

THE ROLE OF INTEREST IN GAME-BASED MULTIPLE SOURCE INTEGRATION TASKS

O. Pesout¹, R. Sperling², J. Nietfeld³

¹Charles University (CZECH REPUBLIC)

²Penn State University (UNITED STATES)

³North Carolina State University (UNITED STATES)

Abstract

Integrating information from multiple sources is a complex skill critical for problem solving but challenging for elementary grade students. Leveraging students' interest may provide a valuable cognitive resource for enhancing their ability to integrate information across sources while problem-solving. Digital game-based learning environments (GBLEs) can foster interest and engagement, offering a promising context for supporting students' integration. This study examined interest in science and interest in a GBLE activity on reading passage comprehension and their integration to solve a final game task adapted from *Missions with Monty*, a classroom game designed to promote science literacy. Grade 5 students in the Czech Republic ($n = 99$) completed a science knowledge test based on selected TIMSS items and a problem-solving task involving three passages with accompanying diagrams and texts over two 45-minute sessions. Measures included interest, value of science, prior knowledge, passage performance, and problem-solving performance. Results revealed that the value of science was related to interest in science and interest in the game. Unexpectedly, interest in science was not an indicator of interest in the game, nor passage or game performance. As anticipated, interest in the game was a predictor of game performance. Prior science knowledge was related to interest in the game and also passage performance, but surprisingly, it was not related to game performance.

Keywords: GBLE, problem-solving, interest, elementary education.

1 INTRODUCTION

Integrating information from multiple sources is a complex cognitive skill that is essential for effective problem solving in academic contexts [1]. Students often struggle to synthesize information from texts, diagrams, and other media, which can limit their ability to construct coherent knowledge representations [2]. Prior research has highlighted interest as a key factor in reading comprehension, motivation, and engagement ([3] [4]). Yet, few studies have examined how interest specifically affects students' ability to integrate multiple sources during problem-solving tasks.

Students' interest functions as a cognitive resource that can facilitate the processing of more complex information [5]. While the role of interest has been well documented in reading comprehension and source integration, its influence on multiple-source integration in problem-solving contexts remains less explored. In addition to interest, prior knowledge could also play an important role when students encounter multiple sources of information. Research has shown that students with higher levels of prior knowledge are more likely to access and utilize optimal supporting information compared to their peers with lower knowledge [6]. This role becomes even more critical when sources need to be evaluated for credibility and relevance [7].

Digital game-based learning environments (GBLEs) offer a promising context for addressing this challenge [8]. GBLEs are designed to engage students through narrative, interactivity, and immediate feedback, potentially fostering both situational interest and deeper cognitive engagement ([9] [10]). Furthermore, prior knowledge could have an additional effect on enhanced performance and interest in the game ([6] [11]). However, most research on GBLEs focuses on general learning outcomes, leaving a gap in understanding how these environments support complex tasks such as multiple-source integration.

Missions with Monty, an established GBLE targeting science literacy that has demonstrated effectiveness in increasing students' reading comprehension, monitoring, and science learning [12], was included in the present study. The focus within this GBLE was on how interest in science and interest in the game relate to problem-solving performance, passage comprehension, and perceived value of the activity. We hypothesized that: (1) interest in science would be related to perceived value of science and these two would be related to interest in the game [3]; (2) interest in the game would be associated with passage comprehension and integration task performance [12]; and (3) prior science knowledge would be associated with interest in the game, passage comprehension, and mainly integration task performance ([4] [6]);

2 METHODOLOGY

2.1 Participants

Ninety-nine fifth-grade students (ages 10–11) from seven schools in the Czech Republic participated in this study. Students were asked to complete the activity in two 45-minute sessions during regular classroom instruction. The sample included students with diverse prior knowledge and experiences in science, providing a representative group for examining the role of interest in learning (see Table 1).

Table 1. Descriptives of the sample.

<i>Demographic Variable</i>	<i>Value</i>
Age, <i>m (sd)</i>	11.01 (0.44)
Gender, girls (boys)	44 (55)
[1] Prior knowledge, <i>m (sd)</i>	7.13 (1.94)
[2] Interest in science, <i>m (sd)</i>	4.09 (0.99)
[3] Value of science, <i>m (sd)</i>	7.77 (1.91)
[4] Interest in game task, <i>m (sd)</i>	23.23 (6.34)
[5] Game integration performance, <i>m (sd)</i>	4.81 (1.65)
Passage comprehension, <i>m (sd)</i>	9.04 (3.72)

2.2 Materials

The study employed a digital gamified problem-solving activity derived from *Missions with Monty*. For this study, three passages were selected, each accompanied by relevant diagrams, graphs, and illustrations. Narrative elements and characters from the original game were preserved to maintain engagement. A three-part problem related to an invasive insect's impact was presented that centered on the ecosystems curriculum. Students were then guided by game characters to read three passages related to producers, consumers, and decomposers and respond to comprehension challenges. Other measures included:

2.2.1 Prior Science Knowledge

Ten TIMSS items relevant to the content of the passages [13]. Each item was scored as correct or incorrect. As a sum of their scores, students could obtain between 0 and 10.

