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THE ROLE OF SELF-REGULATED LEARNING IN DIGITAL GAMES

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Educational research is beginning to mirror society's fascination with digital games, particularly now that their potential for improving the efficiency of learning is being recognized. And this fascination does not appear to be a fad as there has been an exponential increase in the number of studies reporting on the use of games for learning purposes (Boyle et al., 2016). Using a computer game for instruction, once considered a questionable proposition, has now been legitimized by a number of recent meta-analyses revealing advantages of digital games over non-game comparison conditions (Clark, Tanner-Smith, & Killingsworth, 2016; Sitzmann, 2011; Vogel et al., 2006; Wouters, van Nimwegen, Oostendorp, & van der Spek, 2013). Designs to study the impact of digital games are becoming more sophisticated, yet there are still concerns that a majority of digital game studies are using simple gamification effects that promote and assess only lower-level learning outcomes (Boyle et al., 2016; Clark et al., 2016). The study of more complex skills is critical, particularly those that are self-regulatory in nature and equip students to learn more deeply within content domains and to become competent learners across contexts. In order to accomplish this goal, digital-game studies require designs that more fully integrate self-regulated learning (SRL).

The purpose of this chapter is to provide an overview on the current state of research related to digital games and SRL. Figure 18.1 presents a visual organizer for the discussion to follow regarding current and prior research related to SRL and digital games, suggested pathways for future research related to SRL and digital games, and finally educational implications. The graphic and content in this chapter are far from exhaustive but highlight a few critical topics for the field. In particular, the message here emphasizes a move from an isolated to an integrated approach when considering SRL in digital games.

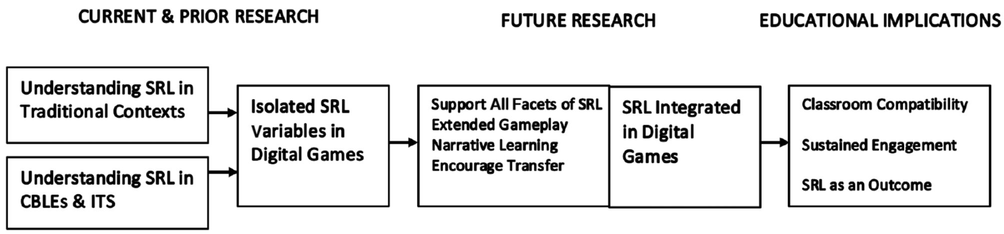

Figure 18.1 SRL research in digital games

RELEVANT THEORETICAL IDEAS

Defining Digital Games

Research involving educational games has suffered from a lack of consistency in terminology (O'Neil, Wainess, & Baker, 2005; Sitzmann, 2011). The term *digital game-based learning environment* was provided by Prensky (2001) to refer to a merging of games with educational curriculum to better represent 21st-century learning approaches. Games can be distinguished as those either built for educational purposes or for commercial purposes. Common terms for games built for educational purposes include *serious educational games* (Annetta, 2008), *educational computer games* (Mayer, 2011), and *simulation games* (Sitzmann, 2011). Mayer (2011) noted four themes common across educational games, describing them as rule-based, responsive, challenging, and cumulative. In short, he used the term educational computer game to refer to any game played on the computer "in which the designer's goal is to promote learning in the player based on specific learning objectives" (p. 282). Similarly, Wouters et al. (2013) described serious games as being interactive, with a set of agreed rules and constraints, having a clear goal often set with a challenge, and within a program that provides constant feedback. Tobias and Fletcher (2011) considered other elements to be critical for games such as storylines, fantasy, competition, and role playing. Simulation games are unique in that they include gaming elements such as those listed above but also involve the user taking a role in a problem-solving context that attempts to approximate a physical or social reality (Gredler, 2004). The focus of the current chapter will be relegated primarily to researcher-developed serious digital games but also, in some cases, to commercial digital games that have been studied for their educational benefits.

