

# WHITEPAPER: HOW STUDENTS LEARN THROUGH ALTERNATE REALITY COURSES

## Evidence-based Design

**Self-explanation**  
**Low-stakes Testing**

**Prospection**  
**Adaptive Challenges**

**Adaptive Feedback**  
**Multi-model Learning**

**Productive Struggle**

**Trial and Error**

This White Paper is a product of Wharton Interactive. It is a part of a larger effort by Wharton Interactive to provide open access to its instructional and game building methodologies and contribute to interactive teaching and learning practices worldwide.

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# INTRODUCTION

Alternate Reality Courses (ARCs), built on Wharton Interactive's ARC platform, are a new breed of simulations for learning. Every course combines world-class subject matter expertise, interactive fiction, the science of learning, and innovative game design. We aim to deeply engage learners, teach through instruction and experience, and promote robust and enduring knowledge that can be applied beyond the course.

**ARCs teach with three core objectives in mind:**

- **Learning objectives** - skills learners will use in the future
- **Practice objectives** - specific experiences learners will encounter so that when they see them in the real world, they will know what to do
- **Thinking objectives** - mental techniques that are applicable outside of the context of the course

ARCs cut through the theory-practice gap, as learners learn new concepts, practice skills they only read about in other courses, and develop mental techniques they can use beyond the game.

*The Under the Hood* whitepapers explain some of the thinking and science behind the ARC method that Wharton has been developing for close to a decade. This white paper will explore our approach to learning in Alternate Reality Courses through the lens of the Entrepreneurship Game, an ARC in which students work in teams and take on the role of a founding team of a startup and experience the challenges of leading a business to success.

## What the science of learning tells us

ARCs are based on the latest in pedagogy, drawing on evidence that games and simulations offer significant increases in learning outcomes.<sup>i</sup> There are fully automated ARCs that run without instructor support, but are also particularly effective when combined with traditional teaching methods. In ARCs, students learn through experience as their decisions affect the in-game narrative, through adaptive feedback delivered in the interface that allows them to focus on attribution<sup>ii</sup>—what led to my success or failure?—and apply what they learn as they continue to play the game. We reinforce learning objectives throughout, giving learners a chance to practice and reflect on that practice. ARCs are designed to provide learners with scaffolding for every objective, providing timely and useful feedback at multiple points and prompting learners to engage in knowledge building as they make connections between new concepts and their actions in the game.

At its core, ARC learning is reinforced through research-based pedagogical principles.

**The following section will provide an overview of those principles and a deep dive into how we apply them in an Alternate Reality Course.**

# PEDAGOGICAL PRINCIPLE:

## LEARNING OUTCOMES

Learning outcomes are the main ideas that students take away from a course; they define the goals of the course. They provide a framework to build from by revealing key questions of the discipline. Building a course requires working backwards—outlining the course goals and incorporating activities, lectures, and exercises that build towards those goals. This approach is called backward design and entails developing tasks and assignments that will help students develop competencies and provide evidence of learning.

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To design assignments that link to course goals, there are a number of considerations: the subject-matter expertise of students; how much practice specific concepts require - some concepts are relatively simple to master, while others are more challenging; and the degree to which assignments may provide evidence of mastery. To effectively teach complex concepts, learners may need additional practice and exposure to a variety of different exercises. A course goal must show learners how concepts connect, thus helping learners to create a mental model of the subject and allowing for a more robust understanding of content.

Along with a set of goals and specific assignments, defining grading and evaluation criteria is crucial; learners need to know how they can succeed, and they need clarity about how to demonstrate an understanding of the subject. Criteria for success must be linked to learning outcomes.

### APPLICATION TO ARC:

To build an ARC, we consider what learners should know, do, and understand at the end of the course, and we work backward, starting from that future state. We break up the goals of an ARC into three categories:

- Learning objectives — the skills we want learners to learn and use in the future
- Practice objectives — specific experiences learners will encounter so that when they see them in the real world, they will know what to do
- Thinking objectives — mental techniques students learn that are applicable outside of the context of the simulation

We then design and build a storyline, scenarios, and escalating challenges that align instruction, assessment, and resources with our goals. We determine how students can demonstrate understanding through challenges and decisions ahead of time.

# PEDAGOGICAL PRINCIPLE:

## ATTENTION

Capturing and maintaining student attention is the essential task of teaching. It is only when students pay attention to what they learn that they notice key ideas in any lesson or field of study.<sup>iv</sup> However, student attention is limited and requires effort to be activated and maintained. Educational researchers note that to harness attention, instructors must cultivate it deliberately.<sup>v</sup>

Decades of research about creativity and problem solving have shown that we can stretch ourselves and operate beyond our comfort zone when we pay attention and focus. This kind of sustained attention has been called “flow,” and it is the ultimate prize in learning, as creativity researcher Mihaly Csikszentmihalyi reminds us:

*“[The] quality of concentrated attention is what creative individuals mention most often as having set them apart... from their peers. Without this quality, they could not have sustained the hard work.”<sup>vi</sup>*

Attention and active engagement is the critical task of any educator, and it is the first principle of an ARC course.

### APPLICATION TO ARC:

To harness and maintain attention, every ARC leverages interactive fiction to deliver a hyper-immersive world, thus making learning compelling and personal.<sup>vii</sup> The story reveals the key questions learners must grapple with. Stories have the unique ability to harness our attention because we psychologically privilege stories over other forms of information.<sup>viii</sup>

Through the story, learners have the autonomy and agency to make decisions and choose among a number of options to advance and change their story in the game. Learners progress through branching narratives in which their choices lead them to different scenarios and, ultimately, to different endings. By immersing themselves in their roles and committing to their decisions, learners live through a narrative arc in which they are deeply invested.

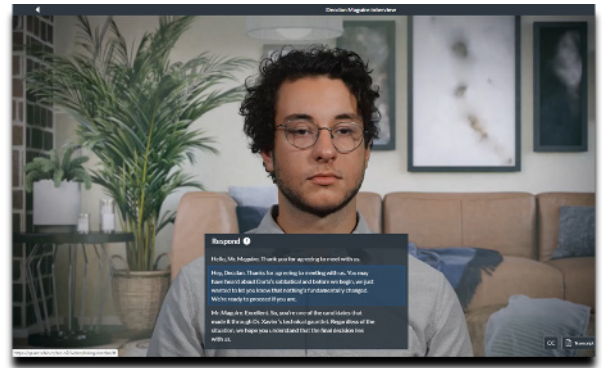


We push the levers of engagement across the ARC experience. Learners want to know what happens next because they live through compelling scenarios that carefully weave the player character (the learner) into the narrative, thus making them a central and integral part of the fictional world. The world building in ARCs is nuanced and multi-dimensional; learners are challenged to move out of their comfort zone and actively explore to gain the critical information required to inform their decision-making.

