Unveiling the Measurement of Self-efficacy in Game-based Learning

Chaewon Kim, Sam Sprenkle, & Curt Fulwider

AECT
THE JOURNAL OF APPLIED
INSTRUCTIONAL DESIGN

This scoping review explores the relationship between self-efficacy and game-based learning (GBL). The study identifies the primary subject areas studied in GBL, such as STEM and language learning, and examines the instruments used to measure self-efficacy. While many studies measured self-efficacy as a dependent variable, some used it as an independent variable alongside other factors. The most commonly used self-efficacy scales are identified. The results suggest that GBL positively impacts self-efficacy, but the improvement in self-efficacy may not match the performance improvement. This review highlights the need for more precise and context-specific measurement of self-efficacy in GBL research, emphasizing the importance of reliable measurement practices.

Background

The motivational benefit is a major influence of game-based learning (GBL) on the affective domain (Shaffer et al., 2005). Self-efficacy is a core component of motivation that "exists with a broad system of multicausality" (Bandura, 1997; Bandura, 1999, p. 35; Eseryel et al., 2014), meaning self-efficacy is part of a complex network of cognitive and non-cognitive constructs. The role self-efficacy plays is unique as, given the credibility of negative feedback, even "highly talented individuals" can have their skills "easily overruled by self-doubts" (Bandura, 1997, p. 37). Therefore, to determine whether game-based learning has a real positive effect on motivation—beyond the effect of novelty—a thorough understanding of how the game-based learning experience influences self-efficacy beliefs is essential. Bandura provides a clear description of how best to measure self-efficacy (Bandura, 1997). Each question should be written in terms of "I can." Enough questions that target concrete tasks within the target content area (e.g., Mathematics) and vary in difficulty should be included. This allows for a generalizable estimate of the respondent's efficacy beliefs—i.e., self-efficacy for the construct (e.g., Mathematics) rather than the specific task (e.g., summing two numbers).

Our purpose for this scoping review is to gauge the existing research on self-efficacy and how it changes or doesn't change in experimental studies of GBL. Beyond collecting general information about the studies being conducted (e.g., location, outcomes, populations), we are interested in exploring common elements of the instruments being used to measure self-efficacy. Specifically, we seek to answer the following research questions:

1. What are the primary areas being studied? (e.g., STEM, language)
2. What types of instruments are being used to measure self-efficacy?
3. What are common outcomes for self-efficacy in game-based learning (GBL)?

Methods

The foundation of this review was initiated by searching a series of relevant terms using Boolean logic in common databases focusing on self-efficacy and game-based learning. Table 1 shows the specifics of the search parameters and terms for the three databases: PsycINFO, Education Source, and ERIC. The results yielded 194 total publications. The results were screened with the following criteria: (1) an empirical study published in the past 10 years, (2) to a peer-reviewed or refereed journal, and (3) measured self-efficacy at least once during the intervention. The screening yielded 47 articles which were transferred to the full-text review process. After excluding 6 studies of which full text was unavailable and 12 studies that measured self-efficacy but used it as a mediating variable, 29 articles were extracted and compared to establish data to answer the research questions.

Table 1

Databases and search criteria used

Database name	Search Criteria	n
PsychInfo	"self-efficacy OR self efficacy" AND "game-based learning OR game based learning"	102
Education Source	"self-efficacy OR self efficacy" AND "game based learning OR game based learining"	31
ERIC	"self-efficacy OR self efficacy" AND "game-based learning OR game based learning"	61

n = number of publications found in search.

Results

As shown in Figure 1, the main subject area being studied was STEM, followed by vocational training and language learning. Other areas included general logic for puzzle solving (Bilgin, 2015), nursing training (Chang et al., 2022), earthquake emergency training for children (Feng et al., 2021), and history (Chu et al., 2015). Self-efficacy was measured as a dependent in 21 studies while playing a role as an independent in 8 studies, usually with other variables shown in Figure 2. Learning achievement (also described as an outcome or performance) was the most commonly measured variable. Other variables measured along with self-efficacy included the perceived ease of play, 21st-century skills, challenge, control, frustration, and empathy along with self-efficacy (See Figure 2).

