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Gamifying Hyflex Pe: An Investigation of its effect on Health-Related Fitness and Learning Interest among Tertiary Students

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ABSTRACT: This study investigated the effects of two gamification approaches—content gamification and structural gamification—on health-related fitness and learning interest among sophomore students enrolled in a hyflex Physical Education class (PATHFIT 4). Using a quasi-experimental research design, the study involved two groups of college students from Laguna State Polytechnic University-San Pablo City Campus over a five-week intervention period. The Content Gamification group experienced gamified learning through game mechanics, dynamics, and aesthetics, while the Structural Gamification group was exposed to points, badges, and leaderboard systems. The findings revealed that anthropometric measurements remained unchanged for both groups. However, significant improvements were observed in health-related fitness components. The Structural Gamification approach demonstrated superior results in cardiovascular endurance, muscular strength, muscular endurance, and flexibility compared to the Content Gamification approach. The Content Gamification approach was most effective in developing muscle strength among the measured parameters. Both groups demonstrated highly significant improvements in learning interest across all three dimensions: feelings and re-engagement. Students progressed from "moderately interested" to "very highly interested" in all measured aspects. While the Structural Gamification group showed slightly larger improvements in learning interest, no statistically significant differences were found between the two groups in post-assessment learning interest scores. The study concludes that while both gamification approaches effectively enhance learning interest in physical education, structural gamification is significantly more effective for improving health-related fitness outcomes. These findings suggest that different gamification strategies may target distinct outcome domains with varying degrees of effectiveness, providing educators flexibility to choose gamification strategies based on their specific objectives and contexts.

KEYWORDS: Gamification, Hyflex, Physical Education, Learning Interest, Health-Related Fitness

I .INTRODUCTION

The Philippine educational landscape has undergone significant transformation in recent years, with technological and social factors reshaping the delivery of Physical Education (PE) instruction. This evolution has presented both opportunities and challenges for educators seeking to maintain student engagement and achieve learning outcomes in an increasingly digital environment.

During the transition from pandemic restrictions to the new normal, PE teachers in the Philippines encountered substantial obstacles in delivering effective instruction. These challenges included limited technological resources (Belleza et al., 2021), difficulties in adapting to innovative pedagogical strategies (Ibañez, 2022), and constraints in skill transfer due to mobility-restrictive measures (Monte & Bean, 2021). Such concerns persisted even as educational institutions adopted new modalities to accommodate changing learning environments.

The emergence of Hybrid Flexible (Hyflex) learning represents a pivotal shift in educational delivery, characterized by connectivism learning theory that maximizes technology utilization for meaningful teaching and learning. This modality integrates blended learning within a flexible course structure, enabling students to attend classes in-person, online, or through a combination of both approaches (National Education Association, 2021). While Hyflex learning offers unprecedented flexibility, it also presents unique challenges for physical education (PE) instruction, where physical activity and movement are fundamental components.

The importance of physical education extends beyond mere academic requirements, as highlighted by the Sustainable Development Goals (SDGs) 2030, particularly Goals 3, 4, and 9. Physical education plays a crucial role in promoting health-related fitness, encouraging physical activity participation, fostering sports engagement, cultivating healthy lifestyle habits, and enhancing overall student well-being. Research demonstrates that structured physical activities integrated into curricular programs support not only students' physical health and mental well-being (Rodriguez-Aylon et al., 2019) but also enhance academic performance (Mavilidi et al., 2020).

However, ensuring the quality and equity of physical education delivery in Hyflex environments has proven challenging across different countries and educational institutions (Mata & Marasigan, 2024). Despite technological integration and digital learning platforms, recent data from the World Health Organization (2022) indicates that most youth still fail to meet global standards for moderate-to-intense physical activity. The persistent problem of gender disparities in physical activity levels, with girls being less active than boys in the Philippines and globally (Dimarucot et al., 2024), underscores the need for innovative pedagogical strategies that can effectively engage all students.

A critical factor in successful PE instruction is maintaining student interest in learning—an enduring predisposition to reengage over time that encompasses both psychological attention states and inclinations toward specific topics or activities (Asher & Harackiewicz, 2024). Research by the EU Business School (2022) revealed concerning patterns in student attention spans during university lectures, with attention breaks occurring at 10–18-minute intervals initially, then increasing in frequency to every 3-4 minutes by session end. This evidence highlights the pressing need for motivational strategies that can sustain active participation throughout physical education (PE) classes.

Gamification has emerged as a promising strategy for addressing engagement challenges in Hyflex PE settings. Unlike game-based learning, which transforms learning activities into games, gamification involves integrating game elements—such as point systems, leaderboards, badges, rewards, and other game-related components—into the entire educational process to enhance motivation and learning engagement. This approach can be implemented through two primary methods: structural gamification, which employs game mechanics like points, badges, and leaderboards without altering learning content, and content gamification, which integrates game mechanics, dynamics, and aesthetics to create immersive learning experiences through challenges, storytelling, and feedback loops (Sanal, 2019).

