

# Designing a Game for Teaching Argumentation Skills

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**Abstract.** This paper describes the design of a game which is aimed at teaching argumentation skills to college students. Ability to understand and generate arguments is critical for STEM and a broad range of other fields, but it is sorely lacking in students today. Building on our prior experience creating intelligent tutoring systems for teaching argumentation skills, we have designed a game so that we can compare the effectiveness of the two approaches. This paper describes the design of the game from the viewpoint of cognitive principles and frameworks for serious game design.

**Keywords.** Game design, game design principles, game design frameworks

## Introduction

Argumentation is a central component of social and political decision making as well as a fundamental skill required by many class assignments and by entrance exams to post-secondary education (e.g., SAT and GRE). It is also an ability that we expect our educational system to impart to students during their schooling [1]. Sadly, many students leave high school unable to identify and write arguments [2].

In previous work, we have created intelligent tutoring systems for argumentation and other areas [3,4,5,6, for example]. In the current project, we are attempting to develop a computer game which will teach the same types of information about argumentation as the tutoring systems did. Our design for the game includes the high-level conceptual knowledge that we have gleaned from our experiments with the tutoring system and some of the underlying AI technology for evaluating generated arguments. We did not, however, try to import any of the modes of tutorial interaction into the game.

Our game is called, “Advisor to the King” (hereafter AttK). In AttK, the student/player is put in the role of a new employee in the King’s bureaucracy. At each level, the player’s “job” is to evaluate petitions from the King’s subjects using a different argumentation skill. The player submits her “work” to her boss. If the boss approves it, she can get a promotion. If she fails, she’ll be sent back to do it right. At present, we have created the initial design for the game, and most

of the materials. We still need to do playtesting, iterative design, and learning testing.

This paper analyzes our game design from the standpoints of different principles of educational game design, namely those of Gee [7] and Clark and Mayer [8]. When we started this project, we were relatively ignorant of any theoretical or empirical approaches to game design. Instead, our game design process was primarily driven by our knowledge of learning sciences and our intuitions about effective game design. Thus, this paper presents a *post hoc* analysis according to the frameworks mentioned, and is meant to indicate:

- how our intuitions fit with recent frameworks for serious game design,
- where our game could use some improvement,
- more generally, the benefits of using these principles and frameworks to guide serious game design.

## 1. Gee's Principles of Learning in Games

Based on his own experience in playing video games with his son, the semiotician James Gee published an influential text which described 31 principles that non-educational video games follow to support learning [9]. In 2005, he published a condensed set of 13 principles in three different conceptual areas [7]. In this section, we describe how these principles apply to the AttK game.

### 1.1. Empowered Learners

#### 1.1.1. Co-Design

According to Gee, this principle holds that good games give players the feeling that they are actively creating part of their experience, having an effect on the virtual world they're inhabiting, and influencing their playing experience. As Gee explains, this can be rather trivially true; in almost every game, each player has a somewhat different experience. It is most effective when a player feels like her choices have a significant impact on the tasks she is attempting and how she approaches them.

In AttK, this principle is in evidence, but not as strongly as it might be. The player has some choices in taking on some side tasks which were primarily intended to support transfer by giving the player practice in different settings within the game. For example, the player may visit a pub where an argument soon breaks out between two other patrons. The player has the opportunity to use their argumentation skills to help settle the argument before it gets out of hand, or they can choose not to act and leave the other patrons to work it out for themselves.

AttK could provide more opportunities for the players to control their own experiences by providing a wider range of practice tasks. In this first stage of development, however, we are concentrating on demonstrating the effectiveness of the general concept, and with our limited budget, we must be satisfied with having one type of task in each level of the game.

### *1.1.2. Customize*

This principle addresses a more fundamental way that the player can influence gameplay: by tailoring it to their favored style of learning. Whether due to gender [10], multiple intelligences [11], or simply individual preference, different game players prefer different types of games. Gee gives examples of various games that allow players to engage in very different modes of gameplay. AttK does not do this. As mentioned above, the initial version of the game is relatively narrowly defined. Its current game mechanics are designed to provide the player with ample time for reflection on the concepts. A more fast-paced version could be created, and it might well be more attractive to a certain type of player, but it would probably also decrease learning by minimizing time for reflection.

