

The Effects of Digital Games on Pre-K-12 Students' Growth Mindset: A Systematic Review

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Abstract: The concept of a “growth mindset” refers to the belief that one’s abilities and intelligence can be developed through effort, learning, and persistence. This systematic review examines the impact of digital games on fostering a growth mindset in pre-K-12 educational settings. Following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines, we analyzed 13 studies focused on digital games designed to enhance a growth mindset. Findings indicate that most games positively influence growth mindset along with other competencies (e.g., creativity and persistence), while a minority show mixed or negligible effects, often linked to the game design or context. The review identifies trends across various game genres, targeted skills, and geographical regions, reflecting a growing interest in growth mindset research. It suggests that digital games represent a valuable avenue for educational interventions which emphasize the need for thoughtful design informed by evidence on effective game features.

Introduction

The concept of a “growth mindset,” introduced by Stanford psychologist Carol Dweck, refers to the belief that one’s abilities and intelligence can be developed through effort, learning, and persistence. In contrast, a “fixed mindset” reflects the belief that abilities are innate and unchangeable (Dweck, 2006). Individuals with a growth mindset embrace challenges, view setbacks as opportunities for growth, and persist in the face of difficulty. On the other hand, those with a fixed mindset often avoid challenges and may feel defeated by failure, seeing it as a reflection of unchangeable limitations (Dweck, 2008). These mindsets align well with learners’ orientation: *learning orientation* which includes learners who enjoy learning new concepts and skills, and performance orientation which includes learners who prioritize performance (e.g., getting good grades) (Shute, 2008). The development of a growth mindset is especially important during the formative years of pre-K-12 education, as it promotes resilience, adaptability, and a love for learning—qualities essential for success both inside and outside the classroom (Dweck, 2006).

Early interventions to instill a growth mindset in students have proven highly beneficial, making pre-K-12 education a critical period for fostering this mindset. Numerous studies have explored strategies to cultivate growth mindsets in educational settings. For example, providing feedback that emphasizes effort, strategies, and progress rather than innate ability has been shown to be effective (Haimovitz & Dweck, 2017). Other evidence-based interventions include explicitly teaching students about the malleability of the brain (e.g., neuroplasticity), setting challenging yet achievable goals, and fostering classroom environments where mistakes are framed as valuable learning experiences (Boaler, 2013; Paunesku et al., 2015). These treatments have demonstrated positive effects on student motivation, engagement, and performance.

One promising approach to fostering a growth mindset is through digital games. Games offer engaging, interactive platforms that can reward effort, persistence, and problem-solving strategies, rather than only emphasizing performance outcomes. For instance, a game might reward players with virtual coins or progress points for persevering through a difficult level, regardless of their ultimate success. Such designs align closely with the principles of a growth mindset by reinforcing the value of effort and encouraging resilience in the face of challenges (Granic et al., 2014; Dweck, 2016).

Current study

Despite the growing interest in leveraging digital games to promote a growth mindset, no systematic review has yet synthesized the available research on this topic. This study aims to address that gap by systematically reviewing the literature on digital games designed to foster a growth mindset in students. Specifically, this review seeks to answer the following research questions:

- RQ 1) What are the trends in using digital games to improve a growth mindset?*
- RQ 2) What competencies (i.e., knowledge, skills, and other attributes) are targeted by these studies?*
- RQ 3) What are the effects of promoting a growth mindset through digital games on students’ outcomes?*

By addressing these questions, this review aims to contribute to the growing body of literature on effective educational interventions and to inform the design of future digital games for promoting a growth mindset. Next, we discuss the methodology we used to identify the relevant studies from the literature.

Method

This systematic review was conducted according to PRISMA guidelines (Moher et al., 2009) to synthesize findings on the promotion of a growth mindset through digital games in K-12 educational settings. The objective was to explore how digital games may contribute to fostering a growth mindset among K-12 students and to analyze trends and methodologies in this area. The inclusion and exclusion criteria are shown in Table 1.

