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Game-based learning on students' motivation and academic achievement in science 9

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Abstract
Game-based learning is the attainment of educational objectives through games. This study investigated the effects of game-based learning on students' motivation and academic achievement in science 9 at Valencia National High School, Valencia City, Bukidnon. It utilized a quasi-experimental research design involving two groups exposed to non-game-based learning and game-based learning. The instrument used were both academic and non-academic assessment. The statistical techniques employed were descriptive statistics and Analysis of Covariance (ANCOVA). Results of the study revealed that after the exposure to GBL students obtained "Satisfactory," while non-GBL obtained a "Did Not Meet Expectation" result, indicating an improved academic achievement after the intervention. Both groups exhibited an overall mean that indicates "moderately motivated." Further, there was a significant difference in the students' academic achievement and motivation between groups.

Keywords: game-based learning, motivation, and academic achievement

Introduction

The rapid pace of scientific progress makes it imperative that students in the Philippines have a firm grounding in science and technology. Learners are confronted with science education issues, including their performance and interest in learning science. Malipot (2019) [14] reported that Philippine education was under scrutiny in 2019 after local and international assessments showed Filipino students' poor performance. The Philippines ranked second from the bottom in PISA 2018 and last in TIMSS 2019. In addition, VNHS students performed poorly in Science based on heir (NAT) mean percentage score in the previous years (Redoble, 2020) [18].

Some problems linked with the poor academic achievement of the students are lack of interest and motivation of learners (Rogayan & Bautista, 2019) [19]. Studies revealed that motivation drives and directs behavior toward success. Steinmayr *et al*. (2019) [22] stressed that success in school is often attributed to a students' level of motivation because it fuels efforts and guides actions toward their academic goals. GBL is designed to balance theoretical content and to learn through games. Even though game-based learning is widespread, little is known about what motivates a child in a way that can directly affect how well they do in school.

Methodology

This study utilized the quasi-experimental research design involving pretest-posttest to determine the effects of game-based learning on the motivation and academic achievement of Grade 9 science students' in Valencia National High School, Valencia City, Bukidnon. Two intact Grade 9 classes from the first quarter of 2022-2023 participated in the study. One group used GBL (experimental) integrating Kahoot and Edpuzzle, while the other used non-GBL (control group). Both groups utilized the 7E learning cycle. This study used academic assessment that consist of fifty (50) item multiple-choice exam and non-academic assessment that consist of twenty (20) item motivation statements adapted from Wang and Liou (2017). Both instruments were content validated by three science experts, pilot tested, and showed reliability of 0.78 (academic assessment) and 0.809 (non-academic assessment). The participants were given an orientation and accomplished the informed consent prior to the study. Statistical tools that were used includes descriptive statistics and ANCOVA.

Results and discussion

This presents the interpretation and analysis of data gathered following the order of the specified problems of this study.

Table 1: Summary of Students' Motivation Towards Science

Motivation indicators	GBL				Non-GBL			
	Pretest		Posttest		Pretest		Posttest	
	MEAN	QI	MEAN	QI	MEAN	QI	MEAN	QI
Self-concept	2.58	MM	3.14	MM	2.58	MM	2.84	MM
Intrinsic value	3.21	MM	3.48	MM	3.14	MM	3.33	MM
Utility value	3.24	MM	3.53	HM	3.17	MM	3.28	MM
WEIGHTED MEAN	2.94	MM	3.34	MM	2.90	MM	3.10	MM

The results showed that both groups generally have the same level of motivation, indicating "moderately motivated." Even so, the GBL group has a remarkably high mean score across all three domains. The results are similar to Partovi and Razavi (2019) [17], that students exposed to GBL had increased their motivation toward science. The active participation of the students in class allows them to cultivate the importance of their learned concepts in their daily life and plans. Integrating Kahoot encourages students' active engagement in class and improves their learning motivation (Tsihouridis *et al*., 2018).

Table 2: Comparison of Students' Mean Scores in the Pretest and Posttest

Raw score	Mean Percentage Score	Non-GBL				GBL				Qualitative Interpretation
		Pretest		Posttest		Pretest		Posttest		
		N	%	N	%	N	%	N	%	
45.00-50.00	90-100	0	0	0	0	0	0	9	29.03	O
42.50-44.50	85-89	0	0	0	0	0	0	5	16.13	VS
40.00-42.00	80-84	0	0	2	6.45	0	0	7	22.58	S
37.50-39.50	75-79	0	0	3	9.68	0	0	1	3.23	FS
0-37.00	Below 75	31	100	26	83.87	31	100	9	29.03	DNME
	Total	31	100	31	100	31	100	31	100	
	Weighted Mean	x = 20.19 MPS = 40.39 (DNME)		x = 32 MPS = 64.90 (DNME)		x = 21.87 MPS = 43.74 (DNME)		x = 41.47 MPS= 82.93 (S)		

The low pretest scores across groups indicate that students entered the course with minimal background knowledge in Biology. The pretest results are similar with Cotamora (2019) when she reported that the students' pretest mean scores obtained an MPS below 75, which indicated "DNME"; presumed that students lacked of knowledge on the topics and thus failed to comprehend. Shirazi (2017) [21] emphasized that a lack of scientific understanding made the students less successful in scientific assessments resulting to poor grades. Binder (2019) [4] pointed out that prior knowledge is a good predictor of success in science classes.