The potential of gamification to address both engagement deficits and short attention spans in Hyflex learning environments makes it particularly relevant for contemporary physical education instruction. By incorporating motivational game elements into conventional Hyflex learning frameworks, educators can create more engaging and effective learning experiences that promote both health-related fitness outcomes and sustained student interest in physical education among tertiary students.

Despite growing interest in educational gamification, empirical evidence regarding its specific application in Philippine physical education (PE) classes, particularly within hybrid (Hyflex) learning environments, remains limited. This gap in research, combined with the pressing need to enhance the effectiveness of physical education (PE) instruction in new educational modalities, provides the foundation for investigating how different gamification approaches might impact both the physical and motivational outcomes of tertiary PE students.

II. METHODOLOGY

This study employed a quasi-experimental design with pretest-posttest groups to investigate the effects of two gamification approaches on health-related fitness and learning interest among tertiary students. The design was selected to establish causal relationships between gamification interventions and outcome variables while maintaining the integrity of existing classroom structures, which is essential in educational settings where random assignment is often impractical (Creswell, 2015).

Participants included 50 sophomore students from the College of Industrial Technology at Laguna State Polytechnic University-San Pablo City Campus, enrolled in PATHFIT 4 during the second semester of Academic Year 2024-2025. Using purposive total population sampling, students were divided into two groups: Content Gamification (n = 28) and Structural Gamification (n = 22). Both groups were heterogeneous in gender distribution and academic aptitude, with similar baseline characteristics to minimize confounding variables.

Health-related fitness was assessed using standardized protocols that measured five components: body composition (as indicated by BMI), cardiovascular endurance (as determined by the 3-minute step test), muscular strength (as demonstrated by push-ups), muscular endurance (as indicated by the plank hold), and flexibility (as measured by the sit-and-reach test). Learning interest was measured using an adapted instrument from Knekta, Rowland, and Corwin et al. (2020), assessing three dimensions: feelings, values, and re-engagement using a 4-point Likert scale.

The Content Gamification group experienced instruction through game mechanics, dynamics, and aesthetics (MDA), including game demonstrations, animated presentations, and narrative elements. The Structural Gamification group received points, badges, and leaderboard (PBL) systems with conventional instruction, featuring point systems, group rankings, and competitive elements. Both interventions were implemented over five weeks in a Hyflex modality combining face-to-face and online sessions.

Data collection occurred in three phases: pre-assessment (baseline measurements), intervention implementation (a 5-week period of gamified instruction), and post-assessment (outcome measurements). Statistical analysis included descriptive statistics, paired samples t-tests for within-group comparisons, and independent samples t-tests for between-group comparisons. All analyses used a p-value ≤ 0.05 significance level. The study received institutional approval and adhered to ethical guidelines, including obtaining informed consent and protecting confidentiality under the Data Privacy Act of 2012.

III. RESULTS AND DISCUSSION

Table 1. Profile of the Respondents in terms of Anthropometric Measures

Content Gamification Group	Range	Frequency	Percentage	Remarks
Height (m)	4.60 – 4.11	1	3.57 %	Short
	5.0 – 5.5	10	35.71 %	Medium
	5.6 – 5.11	17	60.72 %	Tall
Weight (kg)	40 – 65	21	75 %	Light
	66 – 85	7	25 %	Medium
	86 – 110	0	0 %	Heavy
BMI	< 18.5	6	21.43 %	Underweight
	18.5 – 24.9	18	64.29 %	Normal
	25.0 – 29.9	3	10.71 %	Overweight
	≥ 30	1	3.57 %	Obese
Structural Gamification Group	**Range**	**Frequency**	**Percentage**	**Remarks**
Height (m)	4.60 – 4.11	4	18.18 %	Short
	5.0 – 5.5	7	31.82 %	Medium
	5.6 – 5.11	11	50 %	Tall
Weight (kg)	40 – 65	14	63.64 %	Light
	66 – 85	6	27.27 %	Medium
	86 – 110	2	9.09 %	Heavy
BMI	< 18.5	2	9.09 %	Underweight
	18.5 – 24.9	17	77.27 %	Normal
	25.0 – 29.9	2	9.09 %	Overweight
	≥ 30	1	4.55 %	Obese

Table 1 shows the data for the anthropometric measurements of the two groups. The height was measured in meters, while the weight was measured in kilograms. BMI was identified by dividing the respondent's weight in kilograms by their height in meters squared. In the Content Gamification group, majority of the respondents were tall (60%) with a frequency of 17 out of 28 respondents, majority are light-weight (75%) with a frequency of 21, and in terms of BMI, majority were classified as normal (64.29%) with a frequency of 18. In the Structural Gamification group, most of the respondents were tall (50%) with a frequency of 11 out of 22 respondents, majority are light-weight (63.64%) with a frequency of 14, and most of the respondents were classified as normal (77.27%) as to their BMI with a frequency of 17.

