

## Optimizing Flow-State and Learning Outcomes in Sports Nutrition Education: Infographic-Based Learning as an Educational Tool

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### **Abstract.**

*Background and Study Aim.* Creative teaching methods like infographics in sports nutrition education use flow theory from positive psychology to get students deeply engaged and immersed in tasks and improve learning outcomes. This research examines how visual aids, especially infographics, impact learning experiences and outcomes in niche areas like sports nutrition.

*Material and Methods.* A total of 234 female students selected as samples of Avinashilingam Institute for Home Science and Higher Education for Women, TN India, were drawn from various departments engaged in sports nutrition as one of their generic elective courses. The researcher designed an infographic for selected sports nutrition course topics. The samples underwent six weeks of infographics-based intervention. A researcher made a questionnaire comprised of six latent variables: "Learning Attributes (LA), Subjective Norms (SN), Perceived Behavioral Control (PBC), Perceived Usefulness (PU), Intention to Adopt Infographic Method of Learning (IAIML), Perceived Ease of Use (PEU)." For the observable variables of each item, responses were rated from samples on a seven-point Likert scale. The establishment of convergent validity ensured that the test items fit well into constructs based on factor loading. A researcher developed a proposed measurement model to assess hypotheses, drawing on insights from a literature study and theoretical implementations.

**Results.** The results discovered that PU, PEU, and SN influence LA, whereas PU influences PEU as a pathway to enhancement of infographic-based learning performance. PU and LA merely influence IAIML. In contrast, IAIML remains uninfluenced by PEU, SN, and PBC.

**Conclusions.** The research confirms the role of flow theory in optimizing the educational experience through infographic-based interventions.

**Keywords:** Flow State Theory, Infographic-based Education, Latent learning variables, Sports Nutrition

## Introduction

Technological advancement keeps exposing innovations in performance enhancement, specifically in teaching and learning subject matters. While benefiting from technological advancements, the education system lacks distinct regulations for the efficient and effective use of technology to accomplish focused learner engagement outcomes. In order to promote students' learning, educators should provide explicit guidelines on what to teach, how to instruct the content, and the establishment of essential infrastructure. Infographics significantly enhance learning and teaching of subject matters across various educational contexts [1]. The human mind gets disturbed means its physiological system gets disturbed, which likely affects human performance. Decades of research have focused on unraveling the factors that impact human performance. Performance is deeply rooted in the processes referring to mental behaviors and processes that individuals utilize to gather, organize, archive, and seek out information [2].

A visually appealing technique for representing complex information is utilizing infographics. Icons, graphs, and diagrams are examples of visual components that can make abstract ideas more relatable and understandable. The visually appealing nature of infographics captures learners' attention and stimulates their interest. This engagement can promote an environment advantageous to learning and engaged learning processes [3]. Physical education and sports-related professional students engaged more in practical sessions than in theoretical classroom setups. Every day, as per the National Council of Teacher Education (NCTE) norms, prospective physical education professional students should engage in practical and theoretical activities. They engaged in their academic activity with goal-oriented programs to accomplish academic excellence. Adapting infographics in theoretical classes induces active participation and yields concept clarity with a well-programmed approach [4]. Therefore, the student learning model is vital to facilitate teaching and learning instructional conveyance. Understanding virtual experiences requires grasping the theory of current flow, as it is the most relevant notion of flow to these ideas [5]. [6, 7] extensively formulated the optimal psychological state known as "flow," various researchers have confirmed its presence in a range of contexts, including the workplace, education, recreation, and sports. [8] optimal psychological state known as "flow" has been extensively formulated and confirmed by others in a range of contexts, such as the workplace, education, recreation, and sports. [9] established the idea of flow, defining it as the universal sensation people get anytime, they fully immerse themselves in an activity. Whether a person attains a state of flow, they are fully immersed in the activities they are performing, have less difficulty focusing their attention, and feel in control of their circumstances. A significant gap exists in assessing physical education and sporting-related curricula utilizing the flow of theoretical concepts due to fewer studies conducted within the sports background field. Further, the use of infographics and their impact were comparatively high in the medical-related field, and there exists a lack of academic research on infographic influence among education along with physical education programs. This article intends to adopt flow theory concepts and pinpoint factors that enable students learning sports nutrition to adapt the infographic approach to teaching and learning.