Table 1
The Inclusion and Exclusion Criteria

Indicator	Inclusion criteria	Exclusion criteria
Language	Full-text available in English	Non-English
Date	No restriction—up to 2024	NA
Manuscript type	Book chapters, dissertations, peer review articles, conference proceedings	Reports, reviews, and meta-analyses
Relevance 1	Digital games	Analog games, gamification studies
Relevance 2	The game should have some elements that directly or indirectly promote a growth mindset, and the researchers should mention and investigate those elements.	Studies with digital games that do not clearly design promote GM
Education level & target audience	Pre-K-12	Higher education, students with disabilities, adults
Research method/ approach	Empirical studies: Quantitative and qualitative studies: experimental, quasi-experimental, correlational	Studies that were only about the assessment of a growth mindset (i.e., validation studies)

Database search and search strategy

To ensure comprehensive literature coverage, searches were conducted in multiple databases, including ERIC, Web of Science, Science Direct, ProQuest, Google Scholar, and Scopus. A set of search strings was developed to capture studies examining the intersection of digital games, growth mindset, and pre-K-12 education. These search strings included (1) “digital games” AND “growth mindset” AND “K-12 education”; (2) (“digital games” OR “educational games” OR “game*”) AND “growth mindset” AND (“K-12 education” OR “primary and secondary education”); (3) ALL=((“growth mindset” OR “Incremental theory” OR “fixed mindset”) AND (“k-12” OR “k12” OR “pre-K12” OR “pre-K” OR “pre K12” OR “kindergarten*” OR “elementary education” OR “primary education” OR “secondary education” OR “junior high” OR “high school*” OR “middle school*” OR “school age*”) AND (“computer game*” OR “digital game*” OR “gaming” OR “game*” OR “video game*”). Each database required adjustments to the search strategy to accommodate its specific syntax and search functionalities. The use of flexible and inclusive terms ensured that all relevant studies were captured across the different platforms.

Screening process

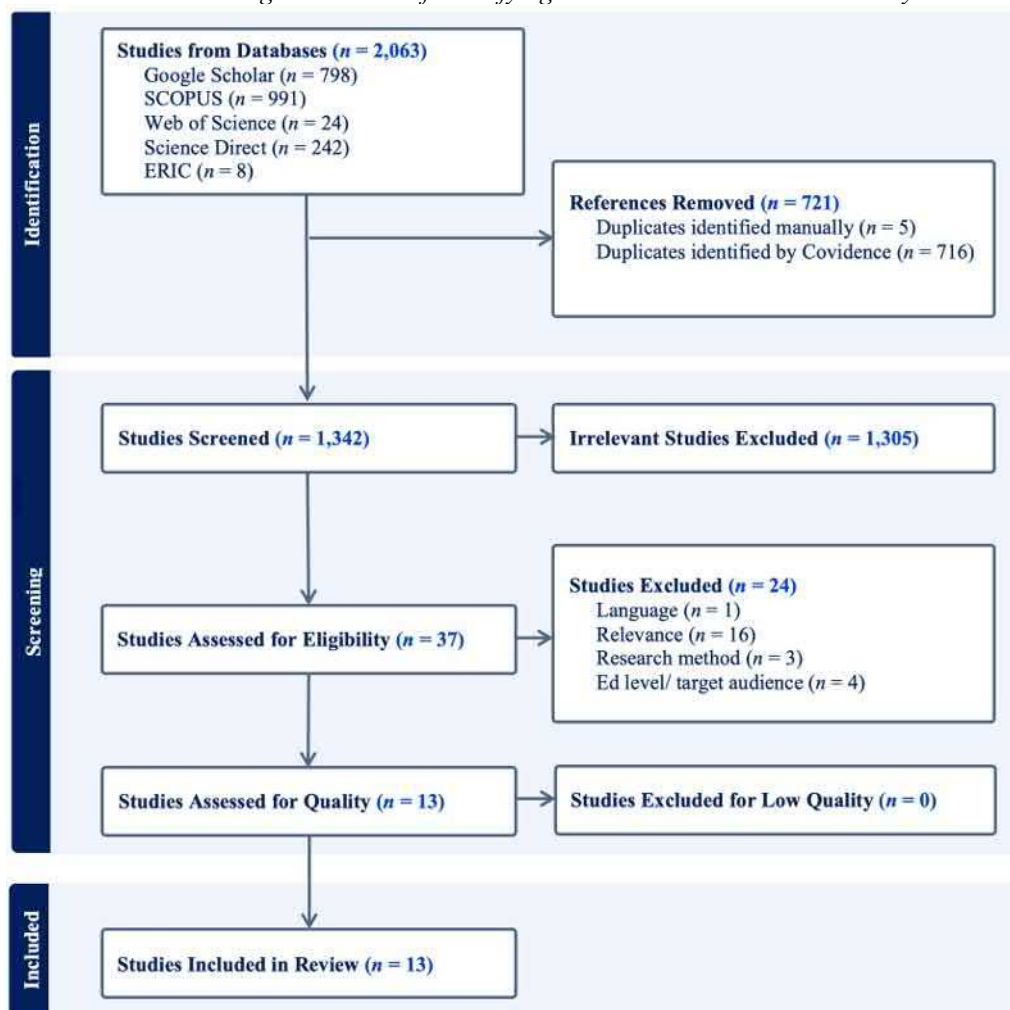
The initial search retrieved 2063 studies across the databases. We used Covidence (Covidence, n.d.) to screen the studies. After removing duplicates, a total of 1342 unique records were screened. The screening process involved two researchers who independently reviewed titles and abstracts, followed by a full-text review for studies