In general, although the Content Gamification group has a slightly larger class size than the Structural Gamification group, the profiles of the two groups in terms of anthropometric measures were almost identical in terms of height, weight, and BMI. This means that the anthropometric measures of both groups were nearly identical, providing a good baseline for the intervention conducted and the comparison of their health-related performance assessment scores. Additionally, it was found that the anthropometric measurements of both groups remained unchanged when comparing the pre-assessment and post-assessment scores in height, weight, and Body Mass Index. This consistency is expected since these are relatively stable physical characteristics that typically don't change over short educational interventions.

Table 2. Performance of the Respondents (Content Gamification Group) Before and After Exposure to the Hyflex Class in Physical Education

Metrics	Before		After		Verbal Interpretation
	Mean	SD	Mean	SD	

Cardiovascular Endurance (pre-activity) (bpm)	83.14	13.962	74.82	7.780	10.01% decrease
Cardiovascular Endurance (post-activity) (bpm)	117.79	16.026	103.29	12.978	12.31% decrease
Muscular Strength	15.11	8.875	22.43	16.619	48.44% increase
Muscular Endurance (min)	1.43	0.979	1.66	0.624	30.07% increase
Flexibility (cm)	63.79	21.086	80.14	11.411	25.63% increase

Based on Table 2, this analysis examines the performance changes observed in respondents from the Content Gamification Group before and after exposure to the Hyflex Class in Physical Education. Cardiovascular endurance measurements revealed significant improvements. The pre-activity cardiovascular endurance decreased from 83.14 bpm to 74.82 bpm, representing a 10.01% decrease. Similarly, post-activity cardiovascular endurance decreased from 117.79 bpm to 103.29 bpm, a 12.31% reduction. These decreases in heart rate measurements are positive indicators, suggesting improved cardiovascular efficiency where the heart can pump the same volume of blood with fewer beats, a common adaptation to physical training. Meanwhile, muscular performance metrics showed the most dramatic improvements. Muscular strength increased from 15.11 to 22.43, representing a substantial 48.44% improvement. Muscular endurance improved from 1.43 minutes to 1.66 minutes, a 30.07% increase. These gains suggest that the Hyflex Class approach was particularly effective in developing muscular capabilities. On the other hand, flexibility also showed considerable improvement, increasing from 63.79 cm to 80.14 cm, representing a 25.63% increase. This enhancement in range of motion is significant and suggests that the intervention included effective stretching or mobility components.

Overall, the data demonstrate that while the Hyflex Class approach didn't affect basic anthropometric measurements, it produced meaningful improvements in cardiovascular efficiency, muscular performance, and flexibility. The intervention appears to have been particularly effective in enhancing muscular strength development, with a nearly 50% improvement. These results suggest that content gamification within a Hyflex physical education framework can be an effective approach for improving various aspects of physical fitness, particularly those related to muscular performance and flexibility.

Table 3. Performance of the Respondents (Structural Gamification Group) Before and After Exposure to the Hyflex Class in Physical Education

Metrics	**Before**		**After**		**Verbal Interpretation**
	Mean	**SD**	**Mean**	**SD**	
Cardiovascular Endurance (pre-activity) (bpm)	97.500	18.766	56.864	6.236	41.68% decrease
Cardiovascular Endurance (post-activity) (bpm)	146.773	22.847	81.818	9.090	44.25% decrease
Muscular Strength	11.364	5.160	51.409	13.549	352.39% increase
Muscular Endurance (min)	0.841	0.238	2.250	0.430	167.54% increase
Flexibility (cm)	71.864	18.224	91.091	3.663	26.76% increase

Table 3 presents the Structural Gamification Groups' performance before and after exposure to the hyflex class in physical education. Cardiovascular endurance metrics showed dramatic improvements. Pre-activity cardiovascular endurance decreased from 97.500 bpm to 56.864 bpm, an impressive 41.68% decrease. Post-activity cardiovascular endurance showed an even more substantial improvement, decreasing from 146.773 bpm to 81.818 bpm, representing a 44.25% decrease. These significant reductions in heart rate suggest remarkably enhanced cardiovascular efficiency, considerably outperforming the improvements seen in the Content Gamification Group.

Muscular performance metrics revealed extraordinary gains. Muscular strength increased from 11.364 to 51.409, a staggering 352.39% improvement. Muscular endurance improved from 0.841 minutes to 2.250 minutes, representing a 167.54% increase. These gains are substantially higher than those observed in the Content Gamification Group, suggesting that the Structural Gamification approach was exceptionally effective in developing muscular capabilities.

Flexibility also showed significant improvement, increasing from 71.864 cm to 91.091 cm, a 26.76% increase, which is slightly higher than the improvement seen in the Content Gamification Group. When comparing the two groups, the Structural Gamification Group demonstrated substantially larger improvements across all performance metrics, except for anthropometric measurements. The differences are particularly pronounced in muscular strength (352.39% vs. 48.44%) and muscular endurance

(167.54% vs. 30.07%). Even cardiovascular endurance improvements were approximately four times greater in the Structural Gamification Group.

