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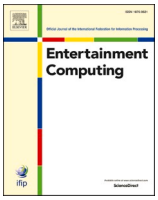

The role of video games in enhancing managers' strategic thinking and cognitive abilities: An experiential survey

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ABSTRACT

Using gamification and video games is one of the modern approaches to cognitive enhancement and improving the abilities and competencies of managers, including strategic thinking skills. Many organizations use video games in the fields of education, marketing, business, and entrepreneurship. This research aimed to investigate the role of video games in enhancing managers' strategic thinking and their potential contribution to developing cognitive capabilities. The sample included 30 students actively involved in the innovation and entrepreneurship ecosystem. To measure the strategic thinking of the participants, Pisapia's strategic thinking questionnaire was used, and the CANTAB test was employed to measure their cognitive capabilities. To identify the individuals' game-playing styles, indicators of micro-management, planning, plan recognition, predictions, gathering resources, partial observability, and damage avoidance were designed. The findings indicated that 53.3 percent of the participants had reflective thinking, 30 percent had systems thinking, and the rest had a reframing thinking style as their strategic thinking dominant dimension. On the other hand, given the identified correlation between the damage avoidance criteria with the thinking and reflective style, as well as the inverse and significant correlation of the gathering resources criteria with the results of the PRM test, it seems that strategic games have the potential to change and even develop some cognitive functions such as attention, reaction, and memory, and can be considered as tools to improve cognitive ability. These games can be used to design tasks to enhance managers' cognitive abilities and subsequently promote their strategic thinking and decision-making skills.

1. Introduction

Survival is contingent upon fulfilling environmental requirements. Similarly, the survival of a man-made entity, such as a business, depends on meeting environmental needs. As the environment changes, businesses also face more competitors and demands. When businesses operate in a dynamic, challenging, and complex environment, it is a competitive advantage that determines which organizations will survive or even thrive. Accordingly, they do their best to equip themselves with effective competitive advantages by acquiring valuable skills and rare and unique techniques to guarantee their survival in complex and constantly evolving business scenarios [1,2].

In competitive markets, the success of an organization is not only limited to meeting the tangible needs of customers, as meeting such needs can be performed by many other organizations. Success in the competitive market arises from the quality of managers' mindsets, and effective management of the organization depends on understanding the market's mentality [3,4]. Survival in a highly competitive environment requires a coordinated and integrated level of competition and cooperation. This is only possible through the promotion of strategic thinking among the managers to establish an effective mental model to enhance the quality of the organization's resources and develop business capabilities. Young entrepreneurs who are learning to lay the foundation for a successful small business and should prioritize acquiring managerial skills early on in their journey. By doing so, they can ensure that their venture is well-managed and structured as it grows, and they can adapt to the increasingly complex demands of business operations [5,6]. In other words, the promotion of strategic thinking at different levels of an organization is the most important task of its leadership to ensure its survival and sustainability and prevent its decline [7,8].

Strategic thinking and entrepreneurial activities reinforce one another at different levels of decision-making and help develop a

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business ecosystem in an evolving cycle in a manner that this two-way interaction can be deemed as the main factor behind driving and strengthening pure innovation [9]. However, many organizations, especially those seeking to enhance the entrepreneurial level of their activities, suffer from the lack of managers with strategic thinking [10–15]. Jelenc and Pisapia [15] found that dimensions of strategic thinking (as a cognitive ability) can correctly predict individual entrepreneurial behaviors. They also indicated that among the three dimensions of strategic thinking (systems thinking, reframing, and reflecting), systems thinking is the strongest predictor of all three dimensions of entrepreneurial behavior (risk-taking, innovativeness, and proactiveness). Therefore, it seems logical to assume that creating a complex systemic decision-making environment such as strategic games, as will be explained in the rest of this article, can contribute to learning entrepreneurial skills.

Using gamification and the capabilities of computer games is one of the modern approaches to improving the abilities of managers, including strategic thinking skills. Organizations already use video games in the fields of education, marketing, business, and entrepreneurship, as it is predicted that game-based learning will emerge as a platform for reflective learning in entrepreneurship topics [3,4,16]; Despite the fact that many research studies have already been carried out on using video games in the education and training of employees and managers, we are witnessing the opening of new windows of research topics amid rapid growth developments in the field which comes against the backdrop of the receptivity of the organizations. However, there are still many research areas, including the study of different genres of video games and the cognitive functions of participants' brains, that can be taken into consideration [17–22]. Given the capacity of video games in enhancing some cognitive abilities, they have been employed in other fields, including education and empowerment [20,22–24].

Despite conventional educational methods, the game-based approach demands skills and strategies to achieve desired goals, outlining diverse paths for success. There has been much progress in the field of games, paving the way to develop strategic and war games specifically designed to enhance team performance, leadership, decision-making, and strategic planning skills [25–28].

