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Web-Based Drill-Games

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THIS CHAPTER COVERS A SUBSET of digital video games that combines the proven instructional strategy of drill and practice with arcade-style gameplay to facilitate learning. Although drill-and-practice games have been around for many years in CD format, there are now many more available—often at no cost—on the Internet. The challenge for teachers lies in finding games that not only fit curricular objectives but also are instructionally sound and engaging for students. This chapter helps teachers locate appropriate drill-and-practice games, evaluate them in terms of drill structure and gameplay, and integrate them into regular classroom activities.

This chapter covers a small but important subset of digital video games that combines the structure of drill and practice with the playfulness of games to produce relatively simple games (henceforth referred to as drill-games) that are engaging while maintaining the focus and instructional efficiency of drills. Drill-games have been around as a form of “edutainment” since the 1970s and are often derided as “drill-and-kill” (Egenfeldt-Nielsen, 2007). However, two recent technology developments may change educators’ impressions of drill-games.

First, many excellent drill-games, now available for free on the Internet, provide variety and accessibility beyond classic edutainment games, such as the Math Blaster! series, that traditionally were distributed on CDs through school or district media centers. Second, the development of Flash animation allows developers to create games that look better and play better than older games.

Websites such as Game Goo (www.eaobics.com/gamegoo/gooney.html) and Arcademic Skill Builders (www.arcademicskillbuilders.com) offer free access to visually enticing Flash games that also have high learning value. While not as “Flashy,” many older drill-games also combine learning and fun. The quantity and quality of drill-games that are accessible and searchable on the Internet should lead educators to reconsider making edutaining drill-games part of their schools’ curricula.

Definition and Value of Drill-Games

Drills use the key elements of repetition, immediate feedback, and progressive difficulty to build fluency, especially in basic math and language skills (Alessi & Trollip, 2001). The value of drill-and-practice learning in math is emphasized in *Foundations for Success: The Final Report of the Mathematics Advisory Panel* (U.S. Department of Education, 2008), which states, “For all content areas, practice allows students to achieve automaticity of basic skills—the fast, accurate, and effortless processing of content information—which frees up working memory for more complex aspects of problem solving” (p. 30).

Although drill-and-practice is well established as an effective instructional method, students—especially young ones—sometimes need to be enticed into drill-based learning by adding gameplay. Gameplay not only invites students to try a drill-game but also provides incentives for them to persist. As with most games, drill-games are driven by players competing—against themselves, other students, the computer, the clock, or a standard of some type (Newby, Stepich, Lehman, & Russell, 2000). Stapleton and Hirumi (2010) make an important point: Though a game may be about winning, losing also needs to be fun so that players are encouraged to try again.

Beyond making drills more palatable, gameplay can also help students develop and strengthen essential mental skills, such as concentration, memory, spatial awareness, hand-eye coordination, and problem solving (Bottino, Ferlino, Ott, & Tavella, 2007). However, “developing students’ mental skills through gameplay” has not become a learning objective in typical K–12 curricula. In spite of the many positive aspects of using educational games in schools, the use of purely entertaining video games, like Tetris, as part of formal classroom activities has not been justified yet, though a creative geometry teacher might be able to use it as a teaching tool. When drill-games

are combined with traditional teacher-led activities to accomplish the primary curricular objectives of teaching basic skills, the mental skills development associated with playing digital video games can provide valuable secondary learning. For teachers who want to explore incorporating digital video games into their classrooms, drill-games are a natural starting point.

The availability and potential benefits of effective instructional drill-games suggest that students and teachers will receive significant educational value when these games are integrated into classroom instruction. However, teachers need to proceed with a degree of caution because the combination of drill structure and gameplay that can work together to create enticing and effective instruction can also work against each other to produce drill-games that are neither fun nor effective. The key to successful incorporation of drill-games into classes is to evaluate the quality and appropriateness for your students and your particular learning activities, which is the focus of this chapter. Of course, you need to find appropriate drill-games first. The next section covers locating digital video drill-games in the vast, sometimes confusing, realm of the Internet.

Locating Drill-Games

You can search the web using terms such as “math drill games” and find a haphazard array of drills without gameplay, games without drill structure, and perhaps a few actual drill-games. A more efficient approach is to visit teacher-produced or teacher-oriented portals—websites that collect and categorize links to a variety of resources for teachers, most of which reside on other websites.

Portals for Instructional Games


Portals such as Teachers First (www.teachersfirst.com/index.cfm) and Teachers’ Domain (www.teachersdomain.org) collect links to online resources for teachers—including lesson plans, worksheets, flash cards, and digital video games, which may include quiz-games, puzzle-games, and simulation-games in addition to drill-games. Resources are usually categorized by type, by content area, and by grade level. Some portals are specific to content areas, for instance, Reading Comprehension Connection (www.readingcomprehensionconnection.com), and Syvum (www.syvum.com), which is oriented to foreign-language learning and math and science homework help. Syvum charges a membership fee and offers a “Complete Solution for Teachers” with interactive learning materials in reading, math, and foreign languages.



TIP



When exploring portals, be sure to take notes and bookmark favorite URLs on your browser. A better approach is to use a social bookmarking program, like Delicious, so that you and your colleagues can access the bookmarks from any Internet-connected computer. Bookmarking programs also let you and other teachers add comments to posted URLs.



Member Log-in
You go it all from here: Search, review, submit, & update

Start new search! Return to your member page

A total of 42 records found

These links open new browser windows.

Module Title	Format	Subject Area	Intended Audience
go to module A+ Math Games	Game	Mathematics	Grades 3-6
go to module AAA Math	Game	Mathematics	Grades 3-6
go to module AAAMath	Game	Mathematics	Grades 3-6
go to module APlusMath	Game	Mathematics	Grades 3-6
go to module Bang on Time	Game	Mathematics	Grades 3-6
go to module Better's Up Baseball	Game	Mathematics	Grades 3-6
go to module BBC Math Zone Games	Game	Mathematics	Grades 3-6
go to module Billy Bug	Game	Mathematics	Grades 3-6
go to module Bobber's Farm	Game	Mathematics	Grades 3-6
go to module Change Maker	Game	Mathematics	Grades 3-6
go to module Cool Math	Game	Mathematics	Grades 3-6
go to module Count Us In	Game	Mathematics	Grades 3-6
go to module Disaster Games	Game	Mathematics	Grades 3-6

FIGURE 13.1 ► WWILD search results for Grades 3–6 math games

Although educator portals provide access to valuable resources, be aware that many portals are vehicles for advertising and promotion. Portals are also limited in that they typically do not provide reviews or recommendations of the resources they collect.