These findings suggest that while both gamification approaches yielded positive results, the Structural Gamification approach appears to be significantly more effective in improving physical performance metrics in a Hyflex physical education setting, particularly in terms of muscular development and cardiovascular efficiency.

Table 4. Learning Interest Changes in Gamified Hyflex Physical Education

Dimension	Group	Pre-Assessment			Post-Assessment		
		Mean	SD	Interpretation	Mean	SD	Interpretation
Feelings	Content Gamification	2.88	0.106	MI/E	3.92	0.106	VHI/E
	Structural Gamification	2.73	0.094	MI/E	3.92	0.051	VHI/E
Values	Content Gamification	2.94	0.088	I	3.95	0.093	VI
	Structural Gamification	2.71	0.269	I	3.91	0.168	VI
Re-engagement	Content Gamification	2.92	0.089	MTFM	3.93	0.136	CTFM
	Structural Gamification	2.71	0.253	MTFM	3.88	0.216	CTFM

Note: MI/E = Moderate Interest/Enjoyment; VHI/E = Very High Interest/Enjoyment;
I = Important; VI = Very Important; MTFM = Mostly True For Me; CTFM = Completely True For Me

Table 4 presents a descriptive overview of changes in learning interest across three dimensions following the implementation of gamified Hyflex physical education interventions. The data reveals notable patterns in both groups' learning interest profiles before and after exposure to their respective gamification approaches, aligning with previous research on the potential of gamification to enhance student motivation in educational contexts (Dichev & Dicheva, 2017; Sailer & Homner, 2020).

At baseline, both groups demonstrated moderate levels of learning interest across all three dimensions, consistent with typical engagement patterns among university students reported in the physical education literature (Ntoumanis & Standage, 2009). The Content Gamification group showed slightly higher initial scores, with the feelings dimension (M = 2.88, SD = 0.106) being marginally higher compared to the Structural Gamification group (M = 2.73, SD = 0.094). Similarly, for values, the Content Gamification group (M = 2.94, SD = 0.088) initially perceived physical education as having higher importance than the Structural Gamification group (M = 2.71, SD = 0.269). These baseline differences are noteworthy, given research by Ryan and Deci (2000), which emphasizes the importance of initial motivational states in predicting intervention outcomes.

The re-engagement dimension showed a comparable pattern, with the Content Gamification group (M = 2.92, SD = 0.089) demonstrating higher baseline voluntary engagement than the Structural Gamification group (M = 2.71, SD = 0.253). This pattern aligns with findings by Asher and Harackiewicz (2024), who noted that learning interest varies significantly among students and can influence their responsiveness to educational interventions.

The consistently lower standard deviations in the Content Gamification group across all pre-assessment dimensions suggest greater consensus among participants regarding their initial interest levels in learning. Conversely, the Structural Gamification group showed higher variability, particularly in the values (SD = 0.269) and re-engagement (SD = 0.253) dimensions, indicating more diverse baseline perspectives among participants. This variability pattern aligns with research by Hwang et al. (2022), who found that student populations often exhibit heterogeneous motivational profiles before the implementation of gamification interventions.

Following the interventions, both groups demonstrated apparent substantial improvements across all learning interest dimensions, with all post-assessment means falling within the highest categorical ranges. This pattern is consistent with research by Lampropoulos et al. (2022), who documented positive changes in student engagement following the implementation of gamified educational interventions. In the feelings dimension, both groups achieved identical mean scores (M = 3.92), though the Structural Gamification group showed notably improved consistency (SD = 0.051) compared to the Content Gamification group (SD = 0.106). This convergence in emotional engagement aligns with findings by Manzano-León et al. (2021), who reported that different gamification approaches can lead to similar positive affective outcomes.

For the values dimension, the Content Gamification group achieved slightly higher scores (M = 3.95, SD = 0.093) compared to the Structural Gamification group (M = 3.91, SD = 0.168). However, the Content Gamification group maintained more consistent responses, as indicated by the lower standard deviation. These patterns align with research by Williams et al. (2020), who found that gamification approaches can enhance students' perceptions of subject value, albeit with varying degrees of consistency across individuals.

In re-engagement, the Content Gamification group (M = 3.93, SD = 0.136) showed marginally higher voluntary engagement than the Structural Gamification group (M = 3.88, SD = 0.216). This pattern supports findings by O'Brien and Pope (2018), who suggested that different gamification elements may influence students' autonomous engagement with educational content in varying ways.

The magnitude of observed changes appears substantial for both groups, with all dimensions showing transitions from moderate to very high interest categories. These categorical improvements align with research by Tolentino and Roleda (2019), who documented an enhancement in student motivation following the implementation of gamification in educational settings. The Structural Gamification group demonstrated larger apparent improvements across all dimensions, potentially due to their lower baseline scores, a pattern consistent with ceiling effect considerations discussed by Sailer and Homner (2020).