Given the capacities of computer games and their relationship with the cognitive aspects of the mind, it is more probable to design mechanisms to enhance such capabilities by identifying the cognitive nature of strategic thinking. Investigating and analyzing the relationship between the process of strategic thinking and the playing style of people while taking their cognitive abilities into account can result in identifying methods for empowering managers and entrepreneurs. This, in turn, can lead to the promotion of managers' cognitive abilities and strategic thinking. As a set of capabilities including decision-making skills, leadership skills, cognitive abilities, team functions, and many other management skills are required in many video games, the question to ask is whether RTS games can be used to enhance strategic thinking ability. The present study seeks to investigate the relationship between people's strategic thinking model and their gaming style while playing strategic games. The results of this study can help organizations and Science and Technology Parks2 enhance the strategic thinking of their managers more efficiently by improving cognitive elements via video games.

As will be later discussed in the literature review, strategic computer games offer a proper capacity to create a simulation environment for decision-making, and we consider gaming style as a surrogate variable to identify entrepreneurial behaviors. The cognitive aspects of strategic thinking will be further discussed in the literature review section. In the next phase of the research, we will review the research studies aimed at improving people's cognitive abilities via playing video games to not only explore the most important cognitive aspects related to video games but also outline a conceptual model featuring the relationship between these cognitive components and the designed performance indicators.

1.1. Ways of developing strategic thinking

Given the significance of strategic thinking in boosting organizational performance, many managers seek ways to improve this skill [29]. There are two major attitudes regarding the enhancement of strategic thinking: One view holds that the ability to think strategically is an inherent cognitive capability that is achieved over time [30]. According to the other attitude, the ability to think strategically can be learned [31].The main activities involved in strategic thinking are exploring, questioning, conceptualizing, and testing, all of which can be enhanced. Experience is one of the components of enhancing this ability, which can be acquired via learning in the environment [31,32]. Strategic thinking is a skill that can be managed and improved, which is not exclusive to a certain group of people and can be enhanced via practice and fostering some competencies. This skill can be improved and developed at different levels of the organization through a series of actions and mental exercises [33–38]. Putting the theory of games into practice and improving some competencies such as "the power to understand ecosystem," "scenario planning," and also being a "good explorer" can be effective in this field [39]. Based on the views of Olson and Simerson [40], strategic thinking consists of three central actions including evaluating the situation, identifying patterns, and making decisions, which are interconnected concepts and are considered tools used in game theory, cognitive psychology, and systems thinking. To enhance strategic thinking, it is necessary to take these concepts into account.

Strategic thinking is a personal ability affected by the context in which it comes into existence. Industry and business environment, competition, organizational competencies, characteristics of the work environment, and the organizational culture as a whole are among the contextual factors. This ability can be enhanced through training. Elaborating on the strategies and tactics used by competitors, participating in team functions, and the environment in which this ability is deemed valuable are also viewed as effective actions in enhancing strategic thinking [31]. The applications of learning theory in the field of strategic thinking are progressing increasingly to such an extent that in all three areas related to adults' learning theory, i.e. the learner, learning process, and content, strategic thinking has witnessed considerable advances [41].

The theory of experiential learning views the learning of strategic thinking as a selective process and an informal, experiential, integrated, and holistic activity that is a combination of perception, experience, cognition, and behaviour [12,42]. Sloan [37] considers implicit, unstructured, and unintended ways of learning as the principal aspect of enhancing strategic thinking ability. Following interviews with a large number of business CEOs, Sloan noticed that many of these managers acquired their strategic thinking skills through experience in unfamiliar and partly complicated environments rather than via formal learning.

1.1.1. Games and strategic thinking

Game-based learning is part of serious games and is viewed as an acceptable solution for the development of people's thinking. A lot of research has been done on its impact on cognitive learning [22]. Generally, game-based learning is more attractive to people and encourages them to do things they have been unable to do before [43]. Research suggests that game-based learning is promising for achieving cognitive outcomes [44].

Games' entry into the business literature goes back a long time [45,46]; Now, we are witnessing discussions on using competition, feedback, and scoring to encourage employees to interact more and check their performance. This technically means using gamification in business areas. It is important to explore how games can improve the behavior and skills of people and managers in formulating business strategies and even lead to the promotion of entrepreneurial thinking. Games can also enhance students' soft skills in this regard. It should be noted that games have the capacity to provide an experiential-interactive understanding of strategy on a significant scale at a low

cost [44,47–49].The use of gamification methods is not limited to business fields, as they are also used in other areas. In 2017, the US Defense Advanced Research Projects Agency (DARPA) put out a call on its website to design computer games that would train the military's future strategists as part of efforts to improve human strategies in war by using gamification. Real-time strategy (RTS), first-person shooters (FPS), and role-playing games were found to be more attractive to the players. It was not the first time DARPA used gamification to enhance the capabilities of military personnel. Back in 2003, under the project called "DARWARS," the organization used simulators to help the US military forces improve their strategic thinking for the war in Iraq and Afghanistan, and tried to use computer games to achieve this goal [50].

A 2016 report shows that the US army has been seeking to increase the strategic thinking ability of its forces through strategic games. According to the report, under the current circumstances, it is difficult to talk about cognition, which is the bottom layer of strategic thinking, among commanders as the required common and comprehensible literature has not been formed among them yet. The formation of such literature can help them successfully carry out the cognitive activities needed to enhance strategic thinking. To realize this goal, special skills and abilities are designed for commanders to improve the cognitive process of strategic thinking enhancement [51,52].