Like the real world, information gathering in ARC often comes from interacting with interesting characters who challenge and surprise them. By making meaningful choices, learners progress as they rack up a series of wins and losses.

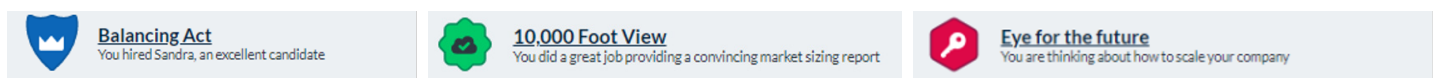
Throughout the ARC, we embed messages from experts, characters who guide learners, and interactive videos that allow learners to speak to characters. These interactive videos promote better learning outcomes; learners pay close attention to the video, and that attention drives learning.<sup>ix</sup>

We use a number of game elements in ARCs to prompt and maintain player engagement and motivation. Learners build a relationship and connection with non-player characters, and in team-based ARCs, learners also connect with their teammates. Learners attain a sense of competence as they achieve mastery, beginning with small wins and progressing to bigger and more consequential decisions.

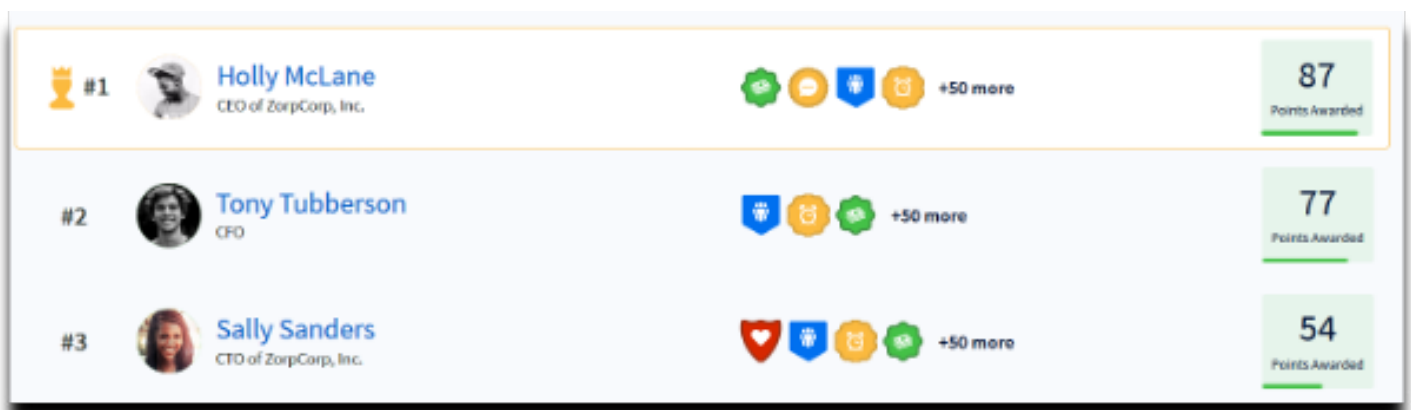


Initial scenarios and choices are fairly straightforward, and learners get a lot of support through those initial choices. But as the game progresses, we increase the stakes so that learners reap the rewards of their initial investment. Learners also have a sense of agency as they make choices throughout the ARC, allowing them to charter their own story.<sup>x</sup>

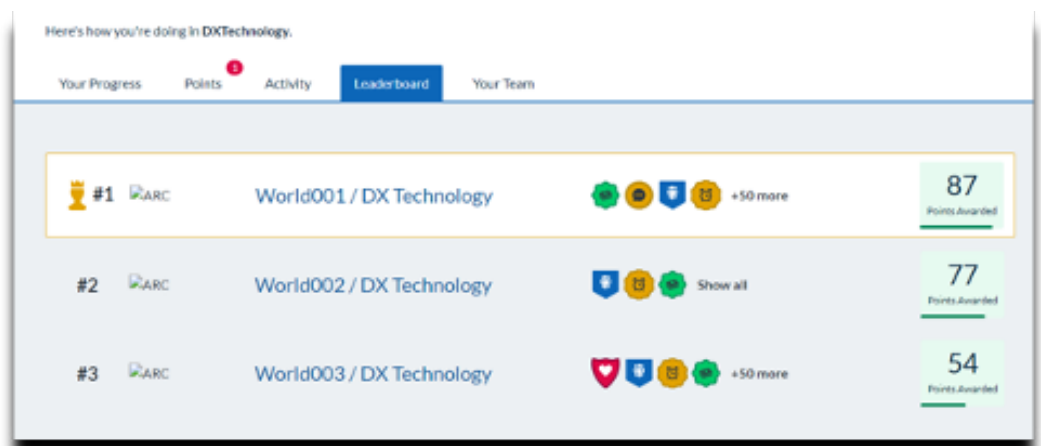
Additional game elements that increase engagement include badges, grades, and leaderboards.<sup>xi</sup> Badges are tokens of achievements that learners get as they progress through the ARC; these mark an end to a scenario or a culminating choice and let learners know how they are doing compared to other learners.



On the leaderboard, learners can see how they rank or stack up against other learners, and in team-based courses, teams can view their progress compared to other teams. This is a powerfully motivating force of social comparison.



Learners who are up to the challenge are also presented with additional, voluntary side quests—these are usually individual challenges that a learner can opt into. Side quests also have a specific learning objective, a narrative component, and a reward for completion. Learners who complete side quests are rewarded with achievements and public acknowledgment for successful completion.



All of these game elements serve a dual purpose: to immerse the learner in the game so that learning is deeply engaging<sup>xii</sup> and to focus the learners' attention on important concepts, harnessing the power of games as drivers of learning.