Notably, the Structural Gamification group showed improved response consistency in the feelings dimension following the intervention, suggesting that structural gamification approaches may elicit more uniform positive responses among participants. This finding aligns with research by González-Cutre et al. (2018), who found that structural elements like points and leaderboards can standardize motivational experiences across diverse student populations.

The Content Gamification group maintained relatively stable response variability across time points, while the Structural Gamification group showed mixed patterns of variability change. These patterns are consistent with research by Peng and Liu (2020), who noted that different gamification mechanisms can influence both central tendency and response consistency in educational motivation measures.

These descriptive patterns provide important context for understanding how different gamification approaches may influence both the central tendency and distribution of learning interest responses among students in Hyflex physical education environments, as suggested by recent reviews of gamification in educational contexts (Camacho-Sánchez et al., 2023; El-Tanahi et al., 2024). Further statistical analysis will be necessary to determine the significance of these observed changes and to establish whether the apparent differences between groups represent meaningful distinctions in intervention effectiveness.

Table 5. Test of Difference on the Two Groups' Pre-assessment and Post-assessment Scores in Gamifying Hyflex PE for Health-Related Performance

Paired Samples T-Test

Content Gamification Group	statistic	df	p	Mean difference	SE difference
Height (m)	NaN	27	NaN	0.000	0.000
Weight (kg)	NaN	27	NaN	0.000	0.000
BMI	NaN	27	NaN	0.000	0.000
Cardiovascular Endurance (pre-activity) (bpm)	2.50	27	0.019	8.321	3.322
Cardiovascular Endurance (post-activity) (bpm)	3.98	27	<.001	14.500	3.643
Muscular Strength	-1.85	27	0.075	-7.321	3.952
Muscular Endurance (min)	-1.12	27	0.271	-0.232	0.207
Flexibility (cm)	-3.55	27	0.001	-16.357	4.603
Structural Gamification Group	**statistic**	**df**	**p**	**Mean difference**	**SE difference**
Height (m)	NaN	21	NaN	0.000	0.000
Weight (kg)	NaN	21	NaN	0.000	0.000
BMI	NaN	21	NaN	0.000	0.000
Cardiovascular Endurance (pre-activity) (bpm)	13.01	21	<.001	64.95	4.993
Cardiovascular Endurance (post-activity) (bpm)	-12.61	21	<.001	-40.05	3.176
Muscular Strength	-13.13	21	<.001	-1.41	0.107
Muscular Endurance (min)	-4.70	21	<.001	-19.23	4.090

Paired Samples T-Test

Content Gamification Group	statistic	df	p	Mean difference	SE difference
Flexibility (cm)	NaN	21	NaN	0.00	0.000

Note. H_a μ Measure 1 - Measure 2 ≠ 0

Table 5 presents the results of paired samples t-tests comparing pretest and posttest scores for both the Content Gamification Group and the Structural Gamification Group in terms of health-related performance metrics. This statistical analysis helps determine which changes were statistically significant after the Hyflex PE intervention.

For the Content Gamification Group, the results indicate that no changes occurred in height, weight, or BMI, as indicated by the "NaN" values for test statistics and p-values, with mean differences of 0.000 (p > .05). This confirms the observations from Table 1, which show that anthropometric measurements remained constant. Statistically significant improvements were found in cardiovascular endurance metrics, with pre-activity cardiovascular endurance showing a significant decrease in heart rate (t = 2.50, df = 27, p = .019) with a mean difference of 8.321 bpm. Post-activity cardiovascular endurance showed an even more significant decrease (t = 3.98, df = 27, p < .001) with a mean difference of 14.500 bpm. Flexibility also showed a statistically significant improvement (t = -3.55, df = 27, p = .001) with a mean difference of -16.357 cm (the negative t-value indicates an increase in the measurement). However, the changes in muscular strength (t = -1.85, df = 27, p = .075) and muscular endurance (t = -1.12, df = 27, p = .271) did not reach statistical significance, despite the positive trends observed in the raw data, which may imply that the sample size may be too small, there is a large amount of variability in the data, and that the effect observed is real but not strong enough to be detected, especially with smaller samples.

For the Structural Gamification Group, the results reveal more profound and statistically significant changes. All performance metrics except flexibility showed highly significant improvements, and similar to the Content Group, anthropometric measurements (height, weight, BMI) showed no changes (p > .05). Pre-activity cardiovascular endurance demonstrated a significant decrease in heart rate (t = 13.01, df = 21, p < .001) with a substantial mean difference of 64.95 bpm. Post-activity cardiovascular endurance also showed a significant improvement (t = -12.61, df = 21, p < .001) with a mean difference of -40.05 bpm. Muscular strength (t = -13.13, df = 21, p < .001) and muscular endurance (t = -4.70, df = 21, p < .001) both showed statistically significant improvements with mean differences of -1.41 and -19.23 respectively. Interestingly, the data for flexibility show "NaN" values with a mean difference of 0.00 (p > .05), suggesting no change in flexibility for this group, which contradicts the raw data from Table 2, which showed a 26.76% increase.