A handful of educator portals focus on games, including drill-games, and provide evaluations that are contributed by educators who use the portal. A good starting place to look for digital video drill-games is the World Wide Interactive Learning (WWILD) site (<http://it.coe.uga.edu/wwild/>), created in 1999 by Lloyd Rieber (1996), an early advocate of simple digital video games for learning. The WWILD website, depicted in Figure 13.1, continues to

be maintained by the University of Georgia and features a searchable database with more than 1,000 profiles of interactive modules, many of which are drill-games.

Teachers are invited to use the database to find interactive modules and to become WWILD Team members and contribute reviews. Profiles of interactive modules include author name, subject area, module format (including “game”), subject area, grade level, and a brief description.

An advantage of WWILD’s format is that all listed games are recommended by the educators who posted them. A drawback to WWILD’s reliance on member-posted reviews is that the list of titles is not as comprehensive or current as some non-reviewing portals. For comprehensiveness, teachers are well served by exploring the Gamequarium (<http://gamequarium.org>) portal, developed by a teacher who started the site as a graduate course project and has maintained it since. Gamequarium does not provide recommendations or reviews of titles but does present a large and varied collection of teacher resources that include digital video drill-games. The portal organizes links to off-site digital resources according to subject area and grade level.

Another noncommercial resource for drill-games is the portal Multimedia Educational Resource for Learning and Online Teaching (<http://merlot.org>). MERLOT complements WWILD, which favors simple educational games appropriate for elementary grades. MERLOT collects links to many multimedia learning activities, most of which are designed for secondary and higher education use. Activities catalogued on MERLOT are organized by subject and can be sorted by material type, which does not include “games” as a category but does include “drill-and-practice.” Educators post all multimedia resources profiled on MERLOT, and many profiles include evaluations and comments.

Single-Organization Game Websites

While portals provide links to resources from a variety of websites, single-organization websites contain games that are produced by a single organization or company. Many single-organization websites feature games of varying types that have a consistent look and format and address a variety of content areas and grade levels including drill-games. When teachers use games in class that have familiar rules, goals, and interface controls, then teachers and students need to invest less time in getting up and running with a new game. Some notable single-organization websites that produce and distribute digital video drill-games are profiled in the Single-Entity Drill-Game Websites supplement (see page 326).

The following scenario illustrates a teacher using a portal to locate a digital video drill-game. The scenario will be continued in later sections of this chapter on evaluating and integrating drill-games.



TIP

Use portals as a starting point to identify favorite single-organization websites that feature a variety of drill-games with consistent formats.

Scenario

Chris Fitch has decided to use a math drill-game to help her fifth grade students gain confidence for year-end standardized testing. She goes to the WWILD website to see if she can find an appropriate drill-game. She joins the WWILD team by registering and does a search of the database for subject area = mathematics, intended audience = 3–6, module format = Game. The search turns up 42 hits. One called Batter's Up Baseball (www.prongo.com) catches her eye. She often talks about baseball with her students and thinks that a baseball theme will get their attention. Here is WWILD's description of the game:

The game provides questions about multiplication and addition. The player can choose the difficulty level of each question by choosing a single (easy), a double (medium), or a home run (difficult). For each correct answer, players are moved around the bases. An incorrect answer results in a strike. Three strikes—You're Out. You can change your level and play again.

Chris checks comments posted by other WWILD members. One comment notes that the game is, "a decent drill with a little game context," and another comment notes that it is very challenging to do the home run-level problems without scratch paper. Chris decides that Batter's Up Baseball may work for her instructional purpose.

Chris then proceeds to evaluate the game—a process that is described in the next section and then illustrated in the continuing teacher scenario.

Evaluating Drill-Games

Evaluating drill-games requires looking at a number of dimensions, including drill structure and gameplay. In addition to working as a drill and as a game, a digital video drill-game must also work as interactive multimedia. Multimedia design, then, joins drill structure and gameplay as fundamental dimensions of drill-games. Multimedia design involves appropriate use of animation, sound, and color to gain students' attention without distracting or confusing them. Multimedia design also includes intuitiveness and friendliness of the user interface that directly affects how the computer program communicates with the user (e.g., on-screen control buttons being consistently placed and directions being readable by the intended users).

Multimedia design, drill structure, and gameplay are key dimensions of the Drill-Game Evaluation Form (Figure 13.3) used by teachers and instructional technology graduate students in the Collaboratory for Interactive Learning Research (CILR) to profile drill-games (see the Drill-Game Reviews supplement [page 328] for sample profiles). The CILR acts as an online gathering of resources and research activities being pursued by faculty and graduate students in Southern Illinois University's Instructional Technology and Instructional Design programs (<http://idt.siu.edu/cilr/research-projects/>). Each dimension of the drill-game evaluation form is delineated below the sample form (Figure 13.3). A fourth dimension of drill-game evaluation, use recommendations, appears at the bottom of the form and is discussed in the Integrate section of this chapter.

Drill-Game Evaluation Form

The CILR Drill-Game Evaluation Form depicted in Figure 13.3 was filled out by a teacher-evaluator for the drill-game Word Frog (Figure 13.2).

Although you may not always conduct as detailed an evaluation of all drill-games that you are considering as this one, the CILR form identifies key factors for evaluating drill-games.

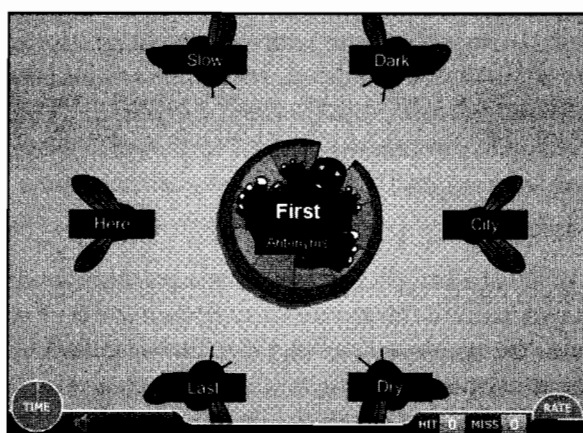


FIGURE 13.2 ► Word Frog screen

Title/Source/URL. The title of the drill-game is given separately from the URL of the website where the game is found. This is because some drill-games are available from multiple websites. It is worth searching the web for different locations of the same game. Different sites may have newer versions of a game. Different sites also have different amounts or types of advertising—which often comes with free online access.