# PEDAGOGICAL PRINCIPLE:

## VERISIMILITUDE

Simulations are valuable because they give learners a chance to experience a situation in a safe place to fail and repeatedly practice skills that are rarely encountered in the real world (e.g., landing a plane in an emergency, managing a team in a crisis, pitching a critical stakeholder). Simulations have been proven to be extremely effective and improve real-life outcomes for everyone, from doctors to truck drivers. <sup>xiii</sup>

At the same time, the sense of realism in a simulation — its verisimilitude — must be adjusted depending on when learners are performing a realistically rendered task in the simulation or one which serves as a less realistic plot or story point. Appropriate levels of verisimilitude allow learners to practice realistic skills while abstracting out the lessons from the parts of the simulation that have lower levels of accuracy. <sup>xiv</sup>

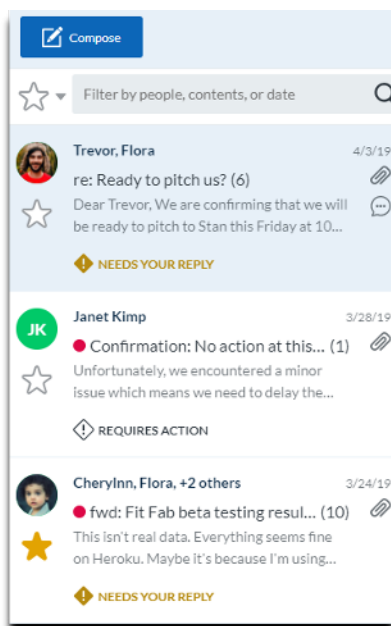
### APPLICATION TO ARC:

ARCs are designed to maintain appropriate levels of verisimilitude. In developing the narrative, the challenges, and the characters, we ensure that the elements that support the learning or practice objectives remain realistic, while other elements that serve other goals of the game (fun and engagement) can be far less realistic.

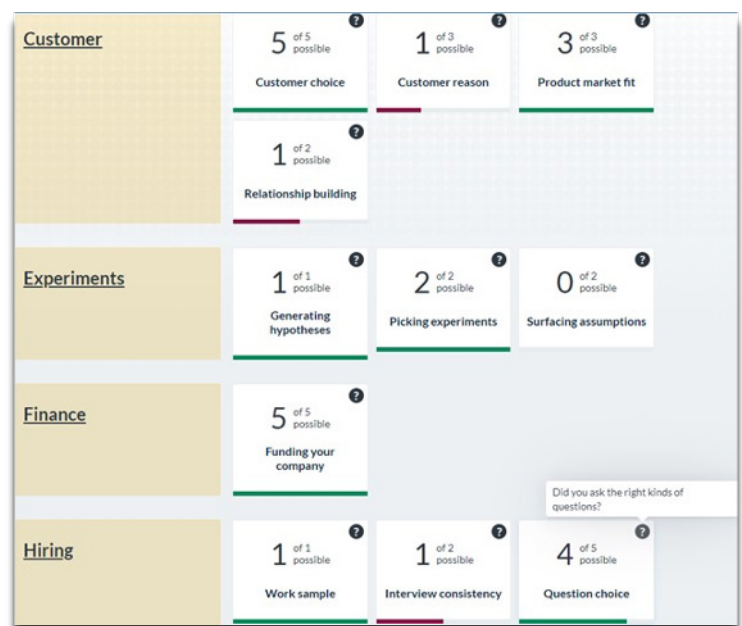
ARC interfaces are designed to mimic real-life office tools — such as presentation software, realistic data dashboards, an email interface, and Excel. We also focus on world-building or creating real-world assets to enhance a sense of reality for learners. In the Entrepreneurship Game, for instance, companies featured have external websites, and characters have social media profiles, citations, and LinkedIn accounts. Interactive interviews with actors, deep financial modeling, and carefully designed scenarios heighten the sense of realism and make practice in the game applicable to real-world situations.

At the same time, more artificial elements of the experience, such as scoreboards and grading, are purposely set apart from the more realistic material. By setting clear differences between the ARC experience elements that are high verisimilitude from those that serve other purposes, we maintain learner immersion without the danger of learners picking up the wrong skills. For instance, the email interface is designed to mimic real life, while the grades and feedback are part of the course.

### EMAIL INTERFACE



### GRADES AND FEEDBACK



# PEDAGOGICAL PRINCIPLE:

## ACTIONABLE FEEDBACK

Studies show that when learners receive timely, clear, and detailed feedback, their performance outcomes increase.<sup>xv</sup> Clear feedback meets learners at the right level; learners must understand the feedback to use it. Feedback must be timed so that learners can use it to improve during a course and while the content is still fresh in their minds. And it must be detailed to provide learners with enough specifics to understand exactly where they went wrong and how to correct their mistakes.<sup>xvi</sup>

Effective feedback should answer three key questions: *How did I do? What should I have done? What should I do next?*<sup>xvii</sup> This is known as **informative feedback**, and it points out a discrepancy between what the learners did and what the learners should do in the future. This is different from **reinforcement feedback**, a commonly deployed method that only rewards learners for good performance and penalizes them for poor performance.<sup>xviii</sup> Informative or actionable feedback aims to help learners do better the next time a similar situation comes up — it addresses a future state.

Feedback should be constructed around clear goals. When learners are presented with clear goals and assessment criteria (what does success look like?) and when they believe that they can succeed, they can accept and integrate feedback and tackle more challenging tasks. Ongoing feedback can also promote self-regulation; learners can develop strategies (such as metacognitive monitoring) to detect errors so that they can solve problems on their own.<sup>xix</sup>

Feedback, however, should not be limited to errors. Learners should receive feedback even for correct answers; as long as knowledge isn't perfectly consolidated, feedback helps improve performance, especially in the long run.<sup>xx</sup>

### APPLICATION TO ARC:

In ARCs, learners get feedback in multiple ways that support course goals through:

- **Feedback messages and achievements appear after every major decision.** Feedback is adapted to the individual learner for individual decisions, and teams for team decisions. ARC's feedback is multi-faceted, and every piece reinforces the learning objectives and reminds learners of what they learned and what they should do next. Learners receive feedback after every significant choice, and that feedback addresses decisions and looks to the future, letting learners know how they can course-correct. Learners receive feedback even if they made the right decision – ensuring that learners understand the ramification of their choices and underscoring significant concepts. Feedback is also cumulative and refers back to previous events and previous decisions, letting learners know that every choice is meaningful and that they have many opportunities to improve.