meeting the inclusion criteria. Discrepancies in study selection were resolved through discussion and consensus. Following this process, 13 studies were selected for detailed quality assessment.

Quality assessment

To evaluate the quality of the studies, we employed the Critical Appraisal Skills Programme (CASP) checklist (Singh, 2013). The CASP checklist covers key research elements, including research aims, methodology, and data collection processes (Singh, 2013). For the qualitative studies ($n = 1$), we specifically assessed the clarity of research aims, appropriateness of the methodology and design, recruitment strategies, data collection methods, researcher-participant relationships, ethical considerations, sufficiency of data analysis, and clarity of findings. In addition, the quantitative ($n = 9$) and mixed methods studies ($n = 3$) were evaluated using a modified checklist, which was adapted from CASP guidelines and additional criteria suggested by Pluye et al. (2009). The criteria used for quantitative and mixed methods studies included clear research aims, suitable methodology, recruitment strategies, sampling and justification, measurement rationale, control for confounding variables, clarity of findings, and generalizability. For mixed methods studies, we also applied additional questions from Pluye et al. (2009) related to the justification for using mixed methods, data integration, and reliability. Each study received an overall quality rating of high (more than 70% of criteria rated “yes”), medium (40-70% “yes”), or low (less than 40% “yes”), following thresholds established by Pluye et al. (2009). To minimize potential bias, a second independent researcher also assessed the study quality. After averaging the ratings of the two evaluators, no study was rated below 40% or classified as low quality. Consequently, all 13 studies were included in this systematic review (see Figure 1).

Figure 1
PRISMA Chart Showing the Process of Identifying the Studies Included in this Study



Data extraction and synthesis

We extracted relevant data to address our research questions using a standardized form that captured details on study characteristics, including year, country, target population, study design, and findings related to growth mindset outcomes. Extracted data were synthesized to identify common themes, methodological trends, and gaps in the literature regarding the promotion of growth mindset through digital games in pre-K-12 settings. Next, we present our findings.

Results

RQ 1: What are the trends in using digital games to improve a growth mindset?

The majority of studies were either journal articles ($n = 6$) or conference proceedings ($n = 6$), with additional contributions from dissertations ($n = 2$). These sources illustrate the varied interest in disseminating research on growth mindset across multiple forums.

Table 2

Included Studies in this Systematic Review ($n = 13$)

Author (Year)	Study Field	Country	TA	SM	TC	SZ	Effects	Game	Genre	Q
Yeh (2023)	Creativity	Taiwan	E	NA	CM, FCM, grit, SD, & CSE	114	Positive	DGLC-A	SG	75
Yang (2023)	Digital Media Design	Taiwan	E	Math	GM, PS	135	Positive	Gather	Puzzle	68.75
O'Rourke (2016)	Computer Science	USA	E	NA	GM, P, SU, PS	25,000	Non-sig.	Refraction	Puzzle	81.25
Leach (2016)	Education	USA	M & H	Geology	GM	83	Non-sig.	Selene	Puzzle	81.25
Yeh (2023)	Education	Taiwan	E	NA	Creativity, PS, DT, CT, GM	118	Positive	Treasure Hunt	Sandbox	75
Gorman (2022)	Computer Science	Ireland	M	CS Education	RT, GM	21	Positive	Maze City	Sandbox	68.75
Raffali (2023)	Education	Malaysia	M	Health	HDM, GM	4	Positive	Better Bites	SG	88.88
Park (2017)	Computer Science	NA	E	HCI	GM, P, PS	40	Positive	Tangram Treasure	Puzzle	50
O'Rourke (2014)	Computer Science	USA	E	Math	P, SU	15,491	Positive	Refraction	Puzzle	100
O'Rourke (2015)	Computer Science	USA	E	Math	P, SU	7,940	Mixed	Refraction	Puzzle	87.5
Ting (2023)	Creativity	Taiwan	E	NA	CM, HB, CSE	132	Positive	GLS-CM	SG	93.75
Dowey (2017)	Education	UK	M	English & Math	Effort, P	42	Non-sig.	Brainology	SG	93.75
White (2019)	Education	USA	E	Math	Attitude, Achievement	24	Positive	Not specified	SG	95

