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Mind games' potential to increase learning: worth investigating further

Потенціал інтелектуальних ігор для покращення навчання: варто подальшого дослідження

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Abstract

Gamification has been used to address educational challenges on a constant basis, but a gap remains in the effects of mind games on executive functions such as memorization, creativity, and cognitive flexibility. The current study outlines the influence of mind games for exploratory behavior and exploitatory behavior on memorization, creativity, and cognitive flexibility. These games were analyzed from the viewpoint of exploration-exploitation types' characteristics. For quantitative data analysis, the paired t-test was carried out to compare pre- and post-experiemntal results, whereas the independent sample t-test was used for determining which set of mind games exerted more effect. Results demonstrated the prevalence of mind games for exploratory behavior on students' memorization, creativity, and cognitive flexibility.

Анотація

Гейміфікація постійно використовується для вирішення освітніх проблем, але залишається прогалина у вивченні впливу інтелектуальних ігор на запам'ятовування, творчість та когнітивну гнучкість виконавчих функцій. У цьому дослідженні описано вплив інтелектуальних ігор на дослідницьку та експлуататорську поведінку на запам'ятовування, креативність та когнітивну гнучкість. Ці ігри були проаналізовані з точки зору характеристик типів "дослідництво-експлуатація". Для кількісного аналізу даних було проведено парний t-тест для порівняння результатів до і після експерименту, тоді як незалежний вибірковий t-тест використовувався для визначення того, який набір інтелектуальних ігор мав більший ефект.Результати продемонстрували переважання інтелектуальних ігор для

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Keywords: exploratory behavior, exploitatory behavior, mind game, creativity, memorization, cognitive flexibility.

дослідницької поведінки на запам'ятовування, креативність та когнітивну гнучкість студентів.

Ключові слова: дослідницька поведінка, експлуататорська поведінка, інтелектуальні ігри, креативність, запам'ятовування, когнітивна гнучкість.

Introduction

In the continually expanding field of education, the development of innovative techniques to improve learning outcomes remains a vital priority. Among the different ways examined, the employment of mind games—also referred to as cognitive training games—has attracted substantial interest. These games are deliberately created to challenge and stimulate diverse cognitive functions, hence holding potential to greatly alter learning processes and outcomes. Despite their growing popularity among educators and learners, the empirical validation of their effectiveness continues to be a contested issue within the academic community.

Mind games are hypothesized to augment cognitive abilities such as memory, creativity, and cognitive flexibility, all of which are integral to effective learning. Preliminary empirical studies have reported promising results, indicating that regular engagement with these games can lead to quantifiable improvements in cognitive function and academic achievement. Reseachers addressed the issues of their effect in the domains of education of philosophy and logic, general knowledge, and skill level (Duman et al., 2023; Güneri & Korkmaz, 2023). An intriguing area in the field of mind games are comprehensive advantages for effective use of leisure time and their effects on memory and cognitive skills (Melike, 2021). However, the existing research is characterized by a heterogeneous mix of methodologies and varying degrees of methodological rigor in the multidimensional development of students, resulting in a body of evidence at different grade levels.

Furthermore, another important research issue correlated with mind games is exploratory and exploitatory behavior in learning. The significant performance implications of exploratory learning and exploitative learning have come to the fore in studies about their contingent value in active learning (Lyu et al., 2023). Despite the growth of learning literature about the exploration-exploitation spectrum, there is a research gap in the effect of some specific types of mind games with exploratory and exploitatory behavior on creativity, memorization, and cognitive flexibility. No one, to the best of our knowledge, has delineated this issue before to provide more definitive guidance regarding their application in educational contexts together with the advancement of mind games' effect on memory, creativity, and cognitive flexibility.

Given the potential of mind games to transform educational practices within the exploration-exploitation spectrum, there exists a pressing need for more sophisticated and methodologically rigorous research. This paper endeavors to reveal if playing mind games that encourage exploratory or exploitative behavior affects memory, creativity, and cognitive flexibility.

We address the following research questions:

1. Does playing mind games that encourage exploratory or exploitative behavior affects memory, creativity and cognitive flexibility?
2. Which mind games lead to larger gains in memorization, creativity and cognitive flexibility?

The rest of the paper is organized as follows: The introduction presents and discusses findings about mind games and exploratory and exploitatory behavior. The literature review highlights the influence of mind games on creativity, memory, brain plasticity, and the exploration-exploitation spectrum within them.

Methodology includes information about participants and research instruments. Results and Discussion present and discuss the outcomes of the experiment, and it is defined if mind games with exploratory or exploitatory behavior are better. Conclusion and limitations present summaries of the research paper.

