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Intentional Technology For Teaching Practice

AFIT Faculty Learning Community

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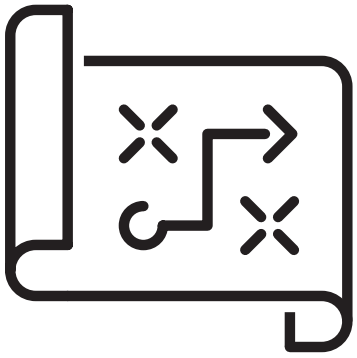
Welcome

In today's era, where educational technology is in a near-constant state of evolution, the imperative is not just to adopt technology, but to do so with a defined purpose and strategy. As educators within military education there is a growing need to discern which technological tools and practices align best with our mission and the goals we set for our students. Teaching is more than just transferring knowledge—it's about fostering environments conducive to growth, critical thinking, and lifelong learning.

This e-book contains collective insights, experiences, and reflections from faculty participating in a Faculty Learning Community (FLC) a yearlong, structured, community of practice, engaged in the thoughtful exploration of educational technology topics during the academic year of 2022-2023 at the Air Force Institute of Technology. Whether by leveraging social annotation tools to engage students in reading, formulating effective methods to produce and utilize educational content, innovating with game-based learning, or seamlessly integrating multiple applications for meaningful classroom experiences, our aim is to provide you with insights and actionable guidance for use within your own classrooms.

Respectfully,

The AFIT Faculty Learning Community, 2022-2023
Center for Innovation in Education



Game-based Education Theory

Mark Reith, Rodney McCoy, Jonathan Moore

What is Game-based Education and Why Might Instructors Adopt It?

Game-based education is a broad term to describe learning activities that incorporate games as part of a student development process. Instinctually, many instructors wonder whether games and gamification might be useful tools/techniques to teach and evaluate students. Their curiosity likely stems from a myriad of factors. First, the term game is often associated with feelings of enjoyment and entertainment. Instructors suspect that merging their course material with games might improve student motivation and engagement. Second, games provide an alternative to lectures, slides, discussions and demonstrations. This may help break up the typical classroom routine for both the student and the instructor. Finally, instructors suspect that games may provide a modeling and simulation opportunity to describe concepts, relationships and applications of theory. Games are systems with well-defined rules, decision points and outcomes. Such systems may represent processes, procedures and products at various degrees of abstraction. This suggests that, with careful consideration, students can both explore ideas and enjoy the experience.

Describing Game-related Terms and Concepts

The term game is deceptively complex and nuanced. The casual observer might easily confuse the term with art, toys, puzzles, competitions and entertainment. For this discussion, let the term refer to "a system in which players engage in an artificial conflict, defined by rules, that result in a quantifiable outcome" (Tekinbas et al., 2003). Some game designers have attempted to reduce the wide variations and complexities of games to "four defining traits: a goal, rules, a feedback system and voluntary participation" (McGonigal, 2011). The phrase serious game or applied game is sometimes used to describe a game with a purpose other than solely entertainment (Ullah et al., 2022).

Closely related, the term gamification involves "the craft of deriving fun and engaging elements found typically in games and thoughtfully applying them to real-world or productive activities" (Chou, 2019).

Comparing game and gamification suggests at least two broad strategies for approaching game-based education. The first involves taking an existing game and modifying it to incorporate curriculum elements. A classic example involves replacing general trivia questions with specific curriculum related questions in the Jeopardy!® format. The trivia game format and monetary reward system are not necessarily aligned with the educational topics, but the game is part of popular culture and easy to understand. The second strategy involves starting with curriculum and gamifying it. For example, the learning games such as Kahoot!™ Socrative and Bingo require instructors to add domain knowledge and cannot be played without it. By adding gamification elements to the curriculum, the instructors may present the material in a more engaging manner.

Kahoot is a game-based polling application [Click here] to read the Quick Kills article and learn more.

The term *edutainment* is colloquially described as a mix of entertainment and education. Designing games that provide sufficient educational value while meeting entertainment expectations is often challenging for several reasons. First, a game that overemphasizes the educational aspects may not be perceived as fun and engaging, thus diluting the expected benefit. Second, a game that overemphasizes entertainment may not advance educational goals because of insufficient material or distractions. Third, regardless of game elements provided by the game, learners have different expectations of what they consider entertaining or repulsive. Finally, mixing entertainment and education may induce the learner to conflate, and possibly confuse, the motivations for participation. Consider the combinations described in Table 1. When the entertainment and education elements are thoughtfully aligned, this might produce positive outcomes. However, negative outcomes are possible and should be carefully managed. The degree in which instructors emphasize game elements and students value game outcomes will likely influence whether the game is a useful educational tool.

Table 1. Combinations of Educational Game Outcomes

Possible Student Game Outcomes	Satisfy Learning Objectives (Desirable by Instructor)	Unsatisfied Learning Objectives
Game Achievement (Desirable by Student	Desirable outcome for both instructor and student	Potentially worst educational outcome due to lost time, possible negative learning
Game Failure	Potentially best educational outcome as the experience is likely memorable	Undesirable outcome for both instructor and student

Game-based education can be decomposed into at least two major subtopics of game-based learning (GBL) and game-based assessment (GBA). Although the concept of using games as part of development likely has primeval roots given the natural affinity between children and play, formalizing this concept for advanced subjects is relatively new. GBL can be described as "an innovative learning approach where a game is developed to deliver immersive and attractive learning experiences" (De Freitas, 2006). Related, but less understood, is the role games may serve as evaluation tools. GBA is considered a specific use of educational games that employs game activities to elicit evidence for educationally valuable skills and knowledge" (Kim et al., 2016). Whereas the goal of GBL might involve the conveyance of knowledge and comprehension, the goal of GBA might involve confirmation of them. As previously suggested, GBL might be desirable to improve motivation and engagement, but GBA might also be desirable to lower test anxiety and demonstrate a student's ability to demonstrate competency in specific situations. Colloquially, GBL/GBA might serve to bridge the gap between "book smart" and "street smart" in a formal, repeatable manner. This may partially address industry's criticism that the modern education system may not produce graduates who can sufficiently and immediately perform.

A common misperception of GBL involves an implied assumption that the game is the sole mechanism for teaching students. This assumption may manifest in the simple scenario where the instructor assigns the student to play one or more instances of the game, then the instructor grades based on the student's game score or outcome. Due to the potential negative outcomes in Table 1, this approach is misguided. Instead of relying on the game to teach the curriculum directly,

instructors should view the game as an opportunity to build foundational and memorable experiences that can lead to deeper post-game discussions compared to passive reading or lecture. Assuming the game offers many decision points and some degree of autonomy, the post-game discussion could yield a rich conversation of various experiences with a common topic. This is particularly important in situations where the student has little or no prior experience with the topic as it provides the scaffolding for deeper understanding. Post-game discussions assist the learning process in at least three ways. First, everyone has an experience to share so the conversation is inclusive. Second, the rest of the class benefits from sharing and comparing those experiences. Finally, the instructor has an opportunity to reinforce the positive effects and mitigate the negative effects outlined in Table 1. In summary, the post-game discussion parallels a hot wash or round table discussion and is the primary learning mechanism rather than the game.

Modeling an Educational Game

As previously mentioned, a game is a system and thus can be at least partially modeled. Modeling the game components such as game elements, decision points and outcomes is similar to modeling other systems. Table 2 describes relationships between these game components, system components and mechanics, dynamics and aesthetics (MDA) framework components (Hunicke, 2004). MDA is a popular framework for modeling games and provides lists of commonly used abstract components.

Table 2. Relating Game Components, Systems View Components & MDA Components

Game Component	**Systems View Component**	**MDA Component**	**Examples**
Game Elements	Data structures & algorithms	Mechanics	Cards, tokens, boards, rules
Decision Points	Inputs	Mechanics	Manipulating game elements
Outcomes	Outputs / State	Dynamics	Observing game state

When attempting to determine whether a game is a candidate for educational purposes, mapping learning objectives to these components can be a useful exercise. Table 3 describes relationships between game components and learning objectives. The associated questions help instructors to make judgements about the feasibility of using a particular game. In addition to these questions, instructors should ask whether the fidelity between these components and the topic is appropriate for the learning objectives? Misalignment between these components and learning objectives may dilute the educational value of the game. Note that learning objectives may include those from cognitive (Bloom, 1956), affective (Krathwohl, 1964), and psychomotor domains (Simpson, 1966).

Table 3. Relating Game Components to Learning Objectives

Game Component	**Traceability to Learning Objective Questions**	**Simple Learning Objective (LO) Examples**
Game Elements	To what degree do the game elements represent concepts relevant to the learning objectives?	LO: Remember/aware/ perceives "x" Game: Learner manipulates "x" as a token
Decision Points	To what degree do the decision points represent the application of concepts relevant to the learning objectives?	LO: Understand/ acknowledge/move "y" Game: Learner chooses "y" in appropriate situation
Outcomes	To what degree are the game outcomes aligned with the learning objectives?	LO: Apply/value/ reproduces "z" Game: Learner practices "z" and observes feedback on result

Games are difficult to fully model because some of the components are subjectively interpreted and system behavior may be non-deterministic (Caffrey, 2019). The aesthetics component describing the emotional response from students is challenging to predict. Likewise, a student's strategy and decisions within the game may also be difficult to anticipate. However, the mechanics and dynamics of a game can be modeled using tools such as a Markov decision process, also known as "stochastic games" (Shipley, 1953), or finite state machine (FSM) models (Pukeng, 2019). An FSM is a mathematical construct for describing the behavior of a system and is often expressed as a graph with a finite set of states, a finite input alphabet, an initial state, a subset of final states, a transition relation function.

Initial states represent game setup, whereas final states represent game resolution. The set of transitions describes the game rules and decision points. Finally, the set of states represents the reachable game states often consisting of game element position or status. The FSM is unlikely to inform an instructor on the degree of fun and enjoyment, but it may inform on the degree of educational effectiveness. An instructor may examine states of the game to evaluate whether the learner is presented opportunities to interact with game elements, presented with decision points, and provided feedback.

Existing Frameworks Supporting GBL

Prior literature suggests at least three frameworks to aid instructors. As the name suggests, the Learning Mechanics, Game Mechanics (LM-GM) framework attempts to identify relationships between these mechanics in order to guide instructors towards best practices (Arnab, et al., 2015). The authors arrange these mechanics among the levels of Bloom's Taxonomy, but do not provide a repeatable process. The framework seems to assert that games can be used to teach higher order thinking skills, however the authors only provided limited case studies as evidence.

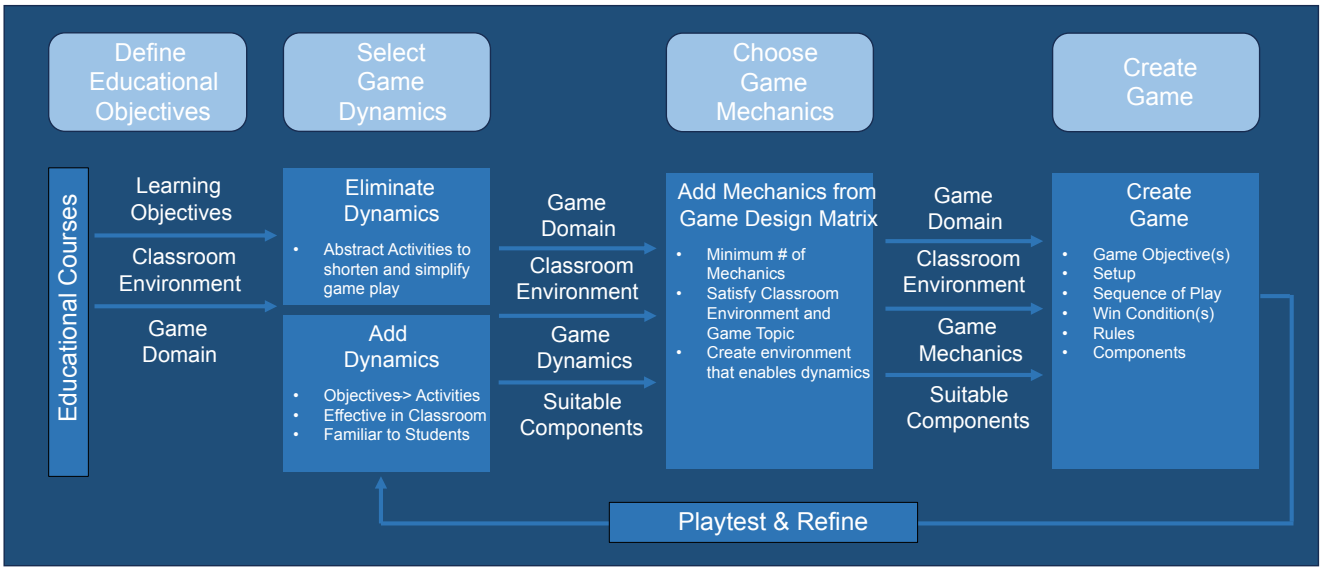
Table 4. The Learning Mechanics, Game Mechanics Framework organized by Bloom's Taxonomy (Arnab, et al., 2015).

GAME MECHANICS	THINKING SKILLS	LEARNING MECHANICS
• Design/Editing • Infinite Game Play • Ownership • Protégé Effect • Status • Strategy/Planning • Tiles/Grids	**CREATING**	• Accountabiliy • Ownership • Planning • Responsibility
• Action Points • Assessment • Collaboration • Communal Discovery • Resource Management • Game Turns • Pareto Optimal • Rewards/Penalties • Urgent Optimism	**EVALUATING**	• Assessment • Collaboration • Hypothesis • Incentive • Motivation • Reflect/Discuss
• Feedback • Meta-game • Realism	**ANALYZING**	• Analyze • Experimentation • Feedback • Indentify • Observation • Shadowing
• Capture/Elimination • Competition • Cooperation • Movement • Progression • Selecting/Collecting • Simulate/Reponse • Time Pressure	**APPLYING**	• Action/Tasks • Competition • Cooperation • Demonstration • Imitation • Simulation
• Appointment • Cascading Information • Questions & Answers • Role-play • Tutorial	**UNDERSTANDING**	• Objectify • Participation • Questions & Answers • Tutorial
• Behavioral Momentum • Pavlovian Interactions • Good/Information • Cut scences/Story • Tokens • Virality	**RETENTION**	• Discover • Explore • Generalization • Guidance • Instruction • Repetition

The Design, Dynamics, Experience (DDE) framework is an enhancement of the MDA framework and addresses shortcomings of the latter (Walk et al., 2017). Specifically, MDA focuses too much on game mechanics and it is not suitable for gamified content or experience-oriented design. The DDE framework explicitly models dynamics and experiences by elaborating on relationships between players and games, as well as how players perceive them. This framework omits a repeatable process and ties to learning theory, but does provide a nuanced understanding of dynamics and experience that may be important to the learning process.

The Game Design Matrix (Pendleton, 2020) extends LM-GM and DDE by relating specific mechanics and dynamics to Bloom's Taxonomy. Furthermore, it provides a step-by-step process, illustrated in Figure 1, for taking learning objectives, classroom constraints and selecting mechanics/dynamics to produce a game prototype. However, all three frameworks remain difficult to use in practice because of the large number of choices among mechanics and dynamic elements. Furthermore, it is difficult to evaluate whether the game satisfies the learning objectives without extensive playtesting.

Figure 1. Game Design Matrix process (Pendleton, 2020).



Other frameworks describing relationships between learning and gaming elements exist. Winn (2008) describes the Design, Play and Experience (DPE) framework that explicitly includes a learning layer, but omits a process for crafting or evaluating a game. Echeverría (2011) describes the Design and Integration of Collaborative Classroom Games (DICCG) as a framework that maps game elements to Bloom's Taxonomy, but also omits a repeatable process.

Tips for Crafting GBL Experiences

Instructors who want to introduce GBL experiences into their classroom may find these tips useful. Instructors should begin by considering which strategy is best for their situation as outlined in Table 5. These include using an existing educational game, modifying an existing game, or crafting a new game. The first strategy is likely the easiest and least time consuming. However, it is often difficult to find an appropriate game to fit a specific curriculum. The second strategy requires a larger investment of effort to refactor an existing game, but will likely better align with the curriculum. Finally, the third strategy is to craft a novel game. This can be challenging and expensive, but will likely best align with the curriculum.

Table 5. Pros/Cons of Three Strategies for Introducing GBL

Strategy	Pros	Cons	Examples
Adopt Existing Game	Professionally crafted, polished, recognizable, easier to learn, likely balanced, likely supported	May not align with curriculum, difficult to find domain specific games	Flight Simulator, Cyber Protect, Minecraft Education (resource library)
Refactor Existing Game	Partially recognizable, easier to learn, partially align with curriculum, limited support	Questionably balanced, partially aligned with curriculum, limited support, some playtesting necessary	Jeopardy, Bingo, Minecraft Education
Craft Novel Game	Aligns with curriculum	Hardly recognizable, harder to learn, likely unbalanced, no support, requires extensive playtesting	Battlespace Next, Agile Adventure

Crafting a novel game offers the best potential for alignment with the curriculum. However, sometimes it is difficult to craft an educational game without prior experience. The frameworks described in the previous section can help guide the process from a macro perspective, but detailed steps are ambiguous.

A simplified approach may assist instructors. Referring back to previous tables and figure, instructors can take an existing concept, process or system identified in the learning objectives, and add game elements to motivate, highlight, challenge, reward and create memorable experiences. Instructors may consider the following steps:

1. Select the concept, process or system to model/simulate from the learning objectives.
2. Decide how the concept, process or system should be represented as game elements to include tokens, rules and responses.
3. Add a storyline, scenario and goals to motivate the student.
4. Identify decision points that allow the student to manipulate the game elements.
5. Ensure real autonomy of choice exists, occasionally coupled with intermediate rewards to reinforce or guide correct behavior. Irreversible decisions should be used sparingly.
6. Identify feedback for both positive and negative outcomes as they both support learning objectives.
7. Refine the game via repeated playtesting.