Note. CM = Creativity Mindset, FCM = Fixed Creativity Mindset, P = Persistence, SD = Self-determination, CSE = Creativity Self-efficacy, PS = Problem Solving, HDM = Health-related Decision-making, SU = Strategy Use, RT = Risk Taking, HB = Hope Belief, TA = Target Audience, Q = Quality.

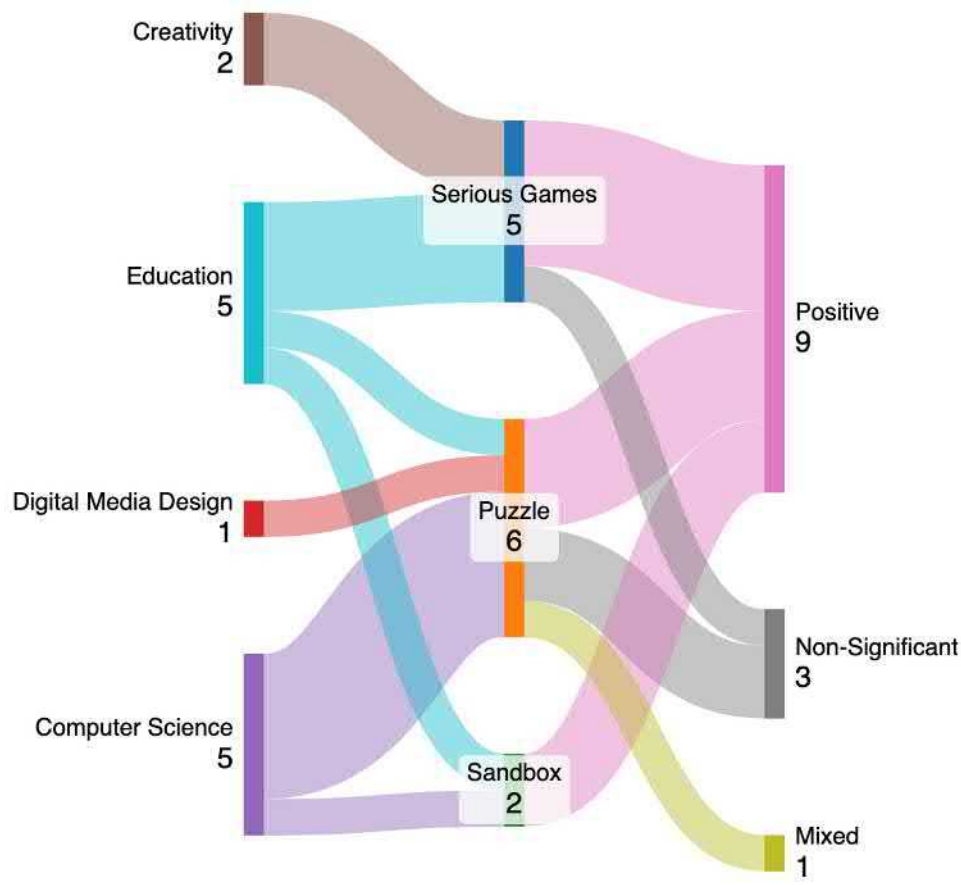
The reviewed studies employed digital games primarily to encourage growth mindset behaviors, with most focused on promoting mindset-related actions within educational games ($n = 5$). These actions included