Feedback addresses in-course progress and beyond-course applications. For instance, we have developed learner takeaways. These takeaways address core elements in the ARC about every major concept and give learners insight into how to apply what they have learned beyond the experience.

**Wharton INTERACTIVE**  
Beyond the Game: Experimentation

We are often optimistic that our view of the world and our product or idea will appeal to everyone. But it's often the case that we base our thinking on assumptions that are unproven and untested. As you learned, testing your idea or product is a critical step in an organization's journey.

But research has increasingly shown that running experiments that *right* way is also critical to the success of any venture. The most successful approach requires:

- surfacing assumptions
- generating a hypothesis based on those assumptions that is testable and falsifiable
- running an experiment to test that hypothesis. That experiment will show you whether you should persist or pivot and try something new.

In the game, you had the chance to run an experiment. You had to develop assumptions, build a hypothesis, and conduct an experiment. But there are some steps and issues that didn't come up in the game and we want to help fill in the gaps.

**Here are a few things to think about as you determine which experiments to run:**

**Assumptions and hypothesis**

You conduct experiments in order to lower your uncertainty about critical assumptions. Ahead of these, you need to figure out the sources of uncertainty in your business. This can be a challenge but looking for unspoken assumptions is critical to success. The point is to be able to understand what needs to be true about the world for your business idea to work, and how well you understand the factors associated with your idea's success. There is usually a large list of these potential assumptions that you will need to narrow down to a small set of key issues.

Then you need to generate hypotheses. These hypotheses need to test at least one of the key assumptions you surfaced; they need to be falsifiable, and they need to be testable. Testable means that you get an answer in a reasonable period of time whether your hypothesis is right or wrong. If your hypothesis requires you to build your full product and launch into the world, that's not testable. If your hypothesis says 80 percent

**Wharton INTERACTIVE**  
Beyond the Game: Your Leadership Journey

As you learned, even successful teams can experience some common team pitfalls, such as uneven engagement or inconsistent information sharing. Despite the focus on collaboration in the workplace, a 2020 Gallup report found that only 4 in 10 employees felt that they have opportunities to learn and grow, only 3 in 10 employees felt that their opinions counted at work, and only 23% of employees feel engaged at work. Today's workplace needs leaders like you. Researchers have found that organizations and teams that perform well have a few things in common: a supportive environment, processes to promote learning (including open rotation, sharing and experimentation), and leadership that reinforces psychological safety. We wanted to share some details about the science behind successful teamwork so that you can continue on your personal leadership journey beyond the game.

You can help create a psychologically safe environment, promote learning, and keep team members engaged. Here is how:

**Ask Questions**

Admitting that you don't know something when you're in a leadership position sends a powerful signal. Researchers note that because we tend to do a lot of talking and not a lot of asking, we often share our expertise but rarely admit to not knowing something. They advocate for humble inquiry: leaders should show they don't know everything, and ask genuine open-ended questions. Leaders who ask open-ended questions prompt others to voice their opinion and model a norm: no one person has all the answers; to succeed, everyone needs to feel that they can contribute. To reinforce learning, admit to not knowing something, ask others to share their expertise, and reward this same behavior when you see it. Your team will follow your lead. Your role as a leader asks questions and acknowledge gaps in your knowledge.

**Give people the benefit of the doubt**

Researchers have shown that for people to engage and make an effort, they need to feel supported and capable. In psychologically safe environments, people aren't held back by fear of failure. The environment pushes them by trying something new and learn from their mistakes. While it may be tempting to judge team members based on successes or failures, trying something new is okay. And fear inhibits learning. Promoting an environment in which team members feel that they can try and perhaps fail but that

**Wharton INTERACTIVE**  
Interview Feedback

Interviews are usually a part of a job search, but research shows that, if done incorrectly, they can backfire. In fact, just talking to candidates without a plan results in worse hires than not interviewing at all!

Interviewing well requires you to:

- Identify key skills you want employees to have. This was already done for you; you knew you had to examine two different behaviors – the ability to build a team and the ability to handle ambiguity.
- Ask the right questions to test these skills. Most interview questions are not useful. Asking people to solve puzzles, for example, seems like it should help you identify good candidates, but does not actually work. Questions that ask people for their opinions are not usually useful; research shows that an interviewer will value only the opinions they share. Finally, avoid commonly used questions such as "what's your biggest weakness" – it is unlikely that you will learn the truth through these questions, and if you haven't specifically designed them for your interview process, they probably won't be useful.

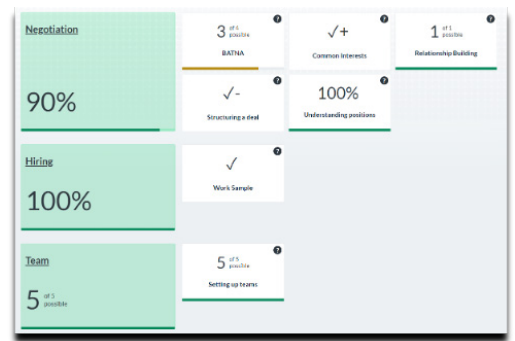
You should focus on:

- Pass** (marked with a red X)
- Learn** (marked with a red X)
- Standard questions** (marked with a red X)

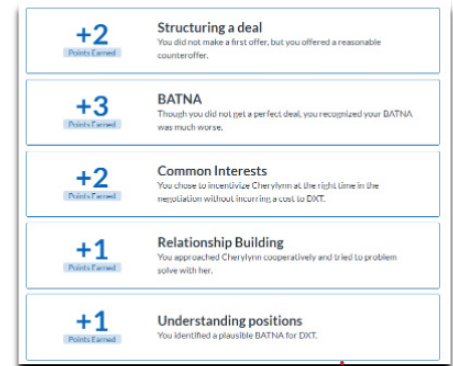
Asking behavioral questions that focus on past performance. Questions that zero in on past performance can help you predict a candidate's future performance – studies show that the best predictor of future performance is past performance. For instance, asking a candidate about how they led a team and how they handled conflict in a team allows them to showcase the skills you are looking for. (You can also ask hypothetical questions – these are "what would you do if" questions that probe a candidate's potential responses to a problem they may face on the job but these were not an option in your interview.)



