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Correlation among game addiction, achievement emotion, and learning motivation: A study of Indonesian youth in the context of e-learning system

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Abstract

This study investigated the correlation between game addiction, achievement emotions, and motivation in the e-learning context. This research collected data through an online questionnaire that briefly explained the study's aim, demographic questions, the Game Addiction Scale (GAS), the e-Learning Achievement Emotion Questionnaire (eLAEQ), and the e-Learning Motivation Scale (eLMS). 607 high school, undergraduate, and graduate students participated in this study — Data analysis involved the utilization of structural equation modeling. The study findings reveal that game addiction substantially impacts positive and negative emotions and intrinsic and extrinsic learning motivations. Moreover, positive emotions significantly affect intrinsic and extrinsic learning motivations. Conversely, negative emotions have a substantial impact on intrinsic learning motivation but not on extrinsic learning motivation.

Keywords: E-learning, Game addiction, Achievement emotion, Learning emotion

Introduction

In recent years, the popularity of computer gaming as a leisure activity has been steadily increasing (Von Der Heiden et al., 2019). In this vein, the advancement of 5G networks has turned mobile games into lucrative assets for major internet platforms (Li et al., 2022). Any individual with a smartphone has encountered embedded mobile games within a web page or application (Li et al., 2022). Gradually, mobile games fulfill a portion of individuals' daily entertainment needs (Yang & Gong, 2021). While games are intended for recreation and entertainment, they have the potential to consume a significant amount of players' time



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and can have a considerable impact on players' well-being (Barr & Copeland-Stewart, 2022). Individuals become isolated from others because they are excessively engrossed in gaming (Le et al., 2023). Consequently, it hinders the development of their personalities, social abilities, and social lives (Ko et al., 2005; Kowert et al., 2014), leading to emotions of isolation and loneliness (Mandryk et al., 2020). Additionally, according to a 2013 study by Lee et al., specific game genres can incite addictive behavior. For instance, playing massively multiplayer online role-playing games regularly leads to addiction (Hsu et al., 2009). Games may cause a behavioral addiction (Şenol et al., 2023) that negatively influences emotional well-being, life satisfaction, self-esteem (Yang et al., 2022), and physical health (Aziz et al., 2021). However, some children addicted to mobile games are psychologically healthy (Li et al., 2022). In addition, mobile games could be a way to escape from real-life dissatisfaction, vent stress, and feel enjoyable when receiving a quick reward (Chafouleas et al., 2021).

From an educational perspective, mobile games that are embedded into learning lead to a more significant learning improvement and academic achievement (Barros et al., 2020; Halloluwa et al., 2018), arousing enjoyment and happiness during the game activities (Schneider & Schaal, 2018; Steinmaurer et al., 2019); and perceiving mobile games-based learning as attractive and innovative (Ramírez-Donoso et al., 2018). However, students who play games excessively/addicted to gaming may disregard their learning. Game addiction exhibits a positive correlation with lower academic performance (Brunborg et al., 2014; Chiu et al., 2004) but a negative correlation with academic success (Sahin et al., 2016). Moreover, academic emotions have been associated with game addiction (Lemmens et al., 2009) and learning motivation (Öztürk & Sarikaya, 2021). Lemmens et al. (2009) found that Dutch adolescents with high game addiction levels experienced fewer positive emotions and more negative emotions while studying. Similarly, Öztürk and Sarikaya (2021) found that the addiction to computer games among students encompasses numerous distractions and factors that hinder their motivation to learn.

Emotions and motivation play crucial roles in determining learning success. For the former, Isen and Reeve (2005) stated that experiencing positive emotions predisposes individuals to form favorable judgments about target stimuli, ultimately leading to increased motivation and active involvement in tasks. Positive emotions impact the learning process by influencing students' attention and motivation. As an example of positive task-related emotions, enjoyment of learning promotes their motivation to learn (Kiuru et al., 2020; Linnenbrink, 2007; Pekrun, 2012). While for the latter, motivation shapes the learning perception and outcomes (Gomez et al., 2010; O'Reilly, 2014). A strong correlation exists between higher levels of motivation and learning outcomes, for example, student GPA (O'Reilly, 2014). However, as far as we are aware, the correlation between game addiction, positive and negative achievement emotions, and intrinsic and

extrinsic learning motivation has not been explored. This study aims to fill the research gap by exploring correlations between variables in an e-learning context. Therefore, this study was guided by the following research question: “To what extent does game addiction influence emotions and motivation in the context of e-learning?”

This study investigated the potential correlation between online game addiction, achievement emotions, and learning motivation. Understanding the psychological factors that affect students’ engagement and performance is becoming increasingly important. Game addiction, achievement emotion, and learning motivation are three constructs that have been shown to impact students’ academic outcomes. By exploring the relationship between game addiction, achievement emotion, and learning motivation, this study aims to comprehensively understand the psychological mechanisms underpinning students’ behavior and academic performance in e-learning environments.

Theoretical framework and hypotheses development

Game addiction

The notion that addiction is linked to attachment issues is widely discussed by several authors, including Coffey (2018), Flores (2004), Gill (2014), and Walant (1997). Individuals with insecure attachments may experience difficulties regulating emotions (Mikulincer et al., 1998). Additionally, Mendelson and Mello (1986) defined addictive behavior as harmful to one’s mental or physical well-being, excessive, compulsive, and challenging to manage.

Online gaming has emerged as the most addictive activity on the internet. Internet game addiction is characterized as persistent and repetitive internet use in-game participation. It often involves interactions with other players, which results in notable distress in various areas of an individual’s life (Markey & Ferguson, 2017). Further, Griffiths (2000) described computer game addiction as a nonchemical sub-category of behavioral addiction, specifically related to active engagement in gaming.