The source of the drill-game refers to the producer of the game rather

than the website on which it appears. Single-organization websites, such as Arcademic Skill Builders (profiled in the Single-Entity Drill-Game Websites supplement, page 326), are preferred because they usually have the most recent version of a game that they produce and also because they are less likely to have intrusive or inappropriate advertising. Another benefit of using drill-games produced by a single company or organization is that the games often have consistent drill structures and styles of gameplay, so that teachers and students learn what to expect and spend less time figuring out how to play. For example, Word Frog's gameplay is almost identical to Arcademic Skill Builder's math drill-game Meteor Multiplication.

DRILL-GAME EVALUATION FORM

Title/Source/URL: Word Frog (Arcademic Skill Builders)
www.arcademicskillbuilders.com/games/frog/frog.html

Content Area/Grade Level/Learning Objectives. Language arts. Elementary grades. Builds fluency in recognizing antonyms, synonyms, and homonyms. Develops visual searching and manual coordination.

Description. Target-shooting arcade-style game. The frog in the middle of the pond uses its tongue to "zap" flies. A target word is superimposed on the frog with other words on the approaching flies. You spin the frog to aim and zap the correct synonym, antonym, or homonym.

Multimedia Design. High quality Flash animation and sound. Score and directions easy to see and read. Controls easy to use for age level but may be hard for kids with some disabilities.

Drill Structure. Time element creates urgency but not panic. Rewards going faster but not a lot of punishment for mistakes. Nine levels with each type of word relationship. Lots of repetition with feedback and progressive difficulty. Solid as a drill.

Gameplay. Fun, well paced intuitive play. The player uses arrow keys to aim the frog at flies (words) as they approach and the space bar to "zap" them. Physically and mentally active.

Use Recommendations. Stands up to repeated use. Good for home use or in computer lab.

FIGURE 13.3 ► CILR Drill-game evaluation form for Word Frog

Content Area/Grade Level/Learning Objectives. Write the content area, grade level, and learning objective(s) addressed by the game. Although most drill-games are intended for mathematics or language arts (including foreign languages), digital video games for science, history, social studies, and other areas can also be found. Two especially good sources for drill-games in different content areas are BBC: Learning (www.bbc.uk.org) and Quia (www.quia.com) (see Single-Entity Drill-Game Websites supplement, page 326).

The great majority of drill-games are intended for elementary grade levels. Some drills are designed for middle and high school (e.g., BBC: Learning) and even higher education (e.g., MERLOT and Syvum), but those intended for older students often consist of less gameplay. Portals and single-entity sites usually indicate the intended grade level for drill-games, but you should write the grade level that you think the drill-game is actually most appropriate for on the form.



TIP



Play the game several times, paying special attention to the first time you get into the game and to any aspects of media or interface design that might cause confusion. Remember, you can only see it with fresh eyes the first time.

Drill-games often address a single learning objective. For example, the Word Frog evaluator, depicted in Figure 13.3, wrote that the game: “Builds fluency in recognizing antonyms, synonyms, and homonyms.” Along with writing the primary objective, you may also note secondary mental skills that are developed by playing the drill-game. For example, the Word Frog evaluator noted that it also: “Develops visual searching and manual coordination.”

Description. A short description of the drill-game tells others what to expect from a game. For instance, the Word Frog evaluator wrote:

“Target-shooting arcade-style game. The frog in the middle of the pond uses its tongue to ‘zap’ flies. A target word is superimposed on the frog with other words on the approaching flies. You spin the frog to aim and zap the correct synonym, antonym, or homonym.” This description should not include detailed comments on multimedia design, drill structure, and gameplay as those dimensions have their own place on the CILR Drill-Game Evaluation Form.

Multimedia Design. Multimedia design includes the appropriate use of animation, video, graphics, sound, text, and colors. For example, the Word Frog evaluator wrote: “High quality Flash animation and sound. Score and directions easy to see and read.” In a drill-game, the primary concern is that media elements appeal to students’ sense of curiosity and imagination but do not distract them from primary learning objectives (Clark & Mayer, 2003). While Flash animation enlivens newer drill-games, older HTML-based drill-games may still attract students’ attention with minimal media use (see Fun Brain in the supplement on page 327). Remember to base your judgment on what you think students will like rather than what you like.

Multimedia design also addresses user interface issues, such as the placement of on-screen control buttons and methods of inputting answers (Alessi & Trollip, 2001). Interface issues are revealed by observing students playing the game or by playing the game yourself while assuming the role of a student. Interface evaluation should start with what happens when you click on the game’s URL. Questions to ask yourself include the following: Does a title screen or splash screen appear that tells you how you will benefit by playing the drill-game (i.e., objectives) and/or how to play the game (directions)? Can you figure out how to play right away, or do you have to play the game once or twice to figure it out? Do you need to refer to written directions to figure out the game, and, if so, are they readily accessible and easy to follow? You don’t need to address all of these questions; just use them to point to any potential problems. For example, the Word Frog evaluator noted: “Controls easy to use for age level but may be hard for kids with some disabilities.”

Drill Structure. Drills build students’ fluency with already learned skills and knowledge through repetition, immediate feedback, and progressive difficulty. Drill-games embody repetition, feedback, and difficulty level within a drill structure that consists of a sequence of steps:

1. Create an item pool,
2. Present each item to the student,

3. Accept the student's input,
4. Judge the student's input and provide corrective feedback,
5. Queue missed items for re-presentation during the drill,
6. Conclude the drill and give summary feedback, and
7. Guide the student to repeat the drill or advance to a more difficult level based on the student's performance. (Alessi & Trollip, 2001)

Few drill-games fully execute all six drill structure steps described. However, the more steps that are included and the more fully the steps are executed, the more effective the drill should be.

First, the key question to ask regarding repetition is: Does repeated play of the drill-game present different items or sequences of items? That is, does the game employ *varied repetition*? Many free web-delivered games, especially those outside of math and language content areas, quiz students on facts and concepts using a limited set of items. Repeating the game gives the same questions, often in the same order. Although quiz games have learning value, they do not support the type of repeated use associated with effective drill-and-practice.

Second, along with varied repetition, drill structure also requires the *delivery of many items in a short time span*. Alessi and Trollip (2001) suggest that drills should take no more than 10 or 15 minutes to complete, in part because drills should involve intense concentration. One of the reasons that many drill-games adopt arcade-style formats is that the rapid-fire presentation of drill items as targets to shoot, zap, or blast does not slow down the pacing of the drill.