examining the persistence for gifted students when facing challenges (Leach, 2016), exploring how the effectiveness of the brain points varies across different demographic groups (O'Rourke, 2015), and investigating the effects of encouraging effort and fostering the growth mindset (O'Rourke, 2015). Others examined the impact on creativity and self-efficacy ($n = 2$), effort and perseverance ($n = 2$), and motivation and mindset ($n = 1$). Additionally, selected studies explored unique approaches, including the use of narrative games for promoting healthy decision-making ($n = 1$), whole-school mindset interventions ($n = 1$), and interactions with a growth mindset robot ($n = 1$). Geographically, most studies were conducted in the U.S. ($n = 5$), followed by Taiwan ($n = 4$), European countries ($n = 2$), and Malaysia ($n = 1$), with one study lacking geographic specification ($n = 1$). This range of contexts reveals the broad interest in understanding and applying growth mindset principles across different educational settings. Table 2 shows the studies we included in this review.

Participants in these studies ranged from 3rd to 12th grade, with elementary school students being the most frequently represented ($n = 9$), followed by middle school students ($n = 3$) and a mixed group of middle and high school students ($n = 1$). Researchers of the included studies were from various fields, predominantly education ($n = 5$) and computer science education ($n = 5$), with others focusing on creativity ($n = 2$), and digital media design ($n = 1$). The diversity in fields highlights the interdisciplinary appeal of growth mindset research within education.

For the game genre, this review explored three different types of digital games including serious games ($n = 5$), which are designed more than just entertainment, the primary goal is teaching academic content (Breuer & Bente, 2010); sandbox games ($n = 2$), which impose few restrictions on the player, giving them the freedom to explore and modify a virtual world as they wish (Yunanto et al., 2021); and puzzle games ($n = 6$), which challenge players to solve problems or complete tasks (Apperley, 2006).

Figure 2
The Relation Among Field of Study, Game Genre, and the Effect



RQ 2: What competencies (i.e., knowledge, skills, and other attributes) were targeted by the studies?

The 13 reviewed studies targeted a wide range of competencies, which focused on knowledge, skills, and socio-emotional attributes. Eight studies targeted knowledge development that emphasized understanding growth mindset principles, neuroplasticity, and subject-specific content such as math (Yang & Xiao, 2023; O'Rourke et al., 2014; O'Rourke et al., 2015; Dowey, 2017; White & McCoy, 2019) and programming (Gorman et al., 2022). Eleven studies focused on skills, with some ($n = 7$) targeting resilience and perseverance (e.g., O'Rourke, 2014; Gorman, 2022), and 5 studies emphasized problem-solving abilities (e.g., Yang & Xiao, 2023; O'Rourke et al., 2016; Park et al., 2017). Also, 3 studies highlighted collaboration through group tasks (e.g., Yeh, 2023a; Yang, 2023). Decision-making was a focus in one study (Raffali, 2023). Nine studies targeted socio-emotional attributes, with six emphasizing self-efficacy (e.g., Ting, 2023; Yeh, 2023a), two studies focused on hope beliefs (Ting, 2023; Yeh, 2023a), and 4 studies focused on emotional engagement and regulation (e.g., Park, 2017; White, 2019). Overall, these studies illustrate the importance of growth mindset interventions on different cognitive, practical, and emotional dimensions.

RQ3: What are the effects of promoting a growth mindset on students' outcomes?

The reviewed 13 studies reveal the varied impacts of promoting a growth mindset on students' learning, motivation, creativity, and engagement. Out of the 13 studies, 9 studies ($n = 9$) reported positive effects, while 4 studies ($n = 4$) reported mixed or no significant effects.

Nine studies provided strong evidence of the positive effects of growth mindset interventions on students' outcomes. Yeh (2023a; 2023b) reported that growth creativity mindset interventions improved creativity self-efficacy and self-determination among 132 students engaged in game-based learning environments. The intervention emphasized mastery experiences, showing that students benefited from scaffolded tasks that supported self-reflection and growth-oriented behaviors (Yeh, 2023a; 2023b). Ting (2023) conducted a pretest-posttest control group study with 132 fourth- and fifth-graders and demonstrated that growth mindset interventions enhanced hope beliefs and creativity self-efficacy. The study further revealed that hope and belief mediated the relationship between mindset and creative performance, underscoring the interconnectedness of psychological constructs in achieving long-term success (Ting, 2023).