Literature review

The number of research papers sheds new light on the mind games as effective guides in the framework of education programs (Esentaş, 2021; Anunpattana et al., 2021). In a study by Turkoglu, it is determined that "game-based cognitive development programs" have a crucial impact on children (Turkoglu, 2019). With this in mind, the impact of learning activities based on mind games on creative abilities has been inverted (Mustafa, 2023). The creative problem-solving scale was administered to students in the control and experimental groups and revealed the positive effect of mind games on divergent thinking, convergent creativity, general knowledge, and skills subdimensions of creativity together with academic success. Paralellism between the results obtained compared with literature and the results of research related to creativity was determined in reviewed research papers (Vidal, 2010).

Following these results, there has been a cluster of recent studies on expanding memory through scientifically designed games (Heiman, 2014). They focus on assessment of paricipants' neuropsychological status (Hesselberth & Schuster, 2008). The research gap is revealed in the lack of evidence about the influence of brain boosters on memory as the results of memory tests.

There is an emerging paradigm of game-based learning predicated on theories of situated cognition and overall efficiency of cognitive skills (Pitic & Pitic, 2022) but there is a lack of studies about the influence of mind games on cognitive flexibility.

The reviewed research paper by Franciosi S., suggests that simulation games can induce learners to generate multiple connections between new vocabulary and episodic, emotive, motor-sensory, and linguistic memory networks (Franciosi et al., 2016) The main point is that specifically vocabulary and memory games have been investigated. Within this scope, the studies have been subject to the number of merits due to them. Research on mind-game films has tended to focus profoundly on crossmemory practices by enlarging the possible manipulations of inconsistent memory related to mind games (Hesselberth & Schuster, 2008).

We initiated research to highlight the possibility of memorization, creativity, and cognitive flexibility improvements due to mind games without exposure to vocabulary content, so-called mind games or brain boosters for exploratory and exploitatory behavior. There remains a paucity of evidence if the previously mentioned executive functions that enable individuals to plan, focus attention, remember instructions, and juggle multiple tasks successfully are changed after playing mind games.

Exploratory behavior and exploration in active learning have received scholarly attention in recent years (Han & Fan, 2021; Liquin & Gopnik, 2022; Hera et al., 2022; Kuang et al., 2023; Lyu, 2022). The most striking results of research are conditions that induce exploratory behavior tasks with complex and dynamic decision-making characteristics (Hardy et al., 2014), error-framing instructions on exploration (Hardy ety al., 2014), specific stimulus information (what), spatial location (where), contextual information (which), observational recency and time of day (when) (Johnson et al., 2012).

The combined version of exploratory-exploitative learning balance has been investigated profoundly in salesperson's self-regulated learning (Han & Fan, 2021). The exploration-exploitation spectrum is differentiated by the state of mind openness dimension. N. Herz outlines findings about openness as a dynamic state that variates from the ability to rely on existing knowledge (Herz et al., 2020) and perform the actions that you know are already awarding (exploitation) to the ability to learn something new, explore the environment, to do search, risk-taking, discovery and use flexibility (Millar et al., 2017). Exploratory behavior in learning is characterized by encoding information in a more meaningful way in the following types of exploration: guided, random, directed and enactive. (Bell & Kozlowski, 2008; Liquin & Gopnik, 2022).

Mind games for exploratory and exploitatory behavior have been analyzed from the viewpoint of exploration-exploitation types' characteristics. These games are open for access only after prior and free of charge registration.

Table 1.
Mind games for exploratory behaviour

	Names of mind games for exploratory behaviour	Exploration types' characteristics
1.	**Task-switching** You are given questions and you have to respond them yes/no. You are shown pictures and you have to define if they match with previous ones. https://www.brainturk.com/taske?tour=1 (Multi Task Switching game (2023, July 29))	Enactive exploration No guidance Train brain's flexibility to think about multiple concepts simultaneously by adapting exploratory behavior to new task-switching circumstances the learner chooses to explore options which will be more informative
2.	**Inhibition** Hit the moles of the target color as fast as you can. Avoid the moles with dynamites and double tap those with helmets. https://www.cognifit.com/aplicaciones/html5/index/game/whack-a-mole (CogniFit. Brain Training. Whack-a-mole (2023, July 29))	Guided exploration (tutorial before the game) External direction on learning and development opportunity progress Ability to adapt behavior to new circumstances
3.	**Planning** Blocks of various shapes are arranged to create layers https://www.cognifit.com/aplicaciones/html5/index/game/blockout ((CogniFit. Brain Training. Blockout (2023, July 29))	The learner chooses to explore options which will be more informative Enactive exploration No guidance Inductive learning promoted in creating new different layers The learner chooses to explore more options overall