The addiction theory is related to attachment issues; focused initially on substance and alcohol addictions, the approach has been expanded to technological addictions. Previous researchers have investigated various types of technological addictions, including social media addiction (Blackwell et al., 2017), smartphone addiction (Kim et al., 2017), internet addiction, and gaming addiction (Savci, 2017; Sigerson et al., 2017; Suárez et al., 2012; Sung et al., 2020). Excessive computer and video game use can result in behavioral addiction, identified by compulsive and extreme use, leading to emotional and social problems. Despite these issues, individuals struggling with gaming addiction cannot control their outrageous behavior.

Suárez et al. (2012) uncovered that individuals who exhibited anxious or avoidant attachment styles were more likely to face challenges in online gaming than those with a secure attachment style. In contrast, Sung et al. (2020) delved deeper into the relationships between attachment styles, stressful experiences, and internet gaming disorder. College students with insecure attachments are more prone to problematic gaming behaviors.

Although games carry the potential to be problematic/addictive, game technologies create opportunities to redesign innovative e-learning to facilitate educational experiences for students (Alhammad & Moreno, 2018). Educators integrated gamified platforms with e-learning systems to enhance students' interactivity and engagement (Bouchrika et al., 2021). The primary goals of gamification include improving particular skills, establishing motivating learning objectives, engaging students, optimizing the learning process, and encouraging shifts in attitude and interaction (Dichev & Dicheva, 2017). Incorporating games' essence increases students' internal enthusiasm to be involved in the learning activities and feel enjoyable (Saleem et al., 2022). In this vein, gamification and game-based learning studies have documented the positive effects, such as increased collaboration, motivation, critical thinking, creativity, and learning satisfaction by maintaining content in working memory (Jesionkowska et al., 2020).

The Game Addiction Scale (GAS) is a valuable tool for evaluating addiction to computer and video games. This scale consists of 21 items, each corresponding to one of the seven criteria that Lemmens et al. (2009) identified. These criteria are mood modification, salience, tolerance, relapse, problems, withdrawal, and conflict. Salience in the context of game addiction pertains to gaming taking on a primary role in an individual's life, with the person's thoughts, feelings, and behavior consumed by the activity. In a tolerance context, individuals gradually increase the gaming time spent, resulting in a higher frequency of play. Mood modification, previously labeled euphoria, includes tranquilizing and relaxing feelings associated with escapism—mood modification related to the personal experiences of individuals reported from playing games. Withdrawal encompasses the negative emotions and physiological effects that arise when an individual suddenly reduces or discontinues gameplay, including moodiness, irritability, and shaking. Relapse refers to an individual's tendency to revert to earlier gameplay patterns, with excessive playing quickly returning following periods of control. Conflict pertains to interpersonal disputes arising from extreme gaming, including arguments, neglect, lies, and deception between the player and others. Finally, problems refer to the negative outcomes of excessive gameplay over school, work, and socialization activities.

Achievement emotions

Emotions result from a multifaceted interplay between subjective and objective factors, which are influenced by neural and hormonal systems, leading to sensations of excitement,

enjoyment, or dissatisfaction (Kleinginna & Kleinginna, 1981). Emotions are essential in shaping students' academic and personal development, influencing their academic performance, personality growth, and overall well-being (Linnenbrink, 2006; Linnenbrink-Garcia & Pekrun, 2011). They also create a positive classroom environment, endorsing self-regulation and helping students make good life and career decisions (Hartung, 2011; Pekrun et al., 2009; Pirsoul et al., 2023; Sharma, 2023). In the classroom, students undergo a range of emotions that significantly impact their learning engagement and academic outcomes. Positive emotions like joy and excitement encourage effort and persistence, while negative emotions such as anxiety, sadness, frustration, and boredom can hinder their involvement and learning success (Pekrun et al., 2007).

Pekrun (2006) defines achievement emotions as occurring while learning and accomplishing tasks. Pekrun also classifies achievement emotions into activity-related and outcome-related emotions, which arise during learning and achievement contexts. Furthermore, Forsblom et al. (2022) and Cheng, Chang et al. (2023) suggest that achievement emotions can affect cognitive aspects during the learning process and are associated with the outcome of that process. Positive achievement emotions have been found to enhance effort and attention and facilitate memory recall, as observed by Meinhardt and Pekrun (2003). Conversely, negative emotions are strongly associated with poor learning outcomes, as highlighted by Pekrun et al. (2011). As technology continues to advance, emotions play a crucial role in e-learning. Previous studies investigated the importance of emotions in e-learning contexts (Cheng, Chang et al., 2023; Forsblom et al., 2022; Meinhardt & Pekrun, 2003; Pekrun et al., 2011). Emotions in the learning process emphasize the need to cultivate specific "emotional competencies" as a prerequisite for successful learning.

The Achievement Emotions Questionnaire (AEQ) is a widely recognized instrument utilized in educational research to assess achievement emotions. Developed by Bieleke et al. (2021), this instrument comprises 32 items, encompassing scales designed to measure positive and negative emotions within a learning context. AEQ has been employed in various studies to explore achievement emotions. For instance, Cheng, Huang et al. (2023) utilized AEQ to detect the achievement emotion profiles and the online learning environment obstacles encountered by vocational college students. Additionally, Cheng, Chang et al. (2023) examined the structural connections among conscientiousness, previous online learning experience, academic procrastination, and achievement emotions within online learning settings. Achievement emotions are pivotal in shaping students' learning experiences in technology-rich educational environments (Lajoie et al., 2020). They influence various aspects of learning, including cognitive resources, academic performance, self-regulated learning, and motivation (Pekrun, 2006).