These posttest results revealed that students exposed to GBL have improved their academic performance in Science; from a MPS indicating it "DNME" on their pretest, it had increased to "Satisfactory" performance of students. These findings are consistent with Arcagok (2021) [2] as reported that students exposed to a GBL class demonstrate superiorlearning performance compared to those in traditional lecture classes. Moreover, Hidayat *et al*. (2021) [10] reaveled that EdPuzzle has successfully improved students' participation, increased their academic achievement and motivation. While the use of Kahoot indeed increases students' motivation in learning and problem-solving (Murciano, 2020) [15] and improves learning skills (De Oliveira *et al*., 2019).

On the other hand, despite the increase of scores of the Non-GBL group, it was not sufficient to reach an average MPS above 75%; Hence, they remained in the "DNME" after the intervention. This suggests that integrating technological tools influences students' performance; technological aids are essential for promoting deeper learning and improved performance in the classroom. (Schindler *et al*. 2017) [20]

Table 3: Analysis of Covariance (ANCOVA) of Students' Motivation after Intervention between Classes Exposed to Non-GBL and GBL.

GROUP		N		MPS	SD
Non-GBL		31		3.10	.40
GBL		31		3.34	.29
Total		62		3.22	.36
Source	SS	Df	Mean Square	F-value	Sig.
Model	3.54[a]	2	1.77	22.89	000
Pre-test (covariate)	2.58	1	2.58	33.40	.000
Group	.800	1	.80	10.35	.002
Error	4.56	59	.08		
Total	8.10	61			

The results imply that intervention effectively promotes increased students' motivation toward science learning, and incorporating Game-based learning captures children's attention and motivates them to stretch their competence, skills, and knowledge. These are similar to those of (Ebrahimzadeh & Alavi, 2017) [8] as reported that the game-based learning context helps to shape a higher level of motivation of an individual; and entails learning and motivational outcomes. Students with higher inner motivation and a positive attitude toward GBL are more likely to have higher learning expectations and be more satisfied with their GBL experience. (Vlachopoulos & Makri, 2017). Further, the exposure of the GBL group on Kahoot enables active participation and interactive learning Holbrey (2020) [11]; it increases learners' desire for competition, goal achievement, and reflection, arouses students' interest in the lesson, and makes the lectures more entertaining. (Ismail *et al*., 2019). While exposure to EdPuzzle increased students' knowledge and motivated learners toward learning. Hence, increased student motivation due to exposure to GBL is correlated with improved academic performance in post-tests.

Table 4: Analysis of Covariance (ANCOVA) of Students' Post-test Scores

GROUP		N		MPS	SD
Non-Game-based learning		31		64.90	4.44
Game-based learning		31		82.93	4.59
Total		62		36.80	6.26
Source	1539.84[a]	D f	Mean Square	F-value	Sig.
Model	372.73	2	769.92	53.41	.000
Pre-test (covariate)	924.78	1	372.73	25.86	.000
Group	850.43	1	924.78	64.16	.000
Error	2390.27	59	14.41		
Total	1539.84[a]	61			

The results revealed that GBL group obtained a high mean score, it was due to students' exposure to Game-based learning. These findings are supported by Brezovsky (2019) and (Fokides, 2020), that game-based learning improves student learning and outcomes; enhances motivation more than the Non-GBL; provides experiential learning among students (Sutton & Jorge, 2020) [24]; and has been observed to aid in the comprehension of complex science concepts. Moreover, it is congruent with the results of Cheng and Su (2021) that the learning motivation of students has a significant impact on learning achievement, and the learning achievements of students with game-based learning are better than those who use traditional face-to-face teaching.

Moreover, the exposure of GBL students to EdPuzzle and Kahoot further enhanced their academic performance. These results are similar to Belmahdi's (2021) [3] notes that EdPuzzle can help promote higher metacognition because

learners have to pause, think, and answer questions regularly.; and increased their academic achievement (Sulak *et al.*, 2022) [23]. Kahoot was considered a practical and worthy pedagogical approach that obtained significantly more learning success as measured by students' performance which showed a positive impact on student's motivation to actively participate in class (Wichadee & Pattanapichet, 2018) [26]; increased motivation, improved classroom engagement, and enhanced learning experience (Alawadhi & Abu-Ayyash, 2021) [1]; were found to elicit positive student motivation for learning (Laremenko, 2017) [12].

Conclusions and recommendations

Based on the findings of the study, the following conclusions were drawn:

The students' motivation toward science learning for both groups under the non-GBL and GBL learning is "moderately motivated." The Intrinsic value obtained the highest mean for the Non-GBL, the utility value obtained the highest mean for GBL, and self-concept obtained the lowest in both groups. The student's academic performance in Non-GBL remained "DNME" after the intervention. GBL improved academic performance from "DNME" to "Satisfactory" for students. Thus, experimental GBL students outperformed non-GBL students (control). The study found that students' science motivation differed between GBL and non-GBL. Hence, the null hypothesis is rejected. The students' academic achievement indicated a significant difference between the two groups, thus rejecting the null hypothesis, indicating that GBL positively affected and increased the students' academic achievement. Therefore, the implementation of GBL in lien of conventional classroom instruction resulted in a notable rise in the level of motivation exhibited by students as well as an improvement in academic achievement.

The study's conclusions lead to the following are the recommendations:

1. Teachers may implement GBL in classroom instruction to support students' interest in learning science and promote increased motivation.
2. Curriculum makers, educators, and school administrators may conduct workshops on using game-based learning and other educational tools to address the learners' needs, improve academic achievement, and attain learning goals relevant to the present situation.
3. Educators and School Administrators may look for different scales to cater to other variables that would help students become more motivated in learning science.
4. Teachers may consider this strategy to address academic gaps while encouraging the development of interest and cognitive skills.

Lastly, for the future researchers may study pedagogy further to yield relevant data on its applications and uses. Teachers can use this method to provide students with a new learning environment in which exciting learning occurs.

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