Designed as compiled by the authors

This table highlights types of mind games for exploratory behavior in correlation with guided, random, directed, and enactive exploration types' characteristics. Students mostly demonstrate enactive exploration, which includes elements of self-guided exploration and error management with no guidance. While active exploration characteristics are inherent to chosen task-switching and planning mind games and can hence be seen as fostering inductive learning, which includes inquiry and just-in-time learning, guided exploration with tutorials is appropriate to inhibition mind games. Relevant exploration types' characteristics also operate as a mediator between learners' active participation in self-regulatory tasks and their disclosure of exploratory behavior in regard to the strategic maneuvers and psychological tactics employed by participants to get high scores.

Table 2.
Mind games for exploitatory behaviour

	Names of mind games for exploitatory behaviour	Exploitation types' characteristics
1.	This addictive game challenges to think ahead and anticipate the ball's movements. The goal is to predict the path of a bouncing ball and select the correct hole where it will ultimately land. https://www.theepochtimes.com/epochfun/bounce-predicition-4077497 (The Epoch Times (2023, July 29))	Rely on existing knowledge of prediction without task-switching and inhibition
2	Place the coloured balls to match the example. https://www.mentalup.co/samples/game-v2/game18?referrer=brain-booster-games&page=Desktop&ga_dp=%2Fblog%2Fbrain-booster-games (MentalUP (2023, July 29))	Follow one example Rely on existing knowledge of prediction without task-switching and inhibition
3	Jackson drove the tractor to check on the crops. What do you predict that he does next? https://www.tinytap.com/activities/g4i4r/play/making-predictions (Making Predictions (2023, July 29))	Limited options and rely on existing knowledge

Designed as compiled by the authors

The table 2 highlights types of mind games for exploitatory behavior in correlation with such exploitation types' characteristics as limited options and relying on existing knowledge. These chosen mind games

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provide all conditions for exploitatory behavior. Their robustness is observed across predicative nature of these mind games and students' ability to make inferences based on their prior knowledge and beliefs.

Our study contributes to the literature in several ways. We leverage these mind games to investigate which group of mind games (exploratory or exploitatory behavior) effects creativity, memorization, and cognitive flexibility better. We illustrate the potential of positive effects of mind games on correlated constructs that share a common cognitive basis in high-level cognitive processes and develop a reliable and valid scale for measuring the effect of mind games on creativity, memorization, and cognitive flexibility.

To achieve this goal, specific theories have been created. We predict that mind games will be more successful in encouraging exploratory behavior for three reasons. So the first hypothesis is that the effects of mind games for exploitatory behavior on creativity, memorization and cognitive flexibility are lower than the effects of mind games for exploratory behavior.

Firstly, with the adaptive transfer performance of exploratory behavior to new task-switching situations to examine the world, articulation of the cognitive process pathways will be more effective. Second, exploratory learning in active learning approaches shapes the cognitive learning processes that support self-regulated learning and metacognitive activity. Researchers have developed a number of discrete learning interventions, including guided and enactive exploration, to align them with trainees' cognitive self-regulatory behavior (Bell & Kozlowski, 2008). Third, inquiry-based learning processes are best facilitated by exploration, which is appropriate for learning forward models in the reinforcement learning paradigm. (Kuang et al., 2023). Inquiry-based learning promotes the general effectiveness of the educational process by enhancing cognitive flexibility, creativity, and memorization.

In contrast, mind games for exploitatory behavior are limited with fewer options and adhere to proven existing skill sets that utilize known knowledge and capabilities to enhance performance.

The second hypothesis is that the effects of either mind games for exploratory behavior or mind games for exploitatory behavior on creativity, memorization and cognitive flexibility are the same.

Our current study aims to elucidate the observed performance differences in the groups of participants due to the influence of mind games for exploratory and exploitatory behavior on the mentioned correlated constructs.

Methodology

The participants of the experiment were two cohorts of 2nd year students (totaling 60) enrolled in the course "General English " at National University of Water and Environmental Engineering. The intervention with the mind games lasted two weeks.

Participants were assigned to two groups. One experimental group (30 students) was given the set of games of exploratory behavior. They played such mind games as task-switching games (Multi Task Switching Game, 2023, July 29), inhibition brain games (CogniFit. Brain Training. Whack-a-mole, 2023, July 29), and planning mind games (CogniFit. Brain Training. Blockout, 2023, July 29).