Alignment and fidelity are crucial to achieving educational value. Alignment refers to agreement and traceability between the educational topic and the game's MDA. This applies to game elements, decision points and outcomes. While some game features may be necessary, instructors should seek to minimize artificial constructs. Fidelity refers to the degree of exactness or realism the game provides relative to the educational topic. While low fidelity may be appropriate for concept introduction and to ease the learning curve, higher fidelity may be necessary for concept reinforcement and to keep the student challenged.

Summary

Introducing game-based learning into curriculum can create opportunities for meaningful development. Whether adopting, adapting or crafting a game, the potential benefits in student motivation, engagement, and understanding can make the effort worthwhile. Instructors considering this approach should carefully evaluate their specific needs and constraints as they apply the strategies and frameworks in this article. With thoughtful planning and execution, game-based education can become a valuable tool for learning.

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Game-based Education Practice

Mark Reith, Rodney McCoy, Jonathan Moore

In today's fast-paced and increasingly digital world, educators continuously seek innovative ways to engage students. The advent of game-based learning (GBL) and game-based assessment (GBA) offers a dynamic shift, providing educators an avenue to rethink traditional methodologies and utilize innovative approaches that resonate with students. This chapter explores the metrics that guide game-based education, offering insight into how faculty can measure the impact and effectiveness of their GBL endeavors. Through the lens of two comprehensive case studies - "Battlespace Next" and "Agile Adventure" – this chapter describes real-world applications of game-based education and their tangible outcomes. By understanding these real-world scenarios, faculty can derive best practices and insights to optimize their own teaching methods.

Game-based Education Metrics

Introducing games into curriculum can be challenging without some type of feedback to evaluate whether the game is satisfying both the learning goals and student expectations. Instructors may include such metrics as effectiveness, efficiency, motivation and opportunity and are described in Table 1. These metrics may be used to compare a Game-based Learning (GBL)/Game Based Assessment (GBA) opportunity to traditional instruction or may be used to compare multiple GBL/GBA opportunities supporting a common topic. Since data is often difficult to obtain prior to introducing games into curriculum, instructors often resort to a trial-and-error approach. Specifically, data collected from one or more class instances may inform future decisions about using GBL/GBA for a topic. The data supporting these metrics may be sourced from post-game/course surveys, homework assignments, classroom observations, and student comments. Faculty interested in estimating the effectiveness of a GBL option might consider the description in Appendix A.

Table 1. GBL/GBA Opportunities

Measure	Description/Units	Simple Learning Objective (LO) Examples
Effectiveness	Measure of the number (or in some cases Bloom's Taxonomy level) of satisfied learning objectives	LO #1: Remember "x" LO #2: Apply "y" Game: Satisfies LO #1, but partially satisfies LO #2 as Understand "y"
Efficiency	Measure of time spent by both students and instructors divided by the number of satisfied learning objectives	The game required 3 hours of instructor prep, 2 hours of student activity and 1 hour of post-game discussion supporting 2 LOs for a learning rate of 3 hours per LO
Motivation	Measure of student engagement time	The instructor expected 2 hours of student activity, but students remained engaged for an average of 3 hours
Opportunity	Measure of how many students were able to fully participate	Each student had a sufficient number of "opponent" learners despite missed class, distance learning class formats, or asynchronous class formats

Effectiveness is a broad metric of performance and often the most important to instructors. The simplest definition involves a measure of the number of satisfied learning objectives. Instructors can measure the effectiveness of games using at least three experimental design templates as illustrated in Figure 1 and listed in order of increasing execution difficulty. The first is called behavior and perception sampling, and often is the easiest to measure. It involves an interpretation of student artifacts (responses in the form of discussions, homework, assessments) that directly correspond to the learning objectives as well as a student survey about perceptions of the game. The former validates that the student was able to correctly answer questions, and the latter measures students' learning experience. Although not as rigorous as other methods, this approach provides reasonable evidence with little impact on students.

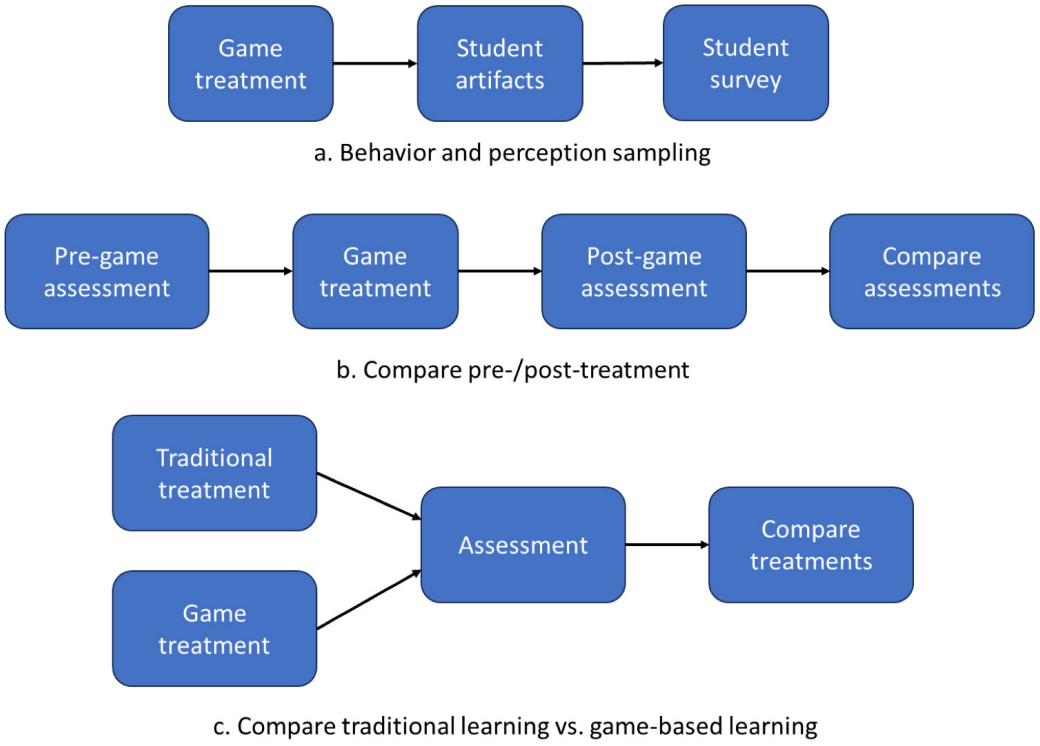


Figure 1. Measuring effectiveness

The second design template compares pre- and post-treatment assessments and directly measures what a student has learned from the GBL experience. It measures the delta between new and prior knowledge and thus a more rigorous approach. However, it requires students to take at least two assessments, which may be difficult to achieve. The final design template involves an A/B assessment and measures the difference between what a student learns from traditional teaching methods (slides, lectures, etc.) and from GBL. The goal would involve demonstrating that GBL is no less effective than traditional approaches. However, it may require randomly partitioning students into two groups where the treatments may not be equitable. Furthermore, it validates competency rather than measures learning. More complicated designs are feasible; however, they may also be more difficult.

Efficiency is the second most important metric to instructors. The simplest definition involves a comparison of a GBL learning rate with the traditional classroom learning rate. In this context, learning rate is the time spent by both students and instructors divided by the number (or Bloom's Taxonomy level) of satisfied learning objectives. While student time is self-explanatory, instructor time includes both planning and execution. In a traditional classroom, planning time might include preparing lectures, slides and activities. A GBL option might also include game development and modification in lieu of lectures and slides. Since initial game development can be a time intensive activity, efficiency tends to be significantly lower than lectures and slides. This can be mitigated using existing games, although finding an appropriate game for a specific set of learning objectives can be challenging.

While measuring instructor time is trivial, measuring student time is more complicated. Students may over or underestimate time spent in self-study, making it difficult to assess. External factors such as course load, disruptive life events and work/family obligations may curtail self-study time. Given the difficulty of measuring actual student time, instructors can playtest with fellow instructors or staff. The playtest should include two important measures. The first involves the time required to learn the rules and play the first game. The second involves the time required to play subsequent games. Complex games may require a significant investment of time to read and comprehend the rules. Even simple games can require a significant time commitment to master complex strategies. Instructors can ease the learning curve by organizing several game instances, where each instance introduces increasingly advanced rules. This works well in cases where the curriculum builds on earlier lessons, and those lessons can be aligned with the new rules. This also increases the efficiency of the GBL option because one game, played over several instances, may satisfy multiple learning objectives.

Motivation is the third most important metric, and it measures student desire and willingness to participate in the learning process. Highly motivated students are more likely to commit the time and energy to learn the material and engage with questions compared to less motivated students. The most significant reason to introduce GBL into a curriculum involves the potential to increase student motivation and engagement, particularly on a complex or dull topic. Potential measures might include questions about the game, the rules, hypothetical scenarios, depth and length of student responses and recommendations for game improvements. When played during class time, a useful proxy measure involves how many times a student checks their phone or is otherwise distracted from the activity.

Instructors should gently encourage students to examine the game and should assist students to understand why the game is an appropriate learning tool with respect to the curriculum and the activity goals. While many students may react positively to games, some may find them less appealing. Anecdotally, younger and less experienced students tend to react more positively to games than older and more experienced students. This may be explained by a number of reasons. First, the younger students tend to have less experience and thus may be more motivated to fill knowledge and skill gaps to pursue career success. Second, the more experienced students may feel that the game is unnecessary or trivial given their observed real-world situations. Experience with the topic rather than age seems to be the prominent factor in lower satisfaction with games.

According to flow theory (Csikszentmihalyi, 1975), if the activity is not challenging enough or does not create new experiences, then the student becomes bored and apathetic. Conversely, if the activity to too challenging, it may produce anxiety. The instructor can align the challenge with the learning objectives based on how the game is introduced. For example, an instructor may introduce concepts using a version of the game with limited game elements, decisions points, outcomes and low fidelity in order to temper anxiety. Later in the course, the instructor may reinforce concepts with a capstone activity by increasing the game elements, decision points, outcomes and higher fidelity in order to challenge the student. Students with more real-world experience with the topic are likely to appreciate realistic models.

Opportunity is a measure of how many students were able to fully participate. This metric recognizes the potential impediments of GBL/GBA. Such impediments may range from accessibility issues to resource issues. For example, some games must be sourced, purchased and delivered within a timeframe that accommodates the curriculum. Leveraging a game as a social ice-breaker or to introduce concepts early in a course seems plausible, but requires students to find a copy and receive the game materials before it can proceed. This can be problematic when the course is delivered asynchronous or distance-learning. In another example, finding partners to play against can be challenging. Board games might work for local residents, but two geographically separated students attempting to play over video teleconference can be awkward and distracting. In some cases, a student can find a local resident (non-student) to play against, but they may not have the background or motivation to participate. Online games might be a reasonable solution to geographically separated students, but some military locations might restrict access. Understanding each student's situation can help inform decisions about which games, if any, are appropriate in the curriculum.

Battlespace Next Case Study

Battlespace Next (BSN) is a low-cost, serious game designed to develop the DoD workforce in Joint All Domain Operations (JADO) concepts across air, space, cyber, land and naval domains (Flack, 2020). It emphasizes the interrelationship between the cyber domain (information operations, intelligence, exploits) and the other domains. It also highlights the challenges of developing and maintaining the "cyber kill chain". BSN recognizes that modern warfare is characterized by a spectrum of competition and conflict, and that players must navigate this spectrum as they make decisions about force employment and order of battle. BSN is a turn-based card game that can be played one-vs-one or two-vs-two, where each player/team represents a Joint Task Force commander with military capabilities from across the domains. Due to its complexity, initial games tend to require 45 minutes to explain and 45-90 minutes to play, while subsequent games require 30-90 minutes to play. Post-game hotwash discussions tend to last about 20-30 minutes depending on the number of players who wish to share their experiences. A sample of game elements (cards) are illustrated in Figure 2.

Figure 2. Battlespace Next cards representing each warfighting domain.

BSN was developed at the Air Force Institute of Technology (AFIT) to support graduate and professional continuing education, and is available at https://www.printplaygames.com/product/battlespace-next/. It is routinely used at AFIT in CSCE 525 Intro to Cyber Warfare & Security and IMGT 687 Cyber Systems Security. CSCE 525 specifically uses the game to examine the value proposition of cyber capabilities across the phases of conflict to include operations to deceive, degrade, deny, disrupt, and destroy. IMGT 687 specifically uses the game to examine how security controls need to be baked into military capabilities during development. Variations to support alternative learning objectives for Undergraduate Cyber Warfare Training (333rd Training Squadron) and Joint All Domain Operations Training (Air Force Research Laboratory and 616th Operations Center) have been crafted by replacing some game components with others (McCurdy, 2022), (Moore, 2023). Additional work to resolve game ambiguities and automate production of new game elements (cards) has helped advance the pursuit of a digital version of the game (Moore, 2023). Efforts to craft a curriculum around progressively harder BSN games yielded WKSP 0726 Intro to Joint All Domain Operations and was well received by learners (Voltz, 2021). An open question remains regarding the comparative difficulty of modifying existing games verses custom crafting them for a set of learning objectives.

Figure 3. https://www.printplaygames.com/product/battlespace-next/

Table 2. BSN Metrics

Metric	Measure	Methodology
Effectiveness	The research with the original version of BSN showed with moderate confidence that four of the five learning objectives were achieved (Flack, 2020). • **[Achieved]** *Recognizes cyber/kinetic kill chain* (survey: supports, game: learner built kill chains within game to attack opponent) • **[Achieved]** *Match military capabilities to threats* (survey: supports, game: learner employed defensive capabilities to specific threats) • **[Likely Achieved]** *Recognize spectrum of conflict levels* (survey: inconclusive, game: learner repeatedly manipulated level of conflict) • **[Achieved]** *Develop and execute multi-domain strategies* (survey: supports, game: learner employed combinations of domain specific capabilities) • **[Inconclusive]** *Anticipate, adapt, and respond to peer adversary* (survey: supports, game: some evidence of response, but little evidence of anticipation or adaptation due to game limits)	Effectiveness in BSN was measured using the pre-/post-treatment methodology. Students were provided a survey before and after playing the game to evaluate their perceived learning achieved from the game.
Efficiency	*Students* – Games take around 45-90 minutes to complete with 30-minute post-game discussion; multiple games may be necessary to reinforce concepts. Instructors – using standard BSN, prep time is around 2-3 hours to understand and explain the game; developing BSN variants can take anywhere from a few hours to a few weeks [with automation] (Moore, 2023) to a few months [by hand] (Flack, 2020).	Students – Student efficiency time was measured by recording the average playtime and discussion time. Instructors – Instructors were provided a survey to ask how long they spent preparing the game.
Motivation	At least two hours of interaction; 90% of players were focused during experiment; 55% of participants reported they would enjoy playing the game again in their free time outside of a formal learning environment (Flack, 2020).	Students' motivation was evaluated through questions on the post-game survey.
Opportunity	The BSN physical game includes two decks of cards, a six-sided die, red and gold chips and an optional timer. Played as a social icebreaker, learners will need to acquire the game early in the course along with other course materials such as a textbook. Asynchronous and distance-learning students may have difficulty finding a suitable game opponent. If played in class, a minimum 2-hour block would be necessary.	Opportunity was measured by introducing the game across several course instances and recording learner feedback.

Flack (2020) and Voltz (2021) showed BSN to be a useful tool for teaching JADO concepts, as described in Table 2. Flack's data included both surveys of learners as well as game observations. Four out of five learning objectives were achieved based on this data. The last learning objective was inconclusive because the survey was interpreted to support the objective, while the game play was partially impeded by the game mechanics. Specifically, it was difficult to adapt to an adversary's strategy because the learner was forced to draw new capabilities from a random pile of mixed domains rather than drawing from domain specific piles. Later variations allowed the latter to occur and thus provided more flexibility to adapt.

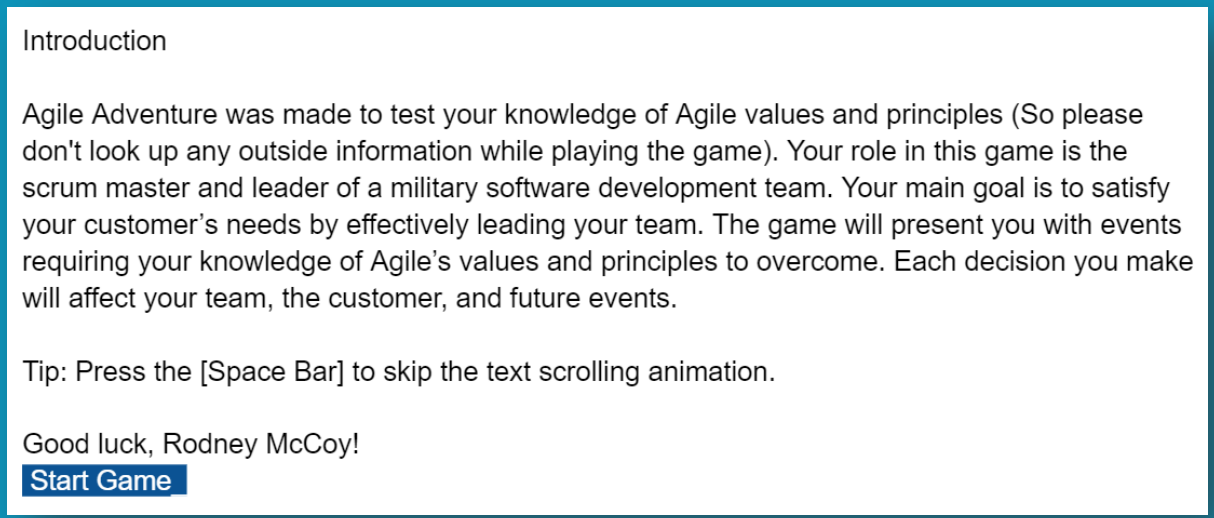
BSN's efficiency is reasonable, but likely less efficient than a 60-90 minute lecture over the same topic. However, BSN's motivation showcases strengths that are common to many serious games. For instance, a survey of BSN players showed that 90% of players felt focused during gameplay (Flack, 2020). Despite the positive feedback, some learners may experience negative effects as well. With BSN specifically, several players reported feeling confused or frustrated, mostly attributed to the complexity of the game. These negative emotions highlight the importance of carefully considering game complexity when integrating serious games into curriculum to ensure that the level of detail is appropriate for the level of learning desired.

