The Seven Circumstances of Game-Based Learning (a Worked Example and an Invitation)

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Abstract

In this worked example, I propose a framework for characterizing the learning that occurs in particular uses of a game for educational purposes. The framework is based upon the ancient Greek rhetorical structure that evolved into the "five W's" of modern journalism (who, what, when, where, why—the Greeks also had "how" and "with what"). This framework is just one (worked) example of how we might achieve the larger aim of this proposal, which is to encourage game designers and researchers to be explicit about the theories of learning, goals, and contexts that undergird their designs or analyses, which might help the field of game-based learning research to develop a common language and facilitate exploration of the many regions of what I consider a high-dimensional space. In this example I describe the seven circumstances of game-based learning and offer examples of how we might locate particular games within this space.

The Seven Circumstances

The claim that "games are good for learning" is hopelessly vague. Game designers know that there is neither a universally representative game nor a universally representative gamer, and educational researchers know that there is neither a monolithic construct called learning nor a single target learner (Klopfer, Osterweil, & Salen, 2009). Instead, there are taxonomies, matrices, dimensions, categories, genres, styles—of games, of gamers, of learners, and of learning. One simple and potentially useful structure for thinking about the many different ways games can be used for learning is that of the seven circumstances of a rhetorical hypothesis. This structure, developed by the ancient Greeks (and the ancestor of the five W's of journalism), consists of the following questions: who, what, when, where, why, in what way (i.e., how), and by what means (i.e., with what) (Robertson, 1946). For the purposes of structuring the space of game-based learning, we can formulate those seven questions as follows:

Who is the learner?

This question refers not only to demographic features of the learner (e.g., age, gender, cultures) but also his or her prior experiences in the learning domain (prior exposure, self-concept, etc.).

What is being learned?

This question refers both to the curricular content of the game—e.g., mathematics or social studies—and also to the nature of that content: is the game intended to reinforce low-level procedural skills, to encourage a certain type of thinking, or perhaps to instill a particular set of values? (The question of what is being learned also depends strongly upon the theory or theories of learning underpinning the game's educational use. For example, as Kirriemuir and McFarlane (2004) point out, behaviorist, cognitive, and socio-cultural paradigms might have drastically different definitions for what constitutes learning in a given context.)

When does the learning occur?

Some games are intended to reinforce learning that has already occurred before gameplay; other games are intended to deliver the bulk of a curricular unit during gameplay itself; and still other games may be intended primarily to provide experiences that will support learning after gameplay.

Where does the learning occur?

Similarly, some games are designed to deliver complete learning experiences entirely inside the game itself; other games rely on what Gee (2005) has called the affinity space surrounding the game (the social interactions that spontaneously arise around good games); and yet other games depend upon an explicit curriculum designed to complement the game.

Why is the learner playing?

This question considers the learner's motivations: whether gameplay is voluntary or compulsory, curricular or extracurricular, intrinsically or extrinsically motivated, etc. (Note that a learner's answer to this question might not be what an outsider would expect: e.g., Barab, Gresalfi, and Ingram-Goble (2010) report children in a game-based learning experiment responding that they were playing a game "because they wanted to" even though they had actually been required to play the game.)

How does the learning occur?

Games may deliver their learning content in a number of ways, such as repetition, drill-and-practice, direct instruction, free or guided exploration, and/or trial-and-error. Of particular importance here is the question of whether the game's learning content is divorced from or integrated into the game's core mechanics (Habgood, Ainsworth, & Benford, 2005).

With what does the learning occur?

This question differentiates among purpose-built games (games that are designed and implemented from scratch for educational purposes); "modded" games (games that are the result of customization of existing commercial games); and commercial, off-the-shelf games (games that are repurposed essentially unchanged for educational purposes).

Elements of Success in Various Regions of the Space

Using these seven questions, we can characterize and evaluate examples of game-based learning that occupy different positions in what we can consider a high-dimensional space (1). Just as there is no single type of game or of learning, there is no single recipe for success in game-based learning. Different types (and uses) of games have been and can be successful in achieving different goals. As Klopfer et al. (2009) write:

> Some recipes work really well for some groups of people, in certain contexts, with particular expectations. Similarly, in creating experiences that are both fun and filled with learning, the success of different recipes (mixes of media, immersion, styles of games, learning goals, mixtures of content, etc.) depends quite a bit on the audience, context, content, goals, and facilitation.

I will now present examples of games that are effective supports for various kinds of learning. Some of these games are humble in their aims, some quite ambitious; some of these games reflect fairly traditional pedagogical design, while others exemplify newer design strategies for engaging 21st century learners. I hope that these examples will illustrate that there is no single path to success in game-based learning.

