSCLE was 4.28, which is interpreted as "highly engaged." The non-CSCLE group was 4.13, which is also interpreted as "highly engaged." In the behavioral domain (Table 4), the CSCLE group has a 4.07 mean interpreted as "highly engaged," and the non-CSCLE group was 3.99 interpreted as "highly engaged". In emotional engagement (Table 5), the CSCLE group has 4.31 mean and 4.05 for the non-CSCLE group. Lastly, in social engagement (Table 6), the CSCLE group has a 4.43 mean, and the non-CSCLE has a 4.08, both interpreted as "highly engaged".

In the pretest, students' academic achievement exposed in CSCLE was 31.13, which is interpreted as "low" academic achievement, while on their posttest was 68.03, which is interpreted as "moderate" achievement. The Non-CSCLE group has 48.26 on their pretest, which is interpreted as "low" academic achievement, while on their posttest was 62.87, which is interpreted as "moderate" achievement (Table 7).

Students' engagement level in science has a significant difference with a p-value of 0.006 ($p<0.050$), indicating a significant difference in the engagement level of CSCLE and non-CSCLE groups (Table 8). Therefore, the null hypothesis that there will be no significant difference between the engagement level of the students in science when exposed to CSCLE and Non-CSCLE has been rejected.

Students' academic achievement in science exposed to CSCLE and Non-CSCLE has a significant difference in their post-test scores (Table 9). Thus, the null hypothesis is rejected, which states that there is no significant difference between the students' post-test scores from both CSCLE and non-CSCLE groups. The CSCLE group has a weighted mean of 68.0263, and the non-CSCLE has 62.8684 on their posttest. Both results are classified as "moderate academic achievement". Even though both have the same descriptive rating, there is still a meaningful difference of 5.1579 in both groups; this means that students' academic achievement improved as they were exposed to CSCLE.

The Analysis of Covariance (ANCOVA) of the posttest results of both groups using the pretest as a cov

ariate is presented in Table 9. Based on the data, students, when exposed to CSCLE and non-CSCLE, obtained a mean of 68.03 (SD=7.02692) and 62.87 (SD=6.56020), respectively. The computed F-value between groups was 5.451 at a p-value of 0.02, indicating a highly significant difference. Thus, those students exposed to CSCLE performed better than those in non-CSCLE (Table 10).

4. Figures and Tables

Table 1: CMULHS Revised Transmutation Table 2021

Score	Percentage Score	Qualitative Interpretation
0-49	74% and below	Very Low
50-59	75% - 80%	Low
60-69	81% - 85%	Moderate/Average
70-79	86% - 90%	High
80-100	91% and above	Very High

Table 2: Engagement Survey Questionnaire adapted from Wang et al. (2016)

Rating	Scale	Descriptive Rating	Qualitative Interpretation
5	4.51 – 5.00	Strongly Agree	Very High Engagement (VHE)
4	3.51 – 4.50	Agree	High Engagement (HE)
3	2.51 – 3.50	Undecided	Moderate Engagement (ME)
2	1.51 – 2.50	Disagree	Low Engagement (LE)
1	1.00 – 1.50	Strongly Agree	Very Low Engagement (VLE)

Table 3: Students' Engagement Level in Science in Terms of Cognitive Engagement

Indicators	CSCLE		Non-CSCLE	
	Mean	Qualitative Interpretation	Mean	Qualitative Interpretation
I try to understand my mistakes when I get something wrong.	4.47	HE	4.47	HE
I think about different ways to answer an activ-ity.	4.45	HE	4.26	HE
I try to connect what I am learning to things I have learned before.	4.37	HE	4.31	HE
*When a lesson is hard, I only study the easy parts.	4.34	HE	4.13	HE
I go through the work for science class and make sure that it is right.	4.29	HE	4.52	THE
*I would instead be told the answer than have to do the work.	4.11	HE	3.78	HE
*I do just enough to get by.	4.11	HE	3.76	HE
*I do not think that hard when I am doing work for class.	4.08	HE	3.78	HE
WEIGHTED MEAN	4.28	HE	4.13	HE