In terms of cognitive ability, people who play video games indicate relatively better visual processes than those who don't play games, which can be traced in higher-level cognitive processes and the use of more advanced strategies [53–55],Strategic games play an effective role in learning and improving strategic thinking. Some games boost problem-solving skills, with people playing more strategic games showing higher levels of problem-solving skills. At different stages of the game, some challenges and situations demand quick and correct decisions [56–58].

Strategic games teach players to gather information first and design a strategy before solving a problem. People who have played video games for a long time, compared to those who played fewer video games, show more strategic behaviors, recommendations, and opinions in their strategies to defeat the enemy [59]. Strategic games can also positively affect students' academic performance. Studies show that playing strategic games contributes to enhancing students' problem-solving skills and improving their scores significantly [57]. Given the popularity of Massively Multiplayer Online Role-Playing Games (MMORPG) and their social styles, in which the strategy of coordination and communication between players is very important, such games have already attracted the attention of many organizational researchers. Studies show that significant aspects of this style of games, such as sense-making and shaping strategies, can predict and even result in effective performance in organizations [60–63].

Almost half of the players of IBM's internal gaming community participating in a survey [64] stated that video games improved their business skills. Almost 40 % of the participants also said that they had previously used computer games to enhance their strategic thinking skills at work. Some of these skills include the ability to simultaneously gather information from various sources, the ability to make various decisions in short periods of time, the ability to manage different communication channels at the same time as well as some other skills [65].

The prevalence of video games has prompted many researchers to study their impacts and applications in various fields. Games have the capacity to not only influence people's thinking way but also change their behavioral characteristics and some functional abilities. Studies show that the social dimension of strategic thinking is conspicuously improved as a result of playing MMORPGs games. There is a relationship between a player's strategic thinking and the social processes of knowledge accumulation at the macro level [60].

1.1.2. Knowledge and strategic thinking

An individual's encounter with any subject in their surrounding environment is formed based on their mentality. Every person has unique experiences, which they view from a special point of view, resulting in their own special aspects of mentality. The human mentality is all-inclusive in some ways because it is formed based on concepts shared among humans in a common language. An external matter, such as an economic enterprise, is specific from one point of view and all-inclusive from another. Therefore, an economic enterprise is faced with various human behaviors resulting from the experience of various people's encounters, as well as the organized behavior of people with mixed mentalities.

Mentality is the basis of human interaction with surrounding subjects. Based on this view, it can be claimed that the key to the success of an enterprise is not in the real world, but in the mindset of its managers. The mentality of humans is formed based on the concepts provided by language, which serve as available bricks in the construction of a subject's mentality. Concepts have polarity, and the more positive concepts used in the construction of the subject's mentality, the better the mentality of the subject in the mind. Once the mentality about a subject, like an enterprise, is formed, any reference to that enterprise triggers each of the concepts in the human mind. In this state of recall, the concept can be considered as an association of the enterprise in the mind. For the successful management of an enterprise, positive associations must be strengthened and negative ones must be weakened or eliminated. However, the first key step is to identify the attitude of the people to be recruited by the enterprise.

Cognitive psychology, systems thinking, and game theory are the only practical and interrelated subject areas through which the nature of strategic thinking can be understood. Strategic thinking, as an individual ability, has cognitive dimensions that make it possible to find novel solutions and understand the current situation in the face of unconventional problems and move towards future goals [10,31,66,67].

A manager's strategic thinking ability is directly influenced by their cognitive abilities [68]. The cognitive capabilities of a manager enable them to engage in mental reflections that lead to the orientation of their decision-making and are considered a critical factor in exploring new paths and discovering hidden opportunities [67,69]. In other words, organizational leaders seek sustainable success by designing appropriate strategies that are technically feasible in a cognitive decision-making process [70,71], given that the formation and implementation of strategies are deeply rooted in human cognitive capacity. Studies have already shown that cognition contributes to identifying required strategies by collecting information and interpreting events [72–74].

Investigating mental functioning can help identify the common characteristics of strategic thinkers and what sets them apart. It should be noted that no tool has been developed so far to measure strategic thinking based on quantitative criteria or cognitive logic [69,75,76]. While common characteristics such as a similar personality model exist among strategic thinkers, it is a distinguishing feature for them as compared to executive or operational managers [77]. Given the relationship between strategic thinking and cognitive ability and its impact on decision-making, it is possible to analyze decisions made by strategic thinkers on various issues and challenges using their cognitive maps [78].

Olson and Simerson [40] assert that strategic thinkers have distinct characteristics formed mainly by their cognitive style rather than personality traits. According to Frederick [79], differences in cognitive ability result in variations in working memory functions, reaction speed, and visual functions, leading to differentiation in a wide range of behaviors, including risk-taking, encountering uncertain and ambiguous conditions, understanding the situation, and ultimately making strategic decisions. Regardless of differences in decision-making style, the way of viewing developments and events, and understanding environmental risks, strategic thinking processes also take place differently among managers [40].