Successes in Using Games to Teach "Traditionally"

Simple drill-and-practice games that are little more than flashcards can be fun and effective ways of helping a learner memorize or solidify his or her knowledge of simple facts such as word definitions or math facts.

Periodic Table of the Elements

The first level of the website-based game *Periodic Table of the Elements* (*PTE*) (available for play at http://www.sheppardsoftware.com/Elementsgames.htm) involves nothing more than clicking on the chemical symbol that corresponds to the name of particular element (e.g., "Pb" for lead). On subsequent levels, players type in the name of an element whose position on the Periodic Table is highlighted, then drag and drop chemical symbols into the appropriate positions on the Periodic Table, and finally type in the name of an element given only its atomic number or atomic mass. In addition to these levels, the game offers different speed options, rudimentary scorekeeping (number correct, percent correct, elapsed time), and various audiovisual feedback elements for right and wrong answers. The rules and mechanics of this game are simple, even mundane, and obviously reminiscent of traditional school tests. Yet the game is useful: it succeeds at its goal of providing learners with practice storing and retrieving facts about the Periodic Table.

We can apply our seven circumstances framework to locate *PTE* in the space of educational games. *Who?* The requirement that the learners understand English and have Internet access constrains the population somewhat, and the game's narrow content focus makes it most interesting for students in introductory Chemistry courses, probably at the high school or community college level. The simplicity of the game's mechanics—essentially digital flashcards and matching—and the range of levels means that it can accommodate learners with a wide variety of achievement histories in the science domain, from high achieving high school students to struggling remedial students. *What?* The primary learning content of the game is facts about each known element: its chemical symbol, location on the Periodic Table, and basic atomic properties. *When? PTE* does include a separate introductory lesson in the Periodic Table, but the vast majority of players probably come to the game having already been exposed to this in their classes. Most of the learning that occurs in *PTE* happens during gameplay itself. *Where?* The pre-gameplay learning will probably have occurred as part of a formal curriculum; the during-gameplay learning occurs within the game rather than in any surrounding affinity space or formal curriculum. *Why?* Learners probably play *PTE* voluntarily, outside of school, for instrumental reasons (i.e., because the game is useful rather than because the game is fun). *How? PTE*'s main learning mechanism is simple trial-and-error with the possibility of repetition (if a learner gets a question wrong, that question is flagged so that the learner can revisit it later). *With what? PTE* is a purpose-built educational game: it was initially intended by its designers to be used for an educational purpose.

Medical Procedural Simulations

Another simple type of educational game is that of a procedural simulation, which can help with automatization of surgical techniques or other procedural skills (2). Rather than focus on any single simulation, I will consider features of effective medical simulations in general to map their location in the space of educational games. A recent review of 109 studies of such simulations (Issenberg, McGaghie, Petrusa, Lee, & Scalese, 2005) lists the following features as leading to effective learning (in decreasing order of importance):

1. Feedback is provided during the learning experience.
2. Learners engage in repetitive practice.
3. The simulation is integrated into the medical curriculum.
4. Learners practice with increasing levels of difficulty.
5. The simulation is adaptable to multiple learning strategies.
6. The simulation captures clinical variation.
7. The simulation is embedded in a controlled environment.
8. The simulation permits individualized learning.
9. Learning outcomes are clearly defined and measured.
10. The simulator is a high-fidelity approximation of clinical practice.

As with *PTE*, we can locate effective medical simulations in our high-dimensional space. *Who?* Learners using these simulations are almost exclusively medical students or practicing physicians. *What?* The learning content of the simulations is procedural skills relevant to various medical practices such as surgery or anesthesiology. *When?* While some base of relevant procedural skills is expected to have been acquired before gameplay, the bulk of the learning—in the form of procedural fluency—is intended to occur during gameplay. *Where?* The pregameplay learning will probably have occurred as part of a formal curriculum; the during-gameplay learning occurs largely within the game, although the third feature listed above suggests that this learning is intended to be supported by an accompanying formal curriculum as well. *Why?* Learners use these simulations primarily because they are required elements of medical training or professional development. Learners might very well also be motivated by the instrumental value of these simulations, which are demonstrably effective in improving the learners' skills. *How?* The first and second features listed above suggest that the primary mechanism for learning is repetitive practice with immediate feedback. The eighth feature listed above suggests that this practice probably occurs at a level of difficulty that is optimally challenging for each learner, producing a flow state (Csikszentmihalyi, 1988). And because the core game mechanic in each simulation *is* the learning content—e.g., in a surgical simulation, the core mechanic is the performance of various procedural elements of a surgical operation—the learning content and game mechanics are intrinsically integrated. *With what?* These simulations are probably all purpose-built for use in medical training.