*negative statement, scoring is reversed

Table 4: Students' Engagement Level in Science in Terms of Behavioral Engagement

Indicators	CYCLE		Non-CSCLE	
	Mean	Qualitative Interpretation	Mean	Qualitative Interpretation
I keep trying even if something is hard.	4.37	HE	4.15	HE
* If I do not understand, I give up right away.	4.37	HE	4.15	HE
I complete my homework on time.	4.16	HE	4.21	HE
I put effort into learning science.	4.13	HE	4.31	HE
* I do other things when I am supposed to be paying attention.	4.00	HE	4.00	HE
I stay focused.	3.97	HE	3.71	HE
* I do not participate in class.	3.95	HE	3.92	HE
I talk about science outside of class.	3.63	HE	3.50	ME
WEIGHTED MEAN	4.07	HE	3.99	HE

*negative statement, scoring is reversed

Table 5: Students' Engagement Level in Science in Terms of Emotional Engagement

Indicators	CYCLE		Non-CSCLE	
	Mean	Qualitative Interpretation	Mean	Qualitative Interpretation
* I do not care about learning science.	4.68	THE	4.60	THE
* I do not want to be in science class.	4.47	HE	4.28	HE
* I often feel down when I am in science class.	4.42	HE	4.13	HE
I look forward to science class.	4.16	HE	3.81	HE
I feel good when I am in science class.	4.11	HE	3.55	HE
* I often feel frustrated in science class.	3.89	HE	3.60	HE
WEIGHTED MEAN	4.31	HE	4.05	HE

*negative statement, scoring is reversed

Table 6: Students' Engagement Level in Science in Terms of Social Engagement

Indicators	CYCLE		Non-CSCLE	
	Mean	Qualitative Interpreta-tion	Mean	Qualitative Interpreta-tion
* I do not care about other people's ideas.	4.63	THE	4.10	HE
* I do not like working with classmates.	4.63	THE	3.94	HE
* When working with others, I do not share ideas.	4.61	THE	4.38	HE
I try to understand other people's ideas in science class.	4.39	HE	4.36	HE

I try to work with others who can help me in science.	4.34	HE	4.15	HE
I try to help others who are struggling in science.	4.24	HE	3.94	HE
I build on others' ideas.	4.21	HE	3.68	HE
WEIGHTED MEAN	4.43	HE	4.08	HE

*negative statement, scoring is reversed

Table 7: Students' academic achievement in science in terms of pretest

	CSCLE n=38		Non-CSCLE n=38		
Grade Scale	N	%	N	%	QI
80-100	0	0	0	0	Very High
70-79	0	0	0	0	High
60-69	0	0	2	5.26	Average
50-59	3	7.89	17	44.74	Low
0-49	35	92.11	19	50.0	Very Low
TOTAL	38	100	38	100	
Weighted Mean	31.13 (Very Low)		48.26 (Very Low)		

Table 8: Independent T-test of Students' Engagement Level

	Group	N	Mean	Std. Deviation	Std. Error Mean
Engagement	Experimental	38	4.27	.33393	.05417
	Control	38	4.05	.34498	.05596

	Group	t	df	Sig. (2-tailed)
Engagement	Equal variances assumed	2.816	74	0.006**
	Equal variances not assumed	2.816	73.922	0.006**

*Significant at p<0.05***

Table 9: Students' Academic Achievement in Science in terms of Posttest

	CSCLE n=38		Non-CSCLE n=38		
Grade Scale	N	%	N	%	QI
80-100	0	0	0	0	Very High
70-79	14	36.84	3	7.89	High
60-69	19	50.0	20	52.63	Average
50-59	4	10.53	14	36.84	Low
0-49	1	2.63	1	2.63	Very Low
TOTAL	38	100	38	100	
Overall Mean	68.03		62.87		

	(Average)	(Average)	

Table 10: . Analysis of covariance (ANCOVA) of students' academic achievement when exposed to CSCLE and those in non-CSCLE