1.2. Cognitive science and video games

As the computer game industry develops, many studies explore the effects of video games on human cognitive functions and the brain. Video games affect the cognitive components of users' brains differently depending on the time period, age, genre, and platform of the games [23,80–82]. Games in different genres have the ability to influence different parts of the brain and cognitive abilities, including reasoning, visual processing, attention, memory, multiple object tracking, perception, and problem-solving abilities [23,83–88]. Improvement has been observed in the cognitive components of spatial rotation and visualization of people who played computer games compared to the group that did not play video games. Due to their visual characteristics, action games require accurate and quick decisions and, accordingly, engage the parts of the brain related to attention and executive processes [89–92]. RTS games have the capacity to impact cognitive abilities and visual perceptual learning processes; those who played strategic-style games improved their decision-making ability and showed better performance in the learning process compared to those who had no experience in this regard. Even the music of these games affected cognitive control and led to more strategic performance [93–95]. Video games in which the player is supposed to pursue multiple goals simultaneously and the brain must process a continuous chain of visual stimuli in a short period of time affect the performance of divided spatial attention. This is due to the performance of multiple functions that require divided attention [96].

1.2.1. Cognitive architecture of strategic intelligent games

The origins of strategic games can be traced back to their cousins, i.e., board games [97,98]. As their name suggests, these games are "real-time" and take place in a setting that includes tools and structures. During the game, participants try to secure and control the position of their facilities and structures, and destroy the equipment of their opponents. The amount of construction of the units is directly related to the resources available in the game. Of course, there is competition among players to obtain resources distributed throughout the map of the game [98,99]. Technologies, facilities, and weapons used in the game, and in general, information about each player's performance, have been hidden on the map. However, players have the chance to learn about the performance of the players based on promotions in the game [100,101]. In this type of game, obtaining information about the opponent's strategies and their strengths and weaknesses is of great significance. The above-mentioned properties make the RTS games an excellent tool for research in the field of artificial intelligence(AI). Because in order to win the game, a player must master many complex situations such as resource allocation, spatial reasoning, strategic planning, as well as predicting the opponent's strategy [102–104].

In these games, just as humans seek to identify the opponent's strategy, goals, tactics, and actions, the same capabilities should also be considered for the agents' opponent to make its behavior similar to that of a human. That is the reason why artificial intelligence developers struggle to design cognitive agents and architectures of computer games based on human behavior, which is, of course, a challenging task. Accordingly, some of the most important tasks of the game for which mechanisms must be designed in terms of computational intelligence include micro-management, planning, plan recognition, predictions, gathering resources, partial observability, and damage avoidance [105–108].

2. Material and methods

The purpose of this study is to investigate the relationship between cognitive abilities, strategic thinking, and gameplay in real-time strategy (RTS) video games. The unique characteristics of RTS games led the researchers to explore whether playing these games could improve cognitive abilities related to strategic thinking. To achieve this goal, the cognitive dimensions of strategic thinking and video games were identified by reviewing previous research studies, and a collection of tests was selected to measure these components. Specifically, Pisapia's strategic thinking questionnaire and the Cambridge Neuropsychological Test Automated Battery (CANTAB) were chosen due to their accessibility and ability to measure the relevant cognitive components. The study then measured the cognitive abilities and strategic thinking of participants and examined the way they played Command and Conquer: Generals, a popular RTS video game developed by Electronic Arts EA Games in 2003 and 2004. The study used the Conquer: Generals - Zero Hour & Command version of the game. Pisapia's questionnaire was used to measure strategic thinking, and the CANTAB tests were used to assess cognitive abilities. Additionally, the study used indicators of micromanagement, including planning, plan recognition, predictions, gathering resources, partial observability, and damage avoidance, to measure players' game-playing styles.

2.1. Measures

Data related to strategic thinking was collected using the Pisapia strategic thinking questionnaire [109]. The questionnaire contained questions on the participants' demographic information, such as gender, age, number of hours spent playing video games per week, and favorite games and genres. The Strategic Thinking Questionnaire (STQ) assesses individuals' information-gathering and analysis skills when faced with complex decisions, and consists of statements related to thinking abilities. The questionnaire includes 25 questions designed to evaluate participants' strategic thinking abilities in the dimensions of systems thinking, reflection, and reframing. STQ is a standard questionnaire used in many studies given its high content validity [110–112]. Also, in order to assess the reliability of the questionnaire, a sample of answers given by 30 people in an online pre-test was checked. The data were analyzed by the SPSS software and the Reliability rate was calculated using Cronbach's alpha test. The results are as follows (Table 1):

To measure cognitive ability, the CANTAB (Cambridge Neuropsychological Test Automated Battery), a neuropsychological test used to assess cognitive functions of the neural networks of the brain, was employed. This test can process visual memory, working memory, attention, and other cognitive aspects. In this method, the subject is seated in front of a touch screen monitor, and based on the type of test (memory, attention, etc.), images and patterns are displayed on the screen that the participant must select by touching[113,114].

The way participants play was examined using the indicators of micromanagement, planning, plan recognition, predictions, gathering resources, partial observability, and damage avoidance. These indicators are among the most important tasks in RTS games [115].