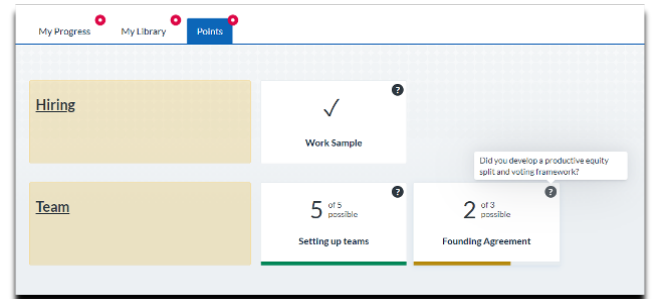
- **Grades.** We use grades in ARCs to let learners track their progress and underscore key concepts and the connections between concepts. Learners are graded on individual and team performance. Grades are coupled with feedback and a clear explanation for each grade or point so that learners can zoom into individual grades and zoom out to track their overall course progress.



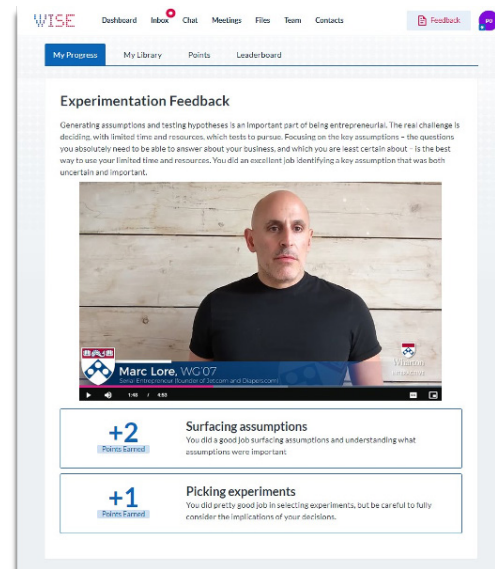
- **Story consequences.** Learners receive behavior-based feedback. Game progress requires that learners make decisions, and every decision involves tradeoffs. What happens next in the story for individuals and teams depends on learners' decisions. And learners have to live with those decisions. Just like in real life, decisions have consequences and can alter the course of events. However, unlike real life, the ARC pushes learners to explore and learn from their choices.



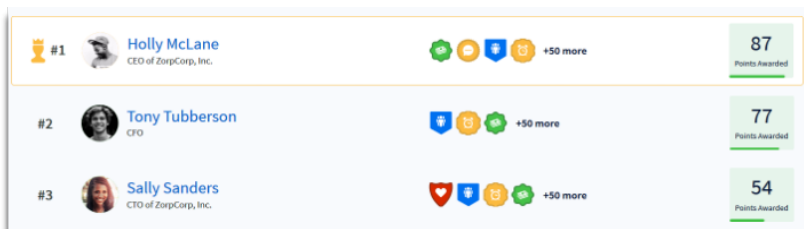
- **360 personalized reviews.** Learners receive individualized feedback designed to help them improve, including a self-assessment and an assessment by team members that provides learners with insight into their skills and practical, evidence-based advice for improving performance. This includes feedback on engagement and psychological safety. We track engagement across a number of variables in the game, and learners can ask game characters for help. We also offer struggling learners help. In the Entrepreneurship Game, a team dynamics (coach) character helps learners build and maintain team cohesion and is available to help teams with specific issues.



- **A personal knowledge library.** The My Library section of the course is a learner's personal library during and after the ARC. The library includes significant feedback, takeaways, faculty lecture videos about specific game topics, expert videos, and additional material. This library serves as a reminder to the learner of what they learned in the course and is updated periodically, notifying learners of new findings and reinforcing key course concepts.



- **Competitive feedback.** Many ARCs are designed to encourage friendly competition; social comparison is a motivating factor and enhances the learners' natural tendency to compare themselves to others.<sup>xxi</sup> Learners can evaluate their performance as compared to other teams.



# PEDAGOGICAL PRINCIPLE:

## SCAFFOLDING

A key element of an effective teaching practice is scaffolding — the practice of supporting students until they can begin to practice on their own, reducing that support and then removing it entirely.<sup>xxii</sup> Effective scaffolding provides learners with support that fades over time as learners gain mastery of the material. The gap between what learners can do on their own and what they can do with support is called the **zone of proximal development**. Effective scaffolding helps learners bridge that gap.<sup>xxiii</sup>

Scaffolding helps learners develop complex skills so that there is initial high task support moving towards no task support.<sup>xxiv</sup>

High task support includes direct instruction, including giving learners directions, modeling activities, and showing learners how to solve problems; reduced support might include guided instructions and feedback; no support may include testing or simply allowing learners to solve problems or tackle material on their own. When scaffolding is effective, learners progress through these phases, and at every turn, they get actionable feedback to help them reach instructional goals.

Educational scholars note that scaffolding makes complex tasks accessible and manageable and consider scaffolding to be a kind of **cognitive apprenticeship** that involves instructor coaching, guiding, and task structuring. In addition, scaffolds direct learner attention to learning goals and prompt them to reflect on their progress.<sup>xxv</sup>

### APPLICATION TO ARC:

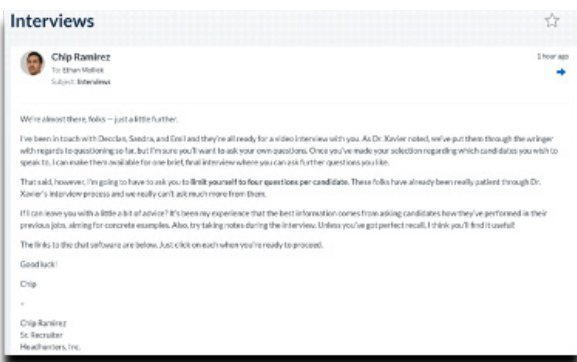
ARC games begin by defining the learning, practice, and thinking objectives for a storyline. Drawing from these goals, the game narrative is architected to scaffold learners: in the first (instruction) phase, learners receive a lot of support and can make mistakes without serious consequences; in the second (practice) phase, learners get a chance to practice what they have learned with some support; and finally, in the third (testing) phase, learner use what they learned and make consequential decisions.

We design deliberate scaffolding across our key concepts, supporting learners as they learn new material, prompting them to try something new, and testing them on their newly acquired skills. We begin by giving learners direct instruction from various characters in the course, along with documents and instructional videos. In this phase, we ask learners to make decisions based on what they learned, but we scaffold those decisions – learners can't go wrong yet.