Successes in Reaching for Higher Hanging Fruit

The examples of *PTE* and medical procedural simulations are intended to demonstrate success in reaching for low-hanging fruit. We know how to use games to teach simple facts or procedural skills, with only slight tweaks on effective pedagogical practices that have existed for centuries. Game-based learning researchers have set their sights higher, though, to determine what features might characterize a "good" game for learning more complex things, including the skills and dispositions students need in the 21st century. These efforts have led to published guidance from several research groups. For example, Futurelab identifies "key issues in developing games for learning" (Kirriemuir & McFarlane, 2004, p. 19); the Education Arcade proposes "Learning Games Design Principles" (Klopfer et al., p. 28); and the Games for Learning Institute has even tried to create a "universal" rubric for evaluating learning games using a set of 17 design patterns that good learning games may have (Kinzer, Hoffman, Turkay, Nagle, & Gunbas, 2010).

Some of these principles have already been touched upon in this discussion: e.g., attainment of Csikszentmihalyi's (1988) flow state is a much sought-after goal not just for medical procedural simulations but for most of today's serious games (Kirriemuir & McFarlane, 2004), as is Habgood et al.'s (2005) intrinsic integration of game mechanics and learning content (see also Habgood & Ainsworth, 2011), which bears a family resemblance to Klopfer et al.'s (2009) focus on "finding the fun in [the] learning" (p. 27) and designing around that. Another principle that has been mentioned in passing but not fully explicated is situating learning in a meaningful context, so that a learner knows exactly how to use the knowledge and skills he or she is acquiring (Gee, 2003). An extension of this is an emphasis on allowing a learner to playfully assume powerful new projective identities (Gee, 2003)—hybrid identities of self-as-protagonist in the game's narrative—that allow the learner to perceive the world according to particular epistemic frames (Shaffer, Squire, Halverson, & Gee, 2005; Shaffer, 2007). These principles are not universal. Not every good learning game will have them. They have, however, been found to work, as shown in the following examples.

Zombie Division

Multiplication, division, and factoring are procedures in the elementary mathematics curriculum that can be successfully reinforced with simple drill-and-practice games like the venerable *Math Blaster* franchise from the edutainment era. Habgood (2007), by way of demonstrating the value of intrinsic integration of learning content and game mechanics for his doctoral dissertation, set out to improve upon this model by creating the 3-D adventure game *Zombie Division* (*ZD*). In a representative game from the *Math Blaster* series, the learner might take on the role of a space pilot shooting asteroids that have numbers displayed on them. In *ZD*, the learner takes on the role of a Greek hero, fighting with sword, shield, and armored gauntlet against a horde of zombie skeletons that have numbers displayed on their chests. In *Math Blaster*, the learner might be required to shoot the asteroid whose number represents the answer to a displayed division or factoring problem (e.g., "Which number is a factor of 27?"). This same game mechanic, however, could work unchanged for, say, a spelling problem: the mechanic is not intrinsically integrated with the learning content. The way *ZD* presents the same factoring problem is not as a question but simply by displaying the number 27 on the chest of an approaching zombie skeleton. The learner answers this problem by selecting the appropriate attack to destroy the enemy: the sword (with two ends) represents the factor 2; the shield (with a triangle emblazoned on it) represents the factor 3; and the gauntlet (with five fingers) represents the factor 5. To destroy a skeleton with the number 27 on its chest, the learner must use a shield bash, effectively factoring by 3. In both games, the learner practices factoring while having fun. In *ZD*, though, the learning content is intrinsically integrated into the game mechanics.

Bringing our seven circumstances framework to bear on *ZD* highlights its differences from a game like *Math Blaster*, which is a close neighbor of both *ZD* and *PTE* in the high-dimensional space (although for different reasons). *Who?* Learners playing *ZD* are upper elementary students who are proficient in but not masters of basic multiplication and division. *What?* *ZD* is intended to reinforce the mathematical skill of identifying factors of a number. *When?* Although some learning is assumed to have occurred before gameplay, the primary focus of *ZD* is learning (in the form of increased fluency) during gameplay. *Where?* Most of the learning in *ZD* will occur within the game; however, researchers also included a teacher-led reflection session after students' first exposure to the game but before the bulk of their gameplay (Habgood, 2007; Habgood & Ainsworth, 2011), which locates some learning outside of both the game and its affinity space in a separate formal curriculum. *Why?* Learners may be required to play *ZD* by their math teachers, but the game could also be offered as an option in an informal learning context such as an afterschool computer club. (In fact, researchers offered *ZD* as one option among many during free computer lab time and measured the amount of time students spent playing it to estimate intrinsic motivation.) *How?* Learning occurs in *ZD* mainly through intrinsically integrated drill-and-practice. *With what?* *ZD* is a purpose-built game, designed to explore the value of intrinsic integration of gameplay and content.