2.2. Participants

The participants in this study were 32 Early-stage young entrepreneurs between the ages of 18 and 30 who were either studying in fields related to entrepreneurship and engaged in nascent startups while incubators aimed at fostering their development into proficient managerial figures in Iran. All of these individuals were interested in playing strategic games, particularly the game Generals. The participants had spent an average of 34 h per week playing computer games over the past year.

Alonso, Diaz and Peris [116] argue that in order to train a generation

Table 1
Cronbach's alpha test results.

Cronbach's alpha	Variables
0.834	Strategic thinking
0.865	Reflective
0.801	Systemic
0.746	Reframing

of young entrepreneurs, special institutions should be established in universities to teach innovation and entrepreneurship simultaneously. They describe the purpose of this educational model as creating a set of tools and methodologies in the university that will help students to form their mental model not only as an expert but also as an entrepreneur so that they can complete their academic courses, create their own businesses, and develop the necessary skills and capabilities for the growth and survival of these businesses. Based on this basic logic, the sample for the present study was selected from active students in the ecosystem of innovation and entrepreneurship.

2.3. Procedure

To find people who met the necessary qualifications for participation in the research, notices were distributed at university dormitories and game-playing centers across Tehran. The researchers also published calls on social networks and online groups of game players, offering prizes to the participants of the study. After completing the Pisapia strategic thinking questionnaire and obtaining the required permission from the Ethics Committee of the University of Medical Sciences, and after completing the consent letter from the National Brain Mapping Laboratory, CANTAB tests were given to each participant. It took approximately 30 min for each participant to take the test. Out of the 32 tests, 30 met the clinical standards and CANTAB test instructions and were considered valid. All of the CANTAB tests were carried out, and the strategic thinking questionnaires were filled out at the National Brain Mapping Laboratory. From all the CANTAB tests (25 tests), those related to the evaluation of attention, memory, and reaction speed were selected. These tests include:

Motor Screening Task (MOT): This test is one of the series of screening tests offering a general evaluation of the subject in terms of sensorimotor and perception. The duration of this test is 2 min.

Paired Associates Learning (PAL): This test measures visual memory and is included in the category of episodic memory.

Pattern Recognition Memory (PRM): This test measures visual recognition and is included in the category of memory tests.

Spatial Working Memory (SWM): This test is classified under the tests of executive functions. It is used to measure working memory and strategic planning.

Reaction Time (RTI): The reaction speed evaluation test, which is defined as an attention test, has been designed to measure the speed of the person's mental and motor reactions and the level of accuracy [113,117].

Each participant was asked to play a similar level of the game, and their performances were monitored to collect the required data and observe the indicators in question, which included the following:

- Gathering resources: Gathering more resources makes it possible to expand structures. Access to more resources ultimately creates a greater competitive advantage for the player [105,118].In this game, equal initial resources are allocated to all players. The game map has multiple resources that players try to find, attract and maintain during the game. A report of all collected resources is provided at the end of the game.
- Partial observability: In RTS games, players are only fully aware of their own territory, and the type of constructions and facilities of the opponent and their defensive and offensive mechanisms are hidden from them. This feature adds a level of uncertainty to the game, making players unaware of when and how they come under attack [118]. At the same time, some equipment has been developed that makes partial observation of the victory of the players possible [119]. The amount of using these tools during the game by each player was limited and recorded.
- Damage avoidance: The style in which each player plays the game affects the amount of damage inflicted on them. One of the most critical functions during the game, in particular, is the series of actions taken by the player to reduce the amount of damage inflicted on their forces and facilities [105]. At the end of the game, a report is released indicating the number of units and facilities each player has lost.

3. Results

The following results (Table 2) were achieved eafter analyzing the questionnaires and ranking the answers based on strategic thinking style.

In the first step, the Kolmogorov-Smirnov test was used to check the normality of the data so that the other necessary tests can be given in the next stage. As the results suggest (Table 3), the sig value of the test statistic for all variables is less than 0.05 or the error value. So it can be concluded that the data is normal.

Analysis of variance (ANOVA) was used to investigate whether a feature such as age affects the components of strategic thinking. From the data provided in the table below (Table 4), it can be seen that since the significance of all components is greater than 0.05, it can be concluded that there is no significant difference between the age of people and the components of strategic thinking in terms of the average of the components.

Correlation and regression tests were used to find the correlation between the variables, and based on the obtained data, the regression correlation between some variables was discovered and the Pearson correlation coefficient was determined.

The results show (Table 5) there is a strong inverse correlation of 0.393 between Gathering resources and the PRM test; On the other hand, it can also be seen that there is a direct correlation of 0.375 between the Damage avoidance component and the SWM test. Accordingly, there is an inverse correlation of 0.394 between the Damage avoidance and the Reflecting component. Since this test measures the executive function of the brain, it is in line with the findings of many previous studies such as [120–124].