Relevant Theory Underlying Digital Games

SRL, the effective regulation of one's own learning in the pursuit of personal goals, is a broad construct that encompasses cognitive strategy use, motivation, emotion, and the metacognitive and metamotivational monitoring and control of learning (Pintrich, 2000; Winne & Hadwin, 1998; Zimmerman, 2000). Prevalent cognitive (see Winne, 2018/this volume) and social-cognitive (Usher & Schunk, 2018/this volume) models of SRL emphasize phases of learning within "episodes" experienced by the learner (Winne, 2010). SRL skills are dynamic and malleable, impacting performance not only at the task level but also through domain-level expertise and aptitude or dispositional tendencies (Glaser & Chi, 1988; Nietfeld & Shores, 2010; Winne, 2010). Effective self-regulation requires the coordination of numerous cognitive and motivational processes that lead to improved academic performance and academic motivation (Pintrich & De Groot, 1990). SRL environments allow for autonomy and control (Pintrich, 2000), the freedom to set goals (Schunk, 1990), the use of cognitive tactics and tools (Winne & Hadwin, 2013), the opportunity to monitor and control learning (Nelson & Narens, 1990), and the encouragement of appropriate help-seeking (Karabenick & Knapp, 1991).

Digital games are ideal environments to examine self-regulation given that learners have a large degree of autonomy over their actions. This includes the freedom to determine their own goals that may or may not align with goals set by the game itself, and also to engage, disengage, or alter these goals over time within the game. Digital games, unlike traditional classroom instruction, are not regulated like traditional classrooms with teachers as leaders; therefore SRL becomes critical given that the learner's choices largely determine the quality of learning that takes place. Even though the study of SRL is highly valued and well established in the educational and psychological literature it has not gained much traction thus far in studies related to digital games. A review of computer game studies in 2005 (O'Neil et al., 2005) reported none measuring self-regulation as defined by measuring metacognition, motivation, or both. Since this review a number of game-based studies have involved measurement of metacognition and motivation, yet there remain very few that have attempted an integrated approach to measuring SRL.

EVIDENCE OF DIGITAL GAMES' PROMOTION OF ACADEMIC ACHIEVEMENT AND MOTIVATION

Overall, current evidence suggests that the use of digital games is having a positive impact on academic achievement in relation to comparison conditions employing non-game-based instructional approaches. Clark et al. (2016) examined digital-game studies from 2000–2012 covering diverse disciplines focused on K–16 students and found an average overall 0.33 standard deviation improvement in learning outcomes for students in game conditions versus those in non-game comparison conditions. Game designs were particularly effective when they included multiple sessions that followed a spaced-learning design. More complex measures of learning such as creativity and critical thinking are currently understudied and will no doubt attract more attention in the literature in the coming years (see Kim & Shute, 2015, for an innovative approach encouraging creativity in Physics Playground).

The learning outcomes findings by Clark et al. (2016) are consistent with other meta-analyses and cross-study reviews (Connolly, Boyle, MacArthur, Hainey, & Boyle, 2012; Sitzmann, 2011; Wouters et al., 2013). However, results related to motivation vary. Clark et al. (2016) found positive effects for the broad domain of intrapersonal learning that included motivational constructs as well as intellectual openness, work ethic and conscientiousness, and positive core self-evaluation in games, both commercial and serious. Yet, Wouters et al. (2013) found no statistically significant advantage for serious games over other instructional methods. Wouters et al. (2013) suggested a number of possibilities for their findings, most notably that most serious games lacked effective instructional design techniques to integrate key learning features within game narratives and instead relied on overt learning prompts that interrupted the flow of the game. The authors also suggested a lack of autonomy for users both within the game and in the choice of when to play the game. Additionally, measurement may play a role as there has been a heavy reliance on the use of self-report scales. The only study in the Wouters et al. (2013) review that did not measure motivation via posttest self-report measures but rather by observations of students during gameplay showed statistically significant motivational advantages for the game over a comparison instructional treatment (Annetta, Minogue, Holmes, & Chen, 2009).

Evidence for Self-Regulation Improving Performance in Serious Games

The bulk of the existing digital games literature that employs an SRL framework has reported on isolated SRL variables and how they impact learning. In sum, these studies have made a number of important advances setting the stage for future work to integrate SRL more fully into gaming environments. Examples of contributions include an examination of goal setting and achievement goals, interest, self-efficacy, metacognitive and teacher scaffolding, strategy use, and metacognitive monitoring.