2.2.2 Interest in Science

A single item measuring general science interest, “*I find science interesting,*” was rated on a 5-point Likert scale.

2.2.3 Value of Science

Two items rated on a 5-point Likert scale assessed task value items, $r = .63$, $p < .001$.

2.2.4 Interest in Game Task

Six items rated on a 5-point Likert scale assessed perceived interest during the game activity derived from the PIQ scale [14]. Internal consistency was sufficient ($\alpha = .72$).

2.2.5 Integration Problem-Solving Task

At the end of the gamified problem-solving activity, students were asked to select the three best solutions from the list of ten solutions to solve the problems. All solutions were rated by experts from 0 to 3. The obtained score was the sum of the three selected solutions, which could range from 0 to 9 points.

2.2.6 Passage Comprehension

As a part of the gamified problem-solving activity, students completed 15 multiple-choice items covering content from all three passages – five for each passage. The comprehension score was the sum of all correct answers on the multiple-choice items with a sufficient internal consistency ($\alpha = .80$).

2.3 Procedure

Students completed the two activities in their classrooms under teacher supervision. They first completed a survey that included the items on interest and value in science, followed by a prior science knowledge task. In the second session, students engaged with the passages and supporting materials, then completed the integration problem-solving task, and at the end, they rated their interest in the problem-solving activity. All measures were recorded on computers via an online survey using Qualtrics.

2.4 Data analysis

Descriptive statistics and other statistical procedures were calculated for all study variables in the R programming language.

3 RESULTS

To address all three hypotheses, a correlation matrix using the Pearson correlation coefficient was used for the analysis (Table 2). The results revealed that prior science knowledge was positively correlated with passage comprehension ($r = .48, p < .01$) and interest in the game ($r = .28, p < .05$), but not with integration task performance.

Interest in science was positively associated with perceived value of science ($r = .58, p < .001$), but not with interest in game activity. However, a positive relationship was found between the value of science and interest in the game activity ($r = .24, p = .02$). Interest in science was not significantly correlated with passage comprehension or integration task performance. Game-specific interest, however, was significantly related to integration task performance ($r = .23, p < .01$) but not passage comprehension.

Table 2. Correlational table among all the assessed variables.

	1	2	3	4	5
[1] Prior knowledge	---				
[2] Interest in science	-0.12				
[3] Value of science	0.11	0.58***			
[4] Interest in game task	0.24*	0.04	0.24*		
[5] Game integration performance	0.05	-0.10	0.05	0.23*	
[6] Passage comprehension	0.29**	-0.12	-0.14	-0.10	0.08

Notes. * $p < .05$, ** $p < .01$, *** $p < .001$

Regression analyse (Table 3) confirmed that game interest was the strongest predictor of integration task performance ($B = .06, p = .04$), accounting for 9% of variance ($F_{[4,80]} = 1.956, R^2 = .09, p = .11$). Passage comprehension was primarily predicted by prior science knowledge ($B = .754, p < .001$) accounting for 19% variance ($F_{[4,80]} = 4.699, R^2 = .19, p < .001$). These results partially supported the study hypotheses: interest influenced perceived value and engagement, but general science interest did not directly translate into better task performance.

Table 3. Table with the regression model predictors on.

Predictors	Game integration performance, β (SE)	Passage comprehension, β (SE)
Intercept	4.79 (0.17) ***	9.36 (0.38) ***
[1] Prior knowledge	-.07 (0.17)	1.47 (0.39) ***
[2] Interest in science	-.031 (0.22)	-.27 (0.49)
[3] Value of science	.27 (0.22)	-.59 (0.49)
[4] Interest in game task	.35 (0.17) *	-.54 (0.39)

Notes. * $p < .05$, *** $p < .001$

4 CONCLUSIONS

This study provided evidence that students' interest promoted by digital GBLEs can support students' performance in complex problem-solving tasks. However, the role of interest was nuanced. While general interest in science predicted perceived value of science and game-specific interest, it was not significantly related to passage comprehension or integration task performance. Alternatively, interest in the game task predicted integration task performance even after accounting for prior knowledge. These findings suggest that situational interest elicited by the game was more influential than interest in a specific domain, science in this case, extending prior research on the role of interest, specifically in GBLEs [15].

Prior knowledge remained a strong predictor of passage comprehension, highlighting the continued importance of foundational knowledge in complex learning tasks ([6][16]). Unexpectedly, prior knowledge did not predict performance on the integration task, indicating that successful integration may rely more on engagement with the game context than on prior content knowledge alone; however, prior knowledge was related to the situational interest elicited by the game.

These findings contribute to the understanding that GBLEs such as *Missions with Monty* provide promising opportunities to scaffold multiple-source integration through interest-promoting activities such as interactive narratives and gamified tasks [12]. Future research should replicate these findings in the full GBLE, as the current study was limited by testing an activity based on *Missions with Monty* as opposed to the entire GBLE itself. Furthermore, studies should explore the connections between general science interest with task-specific engagement and performance, as well as examine how repeated exposure to GBLEs may enhance transfer of skills to new problem-solving contexts.