BSN serves as an instructive example of how serious games and GBL can be useful tools in teaching complex topics. BSN highlights the ability of games to present information in a way that is more interactive, provides more scaffolding for learning opportunities, and is more memorable than traditional teaching methods. Additionally, the work with BSN shows that adding games into curriculum doesn't have to be a large undertaking. Many existing games can be adapted to suit the needs of a course and can provide the benefits of GBL without having to work from a blank canvas.

Agile Adventure Case Study

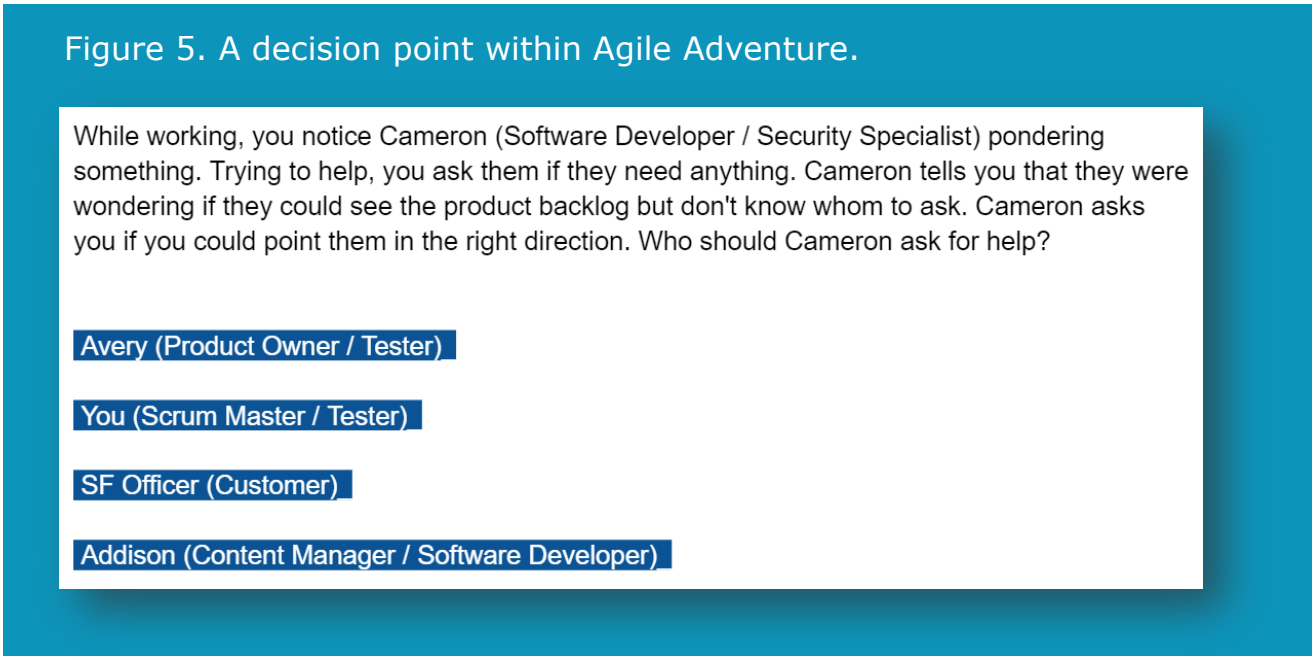
Agile Adventure is a web-based GBA that aims to assess players' knowledge of Agile software development principles through a series of in-game scenarios (McCoy, 2023). The player roleplays as a Scrum Master of a military software development team charged with developing software for their squadron, as illustrated in Figure 4. They are responsible for providing advice during the in-game scenarios that adhere to the principles and values of Agile. Players are presented with multiple responses to the event during each scenario, like in games such as The Oregon Trail. A corresponding effect of that choice follows each decision. The player's primary goal is to provide complete and accurate software while maintaining customer satisfaction. Players accomplish their primary goal by making decisions that best adhere to the Agile value or principle that aligns with each scenario (Figure 5). Upon completion, the game presents players with in-game scores detailing customer satisfaction, team productivity, and team morale and how many scenarios they answered correctly (Figure 6). The game takes 10-15 minutes and has 12 different scenarios.

Figure 4. Agile Adventure's introduction scene.



Agile Adventure was developed at the Air Force Institute of Technology (AFIT) to support graduate and professional continuing education. Students and Faculty from AFIT's SENG 593 Agile Software Systems Engineering course and with AF Software Factory Hangar 18 evaluated Agile Adventure (McCoy, 2023). Table 3 outlines the GBE metrics for Agile Adventure. Nearly all the participants responded positively about having fun and preferring Agile Adventure over a traditional multiple-choice test covering the same learning objectives. Many qualitative responses commented on participants' interest in the GBAs' storyline and feedback for their actions during gameplay. Despite the positive feelings, the data indicated a negligible difference in anxiety while playing Agile Adventure than taking the multiple-choice test. More importantly, some questions exhibited significant deltas between the GBA and traditional assessment, while other questions exhibited moderate or no deltas.

Figure 5. A decision point within Agile Adventure.



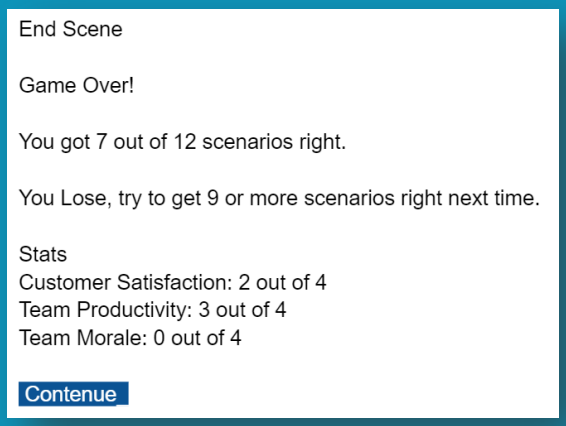
The research conducted on Agile Adventure produced three recommendations for people designing and developing a GBA (McCoy, 2023). First, "a stronger claim of testing effectiveness can be made [when a] GBA is based on and compared to an already established assessment." Additionally, if the crafted GBA is based on a traditional test, running a pilot assessment with multiple subject matter experts can help validate question congruency between assessments. Finally, comparing the questions of a GBA to an existing assessment's questions is more straightforward when each question has the same number of answer choices.

Table 3. Agile Adventure Metrics (McCoy, 2023)

Metric	Measure	Methodology
Effectiveness	Out of 12 questions, three exhibited significant deltas (>= 6) between the number of correct answers (traditional vs. GBA), seven exhibited modest deltas (>= 3), and two exhibited the same number of correct answers. 10 of 13 participants expressed that they had learned something while playing the game compared to 10 participants expressed that they did not learn something from the traditional assessment.	Effectiveness in Agile Adventure was measured by 1) comparing the traditional test results with the treatment results, and 2) comparing pre-/post-treatment survey.
Efficiency	*Students* – The traditional assessment took an average of 4.33 minutes to complete compared to 10.08 minutes with the GBA. Instructors – If using a premade version of Agile Adventure, little to no prep time is needed to explain the game. Developing a new version of Agile Adventure may take anywhere from a few hours to a few weeks.	*Students* – Student efficiency time was measured by comparing the average time to complete the traditional test with the average time to complete the treatment.
Motivation	12 of 13 participants responded positively as "engaged" during the GBA compared to 2 of 13 during the traditional assessment. 10 of 13 participants responded positively as "having fun" during GBA compared to 1 participant during the traditional assessment. The delta between traditional assessment and GBA test anxiety was negligible.	Students' motivation was evaluated through questions on the post-game survey..
Opportunity	Both the traditional assessment and GBA were provided online. The game was presented as a single-player experience.	All participants were able to access the game; however during a pilot exercise, one unit was not able to access due to military firewalls.

Agile Adventure provides insights into the differences between developing and implementing a GBA versus a GBL. Additionally, the GBA gives an example of how to evaluate new GBAs using existing assessments. Finally, the data collected from Agile Adventure gameplay suggests that the game promoted student interest and engagement for a low-stakes assessment opportunity. GBAs could provide instructors with more authentic ways to assess their students' ability to demonstrate competency in specific situations.

Figure 6. Agile Adventure's end scene showing feedback on a player's performance.



Research on the implications and effects of GBAs is a developing area, and more research is being done to better understand how to best develop and apply GBAs in different educational settings. A conjecture from the Agile Adventure research is that adding a story or context to a generic multiple-choice question may cause the new question to target a higher level of Bloom's taxonomy. One of the continued research efforts on GBAs is the implications of using Large Language Models (LLMs), like ChatGPT or Bard, during GBA development. GBAs have the potential to make assessments more authentic and comparable to how students will be assessed outside of the classroom.

Summary

Introducing game-based learning into curriculum can create opportunities for meaningful development. Whether adopting, adapting or crafting a game, the potential benefits in student motivation, engagement, and understanding can make the effort worthwhile. Instructors considering this approach should carefully evaluate their specific needs and constraints as they apply the strategies and frameworks in this article. With thoughtful planning and execution, game-based education can become a valuable tool for learning.

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Appendix A: Estimating Effectiveness of GBL

Faculty might benefit from estimating the effectiveness of GBL options. Table 4 and Table 5 describe some potential relationships between Bloom's Taxonomy and game activities.

Table 4. Estimating Effectiveness (Cognitive Domain)

Bloom's Taxonomy (Cognitive)	**Sample Target Learning Objective**	**Examples described in terms of game components (elements, decisions, outcomes)**
Create	Student constructs...	Creates novel strategy or extends/expands game components
Evaluate	Student critiques...	Compares multiple strategies or decisions within the game
Analyze	Student organizes...	Identifies relationships between game components, particularly decisions and non-immediate outcomes
Apply	Student demonstrates...	Decides to correctly use game elements with immediate outcomes
Understand	Student describes...	Manipulates game element
Remember	Student recognizes...	Observes game component

It remains an open question as to the degree to which carefully crafted games might satisfy cognitive learning objectives, particularly the higher order ones. The argument for Create learning objectives is plausible since creative activities tend to be motivating and engaging, but students would be limited to the elements and fidelity provided by the game. The argument for Evaluation and Analyze seems reasonable, however it may be less motivating or engaging due to the higher cognitive load. The argument for Apply learning objectives seems to be the strongest because decision points within the game can be directly mapped to applications of concepts. Finally, the argument for Understanding and Remembering learning objectives might be reasonable when concepts are explicitly named and represented as some type of token or game element. The relationships and operations between this game element and others provide context for the concept. The lower three levels (Remember, Understand, Apply) are potentially something that could be modeled with a finite state machine (Moore, 2023).

Table 5. Estimating Effectiveness (Affective Domain)

Bloom's Taxonomy (Affective)	**Sample Target Learning Objective**	**Examples described in terms of game components (elements, decisions, outcomes)**
Internalizing Values	Student discriminates...	Adopts a strategy with a clear preference for elements and decisions
Organizing Values into Priorities	Student compares...	Values certain relationships between game components, particularly decisions and non-immediate outcomes over other relationships
Valuing	Student demonstrates...	Repeatedly attempts to use the same game elements (or make same decisions) to produce outcome
Respond to Phenomena	Student performs...	Manipulates game element
Receive Phenomena	Student describes...	Observes game component

The argument for games supporting affective domain learning objectives may be stronger than cognitive learning objectives because the affective domain focuses on emotion and feelings. Since games tend to elicit an emotional response (such as enjoyment and accomplishment), it is unsurprising that games may affect the learner's attitude toward a topic (Kokotajlo, 2022). Furthermore, the game presents choices which may later induce preferences and values. Among the higher order learning objectives, learners may adopt strategies that reflect internal values (i.e., their world view). Clearly, learners do not need to value something in order to memorize it, however they may be more likely to remember and use information that has been internalized. Thus, games may be useful to not only improve motivation and engagement of a topic, but also make it memorable.

Fostering Reading Engagement with Social Annotation Tools

Aaron V. Glassburner, Jonathan Zemmer

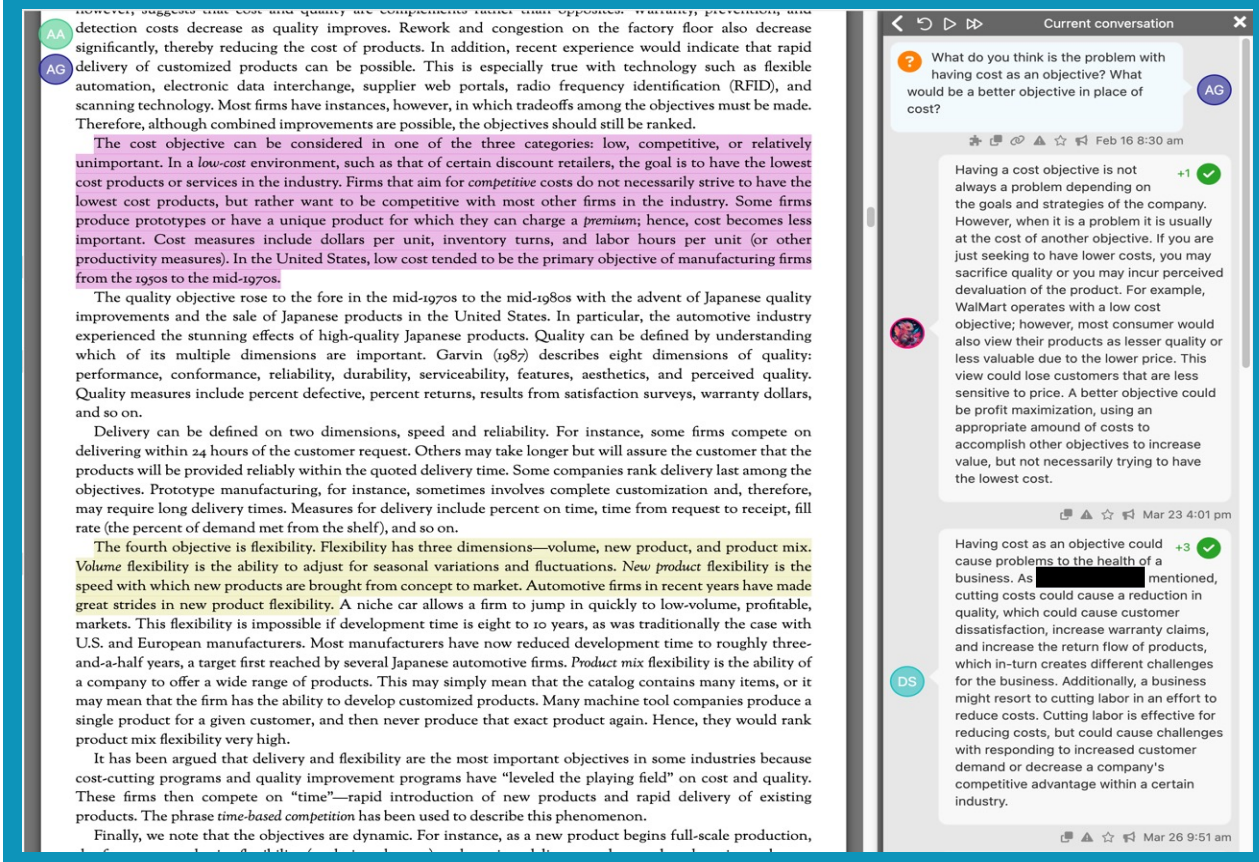
Introduction

One of the growing problems in higher education, particularly in online courses, is the lack of reading engagement among students. This issue is compounded by the concerning trend of students frequently skipping or partially completing assigned readings (Kerr, & Frese 2017). Studies indicate a direct correlation between reading completion and better performance on assessments, as well as increased engagement throughout the course (Lee et al., 2022).

The use of e-textbooks in educational settings can provide several benefits to students and educators. At a basic level, ease of access has made text resources more accessible on mobile devices. Initially, the primary function of e-textbooks centered on the delivery of written content. However, recent features, such as the ability to collaboratively annotate reading material, have created a new mechanism called social annotation, creating a new means to engage students in their reading. Social annotation activities within e-textbook or web-based platforms allow users to collaboratively annotate digital content, such as texts, images, and videos. These platforms facilitate a social reading experience where students can share their thoughts and insights with faculty and peers. Studies have shown that students who actively engage in social annotations with their peers and instructors perform better on exams than those who do not engage in these activities (Suhre et al., 2019).

This article will present a case study highlighting a faculty member's experience using Perusal, one of the leading social annotation platforms at for a graduate course at the Air Force Institute of Technology (AFIT). Perusal features allow users to highlight specific sections of a text, add comments, and reply to comments made by others. Users can also share their annotations with others, creating a collaborative and interactive reading experience.