Group	N	Mean	SD
CSCLE	38	68.0263	7.02692
Non-CSCLE	38	62.8684	6.56020
Total	76	65.4474	7.23398

Source	Sum of Squares	df	Mean Square	F	Sig.
Group	252.740	1	252.740	5.451	.02**
Pretest (Covariate)	34.854	1	34.854	.752	.389ns
Error	3384.462	73	46.362		
Total	329460.000	75			

*Significant at p<0.05** ns = not significant*

5. Discussions

The students' engagement level in science in terms of cognitive engagement, students exposed to CSCLE are enthusiastic and very competitive in learning new concepts in science. This implies that students exposed to CSCLE positively improved their strategies and motivation in learning science, which are uttered by high engagement. Furthermore, students in both groups tried their best to answer the activities incorrectly and connect what they've learned previously to the current discussions. However, part of them still wants to be told the answer instead of doing the work.

Behavioral engagement of students in CSCLE and non-CSCLE, students participated in the activities, and there was an effort to perform a given task. This implies that students in the CSCLE group tried their best to understand the discussion, put effort into learning the subject, and complete their homework on time. Furthermore, students from both groups are motivated to participate in class, but they do not talk about science lessons after classes. The result connected to the study of Kinderman (1993) cited by Nguyen et al. (2016), wherein students with high engagement who group together have been associated with increasing their behavioral engagement and interaction during classes. When exposed to non-CSCLE, students have a moderate behavioral engagement in the indicator "I talk about science outside of class", which means that the non-CSCLE group has minimal effort compared to the CSCLE group in being attentive and in participating in class. Furthermore, students in the CSCLE group are more engaged productively when using computer simulations. They have been seen to be more effective in enhancing students' achievement with the provision of the study of Cunha et al. (2014) and Nkemakolam et al. (2018).

The emotional engagement of students in CSCLE and non-CSCLE. Both groups were highly engaged towards the emotional engagement scale, which connotates students' involvement and enthusiasm in learning science. When they are engaged, they tend to participate and enjoy participation more. This implies that students in both groups pay more attention to learning science, enjoy being in class, and are motivated during discussions. However, students, when exposed to non-CSCLE, sometimes feel frustrated with the subject. One factor for this frustration is the lack of supplementary simulations, and the discussion

is purely teacher-centered. Moreover, when exposed to CSCLE, students are way more emotionally engaged than those in non-CSCLE.

The students in the CSCLE group had an overall mean of highly engaged, while those in non-CSCLE also had an overall mean of highly engaged. With this, both groups were highly engaged towards the social engagement scale.

Students in the CSCLE group are more socially engaged since social interactions with their peers while learning with the supplement of computer simulations. Moreover, despite the social interactions, some of them are still not fully involved in academic and class-based activities and their presence of positive behavior. These findings are similar to the descriptive results of Abrami et al. (2011), which states that student-to-content interaction can occur while watching instructional videos, interacting with multimedia or simulations, and searching for information.

Students pretest scores implies that students in the CSCLE group had little to no background knowledge about the subject since most showed very low scores in their pretest. However, in the non-CSCLE group, half of them have more background knowledge regarding the subject.

As time progressed on the implementation of the CSCLE, students, when exposed to CSCLE, improved their academic achievement with the aid of computer simulations and when they worked in groups. With the revealed outcomes, the CSCLE group has a higher overall mean compared to those in the non-CSCLE group. In addition, the overall students' academic achievement in both groups increased.

6. Conclusions

The level of students' engagement in science in the following domains; cognitive, behavioral, emotional, and social domains in the CSCLE group were "highly engaged".

The student's academic achievement in their posttest in CSCLE was higher with a 5.15 meaningful difference than those exposed in non-CSCLE.

There is a significant difference between students' science engagement when exposed to CSCLE and non-CSCLE, rejecting the null hypothesis. The four (4) different engagement subscales played a significant role in the students' learning outcomes.

A significant difference exists in students' academic achievement when exposed to CSCLE and non-CSCLE, rejecting the null hypothesis. Hence, computer simulations positively impact students' learning process, which results in higher scores in their posttest.

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