As in traditional or non-game environments, goal setting and goal monitoring is critical. It is important to carefully consider how goals are presented or generated in digital games, the level of goal specificity, and also who determines goals during gameplay. Kunsting, Wirth, and Paas (2011) studied the use of specific versus nonspecific goals using what they called an interactive computer-based learning environment that simulated a physics lab on buoyancy in fluids with high-ability high-school students. They found that nonspecific problem-solving goals led to greater use of a control of variables strategy than did specific problem-solving goals. Similarly, Feng and Chen (2014) reported advantages for nonspecific goals in their study of 6th grade students learning basic programming by developing their own digital game. Students given nonspecific goals scored higher on a test of programming comprehension. However, the nonspecific group was also advantaged in that they received metacognitive prompts to guide their actions. More studies related to goal assignment that examine a greater diversity of students are needed to clarify the specificity of goals. Moreover, studies are needed to examine student-generated versus researcher-assigned goals.

Clark et al. (2016) found positive effects for studies that included some form of scaffolding with the greatest effects coming from teacher scaffolding. Bulu and Pedersen (2010) revealed the unique contributions of both domain-specific (e.g., "On which world can the Akona survive?") and domain-general (e.g., "What other possible solutions can you suggest?") scaffolds in the game Alien Rescue with 6th grade students. Alien Rescue is a problem-based learning game environment where students help resettle aliens using their knowledge of the solar system. Students across conditions showed statistically significant content gains after 13 sessions of gameplay. Those in the domain-specific scaffolding conditions scored higher on the science posttest and also on problem representation measures than those in the domain-general conditions. Alternatively, students in the domain-general condition performed statistically significantly better on monitoring and evaluation measures, as students in these conditions more effectively evaluated their solutions, discussed drawbacks, and provided alternative solutions to the game-based problems.

Mayer and colleagues (Fiorella & Mayer, 2012; Johnson & Mayer, 2010; O'Neil et al., 2014) have taken a value-added approach to investigating digital games wherein base versions of games are compared to games augmented with instructional features. These features are largely focused on strategy and metacognitive prompts. For instance, O'Neil et al. (2014) found that added self-explanation prompts can be positive or negative depending upon how they are presented. In this case, 6th grade students playing a fractions game reached higher levels in the game when answering a prompt that connected game terminology with mathematical concepts, compared to those that answered more open-ended or overly easy prompts. Johnson and Mayer (2010) discovered that the manner in which college students provided reasons for their choices in their Circuit Game was critical to their performance on a transfer posttest. Students who selected their reason by clicking on one of the options provided in a menu scored significantly better than those who generated a written reason. Moreover, there were no differences between those who generated written reasons versus those in a comparison condition who provided no reasons for their responses. Fiorella and Mayer (2012) found that paper-based metacognitive prompts increased transfer rates for college students compared to their peers who did not receive the prompts on the Circuit Game.

In one of the few studies that attempted a more integrated approach at examining the influence of SRL in a gaming environment, Nietfeld, Shores, and Hoffmann (2014) found that SRL variables predicted in-game performance in a game called Crystal Island—Outbreak for 8th grade students even after accounting for prior knowledge. The game presents a narrative-based science mystery on an island with a research station where the researchers are falling ill. The goal for the player is to determine the source of the outbreak by talking to characters at the research station and by forming questions, generating hypotheses, collecting data, and testing hypotheses. A structured note-taking tool called the *diagnosis worksheet* is provided for the learner to track and organize information along with a device to communicate with other characters in the game. In order to solve the mystery and "win" the game, the student must submit a correct diagnosis worksheet with correct information about the source object, disease, and treatment. Results showed that significant independent contributions to in-game performance came from all three major SRL facets (Zimmerman, 2000) including cognitive strategy use (e.g., diagnosis worksheet tool), metacognition (e.g., monitoring bias), and motivation (e.g., perceived interest and self-efficacy for science). The strongest predictor of performance was the diagnosis worksheet, revealing the importance of including in-game tools to assist learners in the self-regulation process. In an earlier study using Crystal Island—Outbreak the effective use of the diagnosis worksheet was shown to compensate for low prior knowledge (Shores & Nietfeld, 2011). In that study, low prior knowledge 8th grade students who used the diagnosis worksheet effectively closed the posttest score gap with their high prior knowledge peers, whereas scores for the low prior knowledge students who did not use the worksheet effectively remained statistically significantly lower than their high prior knowledge peers at the posttest.