Figure 1. Example of Instructor/Student Engagement



Use Case

Perusall has been used by AFIT's Logistics and Supply Chain Management faculty in two separate offerings of LOGM570, Principles of Inventory Theory, to increase reading engagement amongst students and aid students in learning how to teach themselves. The Principles of Inventory Theory class surveys contemporary theory and practice in consumable and reparable inventory management. The course has been designed around the textbook Inventory and Production Management in Supply Chains by Edwin A. Silver, David F. Pyke, and Douglas J. Thomas. Seminal works of quantitative models are also presented and discussed throughout the course. This has meant that students must be able to traverse a learning continuum consisting of both qualitative concepts and quantitative models. Given the limited lecture hours during the term, instructors have had to be selective in the material presented during the in-class time, which resulted in students focusing more on in-class presentations than the entire body of course material. Therefore, Persuall was implemented as a solution that required the students to utilize their time to explore further and deeper than the lecture content. In addition, it provided a low-cost way for the instructor to evaluate student comprehension of all course materials.

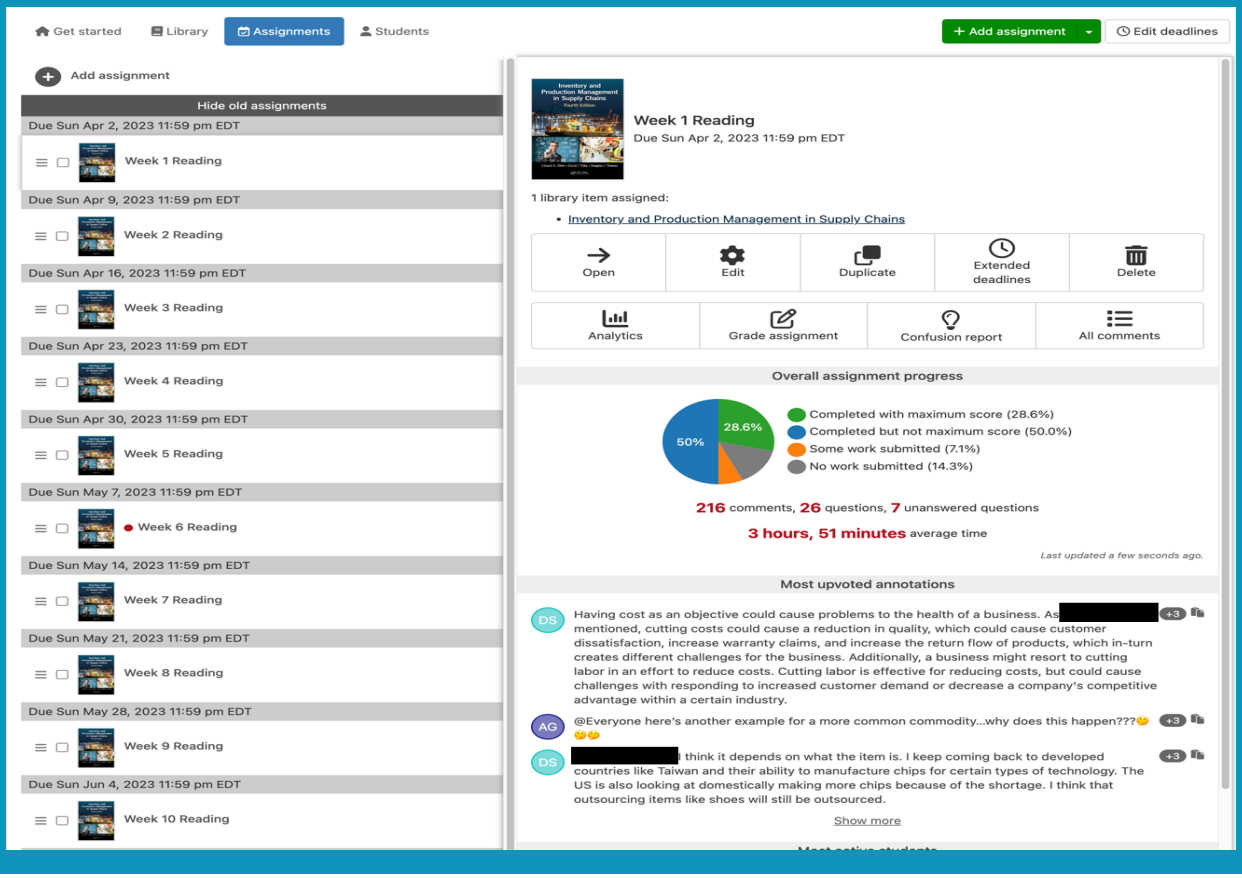
As a tool for social engagement, Perusall was found to be an easy, no-cost platform for implementation into the course. After setting up an initial login, all that was required was for the instructor to create a course shell and add the desired content into the course's Content Library. Once the course content was added, the instructor created assignments that followed the weekly flow of the course and selected the scoring criteria that aligned with the platform's intended use. In this course, the instructor sought to increase student engagement with the material and other students, so scoring criteria within Perusall were weighted accordingly with a focus on social engagement. Further discussion on these aspects of tool use is provided in the subsequent sections. Finally, once the course was set up, the instructor provided the students the link to the course, where they had to create their accounts and use an instructor-provided code to access the course. Since this course utilizes a published textbook, students were required to purchase access to the textbook with one of three options: perpetual online access, 365-day online access, or 180-day online access. Depending on the students; preference, the cost for access to this specific material is 50-70% cheaper than buying a hard copy from a source such as Amazon. In this situation, students were encouraged to use the cheapest method (i.e., 180-day online access) to evaluate the book should they want to purchase a hard copy for future reference.

Assigned Reading and Annotations

Social collaboration platforms allow instructors and students to increase the frequency and length of their engagement with each other and, at times, are more accommodating and flexible than the assigned class time. However, structured class time can be limiting in that it may limit the quantity and quality of questions posed by students. It also means that students seeking clarification or explanation with certain course concepts must wait for an answer to be received either during the next class period or at a time coordinated with the instructor.

Assignments for the use case class were designed within Perusall to increase student engagement and collaboration. Each week students were assigned activities that required them to read content, answer instructor questions, and discuss the material amongst themselves. Additionally, students were sometimes given a link posted by the instructor in the content that may have taken them to a website or another piece of content to view. Structuring assignments in Persuall enabled the instructor to seamlessly integrate a variety of content formats with other course management tools, such as CANVAS Quizzes. This cohesive approach guided students through a well-defined learning path.

Figure 2. Example of Assignments in Persuall



In using Persuall, the instructor offered flexibility to the students by specifying assignment due dates that did not have to correspond with a scheduled class period. Additionally, the ability of Perusall to assess student engagement, collaboration, and participation also made this aspect of assignments very low-cost to the instructor since once the assignment became due, it was automatically graded.

Scoring

As with all class grading, scoring within social collaboration platforms is an aspect that should be given considerable attention. Perusall contains five different preset scoring criteria rubrics, as seen in Table 1.

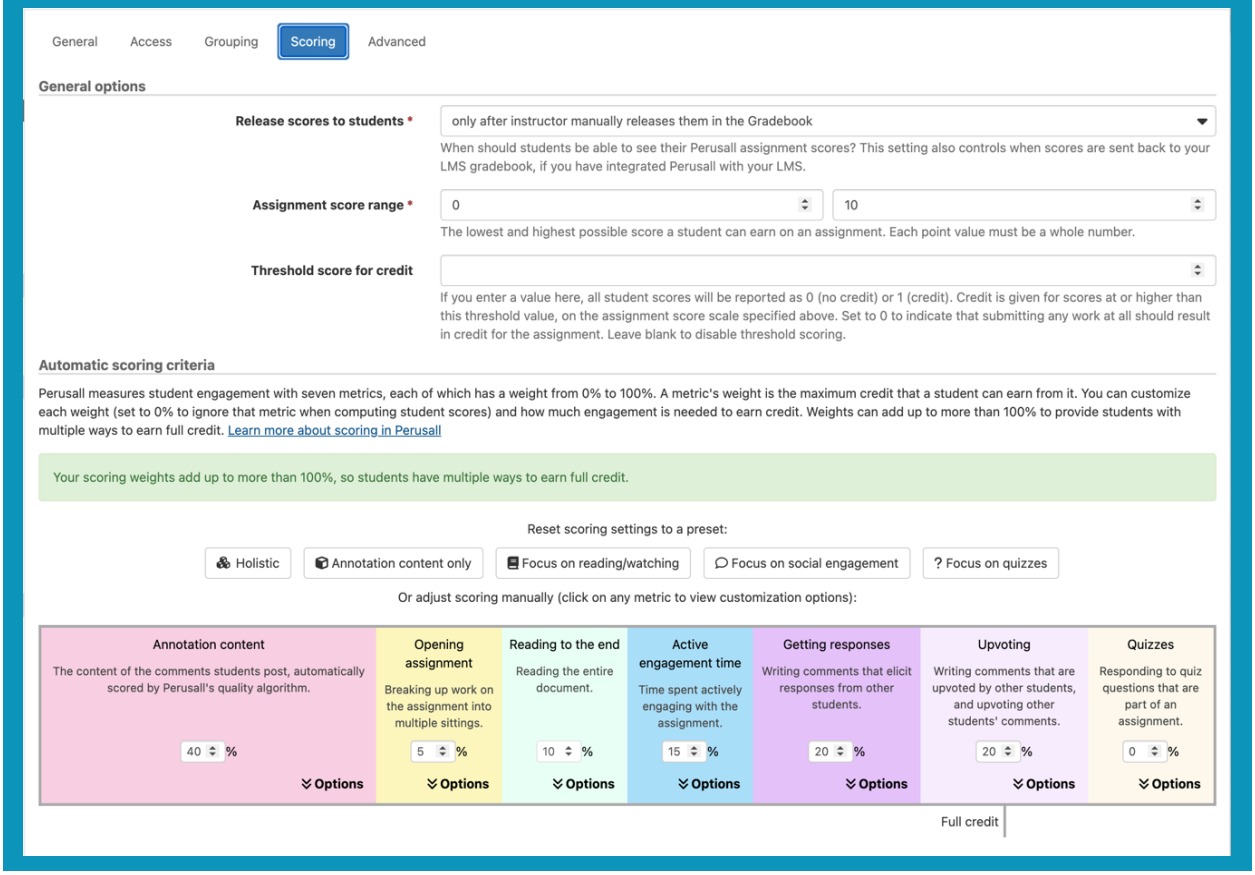
Table 1. Scoring Criteria

Rubric	Description
Holistic	Evaluates the overall engagement with the content, considering both the quality and quantity of annotations, replies, and interactions within the reading.
Annotation Content Only	Focuses solely on the content of students' annotations, evaluating the depth of thought, relevance, and quality of insights without considering social interaction.
Reading/Watching	Examines students' engagement with the assigned readings or media, assessing how thoroughly students interacted with the material.
Social Engagement	Emphasizes students' interactions with peers, assessing their contributions to discussions and collaborative learning within the reading or media content.
Quizzes	A new feature introduced in 2023, incorporates quizzes within content like readings, videos, or podcasts.

In the use case class, the instructor's philosophy was focused on reading and social engagement, so the preset scoring rubric for social engagement was chosen and slightly altered to ensure additional weighting on annotation. The instructor wanted students to not only engage in the material for their learning but also collaborate with other students to help the learning of the class.

Each assignment was worth 10 points which were achievable in various ways. As instructional videos and how-to resources on Perusall indicate, the scoring rubrics are set up so students can achieve maximum points in various ways. Analytics throughout the course supported this notion, as some students tended to post many minor comments. In contrast, other students posted a few extensive comments. The scoring rubric's functionality recognizes that not all learners are the same or learn in the same way. This was never more evident than when it was realized that International Officers often used translator applications to help them get through the content, primarily written in English.

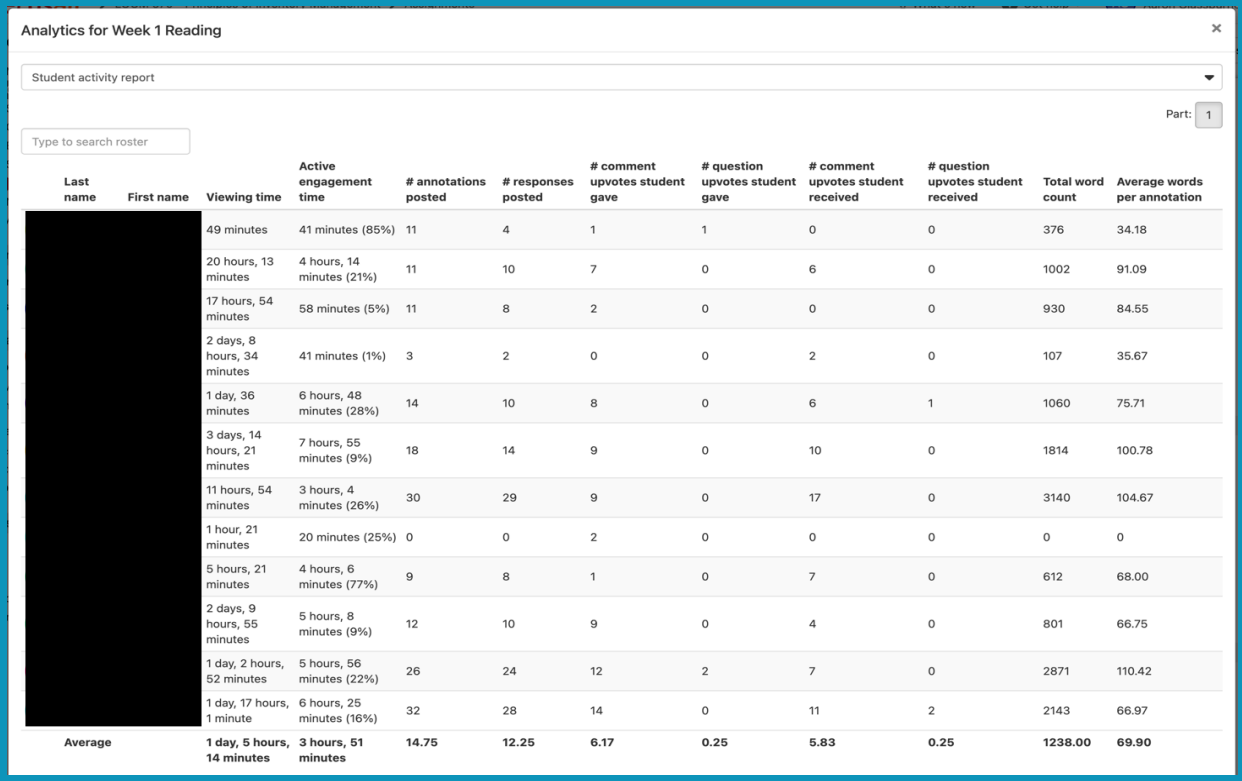
Figure 3. Persuall.com Assignment Scoring Options



Analytics (Confusion report etc.)

Perusall offers a wealth of analytics with which instructors can gauge student efforts. Three analytic reports are offered with each assignment: Grade Distribution, Annotation Submission Time, and an Activity Report. The Activity Report proved to be the most informative, with it, the instructor could gauge how long students were engaging with the material, the amount of time and effort they spent commenting on content, and the quality of their content. This report also allowed the instructor to help the students manage their initial efforts, as he wanted to avoid technology becoming the focus of the class.

