Intrinsic Integration in Learning Games and Virtual Instruction

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Publication Date: 11-17-2020

Educational Technology Research and Development

https://doi.org/10.1007/s11423-020-09886-y

Abstract: This paper responds to a 2016 systematic literature review of the research on learning games by Ke (2016). The review paper unpacked the idea of intrinsic integration in learning games, analyzing important emergent themes. The key ideas and the value of this review are discussed in the context of the recent shift to virtual instruction. The limitations, impact, and future implications are also described, with the perspective of this response focused on education theory. Intrinsic integration is an important consideration when designers create the next generation of digital games, and as researchers try to untangle the affordances of different educational games for student learning.

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1. **Key Ideas**

The article *Designing and integrating purposeful learning in game play: A systematic review* by Fengfeng Ke reviewed 69 articles about learning games. The key idea guiding the review was *intrinsic integration* – the notion that in learning games, the content to be learned should be integral to the gameplay, games rules, and game actions. For example, in the algebra game *From Here to There* (Hulse et al., 2019) the key mechanic is game "gestures" players learn over time for manipulating algebraic equations. These game gestures were created based on previous research into the ways people actually think about and solve algebraic equations (Landy, 2010). However, one could imagine a different educational game where students select multiple choice answers for equations appearing flashcards, and receive rewards and increasing problem difficulty. The latter case does not represent intrinsic integration, as the mathematics content could be swapped out for other content.

When examining issues of intrinsic integration in learning games, Ke identified five themes: (1) the kind of content instruction the game is enacting, (b) the type of intrinsic integration (i.e., objects that embody concepts, simulations of systems that utilize concepts, and rich contextualization of concepts), (3) whether learning is mapped to game mechanics, game worlds/narratives, or a blended space of both, (4) how learning moments are iteratively embedded in to game play, and (5) the kinds of learning support provided from scaffolds, prompts, and game structure. In this response, the implications of this scholarship when taking the perspective of educational theory are addressed. Issues of design, as theories lead to design decisions, are also integrated into the theory perspective.

2. **Value**

Ke offers valuable insights on how to design and select effective learning games for use in classrooms. Learning games are especially timely as we shift to digital instruction, as they can involve fully-developed, immersive instructional sequences that can be immediately rolled out during virtual instruction. There is preparation involved for teachers in gaining familiarity with the game and determining how to implement it, but using high quality learning games can be far less time-intensive than designing new activities. Students are also accustomed to playing video games outside of school, so the shift may be easier for them.

From the perspective of motivation theory, learning games are powerful because they have the potential to spur students' situational interest (Hidi & Renninger, 2006). Games with intrinsic integration specifically may be well-suited to continue to re-trigger and *maintain* this interest over time, as students begin to see the value of the content they are learning and its meaningfulness in and coherence with the game world (Renninger & Su, 2012). Interventions that trigger and maintain students' interest have the potential to impact learning and/or increase long-term interest in the academic domain (e.g., Bernacki & Walkington, 2018).

Ke's article gives useful ways to both understand whether a game has intrinsic integration, what the effects of that type of intrinsic integration might be, and the tradeoffs for embedding different kinds of learning supports and opportunities into the game. Ke operationalizes for learning games an important dilemma in the motivation literature – how to engage students *deeply* in learning, such that motivation is sustained over time through meaningful experiences that allow students ownership of their learning. For example, a learning game about geometry proofs may *trigger* students' interest through a rich narrative and novel motion-capture technology; but interest can become *sustained* and transform into *deep engagement* as students begin to understand how geometric relations can be modelled,

communicated, and understood through body movements and gestures (Schenck, Walkington, & Nathan, in press).

3. Impact & Future Implications

An examination of the app store would likely show the majority of learning games do not include intrinsic integration. Games with intrinsic integration are difficult to produce. They require designers with a deep grounding in the domain's content knowledge and in pedagogy for teaching in the domain, in order to find creative ways to map game mechanics to academic concepts. There are some domain concepts that are difficult to map at all within an intrinsically integrated game, and the total number of concepts such a game could reasonably support within the same set of core mechanics while maintaining coherence is limited. Ke's detailed unpacking of intrinsic integration is timely as educators seek to select games to use in their classrooms, and as more learning games are being imagined and produced. Ke's implication that designers should use games to "involve learners in what is fundamentally engaging about the subject" (p. 237) is perhaps the most important point made in the article.

The Ke article does not discuss the "game-based pedagogy or external instructional support" (p. 239) that can accompany the enactment of learning games. Educators are critical in framing the learning game for students, providing just-in-time support as students grapple with the concepts in the game, and facilitating class discussions where students reflect on and construct knowledge from interactions with others based on their gameplay (e.g., Walkington et al., under review). Teachers are also critical in connecting learning in the game with learning from other classroom activities (Long & Aleven, 2014). In addition, learning collaboratively by playing games with partners may fundamentally change the nature of the learning that is possible

(Walkington, Chelule, Woods, & Nathan, 2019). Such considerations will be critical as we move to implementing more games in virtual classrooms.

The importance of intrinsic integration and the issues Ke identifies have implications for using learning games in virtual settings. Ke comments that "It remains murky how game-based learning may continue from a tacit experience to attentive, reflective use of target knowledge" (p. 237). This echoes research on project-based learning and STEM integration which suggests that making academic concepts explicit and calling them out for reflection is a key strategy teachers use to allow students to learn in these rich, complex, distributed environments (e.g., Nathan et al., 2017). Indeed, if a game like *Dragonbox Algebra* is used in classrooms without a teacher making the formal rules of algebraic equation-solving visible and explicit through discussions, students may learn little more than how to solve illustrated puzzles in one particular game context. Determining how such explicit reflective approaches might make game-based learning more easily transferred to traditional academic contexts is an important pursuit.

Ke also identifies issues with the design and effectiveness of game scaffolds and prompts – and how to best balance cognitive load and opportunities for meta-reflection with a state of flow best facilitated through non-intrusive approaches. The research on STEM integration might suggest that some level of intrusiveness or explicitness of the academic content is necessary, and even desirable, to have learners realistically make connections across disparate contexts. Finally, Ke alludes to the potential of adaptive learning in game environments, and the importance of future work taking into account learner characteristics. Leveraging research on adaptivity (Plass & Pawar, 2020) could be powerful for learning games, although there is still limited consensus on what kinds of adaptations are actually effective, particularly for non-cognitive variables. All

of these issues will be important for the next generation of learning games, which may be increasingly designed for play in virtual settings.

Acknowledgements

The research reported here was supported by the Institute of Education Sciences, U.S. Department of Education, through Grant R305A200401 to Southern Methodist University. The opinions expressed are those of the authors and do not represent views of the Institute or the U.S. Department of Education.

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