Metacognitive monitoring and the importance of being well calibrated are important for learners in serious digital games. Nietfeld, Hoffmann, McQuiggan, and Lester (2008) found metacognitive monitoring judgments to be significantly related to performance in Crystal Island—Outbreak as revealed by significant correlations of $r = 0.59$ with goals completed and $r = 0.74$ with in-game score. The Nietfeld et al. (2014) study pointed out the potential pitfalls of overconfidence as boys, but not girls, who were overconfident performed statistically significantly lower in the game and on a posttest of content knowledge, compared to their underconfident peers. Similarly, Brusso, Orvis, Bauer, and Tekleab (2012) found that a large goal-performance discrepancy for college students playing a first-person military mission video game on the first mission led to poorer performance on a subsequent mission. Thus, the early evidence suggests that overconfidence or large goal-performance discrepancies appear to have profound negative effects on both learning and performance in digital games.

Evidence for Games to Improve Self-Regulation

Less frequent but emerging are studies that examine how digital games impact SRL variables. As mentioned previously, these studies are framed within SRL theory but typically consider isolated SRL variables as outcomes. Likely the most frequent SRL outcome studied in the context of digital games has been self-efficacy, which has been shown to increase as a direct result of playing serious games. Bergey, Ketelhut, Liang, Natarajan, and Karakus (2015) reported changes in self-efficacy for scientific inquiry in direct relation to performance on their assessment module for middle schoolers. Meluso, Zheng, Spires, and Lester (2012) reported significant pre- to posttest gains for self-efficacy and content knowledge for 5th grade students after four sessions of gameplay within Crystal Island—Uncharted Discovery. Sixth-graders who played Alien Rescue showed significant increases in self-efficacy for learning science after 15 daily sessions of gameplay (Liu, Hsieh, Cho, & Schallert, 2006). Jackson and McNamara (2013) found an increasing trend for self-efficacy over time for their game-based intelligent tutoring system iSTART-ME, as opposed to a decreasing trend for the traditional tutoring system iSTART. iSTART emphasizes self-explanation and comprehension strategy training for high-school students. iSTART-ME is the well-established iSTART program but with the addition of game-based features built on top of the program such as a point-based economy that includes leveling, as well as the ability to earn points and trophies, interact with new texts, unlock new features, play mini-games, and to personalize a character. Both programs showed equivalent learning outcomes but advantages for iSTART-ME over time for motivation and enjoyment led the authors to conclude that the game-based components showed potential for sustaining engagement. This finding has significant implications as the field creates games that encompass a larger portion of school curriculum and skills.

One goal of digital games is for them to function as a "hook" or to provide a context that promotes situational interest that may eventually lead to sustained personal interest. Plass et al. (2013) examined how individual, competitive, and collaborative conditions impacted situational interest during a mathematics video game for middle-school students. Results revealed that interest was higher for students in both the competitive and collaborative conditions than the individual condition. A recent attempt to examine the relationships between engagement and in-game variables was undertaken by Ronimus, Kujala, Tolvanen, and Lyytinen (2014). They examined the impact of rewards and challenge for 1st and 2nd graders using a game to improve letter–sound connections. Surprisingly, they found that challenge did not influence students' level of engagement. Moreover, rewards, in the form of in-game tokens, had only a short-term effect on engagement. Finally, Shores, Hoffmann, Nietfeld, and Lester (2012) examined the role of game structure, in this case quests that functioned as subproblems, on situational interest. In the game Crystal Island—Uncharted Discovery, 5th graders played three 60-minute sessions completing various quests in an immersive 3D environment related to landforms, map navigation, and map model curriculum. The quests were created as proximal goals or subproblems to help students more effectively manage the overall curriculum goals. The authors found that the total number of completed quests predicted situational interest even after controlling for pre- and posttest content knowledge measures. More research like this is needed to fully understand conditions in educational computer games that might impact situational interest or engagement more broadly and, in turn, lead to personal interest over time.