Figure 4. Example of Student Activity Report



Analytics for Week 1 Reading

Student activity report

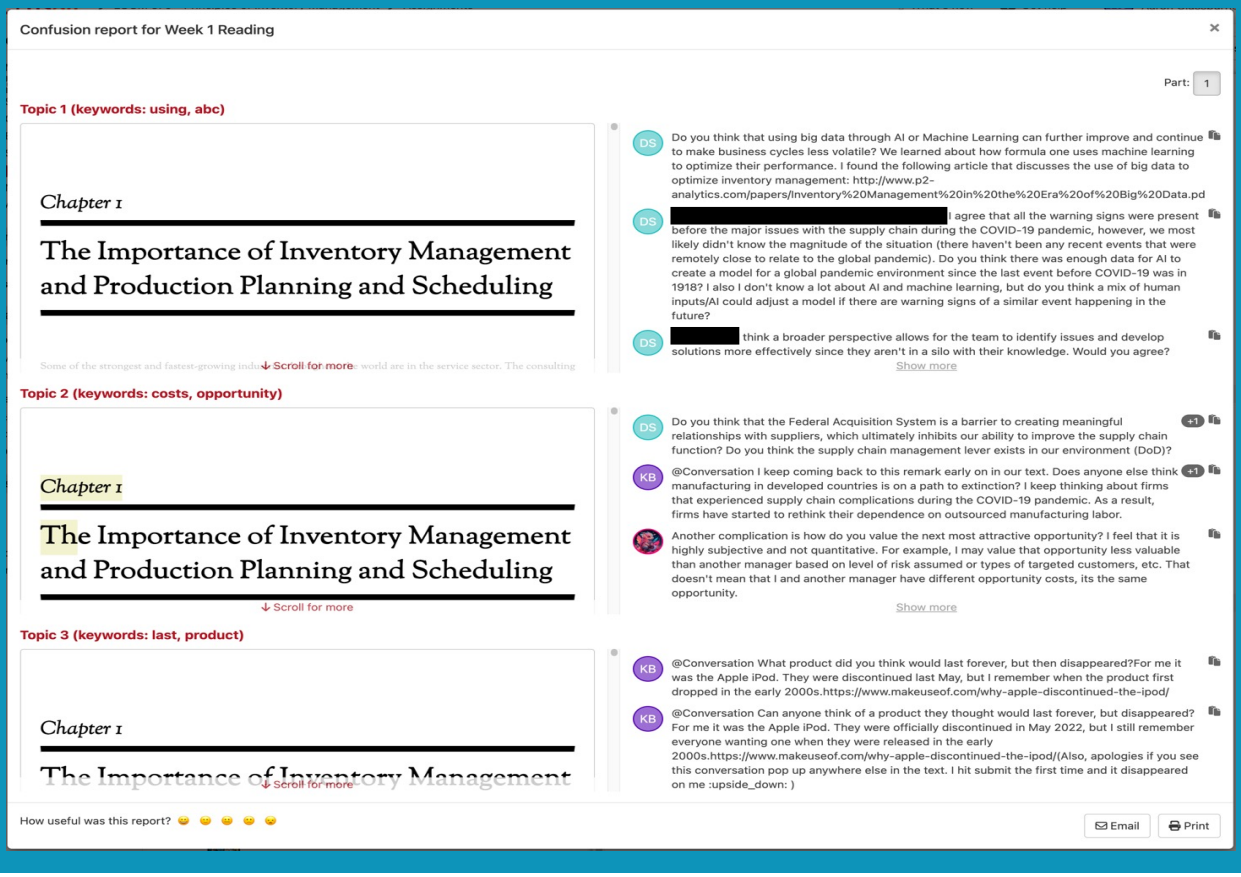
Part: 1

Type to search roster

Last name	First name	Viewing time	Active engagement time	# annotations posted	# responses posted	# comment upvotes student gave	# question upvotes student gave	# comment upvotes student received	# question upvotes student received	Total word count	Average words per annotation
[redacted]		49 minutes	41 minutes (85%)	11	4	1	1	0	0	376	34.18
		20 hours, 13 minutes	4 hours, 14 minutes (21%)	11	10	7	0	6	0	1002	91.09
		17 hours, 54 minutes	58 minutes (5%)	11	8	2	0	0	0	930	84.55
		2 days, 8 hours, 34 minutes	41 minutes (1%)	3	2	0	0	2	0	107	35.67
		1 day, 36 minutes	6 hours, 48 minutes (28%)	14	10	8	0	6	1	1060	75.71
		3 days, 14 hours, 21 minutes	7 hours, 55 minutes (9%)	18	14	9	0	10	0	1814	100.78
		11 hours, 54 minutes	3 hours, 4 minutes (26%)	30	29	9	0	17	0	3140	104.67
		1 hour, 21 minutes	20 minutes (25%)	0	0	2	0	0	0	0	0
		5 hours, 21 minutes	4 hours, 6 minutes (77%)	9	8	1	0	7	0	612	68.00
		2 days, 9 hours, 55 minutes	5 hours, 8 minutes (9%)	12	10	9	0	4	0	801	66.75
		1 day, 2 hours, 52 minutes	5 hours, 56 minutes (22%)	26	24	12	2	7	0	2871	110.42
		1 day, 17 hours, 1 minute	6 hours, 25 minutes (16%)	32	28	14	0	11	2	2143	66.97
Average		**1 day, 5 hours, 14 minutes**	**3 hours, 51 minutes**	**14.75**	**12.25**	**6.17**	**0.25**	**5.83**	**0.25**	**1238.00**	**69.90**

Another report, which proved to be the most useful, was the "Confusion Report". The "Confusion Report" tracked which passages were given the most time from students. The instructor used this report to help guide the focus and discussion of in-class lectures.

Figure 5. Example of Confusion Report



Confusion report for Week 1 Reading

Part: 1

Topic 1 (keywords: using, abc)

Chapter 1

The Importance of Inventory Management and Production Planning and Scheduling

↓ Scroll for more

DS Do you think that using big data through AI or Machine Learning can further improve and continue to make business cycles less volatile? We learned about how formula one uses machine learning to optimize their performance. I found the following article that discusses the use of big data to optimize inventory management: http://www.p2-analytics.com/papers/Inventory%20Management%20in%20the%20Era%20of%20Big%20Data.pd

DS [redacted] I agree that all the warning signs were present before the major issues with the supply chain during the COVID-19 pandemic, however, we most likely didn't know the magnitude of the situation (there haven't been any recent events that were remotely close to relate to the global pandemic). Do you think there was enough data for AI to create a model for a global pandemic environment since the last event before COVID-19 was in 1918? I also I don't know a lot about AI and machine learning, but do you think a mix of human inputs/AI could adjust a model if there are warning signs of a similar event happening in the future?

DS [redacted] think a broader perspective allows for the team to identify issues and develop solutions more effectively since they aren't in a silo with their knowledge. Would you agree?

Show more

Topic 2 (keywords: costs, opportunity)

Chapter 1

The Importance of Inventory Management and Production Planning and Scheduling

↓ Scroll for more

DS Do you think that the Federal Acquisition System is a barrier to creating meaningful relationships with suppliers, which ultimately inhibits our ability to improve the supply chain function? Do you think the supply chain management lever exists in our environment (DoD)? +1

KB @Conversation I keep coming back to this remark early on in our text. Does anyone else think manufacturing in developed countries is on a path to extinction? I keep thinking about firms that experienced supply chain complications during the COVID-19 pandemic. As a result, firms have started to rethink their dependence on outsourced manufacturing labor. +1

Another complication is how do you value the next most attractive opportunity? I feel that it is highly subjective and not quantitative. For example, I may value that opportunity less valuable than another manager based on level of risk assumed or types of targeted customers, etc. That doesn't mean that I and another manager have different opportunity costs, its the same opportunity.

Show more

Topic 3 (keywords: last, product)

Chapter 1

The Importance of Inventory Management

↓ Scroll for more

KB @Conversation What product did you think would last forever, but then disappeared?For me it was the Apple iPod. They were discontinued last May, but I remember when the product first dropped in the early 2000s.https://www.makeuseof.com/why-apple-discontinued-the-ipod/

KB @Conversation Can anyone think of a product they thought would last forever, but disappeared? For me it was the Apple iPod. They were officially discontinued in May 2022, but I still remember everyone wanting one when they were released in the early 2000s.https://www.makeuseof.com/why-apple-discontinued-the-ipod/(Also, apologies if you see this conversation pop up anywhere else in the text. I hit submit the first time and it disappeared on me :upside_down:)

How useful was this report?

Email Print

How the tool helped in-time class discussion

Persuall helped maximize the use of in-class time and the time the instructor was available for students. Talbert (2017) refers to course experience through two categories: individual space and group space. Individual space is the time and context when students work independently and alone, while group space is that time or part of the class when students learn together. Perusall opened the time in which group space was available. Outside of the classroom, students could independently read the course material but, at the same time, asynchronously collaborate. In class time, Persuall allowed content knowledge to be transformed into applied knowledge as the time spent lecturing was decreased in favor of more group work and student-led presentations. Class times were now dedicated to low to no stakes, formative assessments, and the students working through the quantitative portions of inventory management models. The in-class time was afforded this option as Perusall's assessment feature saved time but also allowed the instructor to assess student content knowledge and progress through the required course material.

Additionally, Perusall's ability to highlight areas where students spent the majority of their time also allowed instruction to be focused on those areas while also forgoing the areas where the analytics assessed students spent less time on certain sections. Though this assessment could be erroneous in that students may spend less time in an area because of confusion, prompting questions throughout the week helped alleviate the potential for this misconception.

Discussion and Recommendations

The use of Persuall for two terms has anecdotal evidence of its value in increasing student reading engagement and collaboration. Students were more actively engaged and collaborated more effectively with the material and their peers compared to terms where the course relied on traditional in-class lectures and individual reading. Social collaboration platforms, such as Persusall, do not mitigate the need for instructors to give considerable attention to developing class objectives and structure. Once programmed into a class, though, they provide a helpful platform to increase guided exploration of content, deeper learning, self-regulated learning behaviors, and student access to support (Talbert, 2017).

Two issues challenged the adoption of Perusall in this use case. First, not all students see value in the use of e-textbooks. When examining student preference, it is often reported that students prefer using physical textbooks instead of interacting with the text material on a mobile device (Mennenga, 2016). This finding aligns with what was discovered in our course. Some students preferred using two copies of the same source, one through the Perusall platform and the other a physical copy. Additionally, it was found that international students may be disadvantaged if the course text is in English. Accommodations should be made appropriately for these situations. In this case study, the social annotation tool Perusall, was limited to content within the public domain. Future research should seek to measure its effectiveness and explore options for implementing social annotation tools within government networks.

In this case study, the use of Perusall was constrained to public-domain content. Future research should explore its implementation within government networks. Integrating tools like Perusall within military systems can expand the use case, allowing institutions like AFIT to utilize new affordances from emerging technologies to support effective teaching practice at all levels.

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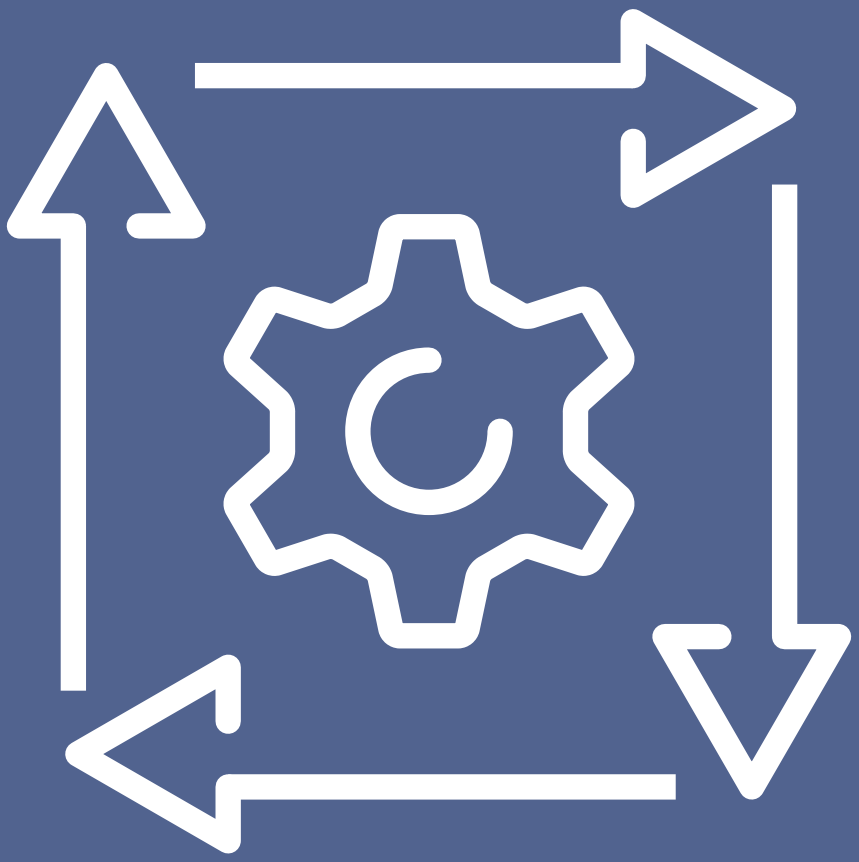


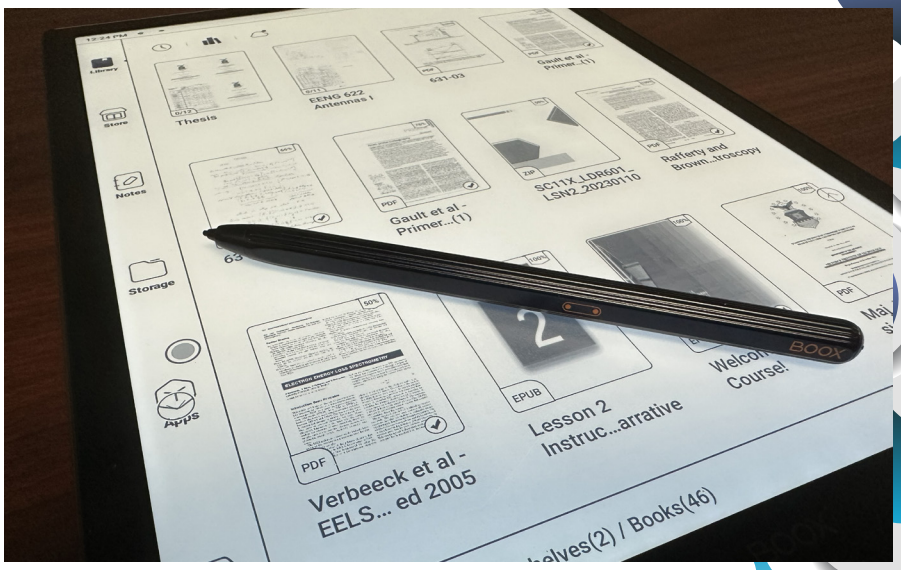
EFFECTIVE WAYS TO CREATE CONTENT

E Ink Tablets

Major Wolfe

Overview:

E Ink tablets can streamline faculty tasks, significantly reducing time spent on grading and preparing materials. They allow direct, paperless annotation on student works, while their glare-free displays make extended reading less fatiguing. Additionally, their ability to convert handwritten notes to editable text aids quick creation of presentations.



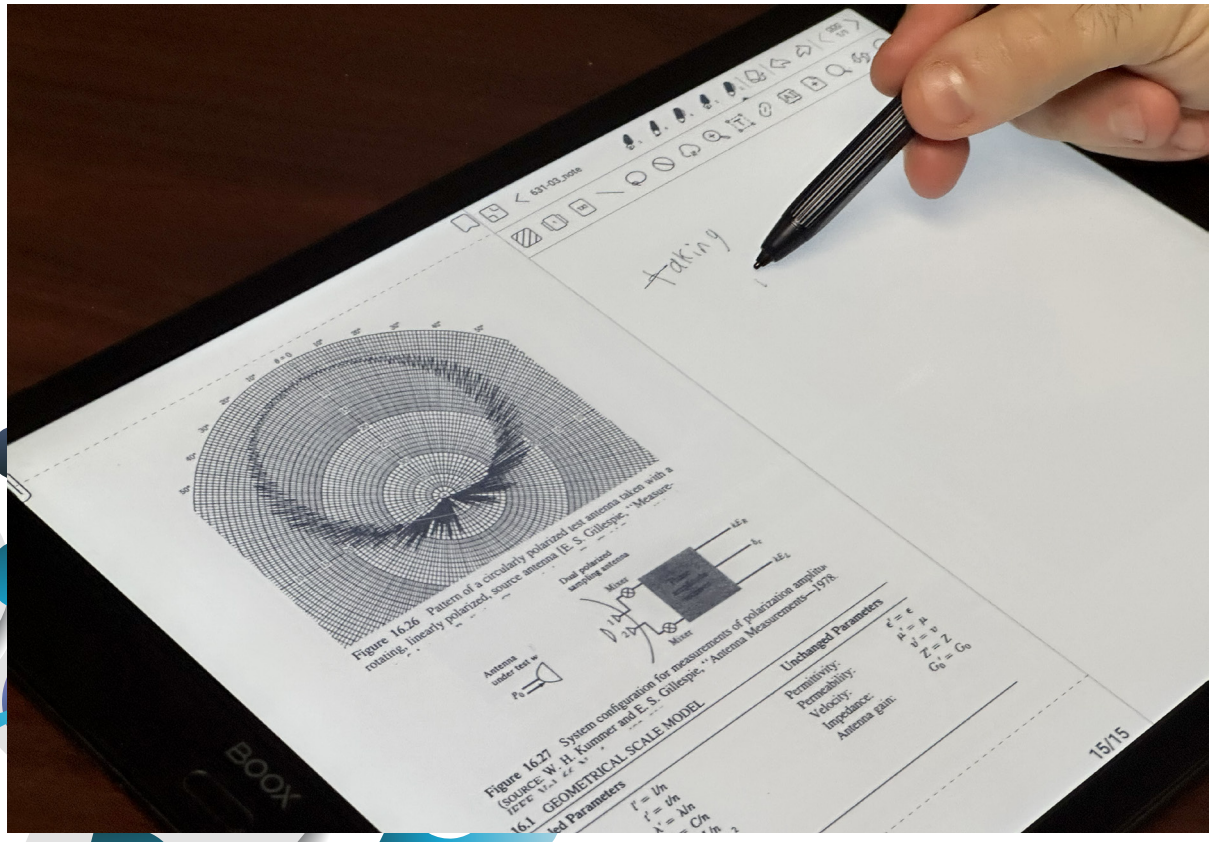
What:

Touch screen tablets that use "E Ink" display technology rather than conventional LCDs. E Ink technology works by manipulating physical particles through digitally modulated electromagnetic signals to create images, instead of emitting light like conventional screens. This feature significantly lowers eye strain, which can enhance productivity, conserve mental and physical energy, and improve overall well-being by preventing headaches or other eye strain-related ailments. Additional advantages include a significantly lower power consumption, extending battery life. While most (but not all) E Ink screens are monochrome, the lack of color tends to serve the minimal-distraction purpose and ensures color-blindness accessibility is observed.

Use Case:

Students tend to appreciate digital feedback for ease of access and archiving. However, the use of E Ink tablet annotations via drawings, arrows, margin notes, etc. like that of analog written feedback makes information retrieval much easier than working through limitations of native software commenting and markup. Digitized handwritten feedback ultimately bypasses barriers presented by software versions across platforms (enterprise-provided or personal), by making the feedback a simple image or .pdf. Thus, the students and the instructor efficiently and effectively via their app of choice (often MS Teams or Canvas at AFIT, both accessible via e-Ink tablets) with minimal version control issues or accessibility problems.

Often the task of grading or editing loses are some of the worst behavioral barriers to "just getting started" and maintaining concentration. The ability to directly access files on an E Ink tablet facilitates providing timely meaningful feedback to students. The elimination of eye strain significantly improves how long an instructor can look at content and interact with it. Even though most E Ink tablets do not display in color, they still provide the option of annotating in color, which tends to help in annotating on student content.



A quick spectrum of capability/complexity from most to least would be Boox – Ratta – reMarkable.