Based on research findings [125], SEM is a multivariate statistical method that allows for the analysis of a comprehensive model involving both observable and underlying constructs. SEM can be utilized for explanatory and predictive research objectives. When analyzing survey data to assess the appropriateness and suitability of a model's components, it is recommended to employ the Partial Least Squares SEM (PLS-SEM) approach [126]. The Partial Least Squares Structural Equation Modeling (PLS-SEM) has some notable differences compared to the Covariance-Based Structural Equation Modeling (CB-SEM). The PLS-SEM does not follow the same requirements as CB-SEM and is considered more flexible. Additionally, PLS-SEM provides certain benefits such as the ability to work with smaller sample sizes [127]. In order to analyze the conceptual model presented in the research in terms of the relationship between the variables, the Structural Equation Modelling method (SEM) was used and the path and regression coefficients were also analyzed. AMOS v26 software was used for this purpose. In this modelling method, the relationships between cognitive elements, game dimensions, and strategic thinking dimensions are examined. Following the initial analysis, a Partial Least Squares Structural Equation Modeling (PLS-SEM) was performed to create a model designed to quantify and evaluate the relationships derived from theoretical deductions and

Table 2
Frequency and distribution of people's strategic thinking style.

variables	Frequency	Relative frequency	Cumulative relative frequency
Systems thinking	9	30 %	30 %
Reframing	5	16.7 %	46.7 %
Reflective thinking	16	53.3 %	100 %
Total	30	100 %	

Table 3
Kolmogorov-Smirnov statistical test of Normality.

Variable Range	Variable	Number	Standard Deviation	Kolmogorov-Smirnov	Sig	Normality status
Game Style	Gathering resources(Net)	30	1163005.16	0.158	0.055	Normal
	Damage avoidance(Net)	30	2.55	0.143	0.123	Normal
	Partial observability(Net)	30	0.01	0.108	0.2	Normal
Cognitive Test	PRM (Pattern recognition memory)	30	105256.01	0.107	0.2	Normal
	PAL (Pair associate learning)	30	10.64	0.129	0.2	Normal
	SWM Strategy(Spatial working memory/Strategy)	30	33.27	0.138	0.152	Normal
	RTI five/simple-choice reaction time	30	706.15	0.112	0.2	Normal
Thinking Style	Systems thinking	30	0.33	0.141	0.134	Normal
	Reframing	30	0.246	0.142	0.124	Normal
	Reflecting	30	0.252	0.125	0.2	Normal

Table 4
ANOVA test of ST dimension among different Age groups.

		Sum of Squares	Degree of Freedom	Mean of Squares	F	Significance
Systems Thinking	Intergroup	5,093	14	0.364	1.196	0.367
	Intragroup	4,564	15	0.304		
	Total	9,656	29			
Reframing	Intergroup	3,705	14	0.265	1.161	0.387
	Intragroup	3,418	15	0.228		
	Total	7,123	29			
Reflective Thinking	Intergroup	4,469	14	0.319	1.687	0.163
	Intragroup	2,839	15	0.189		
	Total	7,308	29			

Table 5
Correlation intensity found between cognitive components and game style dimensions.

Variables	PRM	SWM	RTI	PAL	Reflecting
Gathering resources	−0.393	−0.053	−0.18	0.215	0.315
Damage avoidance	0.07	0.375	−0.053	−0.044	−0.394
Partial observability	−0.011	−0.022	0.347	0.333	−0.105

existing empirical evidence[125]. Furthermore, The authors utilized G* Power 3.1.9.4 software by relying on a power analyses to determine the minimal sample size required for the analysis and provide sufficient statistical accuracy[128,129]; At a significance level of 5 % (α = 0.05), above software advised to have a sample size of 30 observations.

Structural equation modelling for regression analysis (Fig. 1) indicates that a significant relationship can be found between game-playing indicators and some cognitive elements as well as strategic

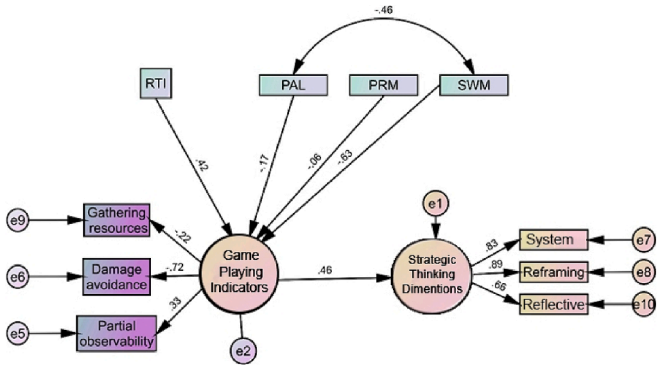

Fig. 1. Illustration of a structural equation modelling.

thinking dimensions. The correlation between the strategic thinking variable and the game is 0.46 and the regression coefficient for the game profile variable and cognitive tests RTI, PAL, PRM, and SWM are 0.63, 0.06, 0.17, and 0.42, respectively. Given the error rate of $\chi 2$ or CMIN, it can be said that as the value is 1.1202, which is less than 3, the model has a good fit.