O'Rourke, Haimovitz, Ballweber, Dweck, and Popović (2014) have begun to investigate how to encourage growth mindset in elementary-school students using a game called Refraction that teaches fraction concepts. O'Rourke et al. created two versions of the game, one that attempted to reward players for strategy use, effort, and incremental progress with what they called "brain points" while also incorporating growth mindset language, and a second version that functioned as a comparison condition that awarded points only for advancing levels and used neutral language. The results showed increased levels of persistence, measured by gameplay time, and increased number of levels played for the treatment group. However, more controlled trials are necessary as the researchers were limited to data collected from an educational website portal, and gameplay was limited to just a few minutes in most cases.

Van de Sande, Segers, and Verhoeven (2015) used trace data in a narrative-based problem-solving game for young children, ages 5–7, and found that executive control skills such as attentional and action control, both requiring inhibitory control (see Hoyle & Dent, 2018/this volume), impacted strategy use, staying on task, and sustaining goal-directed learning in the game. What is unknown is the extent to which this finding would generalize to more complex games and the role that inhibitory control plays across game settings. Snow, Jackson, and McNamara (2014) tested the impact of college students' prior literacy ability within their iSTART-ME game-based tutoring system. Using a repeated-sessions design they found that low prior ability students reduced the differences between themselves and their high prior ability peers over sessions to the point of non-significant differences in the ability to produce self-explanations. In the game low prior ability students tended to choose generative-practice activities (i.e., providing scaffolding and feedback) more frequently than high prior ability students and also tended to check achievement screens (i.e., providing progress feedback) more frequently. The authors suggested that these aspects of the gaming context may have functioned as a means of external monitoring that instigated control processes leading to improved performance over time.

Work by Barbara White and colleagues (White & Frederiksen, 2005; White, Frederiksen, & Collins, 2009) illustrates one of the more overt attempts to have students develop explicit awareness of SRL skills. They created the Inquiry Island and Web of Inquiry learning environments to assist students in the development of metacognitive inquiry-based skills in science. Inquiry Island is a narrative-based game that has students take on roles of advisors both specific to the inquiry task at hand and also as general purpose advisors. For instance, specific advisors might include Quentin Questioner or Ivy Investigator. Examples of general-purpose advisors might be Pablo Planner or Molly Monitor. Herein, the narrative roles encourage students to develop explicit understanding of both domain-specific and domain-general skills that assist in developing self-regulation skills on science projects. White et al.'s inquiry projects encourage the transformation of student metacognitive models from tacit to formal (Schraw & Moshman, 1995). The use of Inquiry Island in 5th grade classrooms resulted in statistically significantly higher scores on performance-based measures of metacognition and inquiry processes than for students in comparison classrooms who did not use Inquiry Island (White & Frederiksen, 2005).

Measuring Self-Regulated Learning in Digital Games

As in traditional learning environments, the measurement of SRL in digital games is in its infancy but shows great potential (Winne, 2010). Snow et al. (2014) stated the best indication of developing self-regulation in games comes by examining students' ability to control and regulate behaviors when presented with numerous options. The authors examined trace data and used transitional probability analysis to determine different regulatory patterns, as described above, used by high- and low-ability students in iSTART-ME. Gaming environments such as this that utilize trace data have the potential to dynamically assess learning and provide feedback in ways not possible to obtain in traditional learning contexts.

One of the strongest proponents for assessment in digital games has been Valerie Shute (2011), who has developed innovative stealth approaches to measure learning. Stealth assessment involves measuring performance of the learner within the narrative of the game and without disrupting the flow of the gameplay experience. Shute (2011) argued that stealth assessment can reduce test anxiety and also improve motivation because students are being assessed while engaged in a pleasurable yet challenging activity. Shute and her colleagues have validated this approach (Shute, Ventura, & Kim, 2013; Ventura, Shute, & Zhao, 2013) by showing relationships between in-game stealth assessment measures and external measures of the same construct (e.g., physics knowledge, persistence). The use of Bayesian models to update and customize the game environment as students play provides the potential to support adaptive learning, an approach that is currently unique to the field. Shute, Ke, and Wang (2017) provided a clear nine-step process of how to develop models and methods to dynamically assess learners while providing a worked example from the Use Your Brainz game. Models such as these are applicable across gaming environments and reveal the potential that games have to provide customization not possible in traditional learning environments.