Another control group (30 students) played mind games for exploitative behavior. They played the following prediction mind games (The Epoch Times, 2023, July 29), (MentalUP, 2023, July 29), (Making Predictions, 2023, July 29).

Participants were voluntarily recruited through announcement to receive course-credit in the discipline "General English " for participation. The students were aged 19-20 years old and were asked to play mind games and pass tests during class time. They gave informed consent to take part in the study. There was a single-blind study because the study was conducted with no knowledge of the group to which they were allocated.

The independent variables of the experiment were: 1) the number of participants in the experimental training; 2) duration of the experimental training. The dependent variables were results of pre- and post-experimental tests on creativity, memorization and cognitive flexibility.

Tests were given before and after playing mind games to gauge students' capacity for creativity, memorization, and cognitive flexibility. The test questions align with the theoretical foundations of the above-mentioned cognitive functions and effectively represent the constructs measured. The mean scores of the creative, memorization, and cognitive flexibility scores (in the context of the experimental and control groups) were calculated in total through the statistical program JASP.

The short-term visual memory test for images was used to match test questions to participants' memorizing abilities. "Testing" is also called "active recall" or "retrieval practice." In the study about retrieval-based concept mapping by Blunt J., the method the students used to test their recall as "recalling as much of the information as they could on a free recall test" has been elaborated (Blunt & Karpicke, 2014). Such tests are supposed to be an efficient measurement of the ability to be engaged in the process of active recalling. The effectiveness of such kinds of short-term memory tests was verified by Jennifer M. Verive's research paper (Verive & McDaniel, 1996). With this simple test, they were capable of testing their short-term memory for images. Students had to memorize as many of the 16 pictures as possible within 20 seconds and choose among 32 different pictures on the result entry page.

Creativity was checked via the creative ability test, based on Frank Williams' theory of creative thinking (Williams, 1979). This test measures creative ability by means of a self-rating questionnaire. Such kinds of tests belong to the measurement of creative thinking in the general domain. Research findings show that creativity tests can be used as an objective measure of creative abilities (Althuizen et al., 2010).

This creativity assessment was in percentage score and included a general creativity scale on the four dimensions: curiosity, complexity, imagination, and risk-taking.

As for the cognitive flexibility test, students had to read each statement and respond by selecting how much they agreed or disagreed with each of them. The results of research validate the use of cognitive flexibility tests as an impartial gauge of cognitive flexibility (Johnco et al., 2014). The statements dealt with their beliefs and feelings about their own behavior. Points were awarded for the cognitive flexibility scale feedback, which was compared to the students' average score of 55 points.

Table 3.
Tests identification

Name of the test	Test type	Average score
Short-term memory for images	Recall the object	16 pictures
Creative ability test	Answer the questions	62,1%
Cognitive flexibility test	Agree/disagree	55 points

Designed as compiled by the authors.

Learners' results were examined at one data collection time to compare test results before and after playing mind games. In order to ensure reliability, tests were piloted and marked consistently. The horizontal nature of the experiment allowed to test the which set of mind games (exploratory or exploitatory) is more effective.

The research data were analyzed in stages. These stages are as follows:

1) The data from the pre-test and post-test were transferred to the statistics program.
2) The mean scores of the creative, memorization and cognitive flexibility scores (in the context of the experimental and control groups) were calculated in total through the statistical program JASP.
3) The obtained data were examined for normal distribution and other normality assumptions. The values vary between -1.5 and +1.5, indicating that the data set has a normal distribution and parametric tests can be used (Harlow, 2002)
4) The study used parametric tests (t-tests for related and unrelated samples) once the data as standard.
5) The research findings were presented in the context of the data obtained.

Considering the mean scores of pre-experimental and post-experimental tests, in this study we employed robust t-tests to check up if test results changed after playing mind games.

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First, a paired t-test was used to compare the results of pre-experimental test and post-experimental test data. Two hypotheses were accepted. The null hypothesis is that pre-experimental test and post-experimental test data are the same. The alternative hypothesis specifies that pre-experimental test data is less than post-experimental test data.

Table 4.
Exploratory behavior descriptives

Measure 1	Measure 2	df	p	Mean difference	SE difference	SE Cohen's d
Creativity before	Creativity after	29	< .001	−7.224	1.228	0.125
Memorization before	Memorization after	23	< .001	−1.875	0.392	0.260
Cognitive flexibility before	Cognitive flexibility after	29	0.001	-5.333	1.587	0.086

Designed as compiled by the authors

Degrees of Freedom, p-value, mean difference, standard error of the difference have been indicated within JASP analysis of research data. The analysis reveals a statistically significant difference between pre-test and post test results in creativity, memorization and cognitive flexibility tests. The result is highly significant ($p < 0.001$), and the provided standard errors indicate reasonably precise estimates of both the mean difference and the effect size. The arithmetic mean of the scores of the students in the experimental (mind games for exploratory behaviour) and control groups (mind games for exploitatory behaviour) from the pre-test before the applications were found to be quite close to each other.

