

Understanding Learner Interaction and Engagement in K–12 Online Learning: Complementary Frameworks and Future Directions

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Abstract: Learner interaction and engagement are widely seen as a critical element of effective K-12 online learning. However, researchers have often examined these constructs inconsistently and without clear conceptual definitions. While additional research is needed on learner interaction and engagement in K-12 online environments, future research should build on insights from the existing research using frameworks to guide their efforts. This article reviews existing research and major frameworks and highlights how they can be used to guide future research. We then share how four frameworks—Educational Interactions, Community of Inquiry, PICRAT, and Academic Communities of Engagement—are distinct but complementary for examining interactions and engagement in K-12 environments. We then end by discussing the tensions between efficiency and effectiveness, the need for research examining interaction and engagement’s impact beyond cognitive outcomes, and the future role of generative artificial intelligence in making K-12 online learning more interactive and engaging.

Introduction

Learner interaction and engagement are the bedrock of online learning and are seen as the keys to unlocking sought-after learning outcomes. Despite their importance, research examining learner interaction and engagement in K-12 online environments is limited, and when researchers do focus on these constructs, they too often fail to clearly define them (Halverson & Graham, 2019). The goal of this article is to provide some clarity to the conceptual haze that often surrounds learner interaction and engagement in online learning environments by providing a review of definitions, frameworks, and research. We also provide examples of how relevant frameworks can be used by practitioners and researchers.

Types of Educational Interaction Framework

In environments where a substantial portion of the content is delivered online, maintaining educational quality requires opportunities for learners to engage in purposeful and constructive interactions. Specifically, Moore’s (1989) framework identified three types of interaction: learner-content, learner-instructor, and learner-learner.

The types and amounts of interactions can vary widely across courses and programs, and the need for all three types of interaction at high levels has been debated. For instance, Anderson's (2003) interaction equivalency theorem argued the following:

Deep and meaningful formal learning is supported as long as one of the three forms of interaction (student-teacher; student-student; student-content) is at a high level. The other two may be offered at minimal levels, or even eliminated, without degrading the educational experience. (p. 4)

Anderson (2003) added that high levels of two or more types of interaction could improve the learning experience but come at the cost of efficiency and flexibility.

Community of Inquiry Framework

In contrast to Anderson's (2003) equivalency theorem, Garrison et al.'s (2000) highly influential Community of Inquiry (CoI) framework is rooted in the collaborative constructivist perspective, emphasizing the need for learners to co-construct meaning together in sustained dialogue. Rather than being optional, the CoI framework positioned learner-learner interactions as essential for establishing learners' social and cognitive presence. Social presence was defined as learners' ability to project "themselves socially and emotionally, as 'real' people (i.e., their full personality)" (p. 94). Recently, Song et al. (2025) found a significant relationship between parents' perceived social presence, their satisfaction with the instructor, and how much they believed their student learned in a K-12 online environment. Lastly, the CoI framework explained that learner-instructor interactions are necessary to establish teaching presence, which supports and enhances social and cognitive presence by setting the climate and regulating learning.

Interactions can also be expanded to include other members, such as facilitators, coaches, counselors, and administrators, and Oviatt et al. (2018) explained that these individuals can be proximal to learners. Researchers have also emphasized the need to incorporate learner-parent interactions to increase social presence and ensure learners feel connected to other members of their support community (Borup et al., 2013b; Borup et al., 2020). Moore's (1989) framework has also been further expanded to add interactions that do not directly involve the learner, such as instructor-instructor, instructor-content (Anderson, 2003, 2008), and instructor-parent interactions (Borup et al., 2013b). Sanders and Lokey-Vega (2020) applied the CoI framework to the K-12 online learning environment and added Collegial Presence to the framework, consisting of online teachers' interactions and collaborations with parental guardians/learning coaches, other teachers, supervisors, and support staff.

PICRAT Framework

Kimmons et al. (2020) explained that learners' interactions with the content and individuals can be designed to be passive (i.e., listening, observing, reading), interactive (i.e., exploration, communication, experimentation), or creative (i.e., producing products, constructing artifacts) (Kimmons et al., 2020). Teacher-designed interactive learning activities can also be classified by how they deviate from previous practice, and the extent to which the interaction either replaces, amplifies, or transforms the learning activity, as follows:

- Replaces—The new activity sustains current practice without making meaningful changes to learning activities.
- Amplifies—The new activity incrementally improves learning activities in ways that may result in some improvements in learning outcomes.
- Transforms—The new activity fundamentally changes learning activities in ways that may result in significant improvements in learning outcomes.

Examining in-person technology integration, Kimmons et al. (2020) developed the PICRAT framework to describe both the students' use of technology (either passive, interactive, or creative), as well as the role of the teachers' interaction (replaces, amplifies, or transforms). Borup et al. (2023) then adapted and applied the PICRAT framework to the K-12 online learning environment.