Learning motivation

Motivation exists on a spectrum from intrinsic to extrinsic, as several researchers described (Chandler & Connell, 1987; Vansteenkiste et al., 2012). Intrinsic motivation is a critical factor in cognitive learning, serving as the primary driving force. Consequently, students who possess high intrinsic motivation typically learn more effectively, making intrinsic motivation highly beneficial for learning (Deci & Ryan, 1985). Learners interested in a task tend to utilize all available learning strategies to tackle the challenge, as Pintrich et al. (1993) noted. In contrast, extrinsic motivation stems from external factors like rewards and drives learners towards accomplishing a goal, often perceiving learning as an obligatory task (Pintrich et al., 1991).

Learning motivation drives learners to engage in learning and achieve the desired learning outcomes (Sun et al., 2008). In other words, students with strong motivation may possess more awareness to accomplish their e-learning tasks and goals (Martens et al., 2004), thus being persistent in interacting with e-learning systems. In addition, the highly motivated student tends to become more self-regulated and independent when accessing e-learning systems (Garcia et al., 2018). Students may actively interact with e-learning systems despite no teachers' existence (Selvaraj et al., 2021) and direct teachers' feedback (Cavalcanti et al., 2021). Previous studies have investigated the motivational aspects embedded in e-learning systems, such as Yahiaoui et al. (2022). E-learning systems significantly impact both student motivation and student outcomes.

Sun et al. (2017) developed the "Intrinsic and Extrinsic Learning Motivation Scale," distinguishing between intrinsic and extrinsic goal orientations in learning. Intrinsic goal orientation involves engaging in learning activities to fulfill personal interests, overcome challenges, and achieve mastery. On the other hand, extrinsic goal orientation involves pursuing learning activities due to external pressures, such as grades or financial incentives.

Correlation among game addiction, achievement emotion, and learning motivation in the context of e-learning

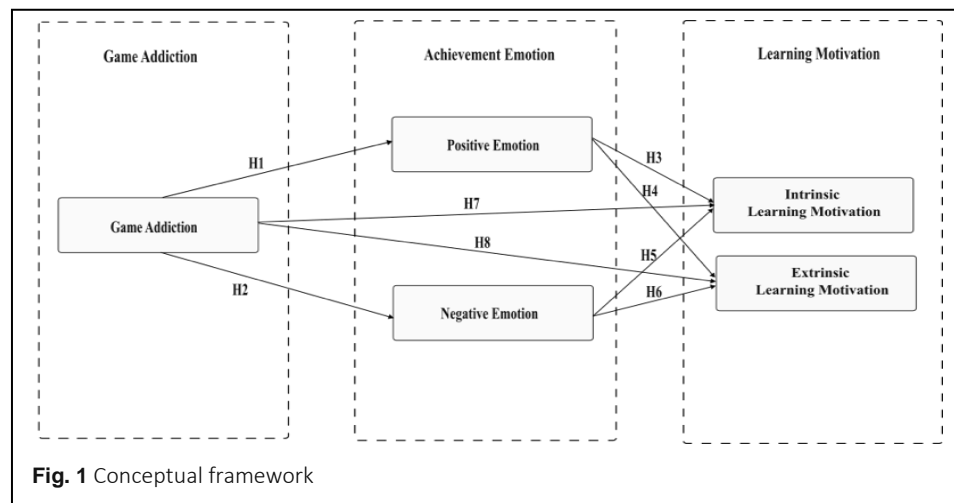
Correlation between game addiction and achievement emotions

Emotions arise from the interplay between individuals and their environment; emotions can be positive or negative based on how events and situations are perceived and processed (Lazarus, 1991). For example, positive emotions arise when an individual's goals are aligned with their emotions, while negative emotions occur when they conflict. For instance, according to Hong et al. (2012), college students frequently exhibit compulsive internet usage for playing mobile games to cope with unpleasant situations or difficulties.

There is a correlation between game addiction and emotion. Excessive gaming leads to negative emotions, for instance, loneliness, anxiety, depression, and anger (Gentile et al., 2011; Haberlin & Atkin, 2022; Lemmens et al., 2009; Wan & Chiou, 2006; Yen et al., 2017). Conversely, some research has focused on the link between game addiction and positive emotions like enjoyment, satisfaction, and the flow state (Gros et al., 2020; Sherry et al., 2012). Additionally, cognitive-behavioral theories suggest that people's behaviors can impact their emotions and cognition (Fenn & Byrne, 2013). As a result, maladaptive behavior, such as game addiction, can negatively affect a person's perceptions and emotions. Previous studies have established a correlation between gaming addiction and positive and negative emotions. This leads to the following formulation of the hypotheses:

H1: Game addiction affects students' positive emotions when using an e-learning system.

H2: Game addiction affects students' negative emotions when using an e-learning system.



Correlation between game addiction and achievement emotions

In virtual learning environments, which rely on electronic devices, students encounter information conveyed through diverse media, including written text, spoken words, animated sequences, and visual depictions. Martínez-Miranda and Aldea (2005) noted that emotions are part of a person's behavior; they could influence cognition (Loon & Bell, 2018) and the ability to acquire knowledge (Pellas, 2014). As a pedagogical approach, e-learning expects learners to be responsible for learning and possess self-directed and self-regulated learning skills (Xu et al., 2023). Additionally, emotional factors can affect students' willingness to exert cognitive effort in learning (Izard, 2009; Park et al., 2015).