Assumption Checks by test of normality (Shapiro-Wilk) demonstrate a deviation from normality and indicate that the null hypothesis (pretest and post test data are the same) can be rejected.

Table 5.
Exploitative behavior descriptives

Measure 1	Measure 2	df	p	Mean difference	SE difference	SE Cohen's d
Creativity before	Creativity after	29	0.385	−0.221	0.751	0.070
Memorization before	Memorization after	23	0.055	−0.583	0.288	0.150
Cognitive flexibility before	Cognitive flexibility after	29	0.220	−0.433	0.552	0.039

Designed as compiled by the authors

Degrees of Freedom, p-value, mean difference, standard error of the difference, standard error of Cohen's d have been indicated within JASP analysis of research data. The analysis reveals a statistically significant difference between pre-test and post test results in creativity, memorization and cognitive flexibility tests. The p value demonstrates the difference between the two measures is not statistically significant at conventional alpha levels. Assumption Checks by test of normality (Shapiro-Wilk) demonstrate a deviation from normality and indicate that null hypothesis (pretest and post test data are the same) can be rejected.

If the normality assumption is met and we have a sample ($n > 25$), then we are permitted to use such ‘parametric’ t-test as Independent Sample t test. This test has been designed to determine and verify if the results of tests on creativity, memorization and cognitive flexibility by students who played mind games for exploitatory behavior are worse than the ones by students who played mind games for exploratory behavior.

In general, students demonstrate the biggest improvement in cognitive flexibility tests and the smallest improvement in memorization after playing both mind games for exploratory and exploitatory behavior. Moreover, the results of the paired t-Test validate the bigger effects of mind games for exploratory behavior.

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Table 6.
Results of Independent Sample T test (memorization)

Exploratory	Exploitatory	df	p	Mean Difference	SE Difference	SE Cohen's d
1	2	58	0.046	−0.867	0.506	0.264

Descriptives

Type of mind game	N	Mean	SD	SE	Coefficient of variation
Exploratory	30	12.367	2.157	0.394	0.174
Exploitatory	30	13.233	1.736	0.317	0.131

Designed as compiled by the authors

Significant results suggest a deviation from normality. Test of Normality (Shapiro-Wilk). Exploi W=0.934, p=0.063. Explor W=0.938, p=0.082. Both test scores for the exploitative and explorative behavior mind games have p-values greater than 0.05, indicating that there is no significant deviation from normality for either dataset. This suggests that the assumption of normality is not violated for these scores. Specifically, the independent sample T test verifies that results of tests on memorization by students who played mind games for exploitatory behavior are worse than the ones by students who played mind games for exploratory behavior.

Table 7.
Results of Independent Sample T test (creativity)

Exploratory	Exploitatory	df	p	Mean Difference	SE Difference	SE Cohen's d
1	2	58	0.237	−2.203	3.055	0.259

Descriptives

Type of mind game	N	Mean	SD	SE	Coefficient of variation
Exploratory	30	33.121	10.791	1.970	0.326
Exploitatory	30	35.324	12.792	2.335	0.362

Designed as compiled by the authors

Both test scores for the exploitative and explorative behavior mind games have p-values greater than 0.05, indicating that there is no significant deviation from normality for either dataset. The Independent sample T test verifies that results of tests on creativity by students who played mind games for exploitatory behavior are worse than the ones by students who played mind games for exploratory behavior.

Table 8.
Results of Independent Sample T test (cognitive flexiblity)

Exploratory	Exploitatory	df	p	Mean Difference	SE Difference	SE Cohen's d
1	2	58	0.266	−2.467	3.918	0.259

Descriptives

Type of mind game	N	Mean	SD	SE	Coefficient of variation
Exploratory	30	49.567	13.776	2.515	0.278
Exploitatory	30	52.033	16.452	3.004	0.316

Designed as compiled by the authors

According to the test of Normality (Shapiro-Wilk). Significant results suggest a deviation from normality. Exploi W=0.732 $p < .001$ ExplorW=0.555 $p < .001$. The Independent sample T test verifies that results of tests on creativity by students who played mind games for exploitatory behavior are worse than the ones by students who played mind games for exploratory behavior.