The PICRAT framework provides a useful lens for classifying the types of interaction that K-12 online teachers report implementing in their classrooms (Borup et al., 2023). Because it positions both students' relationship to technology amid the effect on teachers' practice, PICRAT makes visible how relatively small design decisions can shift both interaction and, subsequently, the learning experience within a digital environment. Borup et al.'s (2023) year-long research at an online program found that teachers' changes in the digital setting tend to fall into the interactive-amplify region of PICRAT, often suggesting incremental improvements to traditional practice (Borup

et al., 2023). This may be, in part, due to the affordances that a digital format provides, in addition to teachers adopting technologies that make their familiar routines more responsive, while not fully redesigning tasks or their role in the process.

Academic Communities of Engagement Framework

Learner engagement is widely recognized as a critical factor in academic success and a key remedy to the lower pass rates often observed in K-12 digital courses compared to in-person learning. Despite its importance, engagement is often not clearly defined, in part due to its multidimensional nature. Christenson et al. (2012) critiqued, “although researchers have reached consensus that student engagement is multidimensional, agreement of the multidimensionality differs from agreement on the number and types of engagement dimensions” (p. vi). However, Borup et al.’s (2020) review of the literature found that researchers are increasingly conceptualizing online learner engagement through three interrelated dimensions:

- **Affective engagement**—“The emotional energy associated with involvement in course learning activities” (p. 813).
- **Behavioral engagement**—“The physical behaviors (energy) associated with completing course learning activity requirements” (p. 813).
- **Cognitive engagement**—“The mental energy exerted towards productive involvement with course learning activities” applied to mastering learning objectives (p. 813).

These dimensions are also reflected in Martin and Borup’s (2022) definition of online learner engagement as “the productive cognitive, affective, and behavioral energy that a learner exerts interacting with others and learning materials and/or through learning activities and experiences in online learning environments” (p. 164).

The ACE framework acknowledges that each learner can engage affectively, behaviorally, and cognitively, independently of support from others, but typically not at levels required for academic success. It is important to note that a learner’s ability to independently engage can vary across the ABC dimensions of engagement. For example, it is possible for a social studies student to have high interest and affective engagement during an instructional unit on the Roman Empire but lack the ability to engage behaviorally and cognitively at the same level.

Similar to Vygotsky’s (1978) Zone of Proximal Development, the ACE framework’s primary hypothesis is that a learner’s ability to engage affectively, behaviorally, and cognitively increases when they receive support from others. Specifically, the ACE framework identified the following two types of communities based on their relationship with the learner and their affiliation to the course:

- *Personal Community* comprises individuals who have formed relationships (often life-long relationships) with the learner outside of the course (i.e., parents, friends).
- *Course Community* comprises individuals within the course who have associations and relationships with the learner due to the learner’s enrollment in the course or program (i.e., instructor, peers, mentors, counselors).

Using a series of case studies in a variety of settings, the authors of the ACE framework identified the following support indicators commonly provided by actors within an academic community of engagement and aligned them to the ABC dimensions of engagement:

- Affective engagement would likely increase with support elements for facilitating communication, developing relationships, and instilling excitement for learning.
- Behavioral engagement would likely increase with support elements for troubleshooting, orienting, organizing, managing, monitoring, and encouraging progress.
- Cognitive engagement would likely increase with support elements for instructing and collaborating.

Discussion

The study of learner interaction and engagement in online learning contexts is an exciting space for researchers with potential for deepening our understanding of learning processes and the supportive interactions that are needed to increase engagement across a wide variety of online learning contexts. In this section, we will touch on three themes (1) the need for complimentary frameworks, (2) tensions between efficiency and effectiveness, and (3) the need for research beyond cognitive outcomes.

The Need for Complementary Frameworks

Researchers can guide practice by developing and providing frameworks and instruments that identify, define, and measure types and attributes of interactions and engagement that support student achievement. Graham et al. (2014) explained that frameworks and theories are essential to the knowledge creation process, and their establishment and use are a sign of the maturity of a scholarly domain. In this paper, we have highlighted four different frameworks that have been influential in the K-12 online learning space: educational interactions (Moore 1989; Anderson 2003), CoI (Garrison et al., 2000), PICRAT (Kimmons et al., 2020), and ACE (Borup et al., 2020). These frameworks are not in competition with each other, but are complementary. They are lenses that help focus attention on different aspects of K-12 learner interaction and engagement in online environments. Table 1 shows the four frameworks and how they focus on distinct (and sometimes overlapping) elements of online learning (e.g., interactions, presence, tech integration, and engagement).