FUTURE RESEARCH DIRECTIONS

Due to the infancy of the field, digital games researchers should draw heavily on the existing literature in SRL to design and test game environments, and also on the more established literatures related to computer-based learning environments (see Moos, 2018/this volume) and intelligent tutoring systems (see Azevedo, Taub, & Mudrick, 2018/this volume). Four suggestions for moving the field forward are described briefly below.

Support All Facets of SRL

While the Nietfeld et al. (2014) study advanced the integration of SRL variables in a game environment, it still did not approach a fully integrated study. In order for full integration to occur the following suggestions should be considered in the implementation of the gaming environment: 1) provide support for the development of SRL skills and the ability to measure the facets of SRL including strategy use, metacognitive monitoring and control, motivation, and emotion; 2) provide extended practice with multiple gameplay sessions; 3) provide activities to assist learners in becoming explicitly aware of important self-regulatory skills that they develop in the game; and 4) measure performance for both content and SRL skills both within and outside (i.e., transfer) the game. These suggestions are informed by Pressley's (1995) characterization of SRL as a complex phenomenon that is developed over time, with training that should emphasize conditional knowledge and application of skills. Relatedly, the call made by Schunk and Ertmer (2000) for further research on the transfer of SRL skills from explicit instruction in content areas is applicable to learning in digital games. While complete integration as described by the four points above may not be feasible nor desirable in every context it seems to be a worthy goal to work toward for serious game researchers seeking to make a significant impact on learning.

Extended Gameplay

Both Wouters et al. (2013) and Clark et al. (2016) emphasized the effect of multiple training sessions in digital game studies. The Jackson and McNamara (2013) study described above was one of the first studies to cite trends for engagement over time matching a game-based program versus a non-game based program. Reiterating a long-standing issue facing research in SRL (Pressley, 1995), the design of programs and interventions that can be maintained over extended periods of time are required to make enduring changes in SRL skills. This is one of the primary challenges for studies of SRL and digital games to address in the near term.

Narrative Learning

One major challenge for digital game studies is the ability to encourage and scaffold engagement that facilitates learning without disrupting the flow of the game itself. For instance, this might involve the ability to seamlessly integrate attempts to encourage mastery goals or to facilitate accurate monitoring on the part of the students using implicit integration techniques that align with the narrative of the game (Nietfeld & Shores, 2011). In order to do this, a unique narrative-centered approach can be presented with "story-centric" problem-solving activities (Rowe, Shores, Mott, & Lester, 2010). This approach is common across many established serious game environments such as Quest Atlantis (Barab et al., 2007), River City (Ketelhut, Dede, Clarke, Nelson, & Bowman, 2007), and Crystal Island (Lester et al., 2014) that use rich narrative settings to contextualize inquiry-based learning scenarios.

Caution must be provided for this recommendation as narrative approaches are thus far not empirically supported when examined across the board (Adams, Mayer, MacNamara, Koenig, & Wainess, 2012; Clark et al., 2016; Wouters et al., 2013). Instead, early evidence has shown content learning advantages for games that provide simple schematics over those that present more realistic settings. A suggested reason for this is that rich narratives have the potential to distract the learner from the central learning objectives. Clark et al. (2016) pointed out that game designers and educational researchers must ensure alignment between the game graphics, environments, and narratives with the assessed learning objectives.

Barab et al. (2007) provided a model of a design-based approach and classroom integration of a narrative version of Quest Atlantis for 4th grade students. The narrative was centered around an area called Taiga Park that was undergoing a water-quality dilemma. In order to solve the dilemma, students were required to engage in an inquiry-based approach testing water samples and examining various stakeholders' activities in the park. The research team found positive gains for both knowledge directly related to the games' curriculum and also on distal-level items that measured cross-context or transferable knowledge across two studies involving both high-achieving and low-achieving students. The studies included sessions spread out between two weeks and one month respectively. Between studies Barab et al. conducted an analysis of the narrative and made critical changes that involved implicating multiple groups of the Taiga Park users, creating more involvement with pedagogical agents, and more complex missions. The Barab et al. (2007) study was not specifically focused on SRL but presents an approach by which an SRL framework could be overlaid and applied in a classroom. Particularly noteworthy was the iterative approach taken to better align the narrative with the learning objectives.