Scholarly investigations have demonstrated the critical role of emotions in shaping learners' motivation and effort in educational contexts. Positive emotions lead to better learning outcomes. For example, a study by Ainley et al. (2002) reveals students who experienced more enjoyment and interest in a task were likelier to exert effort and persist. In addition, emotions are a source of motivation by influencing goal-setting and decision-making. For example, a study by Elliot and McGregor (2001) found that individuals who experienced pride after completing a task were more likely to set higher goals for themselves in the future.

Positive emotions significantly impact students' learning by influencing their attention and motivation. Positive emotions related to a learning task can enhance students' motivation to continue learning (D'Mello & Graesser, 2012; Linnenbrink, 2007; Pekrun et al., 2002). Conversely, negative emotions affect learning motivation (Mega et al., 2014). Negative emotions interfere with cognitive processing and lead to decreased effort and motivation (Pekrun et al., 2009). Drawing from the provided context, it is recommended that the following hypotheses can be formulated:

H3: Students' positive emotions affect intrinsic learning motivation when using an e-learning system.

H4: Students' positive emotions affect extrinsic learning motivation when using an e-learning system.

H5: Students' negative emotions affect intrinsic learning motivation when using an e-learning system.

H6: Students' negative emotions affect extrinsic learning motivation when using an e-learning system.

Correlation between game addiction and learning motivations

Technology improvements have transformed the learning process, contributing to the rise in popularity of e-learning platforms in education. However, it also brought the growing phenomenon of game addiction, which has become a significant concern for many students and affects their learning motivation. Gaming addiction can adversely impact reasoning

abilities and disrupt students' learning motivation. Öztürk and Sarikaya (2021) found that the game addiction of students presents numerous distractions that hinder their motivation to learn. Based on previous research, it has been shown that there is a correlation between game addiction and learning motivation among students. So, the following hypotheses are proposed:

H7: Game addiction affects students' intrinsic learning motivation when using an e-learning system.

H8: Game addiction affects students' extrinsic learning motivation when using an e-learning system.

Research method

Data collection and participants

In September 2022, data was collected from secondary school and university students using a questionnaire distributed through various social media platforms, including Twitter, and online chatting groups such as WhatsApp. This study employed a non-probability technique, convenience sampling, to establish the research sample. Convenience sampling involves selecting respondents who are willing to participate and complete the questionnaire for this study. This method was chosen due to its ease of implementation and suitability for students. The criteria for participant selection in this research were individuals with experience with e-learning and gaming.

We conducted an online survey and received responses from 630 students engaged in gaming and e-learning. They participated in this study by filling out the distributed online questionnaire. Out of the total participants, only 607 responses met our criteria for inclusion in the analysis. The responses of 23 participants were excluded for several reasons, including duplicate data and missing values.

Procedures

This survey study included five phases. First, the Game Addiction Scale (GAS), e-Learning Achievement Emotion Questionnaire (eLAEQ), and e-Learning Motivation Scale (eLMS) were translated into Bahasa Indonesia, and two doctorate students and lecturers checked each item's translation validity. Afterward, all measures were applied to small secondary school and university students' groups ($n = 20$) as a pre-test, and each item was assessed for comprehension by the intended group. Second, the study questionnaires were prepared, briefly explaining the study's purpose and demographical questions. In this stage, students were given information about the research, and their email addresses were collected. Third, the questionnaires were distributed online to 680 secondary school and university students at one-month intervals, and they were asked to fill out the questionnaires by logging in with

a username. In the last phase, validity testing, reliability testing, and SEM analyses were conducted to examine the correlation between game addiction, achievement emotions, and learning motivation.

Questionnaire design and measurement

Consistent with prior research, we modeled the GAS according to Lemmens et al. (2009); the constructs are mood modification, tolerance, salience, relapse, withdrawal, problems, and conflict. Furthermore, this study focused on two critical aspects of learning, namely achievement emotions and learning motivation, which were examined in terms of two main components: positive and negative emotions and intrinsic and extrinsic motivation. We modified the Achievement Emotions Questionnaire developed by Bieleke et al. (2021) to assess achievement emotions, which was adjusted to fit the e-learning context. Meanwhile, we employed the learning motivation scale Sun et al. (2017) developed to measure learning motivation. The 5-point Likert scale includes five answer choices, ranging from “agree” and “fully agree” to “neither agree nor disagree,” “disagree,” and “fully disagree.”

Research instruments

This research investigates the causal relationship between game addiction, achievement emotions, and learning motivation in e-learning contexts. The following research instruments were developed based on a previous literature review (Table 1).