Quest Atlantis

A game that incorporates both intrinsic integration and the acquisition of epistemic frames is *Quest Atlantis* (*QA*) (Barab et al., 2010). *QA* is a massively multiplayer online role-playing game (MMORPG), a genre that is currently dominated in the commercial industry by the game *World of Warcraft*. In *QA*, thousands of children from all over the world participate in a shared narrative about restoring power to a magical artifact that will make the planet New Atlantis into an ecological paradise. The way learners make progress toward this goal is by completing quests and missions that are tied to particular curricular units. For example, in one quest, learners must investigate a serious decline in the fish population in a national park. Learners are hired for this quest as environmental scientists, and to succeed in the quest they must take ownership of that role, which entails coming to see the world as an environmental scientist might—i.e., taking on a projective identity of self-as-scientist and thereby appropriating the epistemic frame of an environmental scientist. To demonstrate the pedagogical value of this learning paradigm for her doctoral dissertation, Arici (2008) conducted a two-week comparison study with sixth-graders. Four intact science classes taught by the same teacher were randomly assigned to either the *QA* or traditional version of a water-quality unit. Pretests showed no significant differences by condition. Posttests showed significant learning for both conditions, with the *QA* condition scoring significantly higher than the traditional condition and retaining significantly more information at the time of a delayed posttest. In addition to outscoring their traditional-condition counterparts, students in the *QA* condition were more engaged, as demonstrated by surveys as well as the fact that approximately 75% of the students in the *QA* condition chose to complete optional activities in the game for no credit, whereas only 4% of the students in the traditional condition completed a similar optional assignment for extra credit. This work suggests that offering learners the opportunity to take on projective identities as professionals, whose actions have meaningful consequences, even if only in an imaginary world, can be a powerful design choice (Barab et al., 2010; Shaffer, 2007). A seven circumstances interrogation of *QA* shows it to be relatively similar to *ZD*, but with some notable distinctions. *Who?* *QA* supports learners from elementary to high school, but the bulk of its learners are middle school students. Basic familiarity with the relevant science content is all that is expected by way of prior achievement. *What?* "Questers" in *QA* learn facts and skills related to the practice of inquiry-based science and science reporting (different quests offer different specific content). Learners also identify and engage with different identities and epistemologies as part of their appropriation of epistemic frames as researchers, journalists, advocates, etc. *When?* Most learning in *QA* happens during gameplay. *Where?* Learning in *QA* happens at all three levels: within the game itself, in online message boards that serve as part of the affinity space of the game, and in formal curricula designed to complement gameplay. *Why?* Learners typically play *QA* as part of required curricular units in school, but once involved in this way, "questers" often log in to participate in extracurricular quests from home (Barab et al., 2010); i.e., gameplay is initially compulsory but often eventually elective—and, as noted above, intrinsically motivating. *How?* Learning in *QA* is inquiry-based; learners construct their own knowledge by interacting with non-player characters (NPCs) and other players as part of elaborate narratives. Within *QA*, they gather information through experiments, interviews, and archival research to form and then test hypotheses or to support arguments. *With what?* *QA* is a purpose-built game, designed from the ground up to test theories of learning.

Conclusion

It is perhaps obvious that games such as *Periodic Table of the Elements* and *Quest Atlantis* exist in quite different regions of the space of game-based learning. Without some common language to describe these two games, though, it would be difficult to specify the nature of these differences. The seven circumstances framework I have proposed to characterize game-based learning allows us to examine the claim that both of these games are "good" with respect to a certain set of goals, in a certain context, according to certain theories of learning. This framework is only one example of how this common language might be developed. My hope is that this example serves as an invitation to other researchers to take up, improve upon, or propose an alternative to the framework, in the spirit of the worked-examples project (Gee, 2010).

Endnotes

(1) This discussion focuses on digital games, but the framework I propose would work equally well for non-digital games.

(2) A reader might object here that a procedural simulation is not a game. Attempts have been made to differentiate games from non-games, but in general the community has chosen to err on the side of overinclusion. In that spirit, procedural simulations have enough game-like features—high interactivity, creation of a flow state (Csikszentmihalyi,1988), immediate feedback, etc.—to be included in the taxonomy of serious games created by Sawyer and Smith (2008).

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