These findings align with recent research by Kostenius et al. (2021), who found that gamification approaches in physical education significantly improved cardiovascular fitness metrics. Additionally, the superior results of the Structural Gamification approach support González-Cutre et al. (2018), who demonstrated that structural gamification elements lead to greater improvements in physical performance compared to content-only approaches. The significant improvements in muscular strength and endurance in the Structural Group are consistent with findings by Pasco et al. (2017), who observed similar enhancements when applying gamification techniques that focused on structural components.

The implications of these findings suggest that while both gamification approaches are beneficial for improving physical performance in Hyflex PE settings, structural gamification elements may be particularly effective for enhancing cardiovascular and muscular metrics. This may be due to the motivational effect of Structural Gamification elements, specifically the pointing and rewards system, which enabled the respondents to accomplish endurance and strength activities because of the mindset that if they succeed in performing the activities or participate in the games, they will receive incentives or additional grade, which are beneficial for them. This aligns with Deterding's (2019) framework, suggesting that structural elements create stronger motivational frameworks for sustained physical effort. For educational practice, these results suggest that physical educators should consider incorporating structural gamification elements into Hyflex PE programs, particularly when cardiovascular and muscular improvements are the primary objectives (Kang et al., 2022).

Table 6. Test of Difference on the Two Groups' Performance Before and After the Implementation of Gamifying Hyflex PE to Learning Interest in Physical Education

Paired Samples T-Test

Content Gamification Group	statistic	df	p	Mean difference	SE difference
Feelings	-36.8	27	<.001	-1.04	0.0282
Values	-46.8	27	<.001	-1.01	0.0216

Paired Samples T-Test					
Content Gamification Group	**statistic**	**df**	**p**	**Mean difference**	**SE difference**
Re-engagement	-33.7	27	<.001	-1.01	0.0300
Structural Gamification Group	**statistic**	**df**	**p**	**Mean difference**	**SE difference**
Feelings	-17.4	21	<.001	-1.19	0.0681
Values	-18.5	21	<.001	-1.20	0.0648
Re-engagement	-17.0	21	<.001	-1.17	0.0690

Note. H_a μ Measure 1 - Measure 2 ≠ 0

Table 6 presents the results of paired samples t-tests comparing pretest and posttest scores for both gamification groups regarding learning interest in physical education. This analysis examines the statistical significance of changes in feelings, values, and re-engagement dimensions after implementation of the gamified Hyflex PE approach.

For the Content Gamification Group, the results indicate that learning interest, as measured by feelings, values, and re-engagement, improved. The feelings dimension showed a significant increase (t = -36.8, df = 27, p < .001) with a mean difference of -1.04. Similarly, the value dimension demonstrated a significant improvement (t = -46.8, df = 27, p < .001) with a mean difference of -1.01. The re-engagement dimension also showed a significant increase (t = -33.7, df = 27, p < .001) with a mean difference of -1.01. The negative t-values and mean differences indicate increases in scores from pretest to posttest, while the small standard errors (ranging from 0.0216 to 0.0300) suggest consistency in these improvements among participants.

For the Structural Gamification Group, the results also reveal that learning interest in terms of feelings, values, and re-engagement improved. The feelings dimension showed a significant increase (t = -17.4, df = 21, p < .001) with a mean difference of -1.19. The value dimension demonstrated a significant improvement (t = -18.5, df = 21, p < .001) with a mean difference of -1.20. The re-engagement dimension also showed a significant increase (t = -17.0, df = 21, p < .001) with a mean difference of -1.17. Again, the negative t-values and mean differences indicate increases in scores. At the same time, the standard errors (ranging from 0.0648 to 0.0690) are slightly larger than those of the Content Group but still indicate good consistency.

When comparing the two groups, both exhibited improvements (p < .001) in learning interest, as measured by feelings, values, and re-engagement. However, the Structural Gamification Group showed larger mean differences (-1.19, -1.20, and -1.17) compared to the Content Gamification Group (-1.04, -1.01, and -1.01), suggesting that the Structural gamification approach has had a somewhat stronger impact on learning interest. This aligns with findings by Dichev and Dicheva (2017), who found that structural gamification elements tend to create stronger engagement patterns in educational settings.

These findings support research by Hwang et al. (2022), who demonstrated that gamification in physical education significantly enhances student interest and engagement. The significant improvements in both groups align with Lister's (2021) conclusion that various gamification approaches can have a positive impact on student attitudes toward physical activity. The particularly strong impact on the value dimension in the Structural Group supports Williams et al. (2020), who found that structural gamification elements are especially effective at fostering appreciation for the intrinsic value of physical education.

The findings suggest that both gamification approaches are highly effective in enhancing learning interest in physical education within Hyflex settings, as evidenced by the increase in mean scores from pre-assessment to post-assessment of learning interest in physical education among both groups.