Third, *appropriate response time* is also an important aspect of drill structure. Drills usually involve a speed/accuracy tradeoff, and fluency is built by pushing the speed factor so that students' mental process becomes more of an association than a calculation (math) or a translation (foreign language). However, time pressure can also be frustrating, especially for very young students (Alessi & Trollip, 2001). Therefore, appropriate use of speed-based scoring is often a key aspect of evaluating drill-games. For example, the evaluator of Word Frog noted: "Time element creates urgency but not panic. Rewards going faster but not a lot of punishment for mistakes."

Fourth, *appropriate corrective feedback* is an essential element of drill structure. In Word Frog, feedback is provided by the fly/word either being swallowed for a correct answer or continuing to advance for an incorrect answer. A teacher playing Word Frog will notice that the drill-game does not give corrective feedback for missed items; rather, players shoot until they get the correct answer.

Whether corrective feedback is appropriate depends on the knowledge level of the students and the teacher's goals in using the drill-game. If a teacher is confident that students already know the synonyms and antonyms of most words and decides to have students play Word Frog to build fluency, then forgoing corrective feedback to maximize the number of items presented and to create consistent drill pacing is a good tradeoff. On the other hand, it is also important that students eventually answer every item presented in a drill correctly.

Fifth, the best drills are designed to cycle missed items back into the item queue to be presented again before the drill is completed, providing *systematic queuing schemes*. The most basic approach is flashcard-style queuing in which missed items are put at the back of the queue (Alessi

& Trollip, 2001). Most online drill-games do not have systematic queuing schemes. However, as commercial education publishers are increasingly involved in producing and distributing drill-games, systematic queuing schemes should become more common.



TIP

Drills build mental fluency in the same way that weight lifting builds muscles, through massed repetition and progressive difficulty.

The sixth essential element of drill structure is *progressive difficulty*, designed for players to advance through more difficult levels of a drill-game as they meet the performance criteria

for each successive level. Levels of difficulty can result from presenting increasingly difficult items, presenting more items of similar difficulty in the same time frame, or presenting the same number of items in less time. The teacher-evaluator of Word Frog noted that the drill-game has “Nine levels with each type of word relationship.” The evaluator concluded the drill structure comment by writing: “Lots of repetition with feedback and progressive difficulty. Solid as a drill.”

While teachers do not need to be experts on drill structure, it is important to recognize how the essential drill elements of (1) effective varied repetition, (2) delivery of many items in a short time span, (3) appropriate response time, (4) appropriate corrective feedback, (5) systematic queuing schemes, and (6) progressive difficulty work together to build fluency. Keeping these elements in mind, you can judge whether a particular drill-game is likely to produce the type of learning experience that you want for your students. To be an effective learning tool, a drill-game should have, at minimum, these three most essential basic elements: effective varied repetition, appropriate corrective feedback, and progressive difficulty.

Gameplay. The essential elements of interactive entertainment posited by Hirumi and Stapleton (2008) are play, story, and game. In this chapter, the elements of play, story, and game are considered together as making up the gameplay dimension of drill-games. In Word Frog, the play element consists of manipulating the left and right arrow keys to rotate the frog and hitting the space bar to zap the bugs. The play element gets the player physically involved by stimulating a response that leads to a reward that generates more stimulation, response, and reward in an on-going cycle. For example, the Word Frog evaluator wrote: “Fun, well-paced. Physically and mentally active.” Teachers evaluating a drill-game intended for very young students or students with disabilities should try to play the game as a student would. Try playing the game opposite-handed, for example, with your left hand if you are right-handed, to check that the play element is appropriate.

Although usually associated with much more complex simulation-games, the power of story is at work in even a modest arcade-style game (Stapleton & Hirumi, 2010). In Word Frog, the story is that the frog needs to zap the approaching flies before they reach the frog. In the arcade-style game on which Word Frog is patterned, meteors must be blasted before they reach and assumedly blow up the planet. It’s not clear what will happen to the frog if a fly makes it through, and in that way the story element of Word Frog is fairly weak.

The question to ask in evaluating the story element of gameplay is, “Does the story entice students initially to play and to persist through repeated rounds of the game?” Some drill-games have lengthy exposition before, during, or after the game. For example, Multiflyer (www.brainormous.com/online/loader_multiflyer.html) is a multiplication drill-game with an elaborate story. Gravitational fields of surrounding planets are causing problems with life-support systems throughout the player’s homeland. The player is tasked with going to each planet to deliver a stabilizer that will counteract the problem. Solving multiplication problems provides the player’s space ship with the required power to reach the next planet. Multiflyer also includes a multimedia tool to assist players in finding a multiplication answer that they don’t know yet.

A teacher evaluating Multiflyer should note that the elaborate story might interfere with drill structure but that the game may provide just the right learning experience for students who don’t yet know all the multiplication tables or who have an aversion to math.

The third element of gameplay is game—that is, the rules, tools, and goal(s) that govern the game. The rules governing Word Frog are obvious; you need to zap the flies before they reach the frog. Although the story aspect of what happens if a fly reaches the frog isn’t clear, the game aspect is absolutely clear. If a fly reaches the frog, then that game round ends, and you will need to start over at the first level. You need to beat nine levels each of antonyms, synonyms, and homonyms ultimately to win the game of Word Frog. That game structure of Word Frog can result in students playing multiple rounds and practicing hundreds of synonyms, antonyms, and homonyms.

Use Recommendations. The final dimension on the CILR Drill-Game Evaluation Form refers to ways of using a drill-game as a classroom activity and is covered in more detail in the Integration section to follow. First, we return to the Locate/Evaluate/Integrate teacher scenario.



TIP

Look for active play, interesting story, and game rules that create the kind of gameplay that motivates students to persist in the progressive practice that builds fluency.

Scenario

Fifth-grade teacher Chris Fitch has located a digital video drill-game that she thinks may help students build fluency in basic math skills. Although the WWILD portal on which she found Batter’s Up Baseball included a description of the game, Chris realizes that she needs to evaluate the game herself before turning over class time to playing it. Chris clicks on the provided URL link, and Batter’s Up Baseball opens up to an introduction screen. The first thing she notices is that the screen has animated advertisements on it that might distract students. She decides to evaluate the game and then decide if it’s worth tolerating the advertisements. Knowing that she will only see the game with fresh eyes the first time, Chris makes sure she has pad and pen ready, with a reminder note to look at multimedia design, drill structure, and gameplay. She puts on her favorite ball cap backward to help her remember to think like a fifth grader.