### *1.1.3. Identity*

Teachers know how motivating it can be for students to feel ownership of and invested in a learning task. Conversely, work which must be done “just because the teacher said so,” is highly demotivating. Games can provide an exceptionally strong method of fostering this type of investment by immersing players in an alternate reality where they take on a different identity. When a player takes on the role of Wizard, or a Tank, or a Healer in a game which they play hour after hour, the player is highly motivated to learn how to help that character succeed.

In AttK, the player starts out in the role of an entry-level civil service worker. It doesn't pay well, and the boss is a jerk, but if the character/player succeeds (by processing argumentative texts), she can advance in the game, possibly displacing the boss. This is a central conceit of the game situation, and the central hope for its success. If the player develops a sense of unified identity with the character in the game, they should be motivated to learn the argumentation skills to help that character succeed.

### *1.1.4. Manipulation and Distributed Knowledge*

This principle deals with the connection between perception and action. In learning to do any task, the learner must come to recognize the situations in which action must be taken, and also learn what actions are possible. Game play provides an excellent environment for focusing the learner on this task with significant advantages over traditional schooling. Immersing the learner in a (simulated) environment provides a much richer setting than a worksheet or other homework assignment could. The player's character acts as a tool with which the player manipulates objects in the game world. As Gee says, this activity “causes humans to feel as if their bodies and minds have stretched into a new space” [7, p. 8].

This touches on the rather controversial issue of endogenous vs exogenous games [12,13,14]. In exogenous games, the learning content is often added into a general game framework like a quiz show or a shooter game. One well-known example is Math Blaster. In endogenous games, the content material is intimately tied in with the gameplay. Oregon Trail is commonly held up as a good example of an early endogenous game, though its critics contend that many students are more engaged in developing their shooting skills (by shooting animals from trains), than they are in learning about the more conceptual learning objectives of the

game. Commercial developers of educational games like exogenous games because they're much less expensive to create [15]. Researchers prefer endogenous games because of their theoretical advantage in learning effectiveness [14].

Although we weren't familiar with the term at the time, we designed AttK as an endogenous game. We created a story in which the player is put into a position where she must use the skills that we are trying to reinforce. Inability to perform the skills will bring feedback and extra practice. Mastery of the skills will bring success and progress within the game. In this case, the skills are more conceptual than perceptual, but the game provides interaction with just the type of conceptual materials that we want students to learn.

If the player's avatar in a game is a tool which allows them to influence the game world, it is a "smart tool." Game characters generally free the player from having to worry about the very low-level aspects of their actions. Pacmen already know how to move and eat, shooters know how to shoot various weapons, and Mario knows how to drive a kart. The player just needs to tell the characters when to act and point them in the right direction.

For educational games, designers have the opportunity to provide avatars with knowledge equivalent to the player's prior knowledge — at least within the narrow context of the game world. Then the learning of the content material within the game can fall neatly in the learner's zone of proximal development [16].

AttK's interface is primarily linguistic, using audio and on-screen text. There is no avatar moving around in a 3D world. But there are assumptions about what the character (and by extension, the player) can and can't do. We assume they can read and make some judgments on texts. We don't assume that they are good at processing argumentative texts. If they are, they should progress quickly to a challenging level within the game. If they are not, the game will help them improve. This should provide learners with minimal barriers to getting started in the game and allow them to learn at their own pace.

## *1.2. Problem Solving*

### *1.2.1. Pleasantly Frustrating*

One general difficulty in education is that students tend to overestimate their knowledge of a subject. This is especially true in dealing with argumentative texts. In a previous study, we showed that more-skilled readers precisely remember the predicate of an argument, while less-skilled readers only retain the general theme [6]. Because these less-skilled readers believe they know what the text is about [17], we expect that they will initially have difficulty completing the tasks which require precise recall of text components. In the context of the game, however, they will get immediate, non-threatening feedback that indicates they are missing something important. If they want, they can also ask for instruction about what is missing within the context of trying to solve a goal. Thus, the game design provides a challenging situation for the player, but also provides mechanisms for solving the challenge, and opportunity to practice the solution.