Results and discussion

Demographic profile of respondents

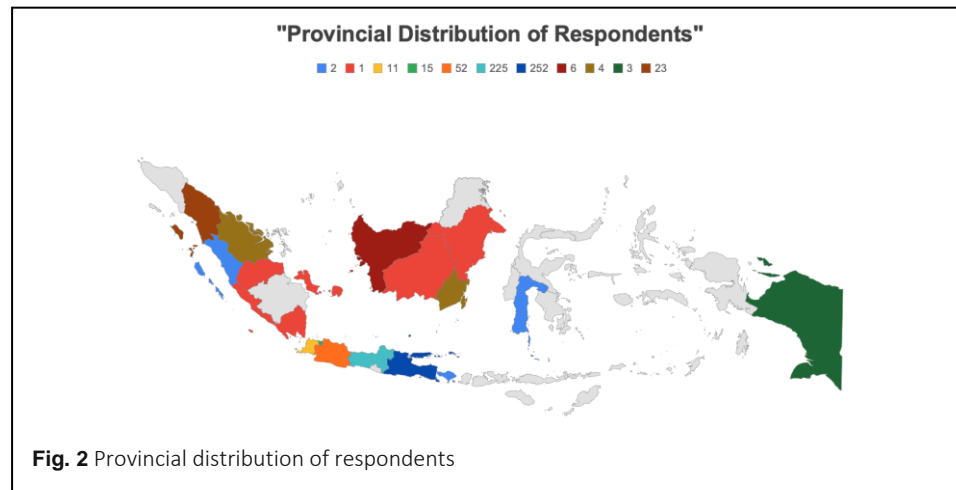
This study includes 607 respondents from various regions in Indonesia. Figure 2 illustrates the participants' demographic characteristics. Respondents come from 19 provinces across Indonesia, with most participants coming from East Java (252) and Central Java (225), and the remaining subjects are from other provinces. Among the respondents, 55% are female, while 45% are male. Most participants are within the 14-19 age range, accounting for 395 individuals (65%), while the remaining 212 (35%) fall into the 20-24 age group. The participants' educational levels range from high school to graduate students, with most respondents being undergraduates (60%). Moreover, most participants spend less than 2 hours a day playing games, with 426 respondents (70%). Conversely, the smallest group played games for over 8 hours, comprising only 11 individuals (2%). In addition, most participants spend less than 2 hours using e-learning per day (48%) (see Table 2).

Table 1 Research instruments

Construct	Measure Items	Reference
Game Addiction		
Salience	I contemplate playing a game throughout the entire day.	Lemmens et al. (2009)
	I devote a significant amount of my leisure time to playing games.	
	I feel addicted to a game.	
Tolerance	I play games longer than planned.	
	I allocate more and more time to games.	
	I cannot stop once I start playing a game.	
Mood	I engage in games to escape from my studies.	
Modification	I play games to relieve the stress from studying.	
	I play games to improve my mood.	
Relapse	I cannot reduce my game time.	
	Others attempt unsuccessfully to limit my gaming.	
	I struggle to cut down on my gaming hours.	
Withdrawal	I experience discomfort when I’m unable to play games.	
	I get mad when I can’t play games.	
	I get stressed when I’m unable to play games.	
Conflict	I argue with others, such as family and friends, about the time I dedicate to gaming.	
	I ignore family and friends in favor of playing games.	
	I lie about my gaming time.	
Problem	Gaming has led to my lack of sleep.	
	I neglect other important activities (e.g., study, school work) to play games.	
	I feel inadequate after playing games for a long time.	
Achievement Emotions		
Positive Emotion		
Enjoyment	In the context of e-learning/study via LMS...	Bieleke et al. (2021)
	I find enjoyment in mastering the material’s challenges.	
	I find satisfaction in handling the course material.	
Hope	I am thrilled with my progress, driving my motivation to keep studying.	
	Studying boosts my confidence.	
	I am confident in my ability to master the material.	
	I am optimistic about making substantial progress in my studies.	
	My confidence drives my motivation.	

Pride	I am proud of myself. I can be proud of my study accomplishments. I am highly motivated to achieve success and take pride in my accomplishments. Excelling at work fills me with pride.
Negative Emotion	
Anger	In the context of e-learning/study via LMS... Studying frustrates me. I feel irritated having to study. I became so angry that I wanted to discard the course materials. Long periods at my desk make my irritation turn into restlessness.
Anxiety	Studying makes me feel tense and anxious. I am concerned about my ability to handle all my coursework. While studying, I feel like distracting myself to ease anxiety. The fear of not finishing the material causes me to break into a sweat.
Shame	I feel ashamed. I experience shame when I recognize my lack of capability. I avoid discussing the course material due to the challenges I have faced with it. I avoid making eye contact when someone notices my lack of understanding.
Hopelessness	I feel helpless. I have accepted that I cannot fully grasp this material. I feel so powerless that I cannot fully dedicate myself to my studies. My lack of confidence drains my energy before I even begin.
Boredom	Studying for my courses bores me. The material is so tedious my mind drifts into daydreams. I prefer postponing this monotonous task until tomorrow. I tend to zone out while studying because it is incredibly monotonous.
Learning Motivation	
Intrinsic e-learning motivation	I prefer online course material that challenges me, enabling me to acquire new knowledge. In online classes, I prefer course content that piques my curiosity, even if it is challenging to grasp. My effort to grasp the content to the fullest extent brings me the most excellent satisfaction in this course. In my online class, I prioritize selecting course assignments from which I can gain knowledge, even if they do not assure a high grade.
Extrinsic e-learning motivation	My current primary source of satisfaction is achieving a high grade in an online class. My top priority at the moment is enhancing my overall GPA, which means that my primary focus in an online class is achieving a high grade. If possible, I aspire to outperform most of my peers in an online class and secure higher grades.

Sun et al. (2017)

**Table 2** Demographics information of subjects

Respondents		N = 607	
		Frequency	Percent (%)
Gender	Male	273	45
	Female	334	55
Age	14 – 19	395	65.1
	20 – 24	212	34.9
Education	High school	219	36.1
	Diploma	12	2
	Undergraduate	364	59.9
Daily game time	Graduate	12	2
	≤ 2 h	426	70.2
	2 – 4 h	140	23.1
	5 – 7 h	30	5
Daily e-learning time	≥ 8 h	11	2
	≤ 2 h	291	48
	2 – 4 h	231	38
	5 – 7 h	67	11
	≥ 8 h	18	3

Results

The reliability of collected data is a crucial aspect of research. In this study, the internal consistency of the questionnaire items was evaluated using Cronbach's alpha. It considers the extent to which the items in the questionnaire are interrelated and measures the same underlying concept. According to Loewenthal et al. (2002), a criterion of acceptability for Cronbach's alpha is an absolute value of 0.7. As shown in Table 3, all of the constructed values in our study exceeded this threshold, indicating high internal consistency among the questionnaire items. Composite reliability (CR) is another method used to test the reliability of collected data. This measure evaluates the extent to which all latent variables are related to their corresponding indicators and exceed the recommended threshold of 0.7.