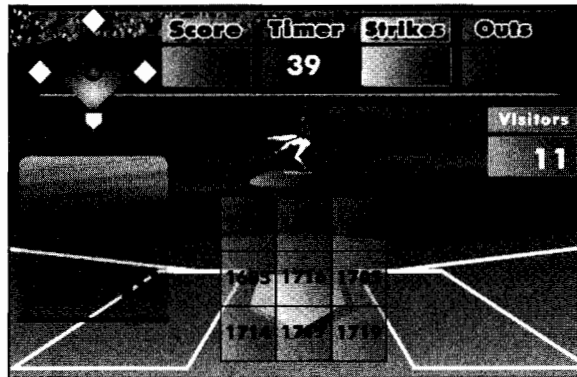


FIGURE 13.4 ▶ Batter's Up Baseball item screen
(home run difficulty level)

Chris reads the directions: a strike for a wrong answer (get to try again), three strikes and you miss the problem, three outs and the game is over: Basic baseball rules. The game offers addition or multiplication mode; she chooses multiplication. The scoreboard appears showing that the other team (the computer) has scored 8 runs. So the game's story is that Chris will have to score more runs than the computer to win the game.

Batter's Up Baseball lets Chris choose whether to try to hit (solve) a single (easier, one-digit by one-digit problem), double (more difficult, two-digit by one-digit problem), or home run (most difficult, two-digit by two-digit problem). Great! The game entices students with a bigger reward for trying harder problems. After the player chooses the difficulty level, then the computer presents a multiplication problem along with a nine-cell grid showing answer choices. Chris applies a bit of baseball strategy, choosing to "hit" singles three times to load the bases. Then she goes for the Home Run. The computer displays a two-digit by two-digit multiplication problem. She reaches for her pen to work the problem, but then she thinks to test how it could challenge even her best math students to solve the problem using mental math. She makes a quick mental math calculation and ... strike one! That's OK; she has two strikes to go. She tries again, and the game announcer intones, "It might be, it could be ... Home Run!" Four runs go on the scoreboard for the home team. Cool!

Chris plays a while longer, trying numerous multiplication problems at all levels. She then takes off her ball cap to make some teacher notes about Batter's Up Baseball. The multimedia design includes modest but entertaining animation, graphics, and sound. The game announcer is funny and doesn't get old too quickly. The game control functions work consistently. She notes that once she started playing the game, she didn't notice the advertisements any more.

Chris then considers the drill structure of Batter's Up Baseball. The problems seem to be randomly generated, so it will stand up to repeated play. There's immediate feedback with "strike" or "hit," although the feedback is slower than it would be in a straight drill. Having players choose different levels of difficulty for each problem is an interesting and unusual feature. But what if some students do not choose to challenge themselves to try harder problems? Most drill-games force the player to higher levels of difficulty. Batter's

Up Baseball rewards players for trying more difficult problems, but does not force them to. Chris notes that if she decides to use Batter's Up in class, she needs to observe whether all of the students challenge themselves appropriately.

Chris notices that Batter's Up Baseball gives the player 45 seconds to answer single, double, or home run-level questions. "That's way too much time for math-facts level problems," Chris thinks. Students should also be able to answer both the one-digit by one-digit and the two-digit by one-digit problems in well under 45 seconds. Of course, Chris can't change the programming code of Batter's Up Baseball. But she can change the *rules* and the *rewards* when playing the game in class. If she takes the students to the computer lab so that they are playing the game individually then she can declare that the first inning is "singles only" and time the inning herself with a stopwatch. "Get as many runs as you can in two minutes. Remember, you have 3 'strikes' for each problem so go as fast as you can. When I call 'time' write down how many runs you scored on your score-card. Ready . . . go!" The 45-second-per-item issue doesn't come into play because the short *total* time provides incentive to answer items as quickly as possible. The 3-strike rule encourages students to push their speed/accuracy comfort zone.

Chris can then call the second inning as "doubles only," again instructing the students to get as many hits (correct questions) as possible in a designated time frame. Chris could also indicate on students' scorecards whether or not they are allowed to use scratch paper when "hitting doubles"—thereby creating differentiated practice depending on the students' level of multiplication ability. Within the same room, using the same drill-game, some of Chris's fifth-graders can be reviewing basic computational skills (multiplying on paper) while others who are ready can be challenged with mental math.

After trying several home run-level problems, Chris realizes that all students will need to write these two-digit by two-digit problems on scratch paper and perform long multiplication. Chris concludes that, for home-run level problems, 45 seconds is an appropriate time limit to write down the problem, perform long multiplication, then find and click the correct answer on the computer screen. But she may need to reconsider the 3-strike rule. With easier problems, Chris felt that the 3-strike rule in the game was appropriate because her goal was for students to increase fluency (speed) on problems that they could easily solve. With more complex, calculation type problems, Chris was more concerned with accuracy and didn't want to encourage guessing. Therefore, she decides to allow students only one "swing" per home-run problem.

Chris shows that she is thinking of a drill-game not as a stand-alone learning activity but rather as part of a learning system in which she plays a critical role. By adjusting the rules for playing the game, Chris has not only overcome deficiencies in the drill structure but she has also customized this simple drill-game into a sophisticated, differentiated learning platform. Overall, Chris concludes that, with her adjustments, the drill structure of Batter's Up Baseball is sound with repetition, feedback, and progressive difficulty.

Looking at gameplay elements, Chris notices that the physical action is limited to clicking the mouse to choose the problem difficulty level (single, double, home run) and then choosing the answer, so the play element is limited, compared with the thumb-

numbing action of the portable video games and cell phone games that kids play. The pace of play is also a bit slow, although Chris notes that real baseball is also slow. The story element is true to real baseball, with the opponent (computer) scoring in the top of the inning and the player trying to match or beat the score in the bottom of the inning. Chris concludes that students who like baseball should enjoy Batter's Up Baseball. But she's a little worried about the students, including some international students, who may not understand or like baseball. Chris cuts out some of the baseball aspect of the game by turning down the sound and focuses on just solving math problems. She finds that while the game isn't as much fun without the baseball connection, it is still challenging and should engage students' interest long enough to get some good math practice.

Chris concludes that, although Batter's Up Baseball has advertising on the site and some problems with the game's scoring rules, she can make the game work in a lot of different ways for her students and to meet the class's learning objectives. She likes the baseball theme and, more importantly, thinks that her students will like it. She also likes being able to have students each work on individual math learning needs—whether practicing multiplication tables, developing mental math, or doing long multiplication on paper to solve more difficult problems.

With these observations, Chris has moved beyond locating and evaluating a drill-game and on to integrating the drill-game into classroom use. Figure 13.5 shows Chris's Drill-Game Evaluation of Batter's Up Baseball, including use recommendations.