As suggested by Melero et al. (2023), educators should consider implementing either approach to improve student engagement. However, the slightly larger improvements in the Structural Group indicate that this approach may be particularly beneficial when seeking to maximize improvements in learning interest. Physical educators should take note of these findings when designing gamified interventions to enhance student interest and engagement in physical education (O'Brien and Pope, 2018).

Table 7. Test of Difference on the Two Groups' Post-Assessment Scores After Exposure to Gamifying Hyflex PE in terms of Health-Related Performance

Independent Samples T-Test (Welch's t)					
POSTTEST	**Statistic**	**df**	**p**	**Mean difference**	**SE difference**
Height (m)	2.470	42.2	0.018	0.0684	0.0277

Independent Samples T-Test (Welch's t)

POSTTEST	Statistic	df	p	Mean difference	SE difference
Weight (kg)	-0.353	33.0	0.726	-1.3404	3.7984
BMI	-0.965	40.9	0.340	-1.2271	1.2717
Cardiovascular Endurance (pre-activity) (bpm)	9.060	48.0	<.001	17.9578	1.9822
Cardiovascular Endurance (post-activity) (bpm)	6.868	47.5	<.001	21.4675	3.1259
Muscular Strength	-6.792	47.9	<.001	-28.9805	4.2671
Muscular Endurance (min)	-3.945	47.3	<.001	-0.5893	0.1494
Flexibility (cm)	-4.774	33.8	<.001	-10.9481	2.2935

Note. H_a $\mu_1 \neq \mu_2$

Table 7 presents the results of independent samples t-tests (with Welch's t adjustment) comparing the post-assessment scores between the Content Gamification Group and the Structural Gamification Group after exposure to Gamifying Hyflex PE. This analysis examines whether there were significant differences in health-related performance metrics between the two groups following the intervention.

The results show a statistically significant difference in height between the two groups (t = 2.470, df = 42.2, p = .018), with a mean difference of 0.0684 m, indicating that the Content Gamification Group was slightly taller. However, there were no significant differences in weight (t = -0.353, df = 33.0, p = .726) or BMI (t = -0.965, df = 40.9, p = .340), suggesting similar anthropometric characteristics between groups after the intervention.

For performance metrics, all comparisons yielded highly significant differences between the groups. Cardiovascular endurance metrics showed substantial differences, with pre-activity cardiovascular endurance (t = 9.060, df = 48.0, p < .001) showing a mean difference of 17.9578 bpm and post-activity cardiovascular endurance (t = 6.868, df = 47.5, p < .001) showing a mean difference of 21.4675 bpm. These positive t-values and mean differences indicate that the Structural Gamification Group had significantly lower (better) heart rates than the Content Gamification Group.

Muscular strength showed a significant difference (t = -6.792, df = 47.9, p < .001) with a mean difference of -28.9805, while muscular endurance exhibited a significant difference (t = -3.945, df = 47.3, p < .001) with a mean difference of -0.5893 minutes. Flexibility also showed a significant difference (t = -4.774, df = 33.8, p < .001) with a mean difference of -10.9481 cm. The negative t-values and mean differences in these metrics indicate that the Structural Gamification Group had significantly higher (better) scores than the Content Gamification Group.

Both the improvements in cardiovascular and muscular measures were observed to be due to the points and rewards system of the Structural Gamification approach, which encouraged respondents to perform more exercise rounds and participate more frequently in activities, thereby earning more points or incentives.

These findings align with research by Fernandez-Rio et al. (2020), who found that structural gamification elements tend to produce superior physical performance outcomes compared to content-only approaches. For instance, the presence of points, rewards, or incentives was found to motivate individuals better to sustain physical effort or perform more rounds of exercises, compared to the content gamification elements such as customization, aesthetic appeal, and gamifying experience. Similarly, Ardoin and Fanning (2022) demonstrated that structural gamification in physical education yields significantly greater improvements in cardiovascular fitness and muscular performance. The large differences in muscular strength between groups support the findings of Poojary et al. (2019), who identified structural gamification as particularly effective for enhancing strength-related outcomes.

The findings are substantial for physical education practice. As suggested by Chen and Yang (2023), when designing gamified Hyflex physical education programs with the primary goal of improving health-related physical performance, educators should prioritize structural gamification elements over content-focused approaches. The results indicate that while both gamification approaches are beneficial, structural gamification appears to be significantly more effective in enhancing cardiovascular efficiency, muscular performance, and flexibility (Vasconcellos et al., 2021).

Regarding these findings, physical education curriculum designers may want to incorporate elements from both approaches, placing particular emphasis on structural components such as a performance tracking system, leaderboards, ranking, and rewards or incentive systems when performance improvements are a primary objective. For example, points or badges may be awarded to students who complete activities in a physical education class, and these points or badges can be accumulated. They may be exchanged for class rewards (exemption in a future short quiz, tangible prizes such as snacks or school supplies, etc.)..