Figure 1

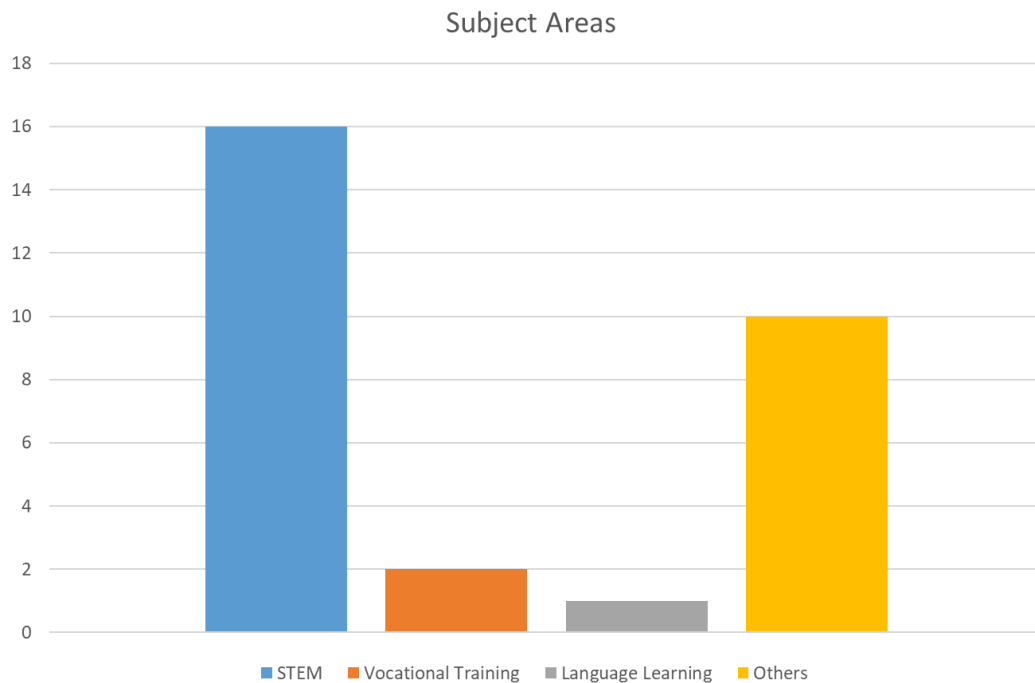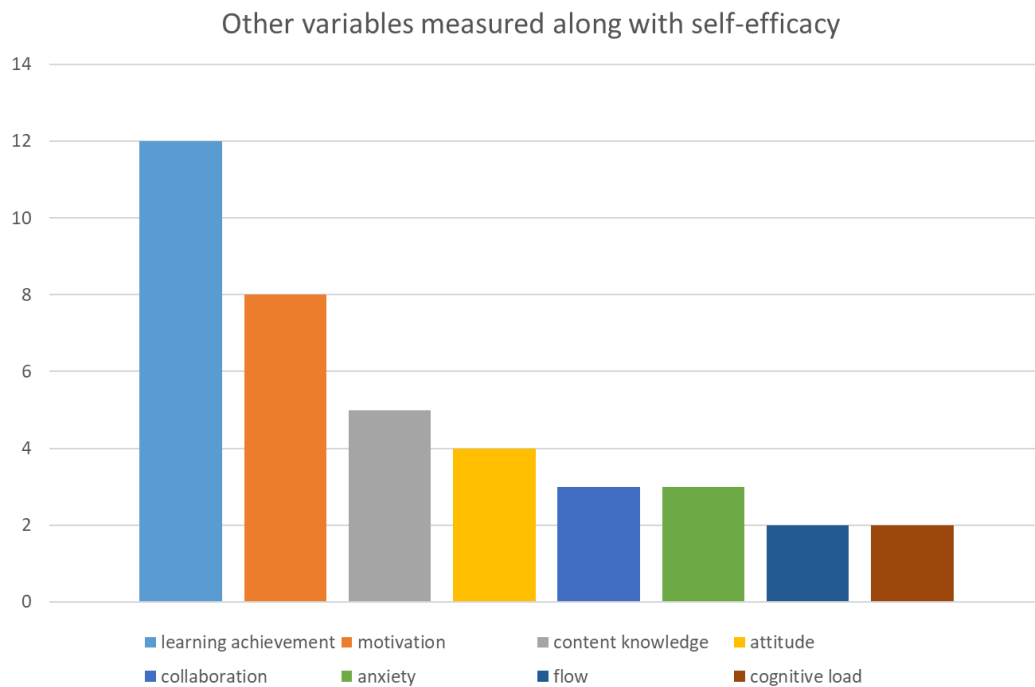*Subject Areas of studies measuring self-efficacy*

Subject Areas

Figure 2

Other variables measured along with self-efficacy

With some variations according to each study's context, the most frequently used scales were those of Pintrich et al. (1991), Pintrich & Groot (1990), Bandura (2006), and Britner & Pajares (2006). Six studies identified and adopted the most suitable self-efficacy measure that fits their context (i.e., population, subject area). They also cited the first validated source for the scale, which is a desirable practice considering the definition of self-efficacy (Bandura, 1997) which makes a premise of context-specific understanding.