Boox is effectively a full android tablet, capable of (though not necessarily optimized for) any android app. It comes with a web browser, microphone, speakers, and a front light. Capabilities include full writing-to-text conversion, screencasting, searchable notes (including handwritten), speech-to-text, audio recording, native pdf reader with annotations (can be made in color for other screens), dual document review, and more. Files can be imported and exported through a Boox website/app or any other android app, such as MS Teams. Boox produces a wide range of screen sizes. The E Ink screen settings can be adjusted to accommodate different applications, to include improving moving video but only to a certain degree due to the limit of how quickly the E Ink particles can be controlled. The user experience is good, with very functional native pdf reader and notes app, built in and customizable templates, good response speed to the stylus, and decent "Feel" (roughly similar to "writing on glass" like other tablets). Cost tends to be high, and Boox has been accused of questionable privacy/security practices (Chinese company, but approved for purchase with sponsor funds).

Ratta is also an android tablet, though not as customizable as Boox. In exchange, Supernote features a well liked "feel" compared to a ballpoint pen on paper, and its metal pens do not need nib replacement. Supernote does contain a good number of features, and is actively expanding them through firmware updates guided by a community driven Trello board run by the developers. Ratta is a Chinese company.

ReMarkable is a Scandinavian company offering a tablet purposely built to minimize features in order to minimize distractions, and offer a pencil on paper-like feel. Amazon has released the Kindle Scribe with writing capability as well.

Best Practices/Use Cases:

• Literature review: reading technical papers with small text is much easier to do for extended periods of time/concentration, and the tablets offer excellent markup and annotation tools.

• Writing/editing: this is especially useful when reviewing and marking up draft theses, dissertations, or other manuscripts for publication. E Ink tablets give the advantages of a paper appearance for readability and the highly flexible markup of pen and ink on a printed page, while still giving the transportability of a digital file.

• Homework grading: for the same reasons as above

• Lesson planning: E Ink tablets provide a good way to jot down ideas and sketches, which can then be directly used as lecture notes when connecting to a display. In this way, an E Ink tablet makes for an ideal planning and execution tool for lectures, as it works well as a digital whiteboard as well. The use of multiple layers, which can be independently switched on or off for display, can be helpful for guided lectures.

Resources:

For a detailed analysis of the options, please consult the following recommended youtube creators and their helpful archive of videos demonstrating use cases, reviews, and recommendations:

Youtubers:

Kit Betts-Masters: https://www.youtube.com/@KitBetts-Masters
My Deep Guide: https://www.youtube.com/@MyDeepGuide
Pixel Leaves: https://www.youtube.com/@pixelleaves

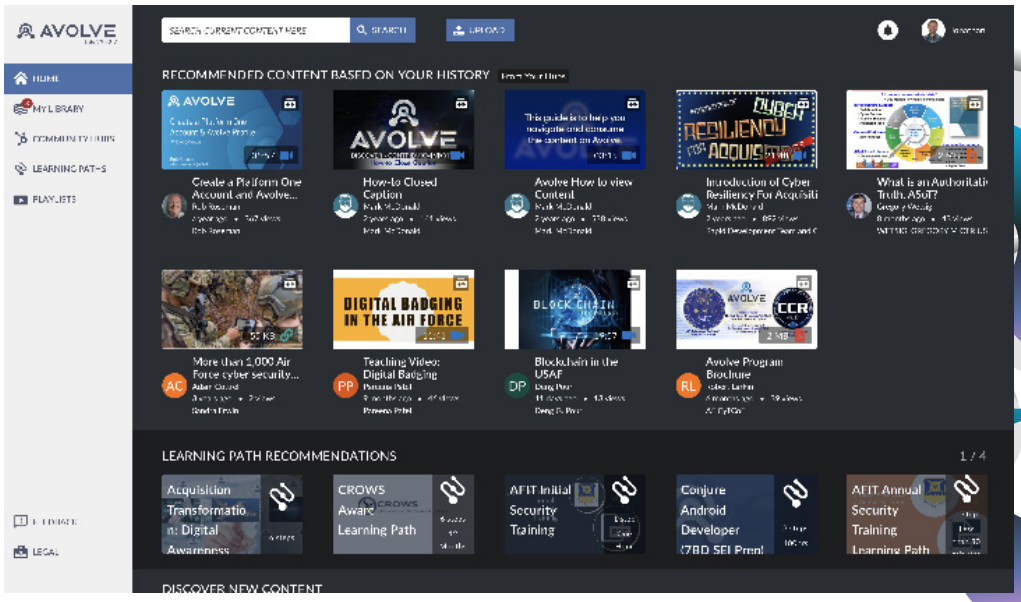
Typically, E Ink devices accommodate .pdf and ebook formats exclusively. While their processing power might be modest, it's usually adequate for the required tasks. The user interface quality can differ substantially among manufacturers. The accompanying stylus, which usually operates without a battery, will need periodic replacements of "nibs," or pen points. A growing number of brands have entered the E Ink tablet space, but the main choices will be reMarkable, Boox, Ratta, and Amazon. Each choice provides a different balance of capability and cost, as well as different screen sizes.

Facilitating Learning with AVOLVE

Jonathan Zemmer

Overview:

AVOLVE serves as a dedicated content-sharing platform for videos, documents, and tailored learning pathways within the DoD. It bridges the functionalities of platforms like YouTube and Netflix, providing a secure and authenticated space where military professionals can both consume and share educational content.



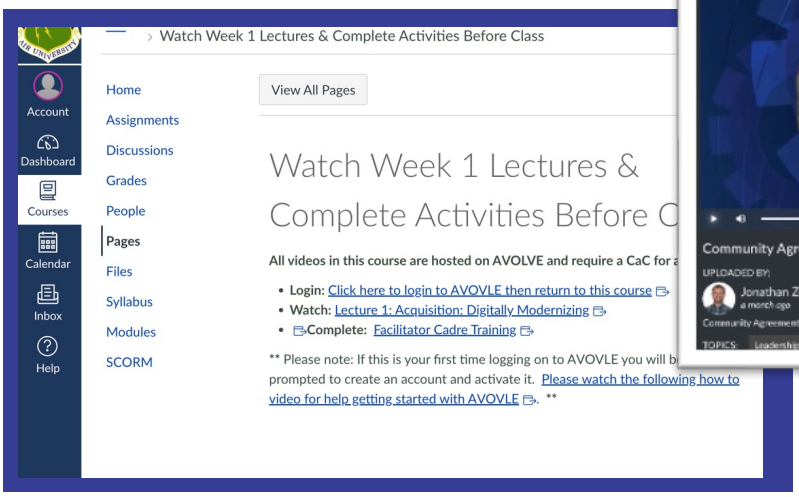
What:

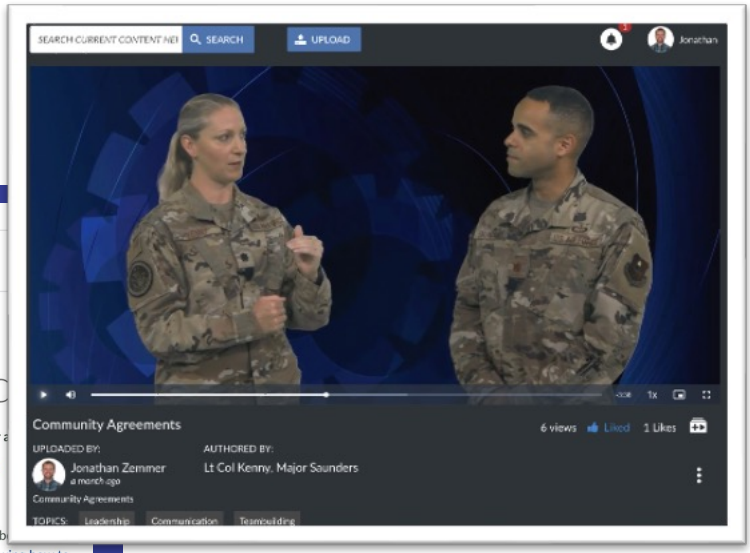
AVOLVE (https://avolve.apps.dso.mil) is a holistic digital platform designed with the education and training missions in mind. Content is categorized into "Hubs" such as the "Aircraft Maintenance Hub" or "Learning Professionals Hub", ensuring easy navigation. Media within AVOLVE is displayed based on user interest and provides users the ability to create custom playlists. The platform also includes the ability to organize content into a sequence of bite-sized, steps called learning paths. It supports a wide range of file types that include mp4, pdf, xls, xlsx, ppt, ppsx, pptx, doc, docx, jpg, jpeg, png, gif, csv, txt, and mdzip.

Use Case:

Flipped learning is an instructional strategy where traditional learning dynamics are reversed: preliminary content is learned outside of the classroom, allowing in-class time to be utilized for interactive exercises and collaborative projects. Instructors can leverage AVOLVE for content delivery by creating or curating videos and documents on AVOLVE. Rather than conventional in-class lectures, instructors can share AVOLVE content through URLs in Canvas or other learning management systems, directing students to engage with the material outside the classroom. With this approach, students are ready for in-class activities focused on applying what they have learned.

CANVAS





AVOLVE

Best Practices:

- Start with Clear Objectives: Before creating or curating content on AVOLVE, outline the learning objectives you want to achieve.
- Chunk Information: Divide content into manageable, bite-sized portions, especially when creating instructional videos.
- Structured Learning Paths: Create well-defined Learning Paths to guide students through content in a logical and cohesive manner. Each step should build on the previous, allowing students to progressively deepen their understanding.
- Clear Instructions: When sharing AVOLVE content or Learning Path URLs though Canvas, provide clear instructions on what is expected from students, including completion timelines and preparation for in-class activities.
- Update: Regularly review and update your AVOLVE content to ensure it remains current, relevant, and in-line with your instructional goals

IDEAS FOR QUICK ENGAGING ACTIVITIES

Polling/Concept Checks

Rick Kappel

Estimated Time to Create

30

MINUTES

Estimated Class Time

5

MINUTES

Use questions to:

- Learn about your students
- Create discussion/interest
- Reinforce important concepts
- Measure student learning
- Introduce variety into your lesson

What: Create polling questions or concept checks

Polling Questions: Ungraded questions designed to gather information about the students, such as their opinions, understanding of a subject at a particular moment, or general feedback on a lesson.

Concept Checks: Graded questions that analyze a student's knowledge on a particular topic or concept. These types of questions may be used as part of a quiz, or other assessment, and are aimed at determining the student's grasp of key ideas within the subject matter

Use Case:

I incorporate polling questions at the start of most lessons to learn about the students in my course and to let the students learn about each other. For example, in my recycling class, I always ask students if their program has a Trade Securities Log, before we discuss it. I get to see how many students are familiar with the topic, which could alter the breadth and/or depth of lecture coverage, while at the same time students can compare their programs to the rest of the class.

For longer lessons (over an hour), I will incorporate concept checks every 20-30 minutes, to keep students engaged, check student learning, and reinforce the most important concepts.

Upon the conclusion of most lessons, I generally ask a few concept check questions to check student learning and reinforce the most important learning objectives.

How:

1. For concept checks, start by looking at your learning objects and main concepts and create questions based upon those. Multiple-choice, Fill-in-the-Blank, Matching-type questions are generally more conducive to concept checks as they are designed to verify student absorption of the lesson objectives in a brief and concise manner.

For polling questions, start by thinking about things that might be interesting for a student to know or something you'd like to learn about the audience. Higher order questions or ones that the preferred method may depend on the given situation, or questions that could drive a larger group discussion are good polling type questions.

2. Once, the question topic is selected, then construct the main body of the question with as much detail as possible.
3. Decide the question type; true/false, multiple choice, multiple answer, word cloud, short answer, etc. (question type variety is good if possible).
4. Construct answers that aren't easily confused with each other.
5. Give specific direction on the type of answer you are looking for (ex. Pick 2 answers).

Question Delivery:

There are a variety of ways to deliver questions. Here are a few choices:

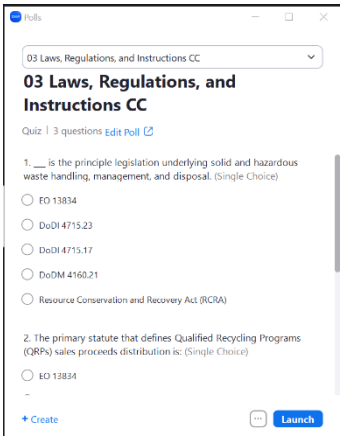
1. **PowerPoint:** Put the question into a power point slide and have students raise their hand, or write their answer on a scrap paper.

2. **Use their phone or computer/tablet:** I use a free polling platform called "Socrative". An instructor can get an account on www.socrative.com (See Socrative Quick Kill article). Once you create a teacher account, you create a room, which you can customize the name. Once you create your question bank, you can launch a quiz. The students will go to Socrative.com and enter the room code. Students submit question answers and results are shown live. There are many different customizable settings, and the program is very user friendly. This is just one of many available free platforms, I like it because of the easy of student use.

3. **Turning Point (Point Solutions):** These are "clickers" that various schools have invested in (figure 1). These clickers don't require students to log in or have a device of their own. This system is a little more complicated for the instructor but has more capabilities and is easier for the student. This method will require more research.

Figure 1.

4. **TEAMS or ZoomGov:** There are built in polling features in both MS TEAMS and ZoomGov. If you are already using these platforms, it is probably best to use these because it doesn't require student to switch apps or platforms. In TEAMS polling is called "Forms" and ZoomGov (see example below) has a polling button. Both require questions to be created ahead of time. Another, very simple option is to have students respond to question by posting an answer in the chat.



zoom for Government

Best Practices:

• Generally, question sets should reflect the length of the presentation (longer lessons will have more questions).

• Do not over do it; generally ask 2-3 questions at a time and never exceed 5 questions (ask them in short bursts, multiple times).

• Make questions that are straightforward and not tricky; confusing questions or providing multiple answer selections with similar wording can have a negative effect on student learning.

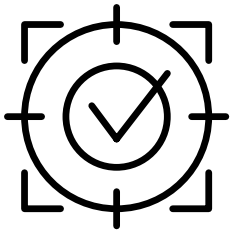
• After you deliver the questions, analyze the results, and adjust the instruction or question depending on how it goes.

• Avoid "all of the above" questions (easy to answer).

• Avoid "which of these is NOT" questions (confusing to students).

• Drum up interest and make it competitive if possible, make it fun.

• Spend time discussing the answers, especially if there are a lot of students who miss the correct answer.



Socrative

Major Gutiérrez del Arroyo

Estimated Time to Create

30

MINUTES

Estimated Class Time

10-15

MINUTES

What:

Using Socrative.com as a live polling tool with access from any internet-connected device

Why:

Live polling can re-enforce your most important concepts, help you review for tests or solicit informal anonymous feedback about the course

Use Case:

Flipped classes require students to do most of their learning outside of class, via videos, readings, and other content. Classroom time is used to work on challenging problems that both reinforce and expand on the lesson objectives. When I started teaching a flipped Discrete Mathematics class, my initial approach was to dive into the in-class problems at the start of the class period, essentially hoping that the students had done enough of the out-of-class work to be able to solve the challenging problems. I often found myself wondering whether students were prepared but not setting any time aside for class to determine if they were. I decided to add a live polling element at the beginning of each class period to assess how well the students understood the material.

Using Socrative.com as my polling platform is simple for students to access without an account. However, there are many other platforms available with varying levels of complexity. With each poll, I also employed a Think-Pair-Share approach to foster student discussion. I first prompted students to think individually about a concept, then pair up with a classmate to discuss their thoughts, and finally share their ideas with the larger group. This approach encouraged active participation and collaboration among all students because it gave the students the opportunity to build confidence in their responses before being assessed by the class and instructor.

For my instruction, the benefits of live polling are two-fold. First, I can to assess what are the least understood concepts from the pre-class work through multiple-choice and true/false polling. This allows me to focus in-class time on the basic concepts before tackling the challenging problems. Second, and most importantly, the polling application allows me to gauge the students' sentiment towards the class content and pacing, which enables me to better cater the class to the students.

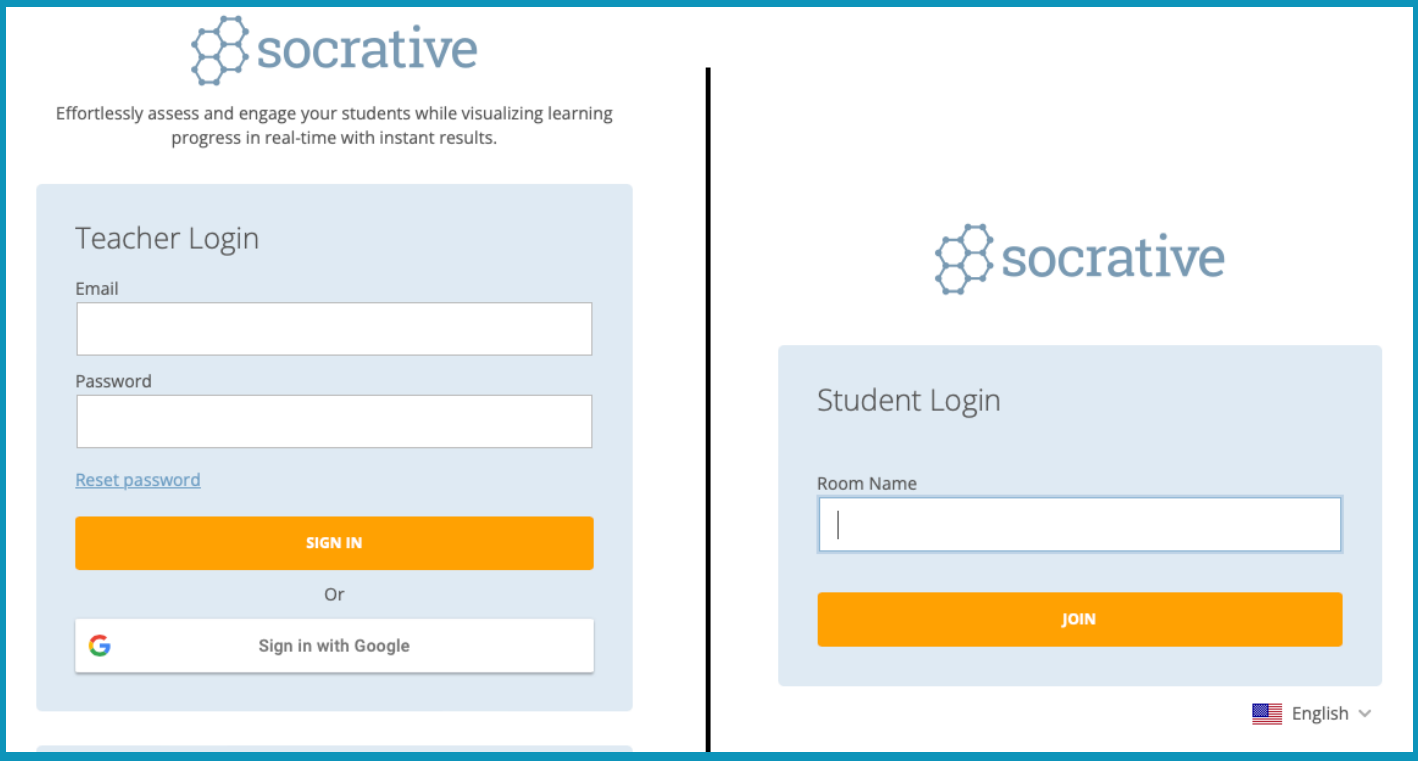


Figure 1: Socrative.com Teacher Login Screen and Student Login Screen.
Note that the student only needs to input a Room Name without creating an account.