4. Discussion

This study aimed to explore the relationship between strategic thinking dimensions, cognitive components, and video game playing style in the strategic genre. The study attempted to use the cognitive benefits of video games to improve thinking skills. Previous studies have explored the cognitive aspects of video games, but few have dealt with strategic thinking and video games for entrepreneurship purposes using a cognitive approach. This study designed and employed performance measurement indicators for players using a cognitive approach and utilized Command & Conquer: Generals - Zero Hour game for the first time.

The study investigated the relationship between the components of the developed model and collected and analyzed data through statistical tests. The target group for the study was early stage entrepreneurs who are on the career path of becoming professional business leaders.

The results of the study confirmed that reflective thinking is the dominant thinking style (53.3 %) among the participants. The results of the study were consistent with previous research on reflective thinking. Reflective thinking has been identified as a critical component in the field of entrepreneurship and also suggest that the social aspect of strategic thinking is influenced by reflective thinking [130–132]. The study found a correlation between the reflective thinking dimension and damage avoidance indicator, indicating that people who play RTS games mostly have reflective thinking characteristics, and their game strategy is to minimize damage to their facilities, equipment, and weapons. This

application can prove to be extremely beneficial when it comes to recruiting and onboarding personnel who are employed in high-risk sectors and operate sophisticated and expensive machinery. Some research findings suggest that certain games can stimulate players to think about relevant things while gaming, and the process of reflection plays a crucial role in the learning process [133–135]; the ability of reflective thinking (which is a necessary component of strategic thinking)exhibited a positive correlation with performance in multi-player online battle arena (MOBA) video games [93,136].

However, the study suggests that more research is required to generalize this finding and find the relationship between this behavioral style and the organizational performance of people, particularly in terms of protecting equipment and facilities. The study conducted ANOVA tests to check the normality of the data and found no significant difference between the age and the components of strategic thinking of people.

On the other hand, the structural equation modeling for regression analysis showed that a significant relationship can be found between game style, cognitive elements, and strategic thinking components. The correlation between the strategic thinking variable and the game was 0.46, and the regression coefficient for the game profile variable and cognitive tests RTI, PAL, PRM, and SWM were 0.63, 0.06, 0.17, and 0.42, respectively. Given the error rate of $\chi 2$ or CMIN for the model, it can be said that as the value was 1.1202, which is less than 3, the model has a good fit.

Multivariate regression analysis was performed, and accordingly, correlation tests between game components and cognitive tests, correlation tests between cognitive tests and strategic thinking components, and correlation tests between game components and strategic thinking were administered. The correlation between the indicators of the game and the cognitive tests, given their significant values, showed that there is an inverse and significant correlation between Gathering resources as one of the components of the game and the PRM cognitive test. In other words, it can be seen that the lower the score people gained in the PRM test, the higher the percentage of errors in their memory performance test, and on the other hand, in order to defeat all enemies and finish the game, they needed to attract more resources from the main base and the surrounding area. In contrast, the people who scored better in the PRM test needed fewer resources to finish the game. As the PRM test is used to measure memory, the results were in line with the findings of previous studies on the relationship between memory and playing computer games [124,137–142]. Much research indicates that expert gamers exhibit superior cognitive skills in various domains. They demonstrate better executive function, emotion recognition, cognitive flexibility, overall cognition, and memory. Their ability to switch between tasks was faster, they were able to detect changes to objects stored in their visual short-term memory more efficiently, they could track fast-moving objects with greater precision, and they were able to mentally rotate objects more efficiently [124,139,140,143,144]. It appears that these individuals have effectively completed the game with greater efficiency. it could be utilized to create assessments that can assist in the selection of more proficient managers in the field of resource management.

On the other hand, there is a significant and positive correlation between another component of the game, which is Damage Avoidance, and the SWM (Spatial Working Memory) cognitive test. This means that those who had better spatial memory performance were able to manage the game in a way that less damage was inflicted on their facilities and forces. It may be argued that as spatial working memory requires the ability to actively keep spatial information in working memory for a short period of time, better performance of this part of the brain prompted the player to attach significance to the strategic points of the game and use tactics to prevent any damage to these points. Since the SWM test measures the working function of the brain, its results are somewhat in line with similar studies exploring working memory while playing games [120–124]. As we said before, damage avoidance is one of the most important tasks of the game and AI agent in a real-time strategy (RTS) game. The growing literature on (AI) in commercial gaming is a clear reflection of the rising need for more advanced game AI systems [145]. The result of this study could help to connect the game engine with a cognitive architecture to improve its performance. Research and investigations into identifying and predicting the actions of Real-Time Strategy (RTS) game players have gained significant attention in recent years [146–150]. The ability to perceive and discern a player's playing style and strategies can be instrumental in understanding their strengths and weaknesses, crafting effective counter-strategies, and advancing AI research. Such predictive models can enable developers to create more intelligent and challenging game opponents [151–154].