Evidence of Games That Encourage the Transfer of SRL Skills

Given emerging evidence for their impact on content learning outcomes, one of the next major foci in the study of digital games will be on the transfer of learning to contexts outside of the game environment. For the study of SRL in games this translates to a focus on in-game scaffolds that facilitate the transfer of both content knowledge and SRL skills. At present there is a small but growing momentum for studying the transfer of content knowledge with digital games but none as of yet for research on the transfer of SRL skills. Early evidence for content-knowledge transfer is encouraging. Barzilai and Blau (2014) found that an external scaffold that preceded gameplay, as opposed to after gameplay, for children aged 6–14 on a business simulation game led to greater problem solving on a formal assessment outside of the game. The scaffold appeared to function as an advanced organizer to provide a framework for understanding relationships between the topics of cost, price, and profit that were included in the game. However, ability to solve the financial-mathematical word problems was low across groups outside of the game, prompting the authors to argue that there is a need to consider metacognitive scaffolds to encourage the explicit abstraction of principles from inside the game to contexts outside the game in order to ensure transfer. Moreno and Mayer (2005) investigated college students using the Design-A-Plant program that required an understanding of plant survival under different weather conditions. Conditions included variations of guidance (e.g., feedback on reasons for the correct answer) and self-reflection (e.g., justification of students' own answers). Explanatory feedback but not self-reflection resulted in better transfer, fewer incorrect answers, and fewer misconceptions, pointing to the need to make explicit the connection between the content and its potential application. These studies are examples of the incorporation of transfer measures; however, they are the exception rather than the rule. More emphasis should be placed on considering transfer during the design of the game, the design of studies, and from the perspective of cross-curricular learning.

IMPLICATIONS FOR EDUCATIONAL PRACTICE

Developing Classroom-Compatible Digital Games

Digital games have the potential to become a part of the everyday culture within schools and become "classroom-compatible" but a number of considerations must be taken into account. First, games must align with important curricular goals and targeted academic skills determined by teachers. In most cases this requires that a game should include sufficient content depth and offer extended practice sessions. Second, games will have to be built for and tested with diverse groups of learners. Careful consideration should be taken so that games and assessments within games do not give advantages to those with more prior experience or higher computer game self-efficacy. Players should be able to adapt to gaming environments within a short period of time regardless of incoming levels of gaming experience. Third, the game-design process should include an iterative development process with on-going collaboration between experts from various disciplines, teachers, and the students.

Sustained Engagement

Digital games hold the potential to sustain engagement over time for learning content and complex skills. The success of maintaining such engagement lies with features unique to games such as role taking, challenge, compelling narratives, and the opportunity to progress through more advanced levels. The game-based environment also allows for customized learning and continual feedback that is relevant to both academic skills and the gaming framework. These design factors can elicit emotional, cognitive, and perceptual processes that generate a sense of purpose or commitment to the game that is hopefully the impetus for the development of more sophisticated mental models and opportunities for transfer (Hacker, 2017).

Using Digital Games to Promote SRL Skills as Important Educational Outcomes

The unique qualities of games also increase the opportunity to promote SRL skills as outcomes. Consider games that require evidence of accurate monitoring, the use of multiple strategies, or indicators of growth mindset to earn badges, gain points, or unlock hidden game features. Digital games can be created to leverage the engagement that these features support and produce SRL variables as outcomes. The opportunity to study SRL variables as outcomes of digital games is currently wide open. Can playing digital games improve conditional knowledge and therefore learners' ability to understand when and why to apply strategies outside of the game? Can digital games help improve the domain-specific or general monitoring skills of learners? Can digital games, if played over many sessions, impact learners' mindsets or increase mastery approach goal orientations? Can games teach learners adaptive help-seeking skills that transfer outside of the game context? These are just a sample of questions that could have profound implications for digital games in practice.

CONCLUSION

Research in digital games related to SRL has yet to gain a strong foothold in the literature but appears to be at a tipping point. Numerous game-based studies framed by SRL theory and even more SRL studies from computer-based learning environments and intelligent tutoring systems are paving the way for the study of SRL in digital games. Current research shows great promise for SRL to impact learning in digital games; however, a more integrated approach to incorporating and targeting all facets of self-regulation is needed. SRL skills can have a significant impact for learning in games and can also be important products of games.

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