The state of complete engagement that people experience while performing at their optimum is referred to as "flow" [7, 10]. When students are in a flow state, they use their physical and psychological capabilities to perform tasks with great focus, enjoyment, and engagement. Individuals can also characterize this condition by entirely focusing on the task and not perceiving time or distance [11]. The preceding flow model was split into three categories relies on an individual's abilities and the level of difficulty of an action: flow, boredom, and anxiety [8]. The framework later expanded under eight conditions: "flow, arousal, relaxation, control, boredom, worry, apathy, and anxiety". These conditions corresponded to a distinct set of abilities and degrees of difficulty.

According to [8, 12] who considered these factors for the development of a state of flow, the state of flow may arise even if just a few of the requirements are met. Furthermore, a number of researchers have found that how students achieve flow experiences is directly related to how challenging skills are balanced [13, 14]. [15] argue that motivation significantly depends on how individuals form actions concerning difficulties, feedback, focus, control, and goals. These effects may change if certain parts of the actions are changed. However, [16] examined how learners interacted with knowing in a computer game-centered learning setting and discovered that a more expanded concept of understanding as "playing" constitutes vital elements that may produce flow and enhance information productivity. In addition, [8] identified eight factors influencing flow. These factors include having clear objectives and immediate feedback, balancing ability challenging levels, integrating action and consciousness, absorbing attention, a feeling managed, misrepresenting duration, losing awareness of oneself, and pursuing gratification oneself. Numerous researches indicate the significance of flow in enhancing the perspectives of learners, achievement, and engagement [17, 18, 19]. As a result, numerous studies have examined how learning is impacted by a student's environment when they are in a flow state [20, 21].

### Research Objectives

1. Assess the effectiveness of the infographic-based intervention in optimizing flow experience and improving sports nutrition knowledge, attitudes, and behaviours among learners.
2. Investigate the direct and indirect effects and the mediating role of PU, PEU, SN, and PBC in the relationship between LA and Intention to adopt the Infographic Method of learning to understand the pathways through which these variables influence learning outcomes.

### Research Hypotheses

**Perceived Usefulness (PU)** significantly predicts behavioral intents and outcomes in various situations, including technology adoption, health behaviors, and performance and search platform assessment [22, 23, 24]. A rudimentary framework suggests that behavioral PU positively impacts behavioral intention. Numerous studies examined a connection between PU and behavioral intention, and the findings indicate PU represents a strong predictor of behavioral intent [25, 26, 27]. According to [28] technology-based learning may enhance teacher-student connection, promote active learning awareness, and arrange learning time flexibly. If such learning has a significant impact, students will adopt it. Rejecting the integrated education method, however, may backfire. Consequently, the following hypotheses are put forth:

**H1:** PU may have an optimistic effect on LA for the Infographic Method of Learning.

**H2:** PU may optimistically influence the IAIML.

**Perceived Ease of Use (PEU)** To the point that learners perceive using technology for education as a physically and mentally demanding accomplishment. An item's PEU shows how easily it may be utilized or understood. Individuals choose to use significantly simpler goods [22, 29, 30].

*Consequently, this study proposes the listed hypotheses that follow:*

**H3:** PEU's optimistic effect on LA towards the Infographic Method of Learning.

**H4:** PEU's optimistic effect on PU towards the Infographic Method of Learning.

**H5:** PEU optimistically influences the IAIML.

**Learning Attitudes (LA)** They were acquiring attitudes and knowledge. The psychological process determines a person's likes and dislikes through their attitudes [31, 32, 33]. A prior study revealed an intense factual correlation between behavior and attitude [34]. Individuals' ideal or adverse appraisal or opinion of an activity can depend on numerous factors.