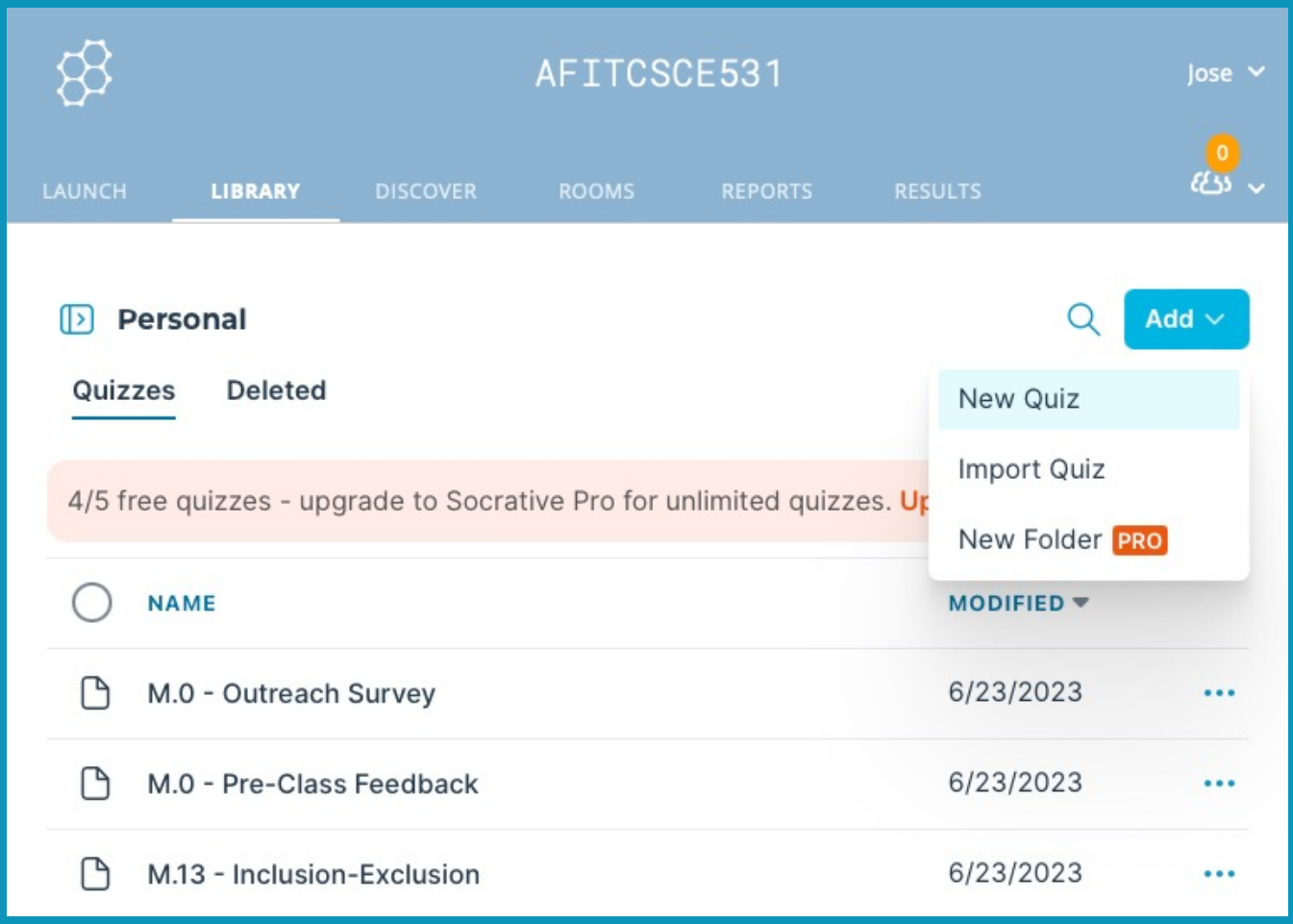


Figure 2: Adding a Quiz using the online quiz builder. You also have the option to Import Quiz if you've created it using the MS Excel Socrative Quiz Template.

How:

1. Design your question(s) – On Socrative.com, the types of supported questions are multiple choice, short answer, and true or false.
2. Log into Socrative.com (Figure 1) – Choose "Teacher Login," and if you have not yet done so, create a free account.
3. Select "LIBRARY" and add a new Quiz (Figure 2) – I found the quiz builder to be mostly intuitive. You can choose to identify the correct answer and provide explanations, though one is not required, e.g., for opinion/survey questions.
4. Select "ROOMS" to view/configure your Room (Figure 3) – Your students will need the Room Name when they log into Socrative.com.
5. Select "LAUNCH" when you're ready to start a Quiz (Figure 4) – Options I've liked exploring are whether to make the quiz anonymous (Require Names), and whether to pace the quiz (Teacher Quiz) or let the students go at their own pace (Instant Feedback/Open Navigation).
6. Select "RESULTS" to see live responses to the questions – You can use these responses to drive further discussion!

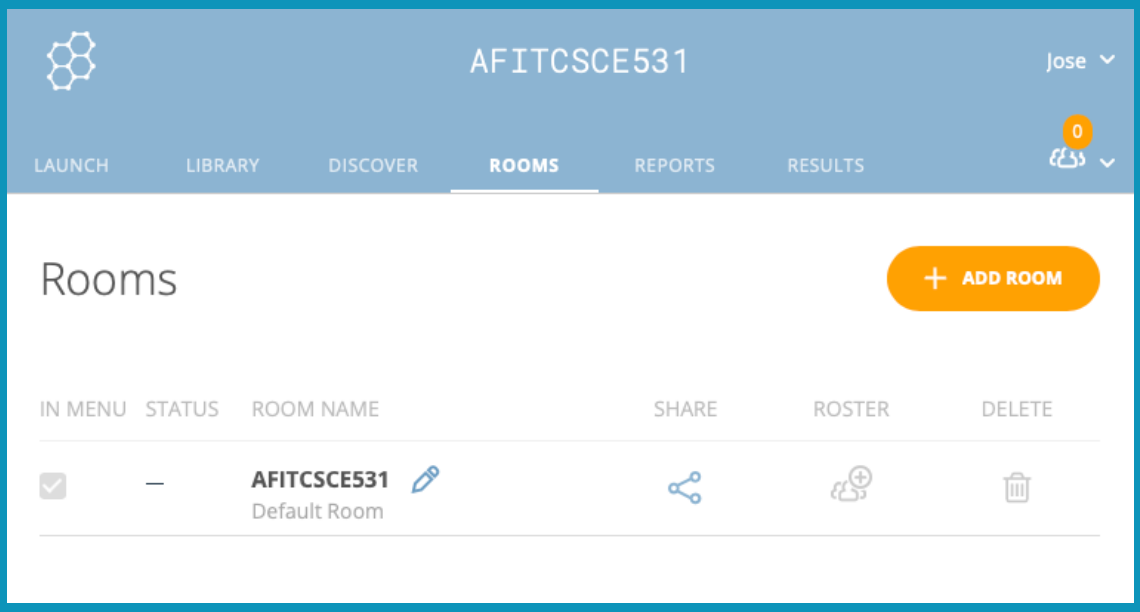


Figure 3: Your students will need to know the Room Name to access your quizzes.

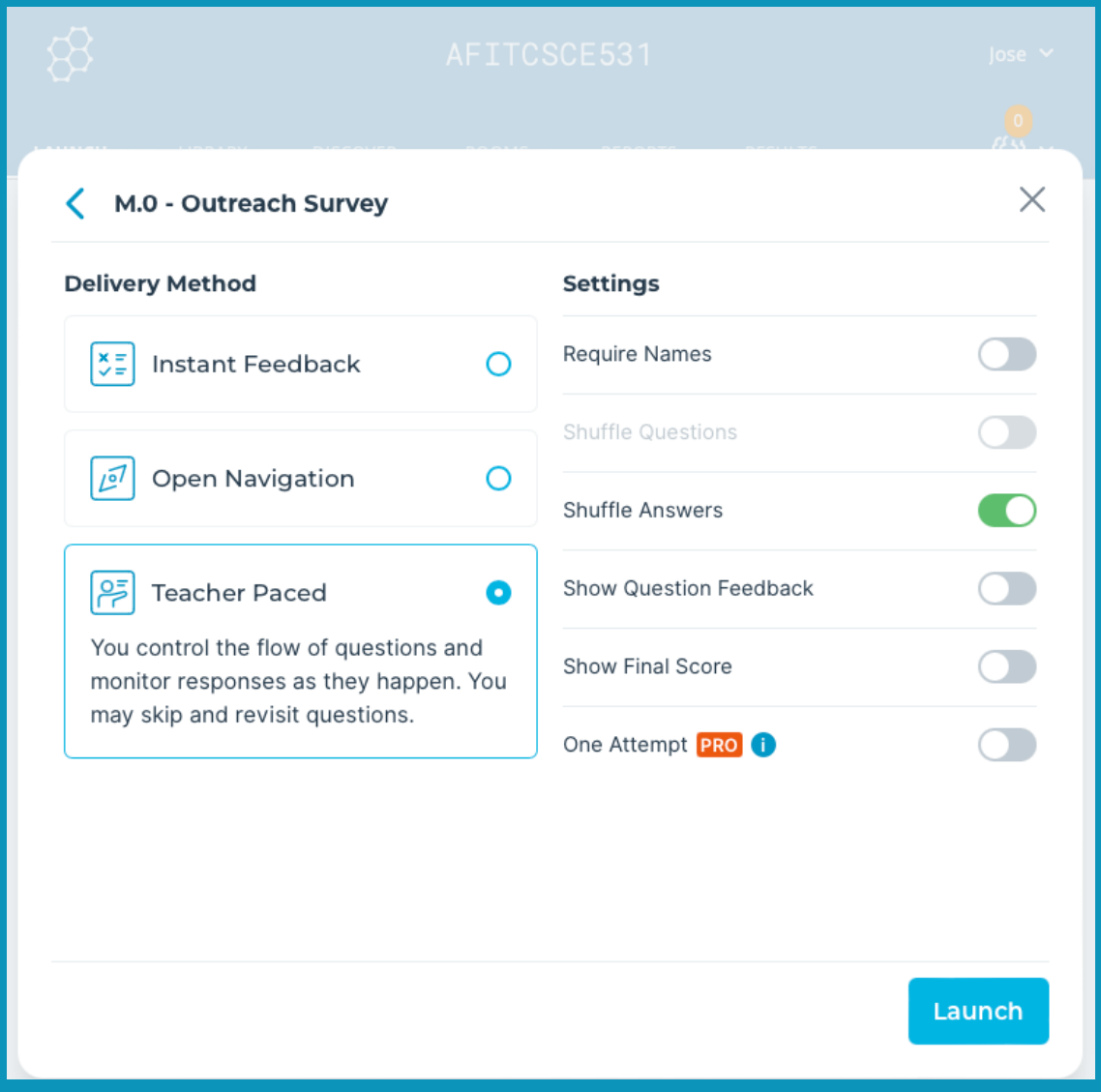


Figure 4: You have many options when launching your quiz – cater these to your class!

Best Practices:

• Whether or not the quizzes are anonymous, disable "Show Names" in the Live Results section, keeping responses private until the students are ready to share

• Do not ask students to write math formulas as their responses to Short Answer questions. As the instructor, you can insert LaTeX in the quiz builder, but Socrative does not provide the same functionality to students.

• Export results (in "REPORTS") after an activity is complete to keep record of student answers, especially if related to course feedback.

• If you have the time, design your questions using the MS Excel Socrative Quiz Template ("LIBRARY"-> "Add"-> "Import Quiz"-> "Download Template") instead of the online builder. This will allow you to easily re-import the quiz in the future if you must delete it due to limited online storage.

• You can easily troubleshoot and test your quizzes by logging in as a student!

• Free accounts limit the number of quizzes you can keep stored on the site at any time, but you can always delete old quizzes and add new ones!

Quick Kills: Kahoot

Mike Frick

Estimated Time to Create

60

MINUTES

Estimated Class Time

30

MINUTES

What: Create a Kahoot! Quiz Game (https://create.kahoot.it/)

Why: Use a Kahoot! Game-based learning activity to assess student content retention; review significant course concepts prior to a quiz or test; or just for general student interest and engagement. Kahoot! enables students an opportunity to review assessment-style questions covering the course content and provides them an indication of specific areas of the material should be reviewed through private study prior to the assessment. It also affords the instructor the opportunity to gather data as to the effectiveness of their instruction and provide additional guidance to students on the course material prior to a formal assessment.

Use Case:

At the conclusion of a Continuing Education Course Unit, in which students attended lecture for 4 days, covering 8 different lesson segments, and 132 pages of textbook material, this Kahoot! Game-based learning activity was utilized on the day prior to a test. The instructor created 28 questions based upon the unit's Samples of Behavior of a similar style to those on the upcoming formal assessment (multiple choice, true false, fill in the blank selection, multiple select). The website is user friendly, and a quiz can be created in just a few minutes depending on how many questions are desired for review, and if any visual aids need to be provided with the associated questions. Kahoot! may be utilized in both in-person and online instruction or a hybrid of both, but all students will need to be live on the system when the activity is conducted. In this case study, the course had 30 in-person students. The instructor will need to establish ground rules for the class (such as a nickname theme or require students to use their actual name for assessment purposes). The questions are routinely reviewed by the instructors to eliminate confusion. In the case study's course, Kahoot! has become one of the most engaging parts of the course and is frequently mentioned via Course Survey feedback as to the benefit of the activity.