An interesting finding emerged from the review process: many games have proved themselves to be effective in enhancing students' performance in the target content, while the improvement in self-efficacy was not as great as that of actual performance. In other words, learners tended not to believe that they were not as good as they were after the intervention. As this is a preliminary qualitative finding, further research is needed to understand this gap between students' beliefs about their performance and their actual performance.

Overall, the studies indicated that GBL has a positive impact on improving students' self-efficacy. However, it can also be interpreted to be affected by publication bias (Gage et al., 2017) that larger positive effect sizes are always welcomed. To precisely measure self-efficacy in GBL, a longitudinal approach is needed along with a precaution about collinearity. Since self-efficacy is sometimes nested in motivation (Schunk, 1995), high collinearity between the variables can compromise the reliability of some studies.

Discussion and Significance

Although a significant number of studies measured self-efficacy as one of the means to prove that their research on GBL is effective, their understanding of self-efficacy tended to be shallow in many cases. It is observed that some studies adopted a general self-efficacy scale, which directly opposes the concept of self-efficacy initially proposed by Bandura (1997). In addition, five studies included in the review used a self-efficacy measure with an unvalidated scale or from a second source, which potentially includes some distortion from the original items. This study is meaningful in that it provides a retrospective for measuring self-efficacy in GBL and refreshes the academic community for a more trustworthy practice of measurement.

References

Bandura, A. (1997). *Self-efficacy: The exercise of control*. W.H. Freeman.

Bandura, A. (2000). Social Cognitive theory: An agentic perspective. *Asian journal of social psychology*, *2*(1), 21-41.

Bandura, A. (2006). Guide for constructing self-efficacy scales. In F. Pajares & T. Urdan (Eds.), *Self-efficacy beliefs of adolescents* (Vol. 5, pp. 307–337). Information Age Publishing.

Bilgin, C. U., Baek, Y., & Park, H. (2015). How debriefing strategies can improve student motivation and self-efficacy in game-based learning. *Journal of Educational Computing Research, 53*(2), 155-182. https://doi.org/10.1177/0735633115602582

Britner, S. L., & Pajares, F. (2006). Sources of science self-efficacy beliefs of middle school students. Journal of Research in Science Teaching: T*he Official Journal of the National Association for Research in Science Teaching, 43*(5), 485-499. https://doi.org/10.1002/tea.20131

Chang, C. Y., Chung, M. H., & Yang, J. C. (2022). Facilitating nursing students' skill training in distance education via online game-based learning with the watch-summarize-question approach during the COVID-19 pandemic: A quasi-experimental study. *Nurse Education Today, 109*, 105256. https://doi.org/10.1016/j.nedt.2022.105256

Chu, H. C., Yang, K. H., & Chen, J. H. (2015). A time sequence-oriented concept map approach to developing educational computer games for history courses. *Interactive Learning Environments, 23*(2), 212-229. https://doi.org/10.1080/10494820.2014.979208

Eseryel, D., Law, V., Ifenthaler, D., Ge, X., & Miller, R. (2014). An investigation of the interrelationships between motivation, engagement, and complex problem-solving in game-based learning. *Journal of Educational Technology & Society, 17*(1), 42-53.

Feng, Z., González, V. A., Mutch, C., Amor, R., & Cabrera-Guerrero, G. (2021). Instructional mechanisms in immersive virtual reality serious games: Earthquake emergency training for children. *Journal of Computer Assisted Learning, 37*(2), 542-556. https://doi.org/10.1111/jcal.12507

Gage, N. A., Cook, B. G., & Reichow, B. (2017). Publication bias in special education meta-analyses. *Exceptional Children, 83*(4), 428-445. https://doi.org/10.1177/0014402916681440

Pintrich, P. R., & De Groot, E. V. (1990). Motivational and self-regulated learning components of classroom academic performance. *Journal of Educational Psychology, 82*(1), 33–40. https://doi.org/10.1037/0022-0663.82.1.33

Pintrich, P. R., Smith, D. A. F., Garcia, T., & McKeachie, W. J. (1991). *A manual for the use of the motivational strategies learning questionnaire (MSLQ).* National Center for Research to Improve Postsecondary Teaching and Learning.

Schunk, D. H. (1995). Self-efficacy, motivation, and performance. *Journal of Applied Sport Psychology, 7*(2), 112-137. https://doi.org/10.1080/10413209508406457

Shaffer, D. W., Squire, K. R., Halverson, R., & Gee, J. P. (2005). Video games and the future of learning. *Phi Delta Kappan, 87*(2), 105–111.