Research proves that people prefer inactivity over act and regret acts rather than inactions in dangerous

circumstances that result in adverse outcomes [35]. The following hypothesis was framed based on this concept.

**H6:** LA has an optimistic influence the IAIML.

**Subjective Norms (SN)** are the outcomes of societal expectations and standards influencing a person's behavior or intentions [36, 37]. This concept implies that some people or organizations promote and encourage specific actions [38, 39, 40]. Professors and fellow learners, alongside other appropriate organizations, place expectations and compliance obligations on learners in higher education who engage with infographic education, establishing the social network involved in its adoption. As a result, instructors, classmates, and class norms influence students' learning based on their expectations leading to the formulation of the following hypotheses.

**H7:** SN optimistically influences LA.

**H8:** SN optimistically influences PBC.

**H9:** SN optimistically influences IAIML.

**Perceived behavioral control (PBC)** [41] asserts that individuals' PBC has the foremost essential elements significantly influencing their adoption of techno-enabled learning courses. PBC is related to how much students think they oversee their time, effort, and resources when they engage in techno-based learning. Additionally, PBC helps students achieve better academic results and enhance their overall performance. [42] discovered specific correlations between a sense of optimistic self-efficacy, the capacity to overcome challenges, and reform implementation regarding PBC or personal beliefs about self-efficacy. Self-efficacy and external facilitation situations have the most effects on PBC intensity. Therefore, this study presents the following hypothesis.

**H10:** PBC optimistically influences the IAIML.

**The mediating roles of learning attitudes and perceived usefulness** Reviews emphasized that the links between PU, PEU, LA, and IABL are as follows: the greater the level of PU of learning experienced by learners, the higher their LA towards engagement, which optimistically affects IAIML [43, 44]. Similarly, the greater the PEU of learning perceived by students, the higher their PU towards involvement, which optimistically influences the IAIML.

Furthermore, participating actively in learning programs may encourage college students to adopt this techno-based teaching strategy [45, 46, 21]. In summarize, this leads to formulation of the following hypotheses.

**H11:** LA acts as a mediator between PU and IAIML.

**H12:** PU influences PEU's action on the IAIML.

## **Materials and Methods**

**Participants:** The Avinashilingam Institute for Home Science and Higher Education for Women, TN India, were selected as samples drawn from various departments students engaged in sports nutrition as one of their generic elective courses during the academic year 2022 – 2023, appeared in the April examination, 2023. From February 2023 onwards, the selection of samples was invited voluntarily. In total, 259 female samples were enrolled, and finally, 234 samples were selected after 25 were removed due to incomplete study registration (informed consent form). Ethical clearance for the study obtained from Institutional human ethical committee. The convenience sampling was adopted to choose study samples because it has several benefits, including convenience sampling to pick individuals based on factors including geographic proximity, ease of access, presence within an established phrase, and unforced participation [47]. The researcher designed an infographic for selected sports nutrition course topics. The samples underwent six weeks of infographics-based intervention. The sample of university students includes undergraduates and postgraduates to provide a comprehensive view

of the student population. Based on the sample's descriptive statistics, 81% were undergraduate students, and 19% were postgraduate students. Table -1 presents the demographic data for the samples.

**Table 1. Demographic Data of Selected Samples (n = 234)**

Classification	Category	Sample Size	Percentage
Level of the Study	Under-graduate	194	81.91
	Post-graduate	40	19.09
School of Study	Home Science	92	39.32
	Arts & Social Science	13	5.56
	Education	75	32.05
	Allied and Healthcare Science	54	23.08

**Research Design:** The researchers constructed their version of the questionnaire according to prior identical research [21, 22, 48]. These questions were modified for this study based on what was found in similar investigations. A few more questions were added to the investigating tool, but only because the chosen instrument did not cover the results of this finding structure. These initiatives were confirmed by earlier research on the technological acceptability of learning, and they were then further adjusted to fit the current study environment (Table 2). The tool is separated into two sections: the first piece includes questions meant to assess the components contained in the proposed theoretical model presented in table 2.