Table 1
Frameworks Related to Online Learning Interactions and Engagement

Framework	Focus	Strengths/Limitations
Educational Interactions	Interactions: Analyzes learning through three primary types of interaction: learner-learner, learner-instructor, and learner-content, also considering how technology, time, and distance shape these interactions.	Strength: Clarifies the critical role of interaction types in effective learning and adapts well to online formats. Limitation: Provides a general classification of interaction types that can be helpful in quantifying interactions but is limited in its exploration of the range of quality of interactions within a category.
Community of Inquiry (CoI)	Presence: Emphasizes three interdependent forms of presence—teaching, social, and cognitive—that together create meaningful learning experiences.	Strength: Highlights the importance of multiple forms of presence to foster deep engagement in online learning. Limitation: Focuses on presence in asynchronous text-based discussion environments in higher education which has some limitations in K-12 and particularly elementary education contexts.
PICRAT	Tech Integration: Explores the student relationship with technology in a particular educational scenario and its impact on previous teacher practice.	Strength: Creates categories for understanding how student interaction with content via technology can range from passive to interactive, to creative. Limitation: Scope is narrowly focused on specific activities and does not address larger contextual factors at the course or community levels.
Academic Communities of Engagement (ACE)	Engagement: Explores how academic and personal communities jointly influence students' affective, behavioral, and cognitive engagement in online education.	Strength: Emphasizes collaboration between school and personal community K-12 microsystems to enhance student online engagement. Limitation: A relatively new framework and additional work is needed to establish validated measures of its constructs.

Tensions Between Efficiency and Effectiveness

There is a need for additional research that examines the tension that undergirds much of the research in K-12 online education, which is the relationship between trying to achieve pedagogical efficiency while maintaining or improving effectiveness. For example, Anderson's equivalency theorem postulates that educational efficiency can be gained by focusing on high-levels of one type of interaction. Instructional designers and researchers should cautiously apply Anderson's (2003) interaction equivalency theorem to online courses with primary and secondary students. The interaction equivalency theorem could be used as a rationale for providing online courses, with high levels of learner-content interaction and little or no interaction with their instructor or peers, to children and adolescents. However, learner-instructor and learner-learner interactions provide developing learners with supports, structures, and social learning opportunities that cannot be provided through interactions with the content alone and are especially important for young learners. Learning is a social experience, and learners benefit by engaging in supportive interactions with peers and more knowledgeable others such as instructors (Vygotsky, 1978). When these

interactions and supports are not provided by online programs, often they need to come from actors within the learner's personal community who may or may not be able or available to provide them. Like Anderson (2003), we also acknowledge that human interactions come at the cost of the same efficiency and flexibility that many learners and parents highly value and at times require. Researchers and education leaders should partner to better understand the types of interactions that appear most beneficial for learners in efforts to achieve affective, behavioral, and cognitive engagement and to identify strategies to make activities as effective as possible.

The ACE framework, likewise, seeks to accommodate a balance between efficiency and effectiveness by allowing for division of labor in providing for affective, behavioral, and cognitive engagement supports. In this case, efficiency allows for task specialization and flexibility. The framework allows those with content expertise to focus on cognitive engagement, as long as there are others who can provide greater behavioral and affective engagement support. In a K-12 environment, this could look like an online teacher providing instruction and feedback at a distance in conjunction with in-person or proximate help to motivate and encourage students (i.e., affective support) and to help students stay on task with reminders about what tasks to complete (i.e., behavioral support).

The Need for Research Beyond Cognitive Outcomes

There are many important outcomes that can come as a result of interaction and engagement in a K-12 digital learning environment. Often these outcomes are referred to generally as learning knowledge, skills, and dispositions (CCSSO, 2013). It can also be thought of as students learning *to know* (i.e., knowledge), *to do* (i.e., skills), and *to become* (i.e., dispositions). While we often emphasize knowledge and skills because they are most easily measured, we want the full development of our students—we want them to become something. We want them to not just have the knowledge and skills of a field (e.g., think mathematician, scientist, writer, etc.), but also to know what is honest and ethical and to want to live honestly and ethically.

This framing has significant implications for how we think about learner engagement. Within the CoI framework, social presence and teaching presence are often thought of as supports for cognitive presence. Likewise, within the ACE framework, one might consider behavioral and affective engagement as necessary precursors to cognitive engagement. A cognitive-oriented perspective can influence how we allocate resources to support different kinds of engagement. How might support for learner engagement be designed for becoming or dispositional outcomes? What strategies can be used to expand students' internal capacity for ABC engagement? This was a focus of parents that is not only related to becoming but also increases efficiency by reducing the need for external engagement support. Additionally, if the primary focus were developing excitement or enjoyment of a subject area rather than just knowledge and skills in the area, would we look at how to address affective engagement differently?

Conclusion

Digital learning enrollments continue to grow even as learning outcomes have often lagged behind those in in-person settings. Learner interaction and engagement are widely viewed as primary mechanisms for improving those outcomes, and existing K-12 research offers an important foundation for continued inquiry. However, that research has frequently defined interaction and engagement inconsistently, limiting comparability and cumulative knowledge building. We argue that four frameworks—educational interactions, CoI, PICRAT, and ACE—offer particularly useful conceptual clarity and practical guidance for researchers studying interaction and engagement in K-12 digital environments. Future research can be especially useful to practitioners by examining how specific interaction patterns relate to varied outcomes, which supports most effectively strengthen learners' affective, behavioral, and cognitive engagement, how programs navigate tensions between efficiency and effectiveness, and how interaction and engagement influence outcomes beyond cognition.

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