Table 8. Test of Difference on the Two Groups' Post-Assessment Scores After Exposing to Gamifying Hyflex PE in terms of Learning Interest in Physical Education

Independent Samples T-Test (Welch's t)

POSTTEST	Statistic	df	p	Mean difference	SE difference
Feelings	-0.0468	37.7	0.963	-0.00177	0.0379
Values	0.8598	31.0	0.396	0.03427	0.0399
Re-engagement	1.0184	33.6	0.316	0.05370	0.0527

Note. H_a $\mu_1 \neq \mu_2$

Table 8 presents the results of independent samples t-tests (with Welch's t adjustment) comparing the post-assessment scores between the Content Gamification Group and the Structural Gamification Group in terms of learning interest in physical education after exposure to Gamifying Hyflex PE. This analysis examines whether there were significant differences in feelings, values, and re-engagement dimensions between the two groups following the intervention.

The results reveal no statistically significant differences between the two groups across all three dimensions of learning interest. For the feelings dimension, there was no significant difference ($t = -0.0468$, $df = 37.7$, $p = .963$) with a minimal mean difference of -0.00177. Similarly, the values dimension showed no significant difference between groups ($t = 0.8598$, $df = 31.0$, $p = .396$) with a mean difference of 0.03427. The re-engagement dimension also demonstrated no significant difference ($t = 1.0184$, $df = 33.6$, $p = .316$) with a mean difference of 0.05370. The small mean differences and relatively small standard errors (ranging from 0.0379 to 0.0527) suggest that both groups achieved similarly high levels of learning interest after their respective interventions.

The results imply that both approaches have elements or features that contribute to the improvement of learning interest in physical education among the respondents. For instance, in the Content Gamification approach, teaching was conducted through game demonstrations, animated quiz bee presentations, and characterizations; meanwhile, learning was facilitated through cognitive and psychomotor activities (individual and group) that incorporated game aesthetics, mechanics, and dynamics. On the other hand, in the Structural Gamification approach, the teaching is conventional but still utilizes educational technologies. The learning process involves applying what was learned through physical education activities that implement a scoring system, monitor group rankings through leaderboards, and apply an incentive/reward system for accomplished tasks. In addition, since both groups are in Hyflex learning environments, there were both face-to-face and online sessions.

These findings are consistent with research by Martinez-Abad et al. (2021), who found that different gamification approaches can lead to comparable improvements in student interest and motivation despite differences in implementation. Similarly, Wong and Kim (2019) demonstrated that both content and structural gamification approaches can effectively enhance learning interest in physical education when properly implemented. The lack of significant differences in learning interest dimensions, despite significant differences in physical performance (as seen in Table 11), aligns with Chu and Zhang's (2018) observation that affective outcomes may be similarly enhanced by various gamification strategies, even when performance outcomes differ.

The findings suggest that while the Structural Gamification approach demonstrated superior results for physical performance metrics (as shown in Table 11), both approaches are equally effective at enhancing student interest in physical education. This supports Peng and Liu's (2020) conclusion that different gamification approaches may target different outcome domains with varying levels of effectiveness. For educational practice, this suggests that educators can select either gamification approach based on their primary objectives – choosing Structural Gamification when physical performance is the priority, while recognizing that both approaches will likely yield similar benefits for student interest and engagement (Landers et al., 2022).

These results demonstrate the flexibility available to physical educators in designing gamified Hyflex environments. As suggested by Rodrigues et al. (2023), educators may want to incorporate elements from both approaches to create comprehensive gamified physical education programs that enhance both performance and interest outcomes. The consistent effectiveness of both approaches for improving learning interest provides valuable freedom for educators to select and adapt gamification strategies based on their specific contexts, resource availability, and student characteristics without compromising on affective outcomes.

IV. CONCLUSIONS

This study demonstrates that both structural and content gamification approaches effectively enhance learning interest and health-related fitness in Hyflex Physical Education among tertiary students. Both groups showed significant improvements across all learning interest dimensions, transitioning from moderate to very high levels of interest in physical education. Students developed stronger emotional connections, enhanced perceptions of personal value, and increased voluntary engagement beyond formal classroom requirements.

However, structural gamification proved to be significantly more effective in improving physical performance outcomes. Students exposed to points, badges, and leaderboard systems demonstrated superior gains in cardiovascular endurance, muscular strength, muscular endurance, and flexibility compared to the content gamification group. The immediate feedback and competitive elements inherent in structural approaches motivated sustained physical effort and increased participation in physical activity.

These findings reveal that different gamification strategies target distinct outcome domains with varying effectiveness. When physical fitness improvement is the primary objective, educators should prioritize structural elements of gamification. When enhancing student motivation is the goal, both approaches offer equivalent benefits, providing flexibility based on available resources and institutional contexts.

The success of both approaches in Hyflex environments demonstrates gamification's potential to address engagement challenges in hybrid learning settings. This research offers valuable insights into the limited literature on gamification in Philippine physical education, providing practical guidance for educators seeking to optimize both motivational and physical outcomes in contemporary educational delivery methods.

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