In contrast, the second section collects demographic information from the respondents (Table 1). The scale design includes the following six latent variables: “PEU, PU, LA, SN, PBC, and IAIML”. For the observable variables of each item (questions), researcher assessed the participants' views utilizing a seven-point Likert scale (Seven being fully agree and one being absolutely disagree).

**Table 2. Measurement Item List**

Construct	Code for Item	Item and variable measurement	Variable Source
Perceived ease of use	PEU1	The infographics e-resources and virtual classes are easily accessible and convenient to learn.	[22, 45, 21]
	PEU2	It is easier to participate in class debates with infographic-based studying.	
	PEU3	Understanding ways to integrate infographics is easy to accomplish.	
	PEU4	Infographic learning offers a flexible timeline.	
Perceived usefulness	PU1	Infographic-based learning has enhanced my productivity.	[22, 45]
	PU2	Infographic-based gaining knowledge may adjust for individual fluctuations.	
	PU3	Infographic studying has promoted my understanding of active education.	

	PU4	Infographic education builds an encouraging instructor-learner interaction.	
Learning attitudes	LA1	It is advantageous to utilize infographics for absorbing information.	[22, 45]
	LA2	Applying infographics for education is beneficial.	
	LA3	Infographic learning topics are eye-catching.	
	LA4	Infographic information can elevate enthusiasm for learning.	
Subjective norms	SN1	My fellow learners feel I should actively participate in Infographic's learning process.	[48, 45]
	SN2	My teacher believes I should actively involve infographics in their academic pursuits.	
	SN3	My friends say that I should be constantly eager for Infographic education.	
Perceived behavioral control	PBC1	I possess effective management of the learning impact caused by infographics.	[48, 45]
	PBC2	I have sufficient time and willingness to engage in infographic education.	
	PBC3	I am skilled in the infographic-based study model.	
	PBC4	Objectives can be set depending on infographics-based materials.	
Intention to adopt Infographic Method of learning	IAIML1	I hope that future curricula will incorporate more infographic-based learning opportunities.	[45]
	IAIML2	I suggest Infographic-based learning courses to everyone else.	
	IAIML3	In the future, I plan to adapt the infographics for other subject concepts.	

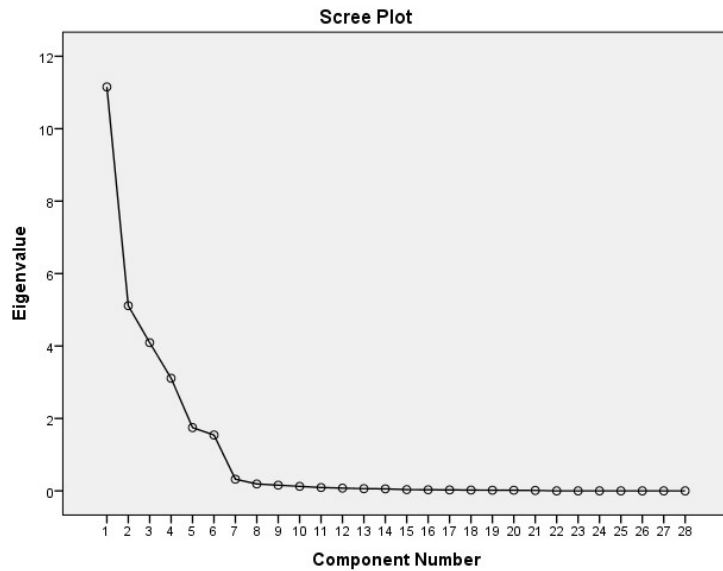
**Statistical Analysis:** Factor analysis was utilized to identify and evaluate the fundamental factors (latent variables) that present correlation structures among a set of observable variables. The factors identified with their corresponding items are based on the eigenvalue; a model was developed considering the theoretical framework and reviews. The proposed model was explored for path analysis. Path analysis enables researchers to make inferences about causal relationships among variables. Researchers can investigate causal pathways and comprehend variables' direct and indirect impacts on one another by identifying the directional paths between variables [22, 45].