DRILL-GAME EVALUATION FORM

Title/Source/URL: Batter's Up Baseball (Prongo)
www.prongo.com/math

Content Area/Grade Level/Learning Objectives. Math addition and multiplication. Various grades. Practice of addition and multiplication facts, calculations, and mental math.

Description. Baseball theme playing against the computer. Player chooses easy (single), medium (double) or hard (home run) math problems to solve. Runs score like baseball.

Multimedia Design. Modest graphics but cool announcer audio and baseball sounds. Easy directions and controls. Has advertisements on game screen that may distract students.

Drill Structure. Automatic problem generation so can play repeatedly. Students choose difficulty level for each problem. First two levels of addition and multiplication can be mental math; home run-level requires long multiplication or addition on paper.

Gameplay. Realistic for baseball fans but fun even if students don't know baseball. Should keep interest for 10 or 15 minutes.

Use Recommendations. Can challenge students according to their abilities. Good for computer lab or for home use. Need to be sure students challenge themselves when choosing difficulty level of problems. Good to set time limit to make game more challenging. Suggest doing one problem level per "inning."

FIGURE 13.5 ► CILR drill-game evaluation form for Batter's Up Baseball

Integrating Drill-Games into Classes

This section addresses the teacher's role in integrating drill-games into classroom activities. Questions to consider include the following: What phase of instruction might a particular drill-game be used in? Can the game be used as an individual, small group, or whole class learning activity? What can I do to improve drill structure or gameplay?

What phase of instruction might a particular drill-game be used in?

According to Alessi and Trollip (2001), there are four basic phases of instruction: introduction, presentation, practice, and assessment. Drill-games are most commonly associated with the practice phase. However, drill-games can also be used in the introduction phase, especially as a pre-test to help teachers determine the beginning skill level of individual students and of the overall class. Teachers can then adjust their teaching based on students' pre-test scores or level attained in the drill-game. Playing a drill-game can also be used for students to demonstrate mastery of target skills during the assessment phase of instruction.

Sometimes the same drill-game can be used in different stages of instruction. For instance, you can have students play Word Frog at the introduction of a unit on figures of speech to see if they need more instruction in synonyms, antonyms, or homonyms. After teaching a lesson on synonyms, you can have students play Word Frog specifically to practice synonyms to a level of fluency. For a detailed discussion of instructional phases and when and how to integrate games based on various instructional strategies, I encourage you to read Hirumi's Chapter 10 in this book on a grounded approach to playing games.

By playing Word Frog yourself, you'll have an idea of what level of the game you can expect students to reach. Students who don't reach the target level in Word Frog can be encouraged or assigned to play the game more at home, in the media center, or wherever a web-linked computer is available until they do reach the target level.

Can the game be used as an individual, group, or whole-class activity?

Drills are generally designed for individualized, self-paced practice. Drill-games, on the other hand, can often be played by pairs of students, by small groups of students, or even by a whole class.

Individualized drill-game activities. Research dating back to the mid-1970s has consistently shown positive learning effects for computer-assisted instruction, mostly using the drill-and-practice method (Kulik & Kulik, 1991). Indeed, drill-based edutainment games have been accepted in classrooms for many years in the important yet ultimately limited role of remediation or enrichment for a few students (Squire, 2003). Drill-games can provide individualized practice to each student in a computer lab or classroom that has a computer for every student. The availability of drill-games on the Internet also increases the feasibility of teachers recommending or assigning drill-games as homework.

Two-player drill-game activities. An alternative approach for situations with less than one computer for every student is to have students play a drill-game in pairs—which not only extends computer resources but also introduces peer interaction. Some drill-games are actually designed with a two-player mode. Other drill-games, such as Word Frog, can be turned into multiplayer games by having students open multiple game windows on the same computer screen and then asking students to take turns playing a round of their own game. Indeed, Gee (2003) notes that one of the lessons educators can draw from how kids play video games is that kids typically learn to play a video game by watching other kids play the game. You can use your knowledge of students' abilities and personalities to put together pairs of students that are evenly matched so they will drive each other with competition or, alternatively, put together pairs in which a less accomplished student can learn from watching a more adept student play the game.

Small-group drill-game activities. Students can be broken up into groups of three or four working as a team at a single computer and competing against other small groups of students using another computer. Although progressive drill-games such as Word Frog are designed as single-player games, the game's nine levels of play—each of which takes only about a minute to play—allow students in a small group to take turns playing a level of the same game. Group playing of games can develop competition strategies, cooperation and teamwork, and conflict resolution.

When you set up a team competition, you are creating a whole new set of game rules—not the rules of Word Frog but the rules of the in-class contest. You can name captains and have them choose teams, playground style. Alternatively, you can assign students to create equivalent teams. You can allow players a few “tip chips” to use to get hints from the team captain or other teammates if they get stuck on an item. The goal is to cultivate cooperation within each team and competition among the teams.

Whole-class drill-game activities. If you are working with one computer and a data projector, sometimes you can break a reasonably sized class into two large competing teams. For example, the classic language arts drill-game Chicktionary (<http://kewlbox.com/Games/GameDetail.aspx?gameID=117>) lends itself to large-group play. You can download Chicktionary (Figure 13.6) and play the game on the class computer/projector without needing an Internet connection. Divide the class into two teams and start a Chicktionary game. Alternate which team gets to form a new word from the letters in “eggs” that the chickens lay at the start of the game. Keep score on the board of the words that each team gets, giving more points as the game goes on and it gets more difficult to think of new words.

You can set the game rules of classroom Chicktionary to manipulate playing and learning conditions. For example, during a team's turn you can allow any student on the team to shout out a word, which you or a student game-master then types into the computer. Alternatively, you can increase the individual accountability of students by calling on team members individually—but not necessarily in a set order—to make the next Chicktionary word. If the students don't know whom you are going to call on, they all need to have a word ready. You can balance the challenge and frustration aspects of Chicktionary by selectively calling on students based on your knowledge of students' confidence and ability. When both teams get stuck on forming a word, the game is over. You can recognize the team with the most points on the board as the winner and reward the whole class if they combine to reach a target score in the Chicktionary game.