Again, as shown in Table 3, all the latent variables in our study exceeded the threshold, with the lowest value of 0.882 from Extrinsic Learning Motivation.

The construct validity was assessed using the Average Variance Extracted (AVE), ensuring all observed variables' convergent validity. To meet this criterion, the AVE value of the construct should be greater than 0.50. Table 3 indicates that all variables have an AVE greater than 0.50, meeting the standard for convergent validity. This finding suggests that the variables in the construct share a substantial amount of variance, indicating good construct validity.

The Fornell-Larcker criterion was utilized to assess the discriminant validity of the constructs. Discriminant validity is evaluated by comparing the Average Variance Extracted (AVE) square root for each construct and its correlation with other constructs in the model. Suppose the square root of the AVE for each construct is higher than its correlation with other constructs. In that case, it indicates that the constructs in the model are distinct and do not measure the same underlying concept, thus confirming discriminant validity. The result in Table 4 demonstrates that all constructs meet the criterion for discriminant validity as each construct exhibits higher correlations with its measures compared to inter-construct correlations. This proves that the construct has discriminant validity and measures a unique underlying concept.

This study tested the model using Partial Least Squares (PLS), a type of structural equation modeling (SEM) often used to analyze complex models with multiple constructs. Path coefficient and t-statistics were used to test the hypothesis, and it evaluated the

Table 3 Convergent validity and reliability testing result

	Cronbach's Alpha	rho_A	Composite Reliability	Average Variance Extracted (AVE)
Extrinsic Learning Motivation	0.799	0.801	0.882	0.713
Game Addiction	0.939	0.940	0.945	0.505
Intrinsic Learning Motivation	0.800	0.811	0.870	0.627
Negative Emotion	0.909	0.914	0.923	0.501
Positive Emotion	0.903	0.905	0.920	0.536

Table 4 Discriminant validity testing result using Fronell-Larcker criterion

	Extrinsic Learning Motivation	Game Addiction	Intrinsic Learning Motivation	Negative Emotion	Positive Emotion
Extrinsic Learning Motivation	0.844				
Game Addiction	-0.163	0.711			
Intrinsic Learning Motivation	0.344	-0.013	0.792		
Negative Emotion	-0.119	0.496	-0.246	0.707	
Positive Emotion	0.367	-0.272	0.543	-0.42	0.732

Table 5 Hypothesis testing result

Hypothesis	Path Coefficient	T Statistics (O/STDEV)	P Values	Significance
H1: Game Addiction -> Positive Emotion	-0.272	6.069	0.000	Significance
H2: Game Addiction -> Negative Emotion	0.496	14.072	0.000	Significance
H3: Positive Emotion -> Intrinsic Learning Motivation	0.548	14.241	0.000	Significance
H4: Positive Emotion -> Extrinsic Learning Motivation	0.377	9.062	0.000	Significance
H5: Negative Emotion -> Intrinsic Learning Motivation	-0.110	2.333	0.020	Significance
H6: Negative Emotion -> Extrinsic Learning Motivation	0.092	1.929	0.054	Insignificance
H7: Game Addiction -> Intrinsic Learning Motivation	0.191	4.663	0.000	Significance
H8: Game Addiction -> Extrinsic Learning Motivation	-0.106	2.321	0.021	Significance

structural path significance in the PLS analysis. In this study, a two-tailed hypothesis test was adopted because the direction of the hypothesis was uncertain. Therefore, a significance level of 0.05 was used, and the critical value commonly used for two-tailed tests is 1.96 (Hair, 2017).

Path coefficient examines the strength and direction of the correlation between variables in a model. Furthermore, t-statistics evaluate the causal links between variables and determine the significance. As PLS analysis results shown in Table 5, all hypotheses except hypothesis 6 are supported at a significance level of $\alpha = 0.05$.

Game addiction significantly correlated with positive and negative emotions, supporting H1 ($\beta = -0.272$, $t = 6.069$, $p = 0.000$) and H2 ($\beta = 0.496$, $t = 14.072$, $p = 0.000$). Positive emotion significantly impacts intrinsic and extrinsic learning motivation, supporting H3 ($\beta = 0.548$, $t = 14.241$, $p = 0.000$) and H4 ($\beta = 0.377$, $t = 9.062$, $p = 0.000$). Negative emotion had a negative impact on intrinsic learning motivation ($\beta = -0.110$, $t = 2.333$, $p = 0.020$), supporting H5, but did not have a significant effect on extrinsic learning motivation ($\beta = 0.092$, $t = 1.929$, $p = 0.054$), failing to support H6. Additionally, game addiction had a significant impact on intrinsic learning motivation ($\beta = 0.191$, $t = 4.663$, $p = 0.000$), supporting H7, and a direct negative effect on extrinsic learning motivation ($\beta = -0.106$, $t = 2.321$, $p = 0.021$), supporting H8. These findings suggest that game addiction and emotions can significantly impact students' learning motivation, both intrinsically and extrinsically.