We also provide feedback that addresses learner decisions, which looks to the future (what key lessons should learners be paying attention to?). Next, we move learners to the reduced support phase and push them to practice what they learned. At this stage, learners make decisions and get feedback about those decisions. Finally, learners are tested as they make a consequential decision that requires them to harness what they have learned through the support loop. Below is an example of one such loop:

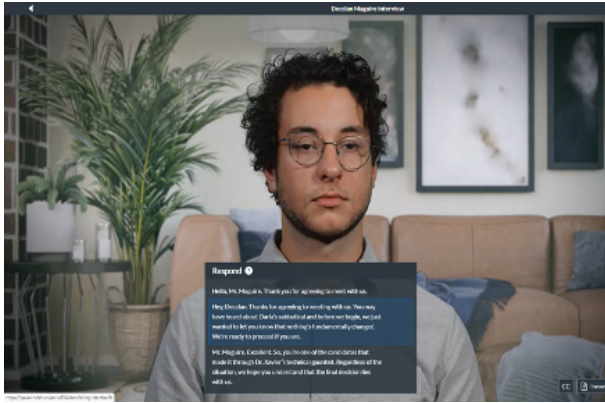
#### 1. The Instruction Phase (lots of scaffolding)

In this scenario, learners get direct instructions from a character in the game and videos from experts in the field. The stakes of the decisions are low, and learners cannot make consequential mistakes as they make an initial, guided decision.



## 2. The Practice Phase (some scaffolding)

In this scenario, learners make a more significant decision and receive feedback. They can ask for extra help from game characters, and those characters will prevent learners from making any significant mistakes that might affect their outcomes. Learners receive feedback on those decisions, and concepts learned previously are reinforced. The feedback that learners receive is bi-directional: it addresses their decisions (what they did right or wrong) and is future-focused (how to use what they have learned later in the course).



## 3. The Testing Phase (scaffolding removed):

In this scenario, learners are tested. At this point, they have been introduced to a topic, have practiced what they learned, and have received feedback about their choices. In this stage of the loop, there are real consequences for learner decisions, and those decisions can alter the course of the narrative and change the course's outcome. After this testing phase, learners receive summative feedback, addressing this latest choice and their previous choices, giving them insight into their progress and advice for the next phase of the course.

# PEDAGOGICAL PRINCIPLE:

## TEAMWORK

Teamwork is not only critical to real-life work experiences, it is also an effective and powerful way to learn. <sup>xxvi</sup> Studies show that classes with higher levels of student interactions and teamwork perform better <sup>xxvii</sup> and lead to happier students. <sup>xxviii</sup> As students collaborate, they practice working with a team and encountering complicated team dynamics that push them to learn to work with others in service of a collective goal — these are skills that are particularly relevant to the workplace. Teamwork in a school setting or a simulated environment is a dry run for teamwork in the workplace. <sup>xix</sup> When students work in teams, each students' success is tightly linked to the success of the team. <sup>xxx</sup>

However, student teams can also be a source of frustration. Teams with uneven workloads or abilities can lead to arguments and undermine learning. Successful teamwork involves both action (performance) and reflection. Teams that learn to question their assumptions, take turns listening and speaking, and focus on building a psychologically safe environment will outperform teams who do not.

Team dynamics are complicated, but collaboration is a skill worth practicing.

### APPLICATION TO ARC:

ARCs frequently include team components, and we take the science and art of teaching teamwork skills seriously, ensuring that teams are both productive and satisfied. We encourage teams to create a social contract. We reinforce that social contract by setting the stage ahead of a course, letting learners know that they should support one another.

**What we expect from you:**

**You'll need to actively work with your team.** This is a team-based simulation. Playing in teams of 4-6, you and your team will be competing against other teams; to do well and learn all you can, you will need to support your teammates and you'll need their support as well. A key skill to practice in the game is your ability to work well with a team and navigate common team pitfalls. You will get support to make your team successful and to ensure an optimal learning experience.

**You need to commit to 6 synchronous sessions with your team over a 3-week period.** The simulation is designed around 6 synchronous periods; that means there will be a lot to do during these periods. **Every team member is required to be online at the same time during these sessions.** Think about your schedule ahead of time so that you can be present for every period.

**You need to commit to working with your team outside of the simulation.** There will be a lot of information coming at you during the synchronous periods. But to do well in the game, you'll need to put in some time outside of those sessions. For instance, there will be instructional videos by Wharton faculty that will pop up during asynchronous periods, and watching these will help you improve and make good decisions in the simulation.

Welcome to the simulation.

**You need to create a social contract with your team**

Wharton

1:26 / 2:42

Team members are asked to set up team meetings, allocate roles, and consider how to create accountability while maintaining a psychologically safe environment. We grade both teams and individuals so that learners know that they are responsible for both personal and team performance. We also provide in-game coaching via a team dynamics (coach) character. Teams can reach out to the coach for help for a variety of common team pitfalls, such as social loafing or relationship conflict. And because we track engagement and performance across the experience, when we detect uneven performance or a drop in team performance, the coach character reaches out to the team and offers advice based on specific issues.

Our focus on teamwork includes teaching teams how to conduct effective after-action reviews to reflect on their performance during the ARC and plan ahead. Our aim in teaching this process is two-fold: we want to encourage teams to learn from their mistakes and teach learners how to conduct effective after-action reviews.

ARCs also look to promote a learning orientation for individual learners and teams. We reward learners for learning, and we reward teams for taking advantage of opportunities to improve —through grades, feedback, and achievements. We view teamwork as integral to ARCs and prompt learners to focus on their teamwork skills so that the practice they get in the course can serve them outside of the course.

# PEDAGOGICAL PRINCIPLE:

## RETRIEVAL PRACTICE

What we learn does not stay intact; instead, as time passes, we forget much of what we know. This is called the forgetting curve (aptly demonstrated by German psychologist Hermann Ebbinghaus), and the only counter to that **forgetting curve** is an active reconstruction of knowledge. Simply put: the brain remembers what it practices. <sup>xxxix</sup>

For decades researchers believed that the mind was a storehouse of information and that memory was akin to taking a picture — we store the picture (information) and surface it again when we need it. But research about systemic errors made in knowledge retrieval has produced a different paradigm — we reconstruct knowledge every time we retrieve it, intertwining what we know with new details and information. The act of retrieval changes what we know. <sup>xxxix</sup>

Reconstruction is a powerful driver of learning. Rehearsing or retrieving what you know produces long-term knowledge. Every time we retrieve information and use it in a new context, that information becomes easier to retrieve.