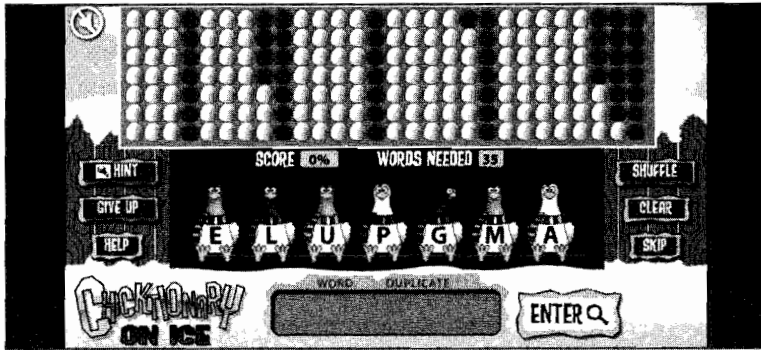


FIGURE 13.6 ► Chicktionary game screen

What can I do to improve the drill structure or gameplay of a drill-game?

In the course of evaluating a drill-game, you can often identify deficiencies in drill structure or gameplay. In many cases, however, you can overcome these deficiencies by changing or adding rules. For example, except for very young students, the building of fluency requires that students increase their speed as well as their accuracy in drills (Alessi & Trollip, 2001). Arcade-based games almost always have a speed element. Many other online drill-games, however, do not include a speed factor. You can enhance drill structure and gameplay by setting time limits for students to beat a level. You can then decrease the length of time to increase the level of difficulty.

As the teacher, you will be able to make adjustments in the classroom use of a drill-game when you have evaluated it thoroughly, including playing it through several times yourself, and when you understand the dimensions of drill structure and gameplay. When a drill-game is well designed and when a teacher integrates it thoughtfully and creatively into the curriculum, the game format can facilitate highly effective and engaging learning.

Let's return to Chris as she wraps up her evaluation of Batter's Up Baseball.

Scenario

Chris Fitch has located and positively evaluated the math drill-game Batter's Up Baseball and is now considering how she can use it with her class. One option is to use the game as a pre-test early in the school year. The students should have the basic multiplication tables down cold, but if any of them don't, then Chris wants to find out and make sure those students get up to speed. Using a computer for each student, Chris can give a multiplication facts pre-test by instructing the students that they may only hit "singles" and cannot get any strikes. She knows from playing Batter's Up Baseball that a student who knows his or her multiplication tables should easily be able to answer 10 problems correctly in 90 seconds of play. A couple of short, timed "innings" of Batter's Up should suffice as a painless pre-test.

To develop students' multiplication fluency beyond the basic tables, Chris can change the rules so that students hit only doubles. Some of these two-digit by one-digit multiplication problems are at the math facts level, while other problems involve fairly challenging mental math. Chris estimates students can comfortably complete 10 double-level problems in two-minute innings. Since this activity is intended to develop rather than test students' multiplication skills, Chris will have them complete numerous innings of doubles-only Batter's Up Baseball, perhaps over several sessions.

Chris also envisions having the students occasionally play Batter's Up in home run-only mode to practice long multiplication. The activity is similar to completing multiplication worksheets, but the gameplay adds interest, and the immediate feedback that the computer provides to students with every problem is superior to the delayed feedback they would receive on a graded worksheet. The game's instant feedback also saves Chris the time she would have spent grading worksheets.

Chris also starts thinking of how she can use Batter's Up Baseball in a more social learning context to take advantage of the single Internet-connected computer she has in her classroom. She envisions making multiple competing teams, each consisting of four students of varying ability. The students would play Batter's Up as designed (without her modifications), self-selecting to attempt singles, doubles, or home runs. The only house rule would be a time limit of five minutes to play a game. Having a limited time to score as many runs as possible should provide an incentive for the students to try more difficult home run-level problems. Team members would take turns "batting" on the classroom computer while the rest of the students complete workbook pages—and wait for their turn on the computer (if their workbook pages are done). Students could give their teams names and write their team scores on the board. If the students take to the game, Chris conceives of a Batter's Up Baseball league, where teams can challenge the team above them in the standings. Chris's efforts have led her to locate and evaluate a fun drill-game that has the potential to be integrated into a variety of learning activities throughout the school year.

Summary

After years of being criticized as "drill-and-kill" edutainment, drill-games—many of them available for free on the Internet—are rapidly increasing in quantity and quality. With the National Mathematics Advisory Panel (U.S. Department of Education, 2008) specifically emphasizing the need to develop fluency in essential math operations and with many years of research supporting the positive effects of drill-and-practice in multiple content areas, drills have an important place in classrooms. Combining drill structure with gameplay makes drill-games more enticing and keeps students playing—achieving the repetition that is necessary to build fluency.

The current generation of web-based drill-games features much higher quality animation than previous generations of edutainment, with the games produced and distributed by Arcademic Skill Builders representing the state-of-the-art arcade-style drill-games. Drill-games like Word Frog and the similarly formatted Meteor Multiplication have solid drill structures and are fun for students to play. Grand Prix Multiplication, also by Arcademic Skill Builders, brings digital video drill-games into the realm of multiplayer online gaming, as students can “race” online with other students in the class or with students who happen to be online anywhere in the world.

As large education companies, such as Houghton Mifflin (Fun Brain) and Pearson Education (Game Goo), become more involved in producing digital video drill-games, we can anticipate advances being made in the structures of drill-games as well as in the overall quality of gameplay. For example, look for more sophisticated queuing schemes to insure that students master all of the content or problems in a drill-game. You can also expect to see advances in tracking students’ performance as they play drill-games, both to guide the students’ individual development and to provide feedback to teachers and administrators on the effectiveness of a drill-game. At some point, the best multiplayer, online drill-games with the most complete student feedback and assessment tracking will be offered as commercial educational services available for purchase at the school or district level—and without advertisements. In the meantime, you and other teachers, parents, and students can easily access a wide variety of free and fun online drill-games.

The lasting appeal of drill-games is that they motivate students to practice and learn, while the drill dimension helps parents, teachers, and administrators embrace gameplay for instructional purposes. For teachers who want to explore integrating digital video games into their classrooms, drill-games can be a great place to start.

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Single-Entity Drill-Game Websites

Game Goo

www.earobics.com/gamegoo/gooeyhome.html

This commercial site features Flash drill-games produced by a company called Earobics and hosted by the Houghton Mifflin Company. The games are free, and there are no banners or ads. The Flash games are consistent in approach and full of funny and funky Flash animation and sounds, many of which adults can also enjoy. The games have sound instructional designs. Game Goo has drill-games to help young learners practice language and reading skills, such as opposites, letter recognition, alphabetical order, capitalization, and fiction versus nonfiction. Games are organized into three levels of difficulty. Students can choose to view or skip the introduction and directions. These are state-of-the-art Flash drill-games for elementary and preschool learners.