### 1.2.2. *Information On-Demand and Just-In-Time*

In traditional tutoring situations, it is either assumed that new content material was previously taught in class, or the tutor begins a session by didactically presenting the new content. Games take a radically different approach. Although most games come with some sort of manual, few players ever read them. Instead, players rely on the subtle hints that good games give them about what to do. Just-in-time information is incredibly useful for learning because it is directly connected to the player's current goals. The player can see immediately how applying that new knowledge will help them advance in the game.

In AttK, we made an explicit design decision to provide minimal instruction about how to do each task. The player gets feedback during play and can request additional help if stuck. This supports learning in connecting actions with solving goals.

### 1.2.3. *Well-ordered Problems*

Good games “teach” players to play by starting with simple challenges and then requiring players to use what was learned to solve increasingly complex problems. There are two negative outcomes associated with presenting players with overly complex tasks. Players may simply give up because it's too frustrating. Alternatively, because humans can be very clever in finding *some* solution to a problem, they may invent solutions which do not apply to related tasks — they don't transfer well [18,19].

AttK's levels are based on theoretical and empirical work on argumentation. [20,21,6, for example]. We have created levels for claim identification, predicate identification, and argument classification. We have plans to create two additional levels for argument evaluation and policy creation from arguments.

### 1.2.4. *Cycles of Expertise; Skills as Strategies*

As Gee summarizes from [22],

Expertise is formed in any area by repeated cycles of learners practicing skills until they are nearly automatic, then having those skills fail in ways that cause the learners to have to think again and learn anew.[7, p. 10]

As mentioned above, in AttK, each new level brings a new challenge that builds on previously-learned skills. Students advance between levels when a certain level of proficiency is reached. Then they continue to practice those skills in the service of higher level goals. Practice helps the student automatize the new knowledge and feel pride in their growing expertise.

At higher levels in the game, students are using the more basic skills in varied ways, applying them to different tasks, learning when to focus on one skill or another [23]. As skills become automated, they serve as components in the higher level strategies that the students learn.

### 1.2.5. *Fish Tanks; Sandboxes*

As Gee defines the term, *fish tanks* are “stripped-down versions of the game,” [7, p. 12] where complexity is reduced, allowing the player to avoid getting lost and

instead focus on acquiring important preliminary skills. *Sandboxes* may have the full complexity of the game, but major negative consequences like “dying” or losing are removed. Sandboxes give players free rein to explore the range of choices in a game environment without feeling pressure to perform optimally or choose too quickly.

The “full” AttK game is much less complex than most video games. It more closely resembles what Gee calls a fish tank. With the exception of the game story elements which are designed to motivate the student to learn the argumentation skills, the content of the game consists entirely of argumentative texts.

### *1.3. Understanding*

#### *1.3.1. System Thinking*

Learning of isolated facts and knowledge is not useful learning. Learning is only useful if it comes with understanding — understanding of associations, applications, conditions, causes and effects [24]. Typical classroom worksheets have students practice skills in isolation. On the other hand, the real world is a complex system where actions are based on goals, and have meaningful consequences. Good games mirror the real world in this way. They present a complex system to the player. The player learns most effectively when she understands her role within the system and can use that knowledge to set goals and determine actions [7, p. 14]. Ironically, exogenous educational games do not provide this type of support.

The AttK story was created precisely to give students this type of system within which to learn and practice argumentation skills. While the system is not nearly as complex as in most commercial video games, it was designed to provide the player with the conceptual connections required for learning with understanding. The side tasks mentioned above supply an extra level of complexity, encouraging the player to understand that argumentation skills are not only applicable within the (simulated) job context.

#### *1.3.2. Meaning as Action Image*

As a semiotician, Gee’s central concern is with meaning making. By linking meaning with action in this principle, Gee formulates his ideas about knowledge and learning in a way that fits very nicely with cognitive architectures like Soar and ACT-R [25,26]. In these architectures, thinking is all about selecting the next action which will make progress towards the agent’s goal, and learning is all about making that selection process more efficient. Gee describes the same process in terms of the game player’s experiences and of strengthening conceptual learning by linking perception and action.

As we have stressed throughout this paper, the AttK design is all about situating the learning and use of argumentation skills within a rich context that enables the player learn with deep understanding. AttK was designed to help the student learn not just the actions that are required, but also the perceptual conditions in which they apply.