Results and Discussion

The research found that mind games were significantly effective in memorization, creativity and cognitive flexibility. The statistical evidence points towards a minor but reliable difference between the two measures in mind games for explorative behaviour. It validates the hypothesis that the effects of mind games for exploitatory behavior are lower than the effects of mind games for exploratory behavior on creativity,

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memorization and cognitive flexibility. The arithmetic mean of the scores of the students in the experimental and control groups from the pre-experimental tests before the applications were found to be quite close to each other. When the post-test scores of the students in the experimental and control groups were compared, it was discovered that the difference between both creativity, memorization and cognitive flexibility sub-dimensions was significantly different in favor of the experimental group (exploratory behaviour). In other words, mind games lead to larger gains in memorization, creativity and cognitive flexibility. Particularly, mind games that foster exploratory behavior have a crucial impact on enhancing students' creativity, memorization and cognitive flexibility abilities.

Table 9.
Average indicators of (pre-experimental test/ post-experimental test)

	Memorization		**Creativity**		**Flexibility**	
Types of mind games	Pre-test	Post-test	Pre-test	Post-test	Pre-test	Post-test
Mind games for exploratory behavior	11.083	12.958	28.100	35.324	46.700	52.033
Mind games for exploitatory behaviour	11.667	12.250	32.900	33.121	49.133	49.567

Designed as compiled by the authors.

The finding corroborates the outcome to the effect that two groups were almost equivalent in pre-test results but better yielded results were demonstrated after playing mind games for exploratory behavior.

Students used the tutorial as the learning intervention before the mind game on inhibition. External direction on learning and development opportunity progress enhanced the adaptability process. The tutorial serves as proof-of-concept for specifically designed instruction to optimize learners' cognitive resources. It correlates with the variation of self-direction as an inquiry-based activity in inquiry-based learning to direct learners towards an area by giving possible connections and providing evidence (Lameras et al., 2014). Unlike games with adaptive difficulties and complex test stimuli, the adaptive transfer performance was easy because, as it had been investigated by Baniqued et al., the available students' resources were sufficient, resulting in a perceived low load (Baniqued et al., 2015). Even without a tutorial in another mind game, students' executive functions boosted in comparison with baseline cognitive performance. The study by Tian Luo et al., confirms that students are in favour of inquiry-based activity to perceive the ability of their cognitive performance (Luo et al., 2022).

In contrast to a more complex cognitive task-switching game called Pen Em Ap, which had been elaborated by researchers of Illinios University, where participants of the experiment did not improve in tests of complex working memory span (Baniqued et al., 2015), the members of the current experiment yielded better results of memory tests after playing mind games than before. This is due to the relative ease of the mind game and simplicity of the memory test, which confirmed their baseline cognitive performance in memorization of objects.

The results of the current finding somehow align with the Effort Monitoring and Regulation Framework bridge-building approach (Seufert, 2020) when depending on the load demands of a task, learners can adjust their self-regulatory activities, and thus cognitive load can cause or affect self-regulation. Despite the fact that mind games were easy tasks for which learners had sufficient resources and might not activate intensive self-regulatory activities, they had to monitor their efforts and regulate the exploration of more informative options, adapt exploratory behavior to new task-switching circumstances, adjust such executive functions as cognitive flexibility and memorization to understanding and rememorating the tutorial.

The current study included a limited chosen range of mind games within the experiment. Future research can extend inquiry into other mind games that align with other executive functions. Future work can focus more on cognitive resources, as these are presumably associated with the learner's cognitive load while playing specific types of mind games. Finally, the current approach can be extended by including additional epistemic fluency specific features related to activities for students with ADHD.

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Conclusion

Our findings suggest that students' creativity, memory, and cognitive flexibility are greatly improved by mind games that encourage explorative behaviour. Therefore, the task of the lecturer in increased learning is to confront students with exploratory behavior activities, including mind games and at the same time to strengthen appropriate facilitating factors for successful study. Analyzes of epistemic fluency and learners' cognitive load may provide further insights into which exploratory activities are efficient for students and why.