When students retrieve information, they recall what they learned. <sup>xxxix</sup> That retrieval of information makes them more likely to remember it in future. The process of retrieving information is also informative — students gain perspective about what they know and what they don't know. <sup>xxxix</sup>

Retrieval has a potentiating effect — when asked to rehearse or recall information, we anticipate that we may need the knowledge in the future. <sup>xxxix</sup>

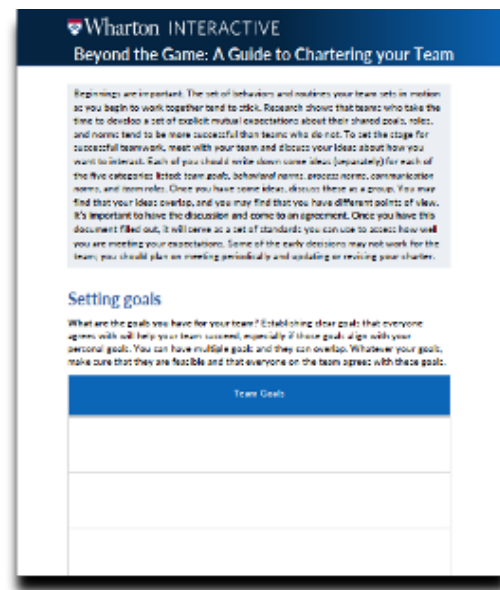
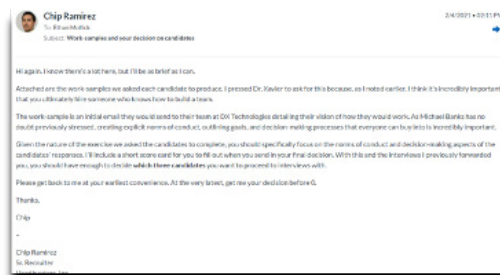
But we can't just rehearse or retrieve something once. Spacing out multiple retrieval practice events (also called **spaced repetition**) helps us remember what we learned. <sup>xxxix</sup> Studies show that students who periodically rehearsed what they learned significantly outperformed students who crammed or engaged in massed practice. <sup>xxxix</sup> Retrieval practice requires effort, but that effort pays off.

### APPLICATION TO ARC:

We integrate spaced retrieval practice in our experiences so that learners have a chance to use what they learned multiple times, making it more likely that they will remember course concepts. ARCs are expansive environments. The courses cue up knowledge; key themes surface and resurface throughout the course in different scenarios so that students have to recall what they learned and use it in a new scenario or context. For instance, in a scenario in the Entrepreneurship Game, learners are introduced to work samples that ask candidates to discuss their goals and decision-making framework for their potential employees. Learners must evaluate those work samples using a grading key with this criteria in mind. Later in the game, learners are asked to produce a team charter, outlining team goals and decision-making processes. In producing this team charter, learners recall what they learned through the work sample exercise — a retrieval practice opportunity.

To succeed, learners have to decide how to proceed based on what they know (adapting what they learned to a new situation). The retrieval practice in this new scenario helps learners use new knowledge — learners view concepts in two different contexts.

Challenges are interleaved and spaced so that learners have to work hard to retrieve what they learned, abstracting out underlying concepts and applying what they learned to this new scenario. <sup>xxxix</sup> By spacing out the exercise and interleaving the topic with a number of other topics, learners will have had a chance to forget some of what they learned, making this retrieval of information more difficult and therefore impactful.



# PEDAGOGICAL PRINCIPLE:

## ADAPTIVE CHALLENGES

There is value in struggle. When learners face and overcome hard but not insurmountable challenges, they are more likely to retain what they learn and are motivated to keep learning. Studies show that creating challenges that push learners out of their comfort zone supports long-term retention. <sup>xxxix</sup>

The key is to create adaptive challenges so that learners can rack up small, motivating wins as they learn. Challenges shouldn't be too easy, or students may disengage; they shouldn't be too hard, or students may give up. Struggle must be carefully calibrated and coupled with timely feedback. It's important to offer support or scaffolding for learners who need it and additional challenges for learners who can tackle more demanding work. The goal is to reach and maintain a flow state, an optimal experience that seems effortless yet highly focused and stretches the learner's capacity. In a state of flow, learners' abilities match the opportunities for action. <sup>xl</sup>

### APPLICATION TO ARC:

ARCs are designed with a serious goal in mind: helping learners to gain and retain knowledge. We push students out of their comfort zone and guide them through increasingly difficult challenges so that the knowledge they build is knowledge they can draw on when they need it. We create an adaptive narrative that adapts to challenge every learner, motivating learners with small, incremental wins that immerse them in the game. Some learners require extra help and support, while other learners need more complex challenges. ARCs track learner progress throughout and offers support or additional challenges, coupling both with personalized feedback.

# PEDAGOGICAL PRINCIPLE:

## METACOGNITION

Metacognitive skills are an interrelated set of competencies that include critical thinking, evaluation, planning, judgment, problem-solving, and decision making. Learners with metacognitive skills have been shown to be better decision-makers, critical thinkers, and possess the ability to handle complexity.<sup>xii</sup> Metacognitive skills can involve actively making sense of the past (*what happened and why?*) and planning for the future (*what should I do in the future, given what I know?*).

Learning from experience requires metacognition—a learner must consolidate the experience into a set of principles or approaches for the future.<sup>xiii</sup> Metacognition involves multiple types of complex thinking, combining opposing approaches: abstract thinking (noticing patterns and underlying principles), concrete thinking (vividly recalling details), self-immersed thinking (remembering how one felt), and self-distanced thinking (integrating the experience within a long-term personal narrative). Learners need to balance all four modes of thinking to make sense of an experience and focus on the broader context.

A common and effective way to prompt learners to engage in metacognition is to encourage them to engage in “mental time travel”<sup>xiii</sup> - to reflectively consider past events and prospectively consider future plans.<sup>xiv</sup> Studies show that taking time to articulate and codify an experience increases performance.<sup>xv</sup> Metacognitive exercises ask learners to make sense of an experience and plan ahead to use what they learned fluidly and creatively in new contexts.