Discussion

The correlation between game addiction, achievement emotion, and learning motivation is complex and multifaceted. This study describes valuable insights into the correlation between game addiction, achievement emotion, and learning motivation in students. Video games provide a sense of escape and relaxation from the stresses of academic and social pressures. Students can forget their responsibilities and challenges, such as completing assignments and projects and studying for exams. They also experience a sense of accomplishment and reward as they progress through the game's challenges—the feeling of pleasure and excitement that can be addictive.

The first finding confirms that game addiction significantly impacts students' positive emotions when using an e-learning system. Specifically, the study found a strong negative correlation between gaming addiction and positive emotions. This suggests that students not addicted to gaming or moderately playing games are more prone to experiencing positive emotions towards academic activities in e-learning systems. This finding aligns with prior research, which states that engaging in moderate gameplay contributes to experiencing positive emotions (Allahverdiipour et al., 2010; Przybylski et al., 2009; Ryan et al., 2006; Wang et al., 2008). Together, these results highlight the importance of promoting healthy gaming habits and balancing leisure activities to enhance students' academic success and positive emotions toward e-learning activities. Moreover, this study has a positive correlation between game addiction and negative emotions. Game-addicted students are more susceptible to experiencing negative emotions (Gentile et al., 2011; Kuss et al., 2013).

Research has shown that positive emotions and intrinsic learning motivation are positively correlated. Students who experience positive emotions are more motivated to engage in learning activities, driven by a desire to explore and understand new information. Pekrun et al. (2009) study showed that positive emotions such as enjoyment and pride were positively correlated with mastery goal orientation and intrinsic motivation. Positive emotions also increase students' confidence, leading to higher learning motivation. According to Fredrickson's broaden-and-build theory, positive emotions expand individuals' thinking and behaviors, increasing cognitive and behavioral flexibility. In addition, positive emotions enhance creativity, problem-solving ability, and social connectedness, all of which contribute to the higher motivation to learn (Fredrickson, 2001).

Positive emotions enhance intrinsic learning motivation and can also be associated with extrinsic learning motivation, such as grades. Excitement and enjoyment resulting from positive emotions can increase students' interest and engagement in learning activities, leading to an increased motivation to achieve external rewards such as grades or teacher praise (Deci & Ryan, 1985). Research suggests positive emotions correlate with intrinsic motivation (Løvøll et al., 2017; Stolk et al., 2016). Moreover, Pekrun (1992) states that the

experience of hope and anticipatory joy can generate positive extrinsic motivation. In summary, positive emotions were associated with greater competence and control over learning, leading to increased motivation to learn for intrinsic and extrinsic reasons.

Negative emotions significantly impact students' intrinsic learning motivation, as they are negatively correlated. When students experience negative emotions such as anxiety, it can decrease their motivation to learn intrinsically by reducing their willingness to engage in challenging activities and lowering their confidence in their abilities (Pekrun et al., 2009). In addition, negative emotions narrow individuals' focus to the perceived threat, limiting their cognitive and behavioral flexibility and reducing their creativity and problem-solving ability (Fredrickson, 2001). For example, when a student experiences anxiety on a test, they avoid studying or do not engage fully in e-learning activities; they believe their efforts will not lead to success. This avoidance behavior can further decrease intrinsic motivation and academic performance over time (Eccles & Wigfield, 2002). This study also provided insight into the relationship between negative emotion and extrinsic learning motivation. Negative emotions do not significantly impact students' extrinsic learning motivation, such as the desire to achieve good grades, because the source of motivation is external and not necessarily tied to the individual's emotional state. In other words, the desire to attain good grades is driven more by external factors, such as the expectation of parents or the need to maintain a certain grade point average for scholarships or other rewards (Kusurkar et al., 2013).

This study investigated the relationship between game addiction and intrinsic and extrinsic learning motivation. The result found that game addiction significantly affects both types of motivation. Specifically, the results indicate a negative correlation between game addiction and extrinsic learning motivation. Students who are addicted to games may assume that games provide more sophisticated rewards than compliments provided in the e-learning system. Hence, students prioritize gaming over other activities, resulting in low extrinsic motivation. Students are motivated to complete tasks/learning because of external consequences (i.e., receiving rewards/grades to avoid punishment).

Moreover, research by Öztürk and Sarikaya (2021) revealed that game addiction had a negative impact on learning motivation. According to a study by Gentile et al. (2011), heightened involvement in extensive gaming is connected to reduced social competence and decreased academic performance. Addicted students prioritize playing games over dedicating time to learning activities.

Contrarily, game addiction has a positive correlation with intrinsic learning motivation. Intrinsically motivated students accomplish tasks based on satisfaction with the task itself without rewards/external factors (Kotera et al., 2021). It is essential to emphasize that intrinsic and extrinsic motivation are not in an either-or-relationship; students can possess both forms of motivation, high and low (Derfler-Rozin & Pitesa, 2020). When designing

game-based learning/gamification into an e-learning system, unpredictability, competition, and challenges are the driving forces of gameplay, which can also trigger the player's curiosity and intrinsic motivation (Liu, 2011), promoting effectiveness in e-learning. Drawing from flow theory, gamers experience happiness and immerse themselves in this enjoyment while playing the game (Liu, 2011). Therefore, the gamified nature of e-learning may mediate the positive correlation between game addiction and intrinsic learning motivation. Students addicted to gaming have high intrinsic learning motivation because they may meet the happiness in the competition and the challenging nature of both games and game-based learning embedded in e-learning.