**Results**

**Table 3. Factor Loading and its variance**

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	11.153	39.833	39.833	11.153	39.833	39.833	5.106	18.237	18.237
2	5.114	18.265	58.098	5.114	18.265	58.098	4.750	16.965	35.202
3	4.092	14.614	72.712	4.092	14.614	72.712	4.684	16.729	51.932
4	3.110	11.106	83.818	3.110	11.106	83.818	4.599	16.424	68.356
5	1.747	6.240	90.059	1.747	6.240	90.059	4.197	14.988	83.344
6	1.542	5.507	95.565	1.542	5.507	95.565	3.422	12.221	95.565
7	.323	1.152	96.718						
8	.191	.681	97.398						
9	.157	.562	97.961						
10	.124	.443	98.403						
11	.093	.333	98.736						
12	.075	.269	99.005						
13	.062	.221	99.227						
14	.056	.201	99.428						
15	.034	.121	99.549						
16	.030	.106	99.656						
17	.025	.091	99.747						
18	.022	.080	99.826						
19	.019	.070	99.896						
20	.017	.062	99.958						
21	.012	.042	100.000						
<i>Extraction Method: Principal Component Analysis</i>									

The factor loading and its variance are displayed in Table 3. The extraction sum of squared loading explains the variance explained by each factor. An eigenvalue greater than one emphasises that six factors represent their construct with total variance explained as 95 %, suggesting that the factors are doing a good job of summarizing the observed variables. Scree Plot also ensures that there were six latent variables shown in figure – 1.



**Figure – 1: Scree Plot of Factor Loading**

Based on the result of factor analysis, the proposed model was constructed, and their hypotheses were explored to test their assumptions.

**Table 4. Rotated Component Matrix<sup>a</sup>**

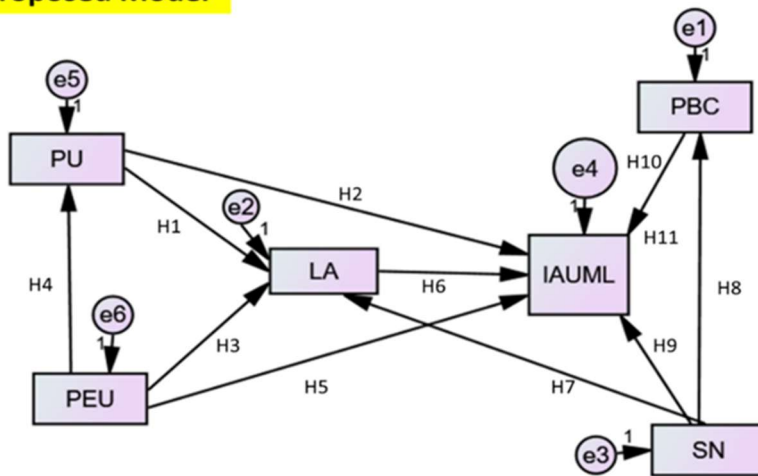
Code for Item	Component					
	1	2	3	4	5	6
PU	.977					
PU1	.973					
PU4	.973					
PU2	.970					
PU3	.932					
PEU1		.917				
PEU		.903				
PEU2		.900				
PEU3		.859				
PEU4		.850				
LA			.936			
LA2			.928			
LA3			.926			
LA1			.870			
LA4			.772			
PBC				.995		
PBC3				.963		
PBC2				.961		
PBC4				.947		
PBC1				.884		

IAUML					.929	
IAIML1					.923	
IAIML2					.916	
IAIML3					.902	
SN						.881
SN2						.830
SN1						.825
SN3						.806

**Extraction Method: Principal Component Analysis.**  
**Rotation Method: Varimax with Kaiser Normalization.**  
**a. Following 7 iterations, the rotation converged.**

Table – 4 indicates the factors possessing a value greater than 0.5, representing the direction and strength of each factor's relationship with each variable.