The study reinforces the important role of interest in GBLEs and highlights their potential for supporting complex cognitive processes like multiple-source integration. While interest in science enhances perceived value and engagement, interest in game activity elicited by the game appears to drive performance on problem-solving tasks. These findings suggest that designing GBLEs to maximize situational interest may be crucial for fostering integrative learning skills in elementary science education.

ACKNOWLEDGEMENTS

The study was funded by the Czech Science Foundation (GAČR), project No. 24-12123S.

REFERENCES

- [1] K. Beker, P. van den Broek, and D. Jolles, "Children's integration of information across texts: reading processes and knowledge representations," *Reading and Writing*, vol. 32, no. 3, pp. 663–687, 2019. <https://doi.org/10.1007/s11145-018-9879-9>
- [2] A. Lammers, M. J. Goedhart, and L. Avraamidou, "Reading and synthesising science texts using a scientific argumentation model by undergraduate biology students," *International Journal of Science Education*, vol. 41, no. 16, pp. 2323–2346, 2019. <https://doi.org/10.1080/09500693.2019.1675197>
- [3] J. M. Harackiewicz, J. L. Smith, and S. J. Priniski, "Interest matters: The importance of promoting interest in education," *Policy Insights from the Behavioral and Brain Sciences*, vol. 3, no. 2, pp. 220–227, 2016. <https://doi.org/10.1177/2372732216655542>
- [4] S. Tobias, "Interest, prior knowledge, and learning," *Review of Educational Research*, vol. 64, no. 1, pp. 37–54, 1994. <https://doi.org/10.3102/00346543064001037>
- [5] S. Hidi, "Interest and its contribution as a mental resource for learning," *Review of Educational Research*, vol. 60, no. 4, pp. 549–571, 1990. <https://doi.org/10.3102/00346543060004549>
- [6] X. Yang, S. Rahimi, V. Shute, et al., "The relationship among prior knowledge, accessing learning supports, learning outcomes, and game performance in educational games," *Educational Technology Research and Development*, vol. 69, no. 3, pp. 1055–1075, 2021. <https://doi.org/10.1007/s11423-021-09974-7>
- [7] S. Brand-Gruwel and M. Stadler, "Solving information-based problems: Evaluating sources and information," *Learning and Instruction*, vol. 21, no. 2, pp. 175–179, 2011. <https://doi.org/10.1016/j.learninstruc.2010.02.008>

- [8] S. Erhel and E. Jamet, "Digital game-based learning: Impact of instructions and feedback on motivation and learning effectiveness," *Computers & Education*, vol. 67, pp. 156–167, 2013. <https://doi.org/10.1016/j.compedu.2013.02.019>
- [9] F. S. Breien and B. Wasson, "Narrative categorization in digital game-based learning: Engagement, motivation & learning," *British Journal of Educational Technology*, vol. 52, no. 1, pp. 91–111, 2021. <https://doi.org/10.1111/bjet.13004>
- [10] I. Leuchter and G. Kurtz, "Effects of instructions, assistance, narrative, competition, challenge, and age on performances in digital learning games," *International Journal of Advanced Corporate Learning*, vol. 15, no. 2, pp. 4–12, 2022. <https://doi.org/10.3991/ijac.v15i2.30867>
- [11] Y. Baek, Y. Xu, S. Han, and J. Cho, "Exploring effects of intrinsic motivation and prior knowledge on student achievements in game-based learning," *Smart Computing Review*, vol. 5, no. 5, pp. 368–377, 2015.
- [12] S. Syal and J. L. Nietfeld, "Examining the effects of a game-based learning environment on fifth graders' reading comprehension and reading motivation," *Journal of Educational Psychology*, vol. 116, no. 5, pp. 805–819, 2024. <https://doi.org/10.1037/edu0000874>
- [13] J. Marôco, H. Harju-Lukkainen, and J. Rautopuro, "Worldwide predictors of science literacy in lower-secondary students: A TIMSS 2019 analysis," *International Journal of Science Education*, pp. 1–19, 2024. <https://doi.org/10.1080/09500693.2024.2369726>
- [14] G. Schraw, R. Bruning, and C. Svoboda, "Sources of situational interest," *Journal of Reading Behavior*, vol. 27, no. 1, pp. 1–17, 1995. <https://doi.org/10.1080/10862969509547866>
- [15] F. T. Eyupoglu and J. L. Nietfeld, "Intrinsic motivation in game-based learning environments," in *Game-Based Assessment Revisited*, D. Ifenthaler and Y. J. Kim, Eds., pp. 85–104. Cham: Springer, 2019. https://doi.org/10.1007/978-3-030-15569-8_5
- [16] J. L. Nietfeld, "Predicting transfer from a game-based learning environment," *Computers & Education*, vol. 146, 103780, 2020. <https://doi.org/10.1016/j.compedu.2019.103780>