Figure 1: Example of Kahoot! After-Action Summary Reports

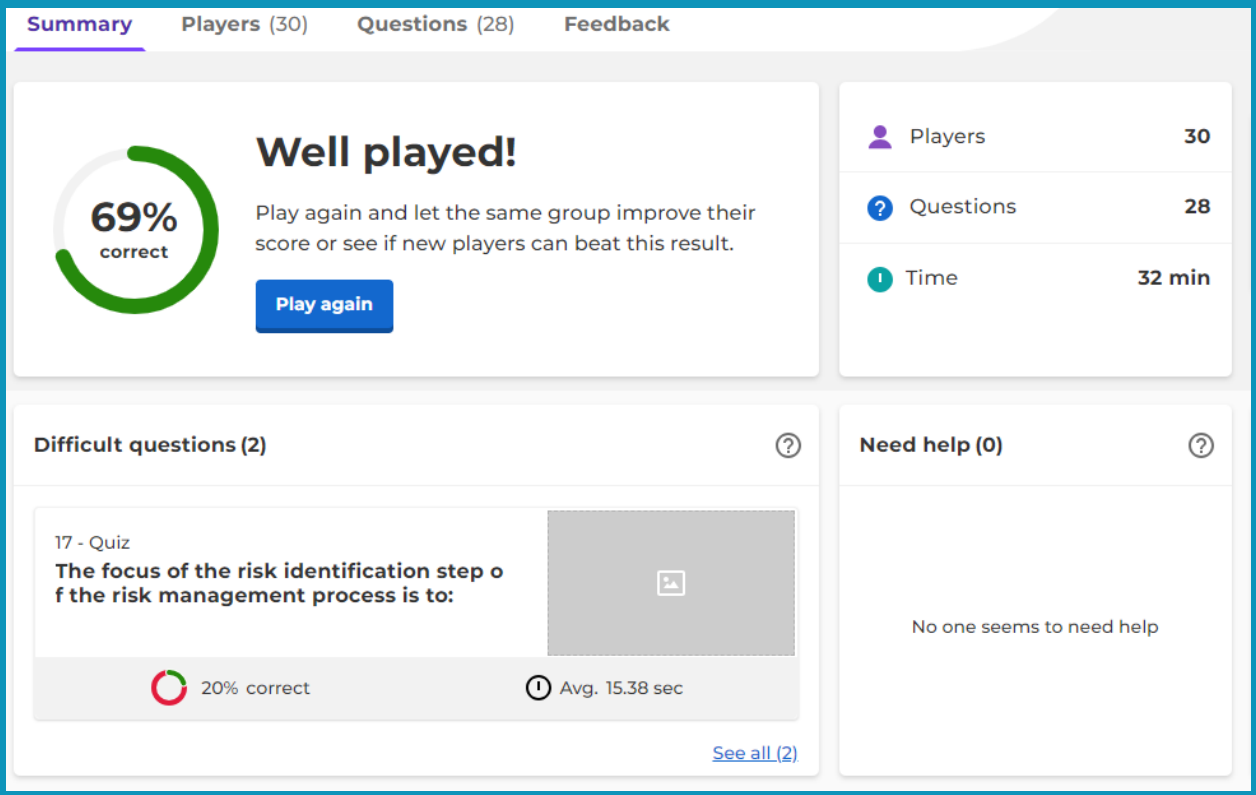


Figure 2: Example of Kahoot! After-Action Podium Report

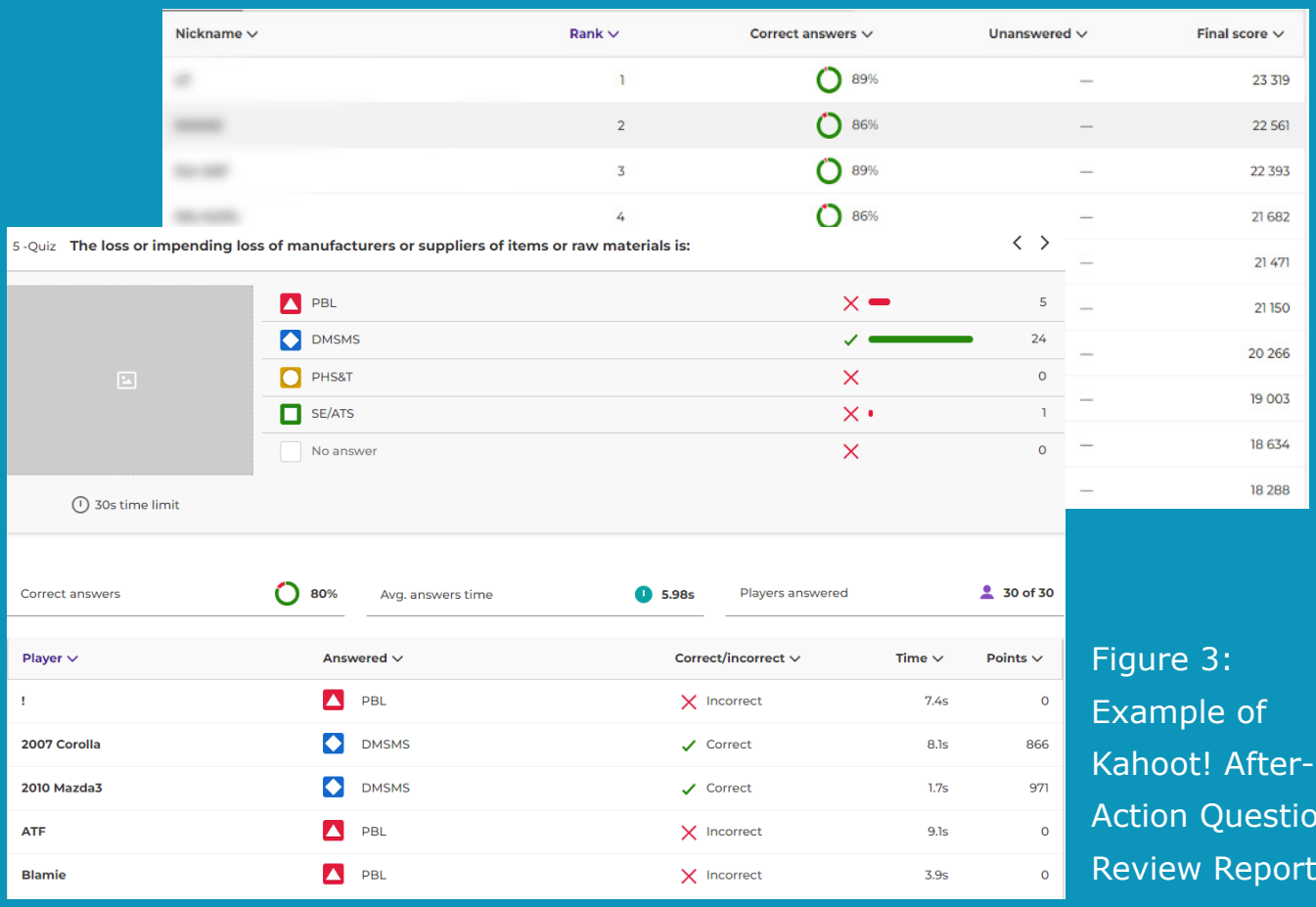


Figure 3: Example of Kahoot! After-Action Question Review Report

How:

1. Start by deciding on a lesson or unit to review.

2. Create questions/answers related to the Samples of Behavior for the lesson or unit. The questions will need to be in a Kahoot! Compatible format (Multiple Choice, True/False, Fill in the Blank, Multiple Select, Sequencing). Include incorrect "distractor" responses to provide opportunities for the instructor to address common misunderstandings for the learning objectives being assessed.

3. Create the Kahoot! Quiz using https://create.kahoot.it/ to input questions, answers, and time length for each question.

4. Design ground rules and prizes (if applicable) and inform students of expectations.

5. Conduct the Kahoot! Exercise with class participants

6. Provide feedback to students real-time for each question, based upon the responses provided.

7. Analyze the reports provided at the end of the activity lesson and adjust the questions/answers/textbook/lesson structure, as necessary. (See Figures 1-3)

Best Practices:

• Blooms Taxonomy Level(s) Targeted: Remember & Understanding

REMEMBER	The ability to retrieve and recall previously learned information without altering it.	Recognize, Recall
UNDERSTANDING	Grasping the meaning of information by interpreting and translating what has been learned.	Interpret, Explain, Describe, Compare, Summarize

• In addition to assessment prep, Kahoot! can be utilized for many purposes such as: review/assessment tool after individual lessons, a pre-lesson assessment to determine which segments of the lesson require additional instructor attention, collect polling data from an audience, or to create a Word Cloud from an ice breaker question or brainstorm a topic.

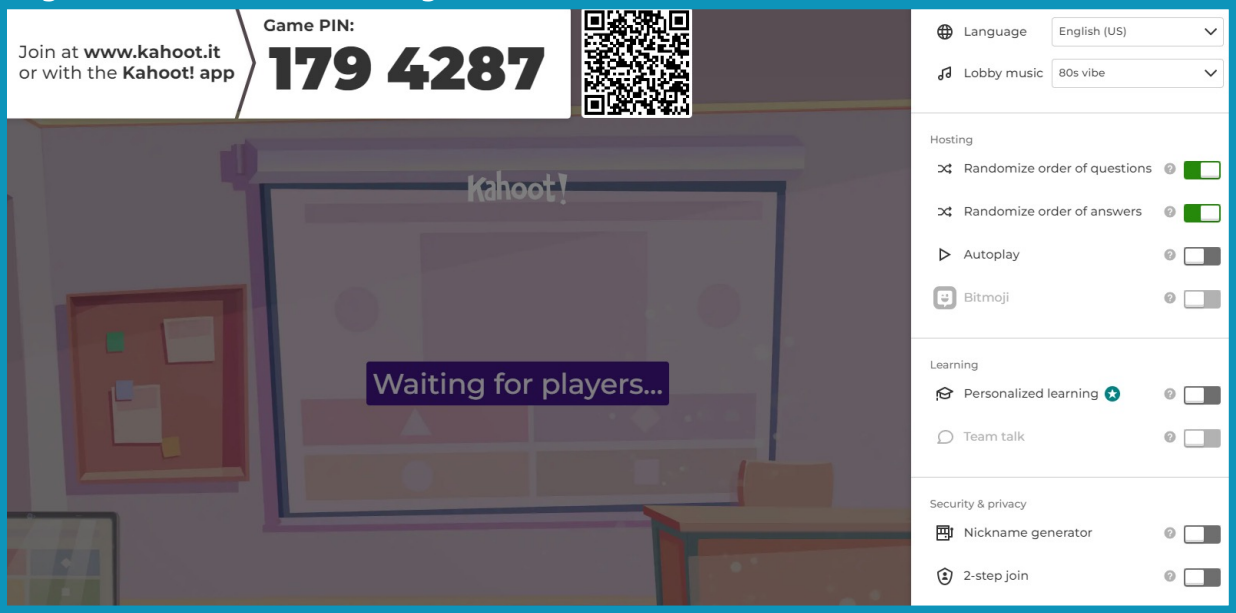
• Kahoot! may be utilized with in-person and online instruction or a hybrid of both, but all participants will need to be live on the system when the activity is conducted.

• If used for the purpose of assessment prep, ensure that the questions are of a similar style and difficulty level as that of the formal assessment and that none are repeat questions from the actual assessment.

• Make sure the choices available are clear and easy to distinguish from each other.

• Set time limits for participants to complete each question to be comparable to the level of effort required to ascertain the correct answer.

Figure 5: In-Game Settings



• Adjust the settings for Kahoot! to randomize the order of questions and answers prior to starting a new game. (See Figure 5)

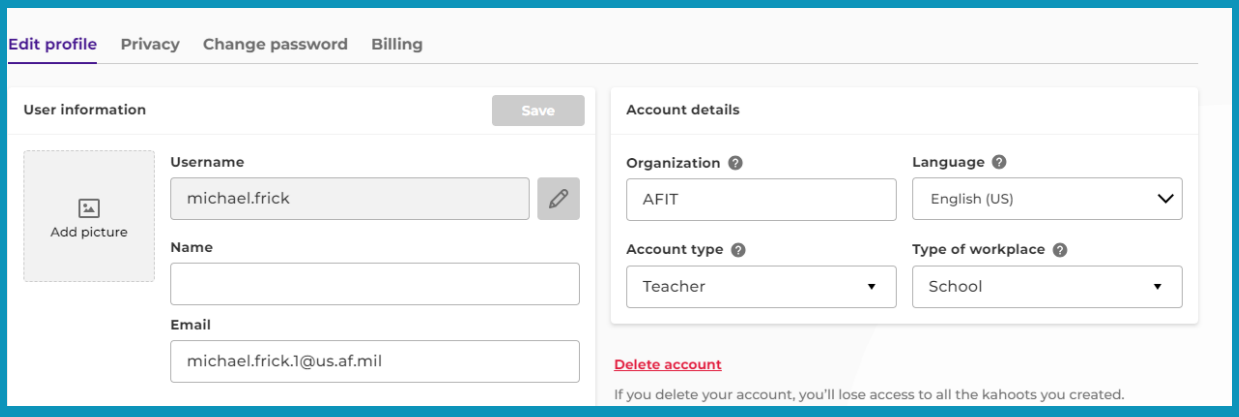
• Explain incorrect answers (selected by the students) after the round is complete.

• Kahoot! Is a free-to-use platform with additional capabilities available for purchase. To enable up to 40 participants on Kahoots created by you, adjust the user profile to indicate the account type is for a teacher working at a school. (See Figure 6)

• The time required to create a Kahoot! Is largely based upon the number of questions developed and the complexity of the answer type.

• Kahoot! Provides a ranking for students after each question's correct response is reveal and the instructor screen will show a current Top 5 "Podium". Students can become competitive amongst their peers which is a terrific motivator for increased learning.

Figure 6: Profile Settings for Teacher Account



Quick Kills: Bingo

Rick Kappel

Estimated Time to Create

60

MINUTES

Estimated Class Time

20-60

MINUTES

Depending on how many games you play

What:

Create a Bingo Activity

Why:

Use a Bingo Board to re-enforce your most important concepts; review for a quiz or test; or just for general student interest and engagement.

Use Case:

The lesson objective was to showcase different hazardous material storage practices (some good, some bad) with inspection pictures. An example is to show a picture of rusty containers (bad example) and talk about how the container needed to be in good shape, not rusted or dented. There were many pictures like this and after a while it gets kind of boring and not engaging for the students, with the instructor doing most of the talking. This situation is a prime area for more student engagement, so the instructor took the 24 most important or interesting pictures and made a brief description of each to put on the bingo boards. There are many free sites that will create bingo boards, such as https://myfreebingocards.com/bingo-card-generator (see Figure 1). The website is very user friendly and a class set of cards could be created in as little as 3 minutes (see Figure 2). This site is just one example. The instructor will need to establish ground rules for the class (like you can only call bingo once a round) and prizes (candy) for the winners (see Figure 3). After conducting the exercise a few times in class I have refined the pictures and clues on the bingo card to make it less confusing. The lesson has been transformed into one of the most engaging parts of the course and the lesson objectives are still met.

Figure 1: Example of Bingo Card Generator Website

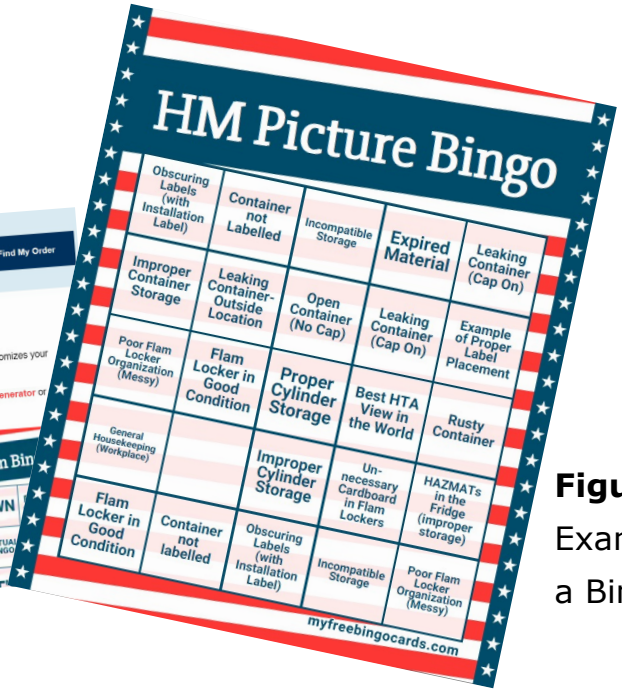
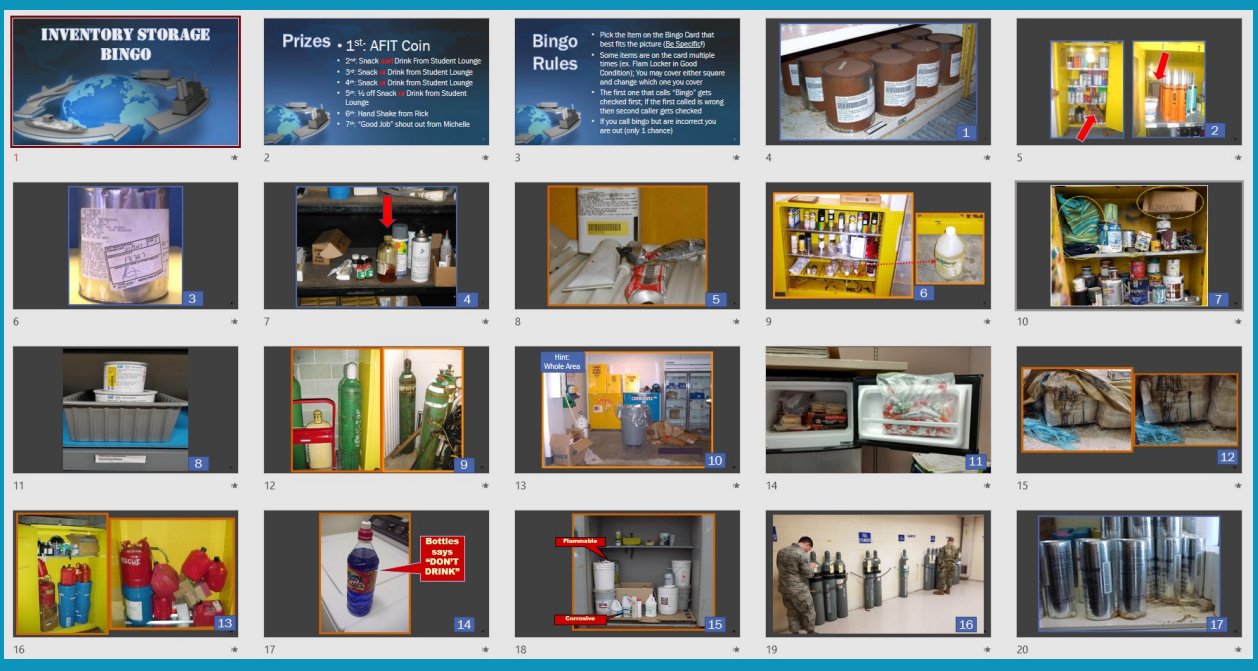


Figure 2: Example of a Bingo Card

How:

1. Start by deciding on a lesson or review you want to transform and make more engaging.
2. Create up to 24 short clues to add to a bingo board.
3. Use a free website to create the boards (see Figure 1).
4. Print the number of unique bingo cards you need (see Figure 2).
5. Optional: laminate cards for re-use
6. Optional: cut paper squares to cover clues (or you can have student tear little squares themselves)
7. Create the items that indicated the bingo clues (I use pictures in my examples; but a sentence or description would also be great to use) (see Figure 3)
8. Come up with ground rules and prizes.
9. Conduct the exercise/review.
10. Analyze the results of the lesson and adjust as needed.

Figure 3: Example of Pictures Students Use to Cover the Bingo Squares



Best Practices:

• Make sure the clues are clear and easy to distinguish from each other

• Make sure the "rules" are clearly stated and the students understand them (example: does four corners win?)

• Have a system to remember the order of clues that have been read (which answers on the board are correct)

• Explain incorrect answers (the students have) after the round is complete.