**Proposed Model**



**Figure 2. Proposed Measurement Model**

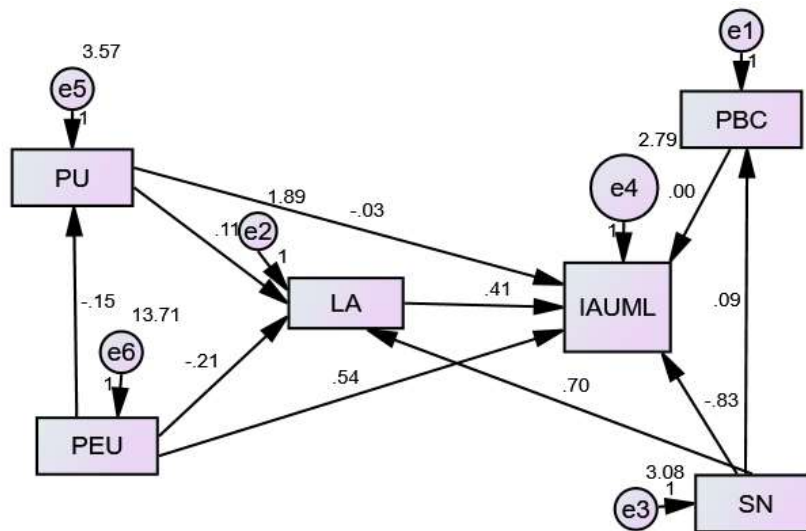


Figure 3. Proposed Measurement Model

Table 5. Testing the Hypothesis

Hypothesis	Relationship		Estimate	P	Result
H <sub>4</sub>	PU	<--- PEU	-.150	.426*	Supported
H <sub>8</sub>	PBC	<--- SN	.087	.301	Not Supported
H <sub>7</sub>	LA	<--- SN	.698	.022*	Supported
H <sub>1</sub>	LA	<--- PU	.109	.042*	Supported
H <sub>3</sub>	LA	<--- PEU	-.214	.037*	Supported
H <sub>2</sub>	IAIML	<--- PU	-.027	.041*	Supported
H <sub>5</sub>	IAIML	<--- PEU	.539	.345	Not Supported
H <sub>6</sub>	IAIML	<--- LA	.412	.026*	Supported
H <sub>10</sub>	IAIML	<--- PBC	.005	.173	Not Supported
H <sub>9</sub>	IAIML	<--- SN	-.834	.035*	Supported
<b>Mediation Analysis</b>					
H <sub>11</sub>	IAIML <--- LA <--- PU		.712	.025*	Supported
H <sub>12</sub>	IAIML <--- PU <--- PEU		.312	.041	Supported

\* Significant at 0.05 level (p<0.05)

Table – 5 indicates the pathways that ensure that infographic-based learning outcomes are enhanced. PU, PEU, and SN affect LA, and PU impacts PEU. IAIML only affects PU and LA. In contrast, PEU, SN, and PBC did not affect IAIML. All framed hypotheses except H5, H8 and H10 were supported, and it recommended that one of the significant productive learning attempts that can affect learners' attitudes and behaviors involves infographic-based education. The learning attitude is highly influenced by the students' intention to adopt an infographic method of learning sports nutrition.

Further, it was influenced positively by SN, PEU, and PU, emphasizing that learners' perceptions of their peer

group impressions favorably affect their overall attitudes and willingness to use this infographic. Further, mediation analysis showed that LA's standardized indirect (mediated) effect on IAIML via PU is .712. That is, due to LA's indirect (mediated) effect on IAIML, When LA elevates by one standard deviation, IAIML exceeds 0.712 standard deviations. Similarly, standardized indirect (mediated) effect of PU on IAIML via PEU is .312. Both mediated effects were found to be at a significant level, and it was concluded that PEU and PU had a significant indirect impact on IAIML via PU and LA, respectively. Respondent readiness to embrace infographic-based teaching may be increased if they have strong views of the true benefits of this type of learning. These perceptions can also help them have favourable attitudes about engaging in infographic-based instruction. The findings were reviewed by [45].