Bibliographic References

Althuizen, N., Wierenga, B., & Rossiter, J. (2010). The Validity of Two Brief Measures of Creative Ability. *Creativity Research Journal*, *22*(1), 53-61. https://doi.org/10.1080/10400410903579577

Anunpattana, P., Khalid, M. N. A., Iida, H., & Inchamnan, W. (2021). Capturing potential impact of challenge-based gamification on gamified quizzing in the classroom. *Heliyon*, *7*(12). https://doi.org/10.1016/j.heliyon.2021.e08637

Baniqued, P. L., Allen, C. M., Kranz, M. B., Johnson, K., Sipolins, A., Dickens, C., Ward, N., Geyer, A., & Kramer, A. F. (2015). Working Memory, Reasoning, and Task Switching Training: Transfer Effects, Limitations, and Great Expectations? *PLOS ONE*, *10*(11). https://doi.org/10.1371/journal.pone.0142169

Bell, B. S., & Kozlowski, S. W. J. (2008). Active learning: Effects of core training design elements on self-regulatory processes, learning, and adaptability. *Journal of Applied Psychology*, *93*(2), 296-316. https://doi.org/10.1037/0021-9010.93.2.296

Blunt, J., & Karpicke, J. (2014). Learning with Retrieval-Based Concept Mapping. *Journal of Educational Psychology*, *106*(3), 849-858. https://doi.org/10.1037/a0035934

CogniFit. Brain Training. Whack-a-mole (2023, July 29). *Trusted by Doctors*. Retrieved from: https://www.cognifit.com/aplicaciones/html5/index/game/whack-a-mole

CogniFit. Brain Training. Blockout (2023, July 29). *Trusted by Doctors*. Retrieved from: https://www.cognifit.com/aplicaciones/html5/index/game/blockout

Duman, E. Z., Arslan, A., & Kuçukşabanoglu, O. (2023). The Place of Intelligence Games in Philosophy and Logic Education. *Science Insights Education Frontiers*, *17*(1), 2651-2676. https://doi.org/10.15354/sief.23.re230

Esentaş, M. (2021). A leisure time educational tool: mind and intelligence games: A leisure time educational tool. *International Journal of Curriculum and Instruction*, *13*(2), 1355-1373. Retrieved from https://ijci.globets.org/index.php/IJCI/article/view/591

Franciosi, S. J., Yagi, J., Tomoshige, Y., & Ye, S. (2016). The Effect of a Simple Simulation Game on Long-Term Vocabulary Retention. *CALICO Journal*, *33*(3), 355-379. Retrieved from: https://www.jstor.org/stable/90014365

Güneri, A., & Korkmaz, Ö. (2023). The effect of mind games activities on problem-solving and computational thinking skills of grade 5 students. *Education Mind*, *2*(1), 1-15. Retrieved from: https://doi.org/10.58583/pedapub.em2301

Han, B., & Fan, H. (2021). Salesperson Self-Regulated Learning and Online Customers' Patronage: An Ambidexterity Perspective. *Frontiers in Psychology*, *12*. https://doi.org/10.3389/fpsyg.2021.795899

Hardy, J. H., Day, E. A., Hughes, M. G., Wang, X., & Schuelke, M. J. (2014). Exploratory behavior in active learning: A between- and within-person examination. *Organizational Behavior and Human Decision Processes*, *125*(2), 98-112. https://doi.org/10.1016/j.obhdp.2014.06.005

Harlow, L. L. (2002). Book Review of Using Multivariate Statistics by Barbara G. Tabachnick and Linda S. Fidell. *Structural Equation Modeling: A Multidisciplinary Journal*, *9*(4), 621-636. https://doi.org/10.1207/s15328007sem0904_9

Heiman, S. (2014). *"A Study on the Perception of Brain Games and their Effect on Memory and Cognitive Skills"*. HIM 1990-2015, 24p. Retrieved from https://acortar.link/XtMRoW

Hera, D. P., Zanoni, M. B., Sigman, M., & Calero, C. I. (2022). Peer tutoring of computer programming increases exploratory behavior in children. *Journal of Experimental Child Psychology*, *216*. https://doi.org/10.1016/j.jecp.2021.105335

Herz, N., Baror, S., & Bar, M. (2020). Overarching States of Mind. *Trends in Cognitive Sciences*, *24*(3), 184-199. https://doi.org/10.1016/j.tics.2019.12.015

Hesselberth, P., & Schuster, L. (2008). Into the Mind and Out to the World: Memory Anxiety in the Mind-Game Film. In J. Kooijman, P. Pisters, & W. Strauven (Eds.), *Mind the Screen: Media Concepts*

According to Thomas Elsaesser. Amsterdam University Press, 96-111. Retrieved from https://www.jstor.org/stable/j.ctt46n2j2.10

Johnson, A., Varberg, Z., Benhardus, J., Maahs, A., & Schrater, P. (2012). The hippocampus and exploration: dynamically evolving behavior and neural representations. *Frontiers in human neuroscience, 6*, 216. https://doi.org/10.3389/fnhum.2012.00216

Johnco, C., Wuthrich, V.M., & Rapee, R. (2014). *Reliability and validity of two self-report measures of cognitive flexibility*. Psychological Assess. Doi: https://doi.org/10.1037/a0038009