Yang (2023) investigated the impact of cooperative virtual escape rooms on learning and mindset development among 128 students. Students in the experimental group exhibited increased motivation and collaboration. Students relied on peer support for problem-solving tasks, while also displaying a greater willingness to tackle challenges (Yang, 2023). White (2019) explored game-based learning interventions among 24 fifth-grade students, reporting significant improvements in both mathematics attitudes and achievement. The study highlighted the role of collaborative problem-solving and growth mindset cultivation in fostering positive work ethics (White, 2019).

O'Rourke (2014) introduced "Brain Points" in educational games, which encouraged persistence and strategic thinking among younger students. The intervention was especially effective for struggling learners, as the gamified incentives motivated effort and strategic improvement. O'Rourke (2015) extended this work, finding that "Brain Points" helped improve student persistence and self-regulation, though demographic differences were noted in its efficacy, with students from low-income groups showing smaller gains. Park (2017) examined social robots designed to model growth mindset behaviors and reported significant increases in perseverance and engagement among students interacting with the robots, demonstrating the role of adaptive, interactive interventions in promoting positive outcomes (Park, 2017).

Gorman (2022) studied gamified interventions in coding tasks and found notable improvements in persistence and mindset shifts, particularly in disadvantaged schools. The study emphasized the importance of gamified reinforcement in maintaining student motivation. Raffali (2023) demonstrated how narrative-based games embedded with growth mindset principles promoted healthier decision-making and greater engagement in learning tasks.

Four studies reported mixed ($n = 1$) and no significant ($n = 3$) effects, highlighting the challenges in designing universally effective interventions. O'Rourke (2016) evaluated narrative-based interventions aimed at fostering growth mindset behaviors and noted early disengagement among some students. This finding indicates that the design of messaging plays a critical role in its effectiveness (O'Rourke, 2016). Leach (2016) examined the effects of growth mindset interventions among gifted students and found no significant differences in persistence or engagement between experimental and control groups. The study suggested that such learners may require more complex and challenging interventions to maintain their engagement (Leach, 2016). Dowey (2017) compared a whole-school mindset approach with an intensive intervention and found no statistically significant differences in mindset scores or teacher-rated effort in English or Mathematics. The study highlighted the

difficulty of achieving measurable outcomes without highly targeted components (Dowey, 2017). Ting (2023) noted that while fixed mindsets were reduced, significant changes in growth creativity mindset were not observed, suggesting that overcoming fixed beliefs may require less effort than cultivating growth-oriented ones (Ting, 2023).

Discussion

The first point of discussion centers on the limited number of studies we identified that focus on fostering a growth mindset in pre-K-12 educational settings through digital games. While the concept of growth mindset has been well-established and its importance widely emphasized (Dweck, 2006, 2008), and the potential of digital games to promote this mindset has been discussed (Granic et al., 2014), few studies have rigorously designed digital games to achieve this goal within pre-K-12 contexts. This gap represents an urgent need for future research, particularly design-based studies, to fully leverage the potential of digital games in cultivating a growth mindset from an early age.

Second, despite the limited number of studies, our findings reveal a diverse group of researchers (e.g., Education, Computer Science) from across the globe addressing this gap, focusing on various competencies such as creativity, persistence, and collaboration. Encouragingly, most studies reported positive findings which underscore the potential of digital games to impact students' growth mindset in educational settings. However, conducting a meta-analysis could provide further insights into the strength and consistency of these positive effects. Conversely, for studies reporting negative or null effects, deeper examination is necessary to identify potential factors contributing to these outcomes, such as game design, implementation fidelity, or contextual influences.

By the time of the conference, we aim to share more detailed data on the design features of digital games that have led to positive, negative, or no effects. This analysis will provide more insights for researchers and practitioners who aim to design effective interventions that use digital games to foster a growth mindset in pre-K-12 education.

Conclusion

Growth mindset is one of the most essential mindsets for children to develop. This study aimed to explore the literature on the potential of digital games to foster a growth mindset among pre-K-12 students. Digital games can serve as powerful tools for nurturing this mindset in children. However, our review revealed a notable lack of rigorous studies that have specifically designed and evaluated digital games with this purpose in mind. This gap presents a valuable opportunity for learning scientists to step in and create high-quality digital games that can effectively foster students' growth mindset, addressing this critical gap in the field.

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