### APPLICATION TO ARC:

Converging evidence from cognitive psychology, neuroscience, and educational research shows that to learn, we have to create a mental model of the world that helps us make predictions, even at the risk of making a mistake — *what should I do next given what I know?*<sup>xvi</sup> To create that mental model, we have to pay attention and actively engage with the material.<sup>xvii</sup> Part of that engagement is prompting learners to think about their actions during the ARC.

We include metacognitive exercises in our experiences so that learners must make sense of past challenges and decisions and plan ahead. Metacognitive exercises prompt learners to examine both their successes (*how much of my success was due to luck or skill?*) and their mistakes (*what could I have done differently?*). At a variety of inflection points in an ARC, we prompt metacognitive thinking in both team and individual settings.

We ask learners to reflect on their past decisions, consider what happened and why, and think about how they want to tackle challenges in the next phase of the experience. This is a way for learners to take some time to generalize critical lessons, take a “fly on the wall” approach, understand their missteps, and recognize their successes. The exercises serve two purposes: learners get a chance to course-correct, and they consider what they have learned and how they can use that knowledge outside of the current context.

The experience is built around interweaving scenarios that require learners to switch contexts. Switching up context prompts learners to abstract out underlying principles and engage in metacognition. Learners must assess how the concepts they learned previously connect to a new situation within the narrative.

In team-based ARCs, we ask teams to conduct planning sessions and after action reviews. These reviews ask the team to consider their decisions and think about how they want to approach future decisions. The exercise gives teams a chance to reflect on what happened and discuss team dynamics and goals. Importantly, teams who engage in this exercise can change what happens in the experience—struggling teams can improve, and successful teams can improve on their performance. Examining the past can give teams insight into what should happen in the future.

# PEDAGOGICAL PRINCIPLE:

## THE DEBRIEF

### Making Sense of What Happened and Planning Ahead

The debrief is the bridge between an experience, game, or simulation and real life. While there are a variety of models of debriefing, the nature of the debrief depends on the experience itself. The notion of a debrief stems from the military, who deploy the post-simulation or post-mission debrief so that learners can glean lessons from their experience and improve performance in the field. After simulations or missions, soldiers review their performance and identify potential improvements.<sup>xlviii</sup>

Debriefing is standard practice across a variety of fields—from medical to military to business simulations. Debriefing usually takes place after an experience and is generally run by a subject-matter expert. The process serves to create a shared mental model of what happened, discuss what needs to change, and address plans for the future.

Different experiences and varying class contexts require different kinds of debriefs. In classrooms, following a simulation, debriefs can create a common ground for learners to discuss their experience.<sup>xlix</sup> Learners take time to understand how they think about the experience, hear other points of view, unpack their successes and mistakes, and pinpoint newly discovered competencies. During a debrief, the instructor can encourage learners to reflect, describe, and analyze what happened and recognize meaningful connections between the experience and the real world.<sup>1</sup> The debrief should serve as a retrospective and prospective exercise—learners can examine past events to understand how to apply what they learned in new contexts.

#### APPLICATION TO ARC:

Throughout ARCs, learners face carefully designed challenges. At the end of the course, learners receive an epilogue or a conclusion to the story, placing their decisions into a broader context and giving learners perspective. The debrief or post-course discussion is a key component of every ARC. It is a time to reflect on what happened, create common ground, reinforce key ideas, and think beyond the boundaries of the experience. Learners will have received their takeaways, which connect what they learned in the course to the real world. These are a preamble to the debrief.

The debrief should prompt learners to think about how each decision they made impacted their progress and affected what happened next in the course. It should also connect player decisions within the course context to major concepts and real-world scenarios. Learners should be invited to discuss how they can apply lessons learned to the real world.

The nature of the debrief depends on the specific ARC and instructor preference. Some ARCs place learners in realistic scenarios, and the debrief discussion will vary depending on whether learners have previously practiced a particular skill. Some ARCs test how well learners can apply what they have learned previously, and the debrief may focus on why and how learners applied what they knew. Some ARCs may place learners in an unfamiliar environment; the debrief can connect the lessons of the course to the real world, revealing that the learners' challenges are the same as those faced by organizations in the real world.

ARC debriefs can vary depending on the course, the nature of a particular class, and the instructor's goals for their class. The ARC platform allows for automatic processing and reporting of learner decisions during and across the course. We provide summaries of group dynamics and individual efforts, and whole-class performance in the course, giving the instructor a lot of information to share and unpack during the debrief. Instructors can guide a discussion around team and individual experiences, creating revelatory moments. Learners have similar but not identical experiences in the course, making for a rich discussion of choices, consequences, and core concepts. Instructors can prompt learners to make sense of the experience retrospectively and lead the class in a discussion of how core course concepts connect to the real world.



# THE ROLE OF THE INSTRUCTOR

There are several ways to incorporate ARCs into a class and each offers you flexibility in terms of workload. Typically an ARC game is entirely self-contained and can be used as a self-running experience. Everything your students need is contained in the ARC - assessment, adaptive feedback, additional information, and instructional videos. To run a game with a hands-off approach, you only need to configure the timing and simply let the game run.

For a more hands-on approach, there are a few ways to get more involved:

**You can run your own discussion or debrief at the end of a game and intervene and coach students who need help.** You can adopt a laissez-faire approach (ARCs generally have built-in coaching and feedback) or adopt a hands-on approach and, based on insight gleaned from Reports, coach students during the experience.

In terms of your debrief, there are many discussion pastures that you can explore at the end of every ARC. Because students have gone through the same experience, you can have a rich conversation based on those experiences. To illuminate student experience, you incorporate data from an ARC about student performance and illustrate this in your debrief.

**You can externally grade materials that might inform the grade for the class.** In many ARCs, students receive a number of essay prompts. You can let students know that you'll be grading these separately and assess student progress. You can also include additional post-Game assignments that help assess and reinforce concepts learned in the game. How involved you want to be is up to you.

# CONCLUSION

ARCs represent a new form of instruction, but they are built by drawing on established pedagogical science. ARC uses the "all of the above" approach to maximize effectiveness, combining multiple proven methods for aiding learning and retention in a single course. As we conduct further research into ARC's effectiveness, we will incorporate new techniques and insights and share what we learn with the educational community. All indications, however, show ARC to be an effective and engaging method of teaching.

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