### Discussion

The findings inform the effectiveness of sports nutrition education through infographic-based learning and the role played by flow theory. This section focuses on the key associations among utilitarian PEU, SN, LA and IAIML and implications for teaching strategies and student engagement. The results of the study strongly support the role of PU in predicting LA and predicting IAIML, consistent with previous research positing PU as the key determinant in behavioral intentions and learning adoption [22, 25]. These finding calls attention to the idea that students will find infographic-based learning more acceptable if they perceive it useful for their academic success. The findings imply that if students perceive that the learning method is useful, they have an easier time using it and that it becomes more desirable. Thus, PEU is confirmed to be a foundational element in any technology adoption model [22] and, hence, the other relevant construct. However, IAIML was not directly influenced by PEU, as ease of use does not itself lead students to have intentions to adopt infographic learning. It means that although simplicity is important, students are motivated by what they think it will give them rather than how easy it will be to use the learning method. The Attitudes of Learning and Subjective Norms emerged that PU mediated via LA to reach with IAIML. The finding implies that perceptions of the usefulness of the method used to promote infographic-based learning affect students' willingness to accept it. The mediation analysis revealed that LA has a large indirect effect on IAIML through PU, implying that one should promote a positive learning attitude to promote engagement with infographic-based education. Social aspects of learning can be best seen in the influence of SN on LA and PU but not on IAIML. The students' acceptance of their peers' and teachers' expectations and behaviours indicate that students' learning attitudes were positively affected by their social peers and teachers. SN, however, directly impacts IAIML, suggesting that students may do what their peers or educators tell them to do, i.e., practice new methods. However, the real inclination of the student lying behind this depends on his attitude and the perceived usefulness of the process adopted.

PBC However, contrary to some earlier studies that highlighted the importance of self-efficacy for the success of technology adoption, PBC did not significantly correlate with IAIML [34]. A finding suggests that, in this context, the greater students' perceived control of the learning process, time, and effort they were exerting did not lead to a stronger intention of adopting infographic-based learning. Nothing to do with it. Infographic-based education is unique; there are factors outside the learner's ability to control what learners learn, such as instructional design and peer influence. In this work, flow theory is appropriate for using infographic-based learning to offer immersive and engaging educational learning experiences. The positive impact of PU, PEU and SN on LA shows promise for deep engagement with infographic-based methods when students perceive the content as useful, navigable, and supported by their social environment. The study's findings confirm that the infographic-based interventions optimize this immersive state or flow, and the type of learning flow theory suggests leads to better educational outcomes when students are deeply involved in their learning tasks.

## Conclusions

The primary contributions and innovations of the study, as compared to previous research, are found in its examination of students' acceptance of infographic-based learning with special reference to flow theory perspectives. Furthermore, this research makes a contribution by offering a more thorough understanding of blended learning, specifically by pointing out the way to enhance its educational influence on female university students. Infographic-based educational outcomes can be enhanced significantly because PU, PEU, and SN influence LA and PU influences PEU. Overall intention to adopt Infographic-based education is influenced by participants learning attitude and PU from their peers. In this way, it is recommended that differentiated educational instruction be used, and the practicability of the curriculum must be improved. In order to achieve student learning outcomes effectively and infographic-based learning efficiency, educators should also concentrate on perceived usefulness while creating their courses. Consequently, it is necessary to implement a procedure that increases awareness of infographic-based learning among all stakeholders, from top-level administrators to gross root-level students. This study confirms that learning in infographic-based learning, grounded in flow theory, significantly increases students' learning attitudes and sports nutrition education engagement.

## Recommendation and Practical Implications

The examination was carried out in a specific geographical environment limited to the Coimbatore region, and the results obtained are not generalizable. Further, the rural, urban, semirural, and semi-urban areas have to be considered when selecting the diverse samples with diverse academic backgrounds. A longitudinal method can be used in upcoming research to gain a deeper comprehension of the dynamics related to the variables throughout time. Investigating additional factors affecting teachers' approval of infographic-based learning would also be interesting. Although the current study concentrated on student attitudes, future research approaches might include investigating instructors' and higher education institutions' administrative bodies' perspectives.

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