BBC Learning: Schools

www.bbc.co.uk/schools

This non-commercial site, managed by the British Broadcasting Corporation (BBC), has a wide variety of drill-games and other activities for preschool through high school levels and covers essentially all content areas. Flash drill-games for elementary language skills are well executed—and listening to English spoken with a British accent is fun. This site is especially valuable as a source of multimedia activities for secondary students, as they are harder to find on the web. There are many multimedia activities to explore in addition to games, including a link to the BBC's home page, with access to international news; sports; feature stories

on health, history, science, music, arts, recipes children can follow; and more. The biggest problem is that there is so much on the site that it can be confusing to use at first. Educational games and activities are of a consistently high quality, and the site has no pop-up advertising.

Fun Brain

www.funbrain.com/kidscenter.html

Fun Brain is a commercial site with ads. The site has numerous parts. Pearson Education runs the site and has added new activities and games, including drill-games. The classic Fun Brain games are also available. Drill-games, such as Math Baseball and Grammar Gorillas, are older and very basic graphically, but many have good drill structures. For instance, Spellaroo displays sentences and has players click on the misspelled word—developing the critical skill of recognizing misspelled words in context. The newer parts of the Fun Brain site are much flashier but not always as instructionally sound. Arcade and Math Arcade each feature 25 Flash mini-games, some with clear instructional objectives and some not. In the site's arcade areas, players are forced to play the games in order, and ads are embedded. Fortunately, the same games can be accessed individually and without ads (kidscenter page). The centerpiece of the new area of Fun Brain is an exploratory learning environment called Poptropica. Players are asked whether they are a girl or boy and how old they are (up to age 15). A game board appears that offers (for example, after signing in as a 15-year-old girl) 12 islands to choose from, each with a different game, such as mythology, spy, super power, reality TV, astro-knights, shark tooth, time tangled, and 24 carrot.

Arcademic Skill Builders

www.arcademickillbuilders.com

This noncommercial site contains drill-games that incorporate features of arcade games into fun, online drill-games that are highly evolved by the site founder, a professor of special education at University of Kansas who has long history in developing educational video games going back to 1970s. The math and language arts drill-games are state-of-the-art Flash games with simple gameplay, good animation, and sound drill design. The online, multi-player Grand Prix game takes drill-games to a new level. All of the drill-games stand up to repeated play and emphasize players' development of fluency in basic skills.

Quia

www.quia.com/web

This noncommercial site offers templates to teachers for creating their own quiz games and various other multimedia activities. The quiz games are then organized by content area and type of multimedia activity (e.g., quiz, hangman, battleship, scavenger hunt, jumbled words) and are available to anybody using the Quia site. Because the games are "homemade" teachers should check them thoroughly before having students use them. The game templates work best with concept and definition content rather than the vocabulary or math content that both call for true drill-and-practice. Teachers who register for a modest fee can use the templates to make games and can also register their students so that students' participation and performances are recorded individually.

Drill-Game Reviews

Squanky, the Tooth Taker (*Game Goo*)

www.earobics.com/gamegoo/games/squanky/squanky.html

Content Area/Grade Level/Objectives. Language arts. Early elementary readers or pre-readers. Match a given word with its antonym. There is also a synonym game.

Description. The tooth taker leads the learner through the drill-game. Each of 10 kids asleep in a big bed is associated with a word. A trigger word appears out of a chest of drawers. The player clicks on the word/kid with the opposite meaning. If the answer is correct, positive feedback is given. If an incorrect answer is given, the learner is cued to try again. After three misses, the answer is given, and the game moves on—although the missed word will be re-presented later (queuing). After all words are matched, then the player is “rewarded” by moving the cursor to place teeth into empty spaces in a gaping mouth. Kids seem to get it.

Multimedia Design. The Flash animation and sounds are high quality and “ticklish.” The voices are humorous. The interface controls are easy for a target learner to use. Words are highlighted and pronounced on mouse rollover.

Drill Structure. Good repetition; the game can be played repeatedly. Immediate and corrective feedback is provided. No progressive difficulty, though the Game Goo site has games categorized as beginner, intermediate, or advanced levels that learners self-select.

Gameplay. Good example of drill structure and gameplay working to amplify the value of both. The “pedagogical agent” (tooth taker) is silly and a bit obnoxious yet supportive. Pacing is appropriate. The game is fun and seems to connect with kids.

Use Recommendations. Could be used as a one-computer group activity.

Grand Prix Multiplication (*Arcademic Skill Builders*)

www.arcademicskillbuilders.com

Content Area/Grade Level/Learning Objectives. Math. Elementary grades. Practice multiplication facts and some calculations.

Description. Players race cars by answering multiplication questions. Players choose to race against the computer, classmates, or unseen people on the Internet.

Multimedia Design. Nice Flash animation and good race sounds.

Drill Structure. Rewards speed as well as accuracy. Doesn’t punish mistakes too much—the car loses speed. Doesn’t give correct answer if player gives wrong answer. Wrong answers with correct answer are shown on post-race report.

Gameplay. Great multiplayer gameplay. OK against computer but really fun against classmates or unseen online players. Game and drill well integrated. Stands up to repeated playing.

Use Recommendations. Great for learners who have more confidence in gameplaying ability than math ability. Can be used in a computer lab with up to four students in a race.

Ball Hogs (Family Education Network)

<http://fen.com/studentactivities/BallHogs/BallHogs.html>

Content Area/Grade Level/Learning Objectives. Language arts for elementary grades. The game says it goes up to Grade 6, but it's too easy for average sixth graders. Appropriate for Grades 1–4 and for remediation and ESL students through Grade 6. Practice synonyms and antonyms.

Description. Pig-like characters squat as ball boys/girls on either side of a tennis net. After the tennis ball goes back and forth over the net a few times, a target word appears on screen. Three other words rotate, one of which is the desired synonym or antonym of the target word. The player-pig and another player-pig or computer-generated pig compete to jump on the ball when the correct word appears. First to get three correct answers wins the round. A tournament includes multiple rounds with zany pig characters.

Multimedia Design. Simple but creative Flash animation and sounds.

Drill Structure. Good design to have consistent time for players to see the clue and anticipate what the answer might be. The player should be ready to jump fast if the expected word is revealed but also must be open to changing to another word if the expected word doesn't show up, a unique drill feature. Corrective feedback is not given. If the player jumps on the first answer word and it is incorrect, the other player gets the point. Sometimes a missed item repeats.

Gameplay. Different sort of game from arcade-style games. It is playful, especially in two-player mode. Unique format may not stand up to repeated play. Changing grade levels as an option doesn't seem to change the difficulty much.

Use Recommendations. Good for occasional use, especially in two-player mode. Rounds are short enough to allow multiple students to take turns on one computer.