## 2. Clark and Mayer's e-Learning and the Science of Instruction

In 2003, Ruth Clark and Richard Mayer, a professional training developer and an educational psychologist, published a collection of principles for creating effective e-learning systems. The principles were based on cognitive science theories and backed with empirical studies. In 2008, they released a second edition of the book [8] which included specific recommendations for educational games. Although they admit that significant research to fill out our understanding of what makes educational games effective, they offer several general principles which provide a useful alternative view on game design.

### 2.1. Match Game Types to Learning Goals

Clark and Mayer are not very specific about which types of games to use for which purposes. In fact, the only game type they mention is Jeopardy-style games which, they say (citing Van Eck [27]) are best suited for what Bloom classified simply as knowledge, e.g. facts, labels, and dates [23]. This principle does fit in well with the general comments made above about endogenous and exogenous games.

### 2.2. Make Learning Essential to Progress

This principle makes clear a fundamental difference between games and education. In most educational settings, a student is only required to repeat an assignment, class, or grade if that student's performance is dismal, and that repetition is seen as punitive by both teachers and students. In games, on the other hand, players are not allowed to advance to the next level unless they demonstrate a high level of performance, often by battling a level's boss. To defeat the boss, players must apply what they've learned in that level in novel ways (*a la* Gee's "Skills as Strategies"). AttK adheres to this principle by requiring the student to correctly process a high percentage of the texts that they receive in each level before they can "get promoted." If they fail, students receive instructional feedback and more practice items. Within the context of the game, this feedback is not face-threatening and should motivate students to learn to perform the skills correctly.

### 2.3. Build in Guidance

Clark and Mayer suggest a variety of ways to build guidance into an educational game. These are listed below, along with explanations if necessary, and examples from AttK.

**Incorporate explanations** In AttK, the boss character and a co-worker both can provide explanations to the player, before they take on a task and if they make incorrect judgments.

**Encourage reflection** Self-explanation is not currently part of the game design, but when a player fails to get a promotion within the game, she is implicitly encouraged to figure out why. Furthermore because the game is not timed, players can take a break from the game to reflect and plan new approaches.

**Optimize interface fidelity** Learning can be hindered if the game interface is too complex — too many distractions — or if it is so simple that players don't get the appropriate environmental cues. We have tried to include only the content materials and enough story to motivate the player. Play testing is required, however, to see if we achieved our goal.

**Provide instructional support** At the beginning of each level in AttK, the boss character demonstrates how the task is done. We do not currently provide memory support and visualization support as Clark and Mayer suggest, but these could be incorporated in future versions.

#### *2.4. Promote Reflection on Correct Answers*

This principle is nicely orthogonal to Gee's. It is based on empirical studies which showed that students who reflected on correct answers learned better than those who reflected on their own answers, some of which were wrong. It was not in the original design of AttK, but we have decided to include it, due to the cited research.

#### *2.5. Manage Complexity*

This principle is generally in line with Gee's "Well-Ordered Problems" principle, but Clark and Mayer provide some alternative perspectives.

**Simple to complex goals** This is closest to "Well-Ordered Problems."

**Minimize interface complexity** As mentioned above, too much complexity in the interface can hinder learning by providing distractions.

**Training wheels** This is similar to Gee's notions of Fish Tanks and Sandboxes

**Use faded worked examples** As mentioned above, we do provide a worked example at the beginning of each level. AttK does not include fading, however, because the different skills are practiced and perfected individually before they are combined into more complex skills.

**Manage Pace** Games which are too fast hinder learning by requiring "twitch speed" responses and leaving no time for reflection. Games which are too slow can reduce player motivation. ("This is so boring!") Because AttK is a turn-taking game, the pace is primarily determined by the player. Only play testing will show if we need to speed it up or slow it down in other ways.

### **3. Conclusions**

This paper has analyzed the design of the AttK game using two different sets of principle. One set was intended to demonstrate how good commercial video games address an interesting paradox: although learning is hard work, and these games require lots of learning, players are highly motivated to continue playing them until they achieve mastery. The other set of principles was based on cognitive theories and empirical studies of learning. These principles are intended to provide



a set of “best practices” to help create educational games which are effective for learning. Despite their different origins and intentions, the different frameworks largely agree. We feel that they validate many of the design choices that we made. There is still two huge questions that remain though:

- Will the game be fun?
- Will it help students learn?

These questions can only be answered empirically. We plan on addressing them in our future research this year.

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