Conclusions and recommendation

Our study has several theoretical implications. First, our study is unique for delving into the distinct emotions linked to intrinsic and extrinsic motivation, setting it apart from previous research that primarily focused on examining the connection between emotions and learning motivation (D'Mello & Graesser, 2012; Linnenbrink, 2007; Pekrun et al., 2002). As a result, this research offers a more intricate and nuanced comprehension of the role emotions play in shaping learning motivation.

Second, our study contributes to the existing literature by exploring a novel area—the correlation between game addiction and achievement emotion in the context of e-learning. While prior researchers have investigated the impact of game addiction on positive and negative emotions (Gentile et al., 2011; Lemmens et al., 2009; Wan & Chiou, 2006; Yen et al., 2017), these studies did not explicitly address the context of learning. This highlights the significance of considering the unique characteristics of e-learning environments when examining the relationship between game addiction and achievement emotions.

Third, our study extends the scope of research on game addiction and learning motivation, as previous studies have mainly concentrated on game addiction's impact on learning achievement. By investigating the association between game addiction and intrinsic and extrinsic learning motivation, we shed light on the underlying factors that link game addiction to changes in students' motivation to learn. This insight can prove valuable in developing targeted interventions and strategies to support these students in attaining their learning objectives.

This study highlights practical implications that can be derived from its findings. It reinforces the existing evidence that game addiction significantly influences achievement emotion. This aligns with previous research (Gentile et al., 2011; Lemmens et al., 2009; Wan & Chiou, 2006; Yen et al., 2017), consistently indicating that students addicted to games tend to experience more negative emotions. This suggests that excessive gaming can be detrimental to student's emotional well-being. To address this issue, educators and parents must proactively encourage healthy behavior and promote alternative activities that

foster positive emotions and learning motivation. For example, educators can incorporate game-based learning into e-learning systems to engage students and encourage intrinsic motivation. Liu (2011) integrates computer games into teaching by incorporating digital games into the school curriculum. They provide students with a similar flow experience in studying as they get from playing games, fostering effective learning. Teachers and parents can also use board games to replace digital games face-to-face and promote students' learning. The board game was enjoyable, facilitating students' critical thinking and introducing clinical professionalism (Essop et al., 2018).

Students' positive emotions have a direct effect on intrinsic and extrinsic motivation. This suggests educators should create a positive, supportive learning environment that encourages positive emotions and motivation. To illustrate, educators have the opportunity to integrate various strategies into their teaching approach to foster positive emotions among students. These may include implementing cooperative learning, encouraging peer teamwork, assigning group projects, conducting enjoyable quizzes, and facilitating discussions. Furthermore, educators can create avenues for students to participate in activities aligned with their personal interests while also offering additional benefits such as extra rewards and positive feedback.

Game addiction has a negative effect on students' extrinsic learning motivation. Prior studies (Chiu et al., 2004; Gentile et al., 2011) reveal the negative impact of excessive gaming on academic performance and motivation. Educators and parents need to recognize the potential negative outcomes of extreme gaming on students' learning motivation. They can take steps to set a reasonable amount of time to play games and encourage alternative activities that promote extrinsic motivation, such as goal-setting, rewards, and recognition for achievements. Additionally, incorporating game-based learning into e-learning systems can provide a more engaging and motivating learning experience that is less likely to detract from students' extrinsic motivation.

Limitations and future research

The data collection for this research was constrained to include only secondary school until graduate students, which limits the generalizability of the findings to other student populations. To address this constraint, future research should involve a more diverse range of participants' academic levels, such as elementary school students and individuals in higher education, including those pursuing doctoral-level studies. By doing so, a more comprehensive understanding of the relationships between game addiction and learning motivation, game addiction and achievement emotion, and achievement emotion and learning motivation can be achieved across various age groups and academic levels. This expanded approach may unveil crucial insights into these variables that may not be apparent in the current study.

In future research, broadening the scope by encompassing a more comprehensive age range would be valuable. Additionally, it is worth exploring studies that delve into the impact of cultural or geographical variations, as these factors may substantially influence the interplay between game addiction, academic emotions, and learning motivation.

This study examines the correlation between game addiction and learning motivation; however, it did not explore the potential influence of achievement emotion as a moderator in this relationship. Future research could build on these findings by exploring whether achievement emotion moderates the relationship between game addiction and learning motivation. This would help to understand the complex interplay between these variables better and could potentially provide important insights into the mechanisms underlying the negative impact of game addiction on learning motivation.

An avenue for future research could be to extend the current research model by incorporating technological influences, particularly in e-learning systems. For example, the e-learning system's quality, information quality, and service quality could be evaluated to understand better the technological perspective on game addiction, achievement emotion, and learning motivation. This could help identify potential factors that may facilitate or hinder the effectiveness of e-learning systems and inform strategies for optimizing these systems to enhance students' motivation and learning outcomes.

Abbreviations

AEQ: Achievement Emotions Questionnaire; AVE: Average Variance Extracted; CR: Composite Reliability; eLAEQ: e-Learning Achievement Emotion Questionnaire; eLMS: e-Learning Motivation Scale; GAS: Game Addiction Scale; PLS: Partial Least Squares; SEM: structural equation modeling.

Authors' contributions

Amriza, R.N.S. developed a theoretical framework, performed data collection, and wrote the original manuscript. Husnaini, S.J. developed a theoretical framework, completed data collection, provided feedback to analyze the data, and contributed to reviewing and revising the final manuscript. Firmansyah, A.Y. contributed to data collection and data cleaning.

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Availability of data and materials

The dataset that underpins the findings of this article has been provided within the article itself.

Declarations

Competing interests

The authors affirm that they do not have any conflicts of interest.

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