This study used the CANTAB test for the first time in the field of video game studies, while many researchers have already used other tests and tools to measure cognitive ability [87,89,155,156]. It also employed the Pisapia strategic thinking assessment questionnaire for the first time in the field of video games. In addition, the authors of this article, for the first time, used the Pisapia strategic thinking questionnaire and CANTAB tests to explore the relationship between the dimensions of strategic thinking and cognitive abilities in early-stage young entrepreneurs. The performance indicators selected to measure the performance of players in the game were designed by the researchers themselves for the first time. As mentioned earlier, the idea was based on the artificial intelligence mechanisms designed by the cognitive architects of the RTS games [105–107,115]. In general, studying the above components together, i.e. the dimensions of strategic thinking, cognitive abilities, and performances while playing the game, is among the innovations of the present research.

The findings of this study can contribute to designing better tasks to improve people's cognitive abilities. Some research suggests that different video game genres have varying effects on cognitive control [157–159]. Strategy games, due to their unique characteristics, may have specific effects on proactive and reactive cognitive control [157,160]. Also, as previous studies have shown, video games in a certain genre can improve some people's cognitive abilities [23,94,95,161–163]. On the other hand, if an organization needs employees with a reflective thinking style, it is possible to identify these people or at least promote such a capability among its own staff through some computer games.

Given the difficulties in identifying and recruiting competent human resources, the new approach presented in this study, i.e., the use of cognitive tools, can be very helpful and significantly reduce the complications that exist in other methods. Novice entrepreneurs require support throughout all stages of their entrepreneurial journey, from the start-up phase to the midpoint and end-point. In addition, entrepreneurs need to acquire skills in order to prepare for future challenges. Integrating entrepreneurship education with industry can improve students' career readiness. To facilitate this connection between the university and industry, an innovation and business ecosystem has been established in the university, complete with a network of business programs and effective support systems. This ecosystem enables entrepreneurial young students to acquire the skills necessary to continue their career paths. Incubators are designed to foster the development of managerial competencies, preparing them to overcome challenges and difficulties associated with starting and running a business at high levels of the organization [164–168].

This research can pave the way for designing video games for students to improve cognitive abilities related to management skills at all management levels of the organization. Of course, more research needs to be done in this regard, but it may be possible to create a cognitive profile for each employee in the future. In addition to the existing methods used for training employees, the capacity of video games can also be taken into account. It may be possible to design training tasks to further empower employees while actively engaging them in entertaining games.

Using video games as a method for empowering and training

students, early stage entrepreneurs and employees has already attracted a lot of attention [4,49,169,170]. As mentioned earlier, many studies show that people who play video games have better abilities in some areas compared to those who don't play such games. It could be a good idea to consider certain criteria, such as a candidate's level of experience with video games and their preferred gaming genre, when selecting staff for an organization. This approach can help to identify individuals with relevant skills and interests.

Future studies can conduct the present research for different age groups with multiple thinking styles. The sample of the present study included entrepreneurs, but future studies can use diverse samples from marketers to public policymakers. It could also be a good idea to measure the strategic thinking of people before and after playing RTS games for a specific period of time to see whether such games can help enhance their strategic thinking capabilities. As most of the people who participated in this research had a reflective thinking style, future studies could bring about interesting results regarding the relationship between reflective thinking style and the genre and amount of video game play. Ethnographic studies have already identified the relationship between strategic thinking styles and MMORPGs. Outstanding results may be achieved if future studies explore the relationship between RTS games and strategic thinking style. Several limitations of the current study must be acknowledged; Firstly, while the participant size in this study was less than in many previous studies, it is preferable to have a larger number of participants per condition to enhance statistical power. Due to the limited number of students who were entrepreneurs in incubators and startups, particularly in the business field, and also played computer games, specifically RTS games, our sample size was small. The CANTAB test had to be conducted using the official version, and the only laboratory in Iran that met the researcher's specifications was already catering to the requirements of multiple researchers. As a result, specific arrangements and limitations were made to accommodate the needs of the researcher.

The majority of academic papers on the topic of games in business focused on the potential benefits of games for learning discussed the design of games, or presented theoretical frameworks for game design. However, many of these papers lacked empirical evidence to support the positive impacts and outcomes of games in regard to learning and engagement we tried to find empirical evidence in our study. The research in this area is interdisciplinary, reflecting the varied backgrounds and interests of researchers, and includes a wide range of applications and uses for video games. This research makes a significant contribution to the literature on video game training. it sheds light on the intricacies of the subject matter and offers insights that can help inform future studies and practical applications by: (1) Improving cognitive functioning through training in a real-time strategy video game has been shown to be effective in various demonstrations, (2) It is possible to demonstrate a correlation between enhancements in cognitive functioning and particular improvements in in-game performance, and (3) Using video games as a method for empowering and training people and employees.

The present study was conducted in accordance with the recommendations of the Research Ethics Committee of the IUMS's (Iran University of Medical Sciences) Ethical Review Board, which approved the trial. The ethics.research.ac.ir database (ID: IR.IUMS.REC.1399.1140) contains registration information for this clinical trial. Before the study began, all participants provided written informed consent and were informed of their right to withdraw from participation at any time.

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CRediT authorship contribution statement

Omid Ghasemi: Resources, Methodology, Investigation. **Mohammad Abooyee:** Writing – original draft, Formal analysis, Conceptualization. **Somayeh Labafi:** . **Mansour Shirzad:** Data curation.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

Data will be made available on request.

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