Kuang, X., Eysink, T. H. S., & de Jong, T. (2023). Presenting domain information or self-exploration to foster hypothesis generation in simulation-based inquiry learning. *Journal of Research in Science Teaching, 61*(1), 70-102. https://doi.org/10.1002/tea.21865

Lameras, P., Savin-Baden, M., Petridis, P., Dunwell, I., & Liarokapis, F. (2014). "Fostering Science Teachers' Design for Inquiry-Based Learning by Using a Serious Game," *2014 IEEE 14th International Conference on Advanced Learning Technologies, Athens, Greece*, 222–226. https://doi.org/10.1109/ICALT.2014.71

Lyu, L., Zhang, H., & Gao, K. (2022). Why Does Distributed Leadership Foster or Hamper Bootlegging Behavior of Employees: The Role of Exploratory-Exploitative Learning Tension and Paradox Mindset. *Mathematical Problems in Engineering, 2022*(1), 3093641.

Liquin, E. G., & Gopnik, A. (2022). Children are more exploratory and learn more than adults in an approach-avoid task. *Cognition, 218*(4). https://doi.org/10.1016/j.cognition.2021.104940

Luo, T., Arcaute, K., & Muljana, P. S. (2022). Integrating inquiry-based learning into engineering education: A case study. *Innovations in Education and Teaching International, 60*(6), 836-847. https://doi.org/10.1080/14703297.2022.2130393

Lyu, L., Ji, S., Chen, J., Jiang, G., & Zhang, H. (2023). How Distributed Leadership Fosters Individual Leadership Emergence: The Mediating Role of Empowerment Role Identity and Enacted Leader Identity. *Systems, 11*(2), 77. https://doi.org/10.3390/systems11020077

Making Predictions (2023, July 29). *TinyTap – Create Games & Learn from Others*. Retrieved from: https://www.tinytap.com/activities/g4i4r/play/making-predictions

Melike E. (2021). A leisure time educational tool: mind and intelligence games. *International Journal of Curriculum and Instruction, 13*(2), 1355-1373. Retrieved from: https://ijci.globets.org/index.php/IJCI/article/view/591

MentalUP. (2023, July 29). *Educational Games for Kids*. Retrieved from: https://acortar.link/kDKU3D

Millar, C.C., Chen, S., & Waller, L. (2017). Leadership, Knowledge and People in Knowledge-Intensive Organisations: Implications for HRM Theory and Practice. *International Journal of Human Resource Management, 28*(2), 261-275. Retrieved from: https://acortar.link/dvqSiM

Multi Task Switching game (2023, July 29). *Brainturk Games*. Retrieved from: https://www.brainturk.com/taske?tour=1

Mustafa, U. (2023). The Effect of Mind and Intelligence Games on the Creative Problem- Solving Skills of Primary School 4 th - Grade Students. *International online Journal of Educational Sciences, 15*(2), 207-218. Doi: 10.15345/iojes.2023.02.001

Pitic, A. E., & Pitic, A. A. E. (2022). The Positive Effects of Video Games on the Human Mind. *International Journal of Advanced Statistics and IT&C for Economics and Life Sciences, 12*(2), 24-31. https://doi.org/10.2478/ijasitels-2022-0004

Seufert, T. (2020) Building Bridges Between Self-Regulation and Cognitive Load—an Invitation for a Broad and Differentiated Attempt. *Educational Psychology Review, 32*(4), 1151-1162. https://doi.org/10.1007/s10648-020-09574-6

The Epoch Times. (2023, July 29). *Bounce Prediction*. Retrieved from: https://www.theepochtimes.com/epochfun/bounce-predicition-4077497

Turkoglu, B. (2019). A Mixed Method Research Study on the Effectiveness of Board Game Based Cognitive Training Programme. *International Journal of Progressive Education, 15*(5), 315-344. Retrieved from: https://eric.ed.gov/?id=EJ1232511

Williams, F. E. (1979). Assessing Creativity Across Williams "Cube" Model. *Gifted Child Quarterly, 23*(4), 748-756. https://doi.org/10.1177/001698627902300406

Verive, J. M., & McDaniel, M. A. (1996). Short-term memory tests in personnel selection: Low adverse impact and high validity. *Intelligence, 23*(1), 15-32. https://doi.org/10.1016/s0160-2896(96)80003-1

Vidal, R. V. V. (2010). Creative Problem Solving: An Applied University Course. *Pesquisa Operacional, 30*, 405-426. http://dx.doi.org/10.1590/s0101-74382010000200009