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What is This?

The Development of Educational and/or Training Computer Games for Students With Disabilities

Jungmin Kwon, PhD[1]

Abstract

Computer and video games have much in common with the strategies used in special education. Free resources for game development are becoming more widely available, so lay computer users, such as teachers and other practitioners, now have the capacity to develop games using a low budget and a little self-teaching. This article provides a guideline for teacher-, clinician-, practitioner-, and parent-developers on the development of a game for the education and/or training of students with disabilities.

Digital games play a significant role in the lives of today's youth, so the search for viable methods that successfully incorporate gaming into education has received increasing attention in recent years (Gee, 2007; Squire, 2006; Vorderer, Bryant, Pieper, & Weber, 2006), including the education of students with disabilities (Akhutnia et al., 2003; Beal, Kato,

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Marin-Bowling, Guthrie, & Coles, 2007; Deutsch, Borbely, Filler, Huhn, & Guarrera-Bowlby, 2008; Jannink et al., 2008). Digital games have much in common with the strategies used in special education. Repetitive practice (Grodal, 2003), immediate feedback (Dickey, 2005), attention grabbing through visual/sound cues (Aldrich, 2009), task analysis (Gopher, Weil, & Bareket, 1994), provision of experience of success (Gee, 2008), and individualized play (Klimmt & Hartmann, 2006) are some of the features of games that are also often used to assist students with disabilities.

Research has shown that games that have been carefully designed to meet the educational/training/social needs of students with disabilities can yield positive effects. It has been reported that games can encourage players to change their behaviors and attitudes towards their disability (Lieberman, 2001), increase self-efficacy (Thomas, Cahill, & Santilli, 1997), provide enthusiastic experience (Weiss, Bilalik, & Kizony, 2003), enable players to learn curricular content areas (Ota & DuPaul, 2002; Sanchez & Flores, 2008), and/or increase their social interaction (Piper, O'Brien, Morris, & Winograd, 2006). Examples of games that have successfully produced desired outcomes by carefully targeting the particular needs of specific populations include face recognition games for children with autism (Tanaka et al., 2010), wheelchair-driving games for first-time wheelchair users (Hasdai, Jessel, & Weiss, 1998), diabetes self-treatment games for children with diabetes (Lieberman, 2001), and social skills training game for students with Asperger's syndrome (Piper et al., 2006).

Although the games market is rapidly expanding, it may be difficult to find appropriate games for classroom or clinical use (Rice, 2007). The gaming industry is strongly driven by commercial outcomes (Michael & Chen, 2006). Whereas an infinite number of games are available for general play, far fewer games have been designed for educational purposes, and even these have been developed for commercial markets. This means that the games are driven to accommodate large populations and typically only offer general educational tools. This translates into limited options for special educators and clinicians (Rice, 2007). Furthermore, researchers suggest that much of the educational software on the market has been developed without instructional considerations for students with disabilities (Boone & Higgins, 2007). Research into, and development of, games for students with disabilities has been ongoing since the 1980s, but when the wide range of the abilities, needs, and characteristics of these students are considered—as well as the breadth of curricular areas—there remains a substantial lack of games (Ossmann, Miesenberger, & Archambault, 2008; Rice, 2007) that could be used for educational and/or training purposes.

With evolving technology, the design and development of computer games has become significantly easier than it has been in the past, enabling lay computer users, such as teachers, clinicians, and parents, to construct their own games for specific purposes. These amateur developers can create games that are based on the precise needs, characteristics, and learning objectives of the players. This article describes how to develop a game for students with disabilities using free tools and resources that are available for teachers and clinicians. Furthermore, by providing insights and strategies for computer game development, it is hoped that the professionals who meet these students face-to-face will be encouraged to become designers and developers of games.

Overview

For a first-time game-developer, with limited access to resources, the task may initially appear daunting. There may be a vague idea of what the game will be like when completed but no idea as to how to progress. In this article, the various steps involved in designing and developing an educational game are described. The process resembles the working practices of a group of professional developers, but with little financial investment, time, and labor available for independent amateurs, it has been modified into a more linear fashion than that which would be used by a group of professionals working simultaneously on a single project. The steps suggested in this article are (a) decide target audience and learning objectives, (b) select a genre for the game, (c) write a short concept paper, (d) create a storyboard, (e) write a detailed script, (f) create graphics, (g) shop for sound, (h) put together using a game-developing tool, and (i) test on potential users. A detailed explanation of each of these steps follows, using examples from a game titled *Adventures on Coolong Island* (see Note 1).

Adventures on Coolong Island is a job skills training game, based on a job training manual. In the game, the player is shipwrecked upon a shore of an unknown island after a storm. To escape the island and go home, the player must work on the island to earn money to mend the ship. There are several jobs available on the island, and each of those jobs can be practiced in the form of minigames for the player to master. The game was developed for students with mild to moderate intellectual disability.

Step 1: Determine the Target Audience and Learning Objectives

As in planning any instruction, the teacher or designer must first identify the characteristics of the learner. Many people would think only teenagers are attracted to computer or video games; however, recent surveys (Entertainment Software Association, 2011; Pew Internet Project, 2008) have found that players come from a broad cross-section of the population, regardless of age, gender, education, and race. Game developers who wish to design games that interest a wide range of players (e.g., ages 18 to 37) may actually dilute the quality of the game, so attempts should be made

Table 1. Game genres, characteristics, and examples

Game genre	Key characteristics	Examples of commercial games	Possible use in curricular areas
Role playing (incl. 2D platformer)	Story/fantasy-based, player plays the hero character who intends to save the world	Dungeons and Dragons, Final Fantasy series, Diablo series, Pokemon series	Self-care skills (Beale et al., 2007; Lieberman, 2001), Self-efficacy (Thomas et al., 1997) Interaction (Mangan, 2008)
Sports	Simulates traditional physical sports, their rules, and competition	Madden NFL series, MLB series, FIFA Soccer series, Tiger Woods PGA Tour series, Mario Sports series	Sports and leisure (Weiss et al., 2003; Yalon-Chamovitz & Weiss, 2008)
Adventure	Interactive, explorative, little competition	Myst, James Bond 007 series, Donkey Kong series, Grand Theft Auto series, Legend of Zelda series	Self-care skills (Bartholomew et al., 2000), Safety (Coles et al., 2007), Science (Barab et al., 2005), Language arts (Warren et al., 2008); Social studies (Barab & Jackson, 2004)
Construction and management simulation	Build and manage fictional cities as an ongoing process with limited resources, God-like view	SimCity series, Tycoon series, Capitalism	Business (NCube, 2010), History (Squire, 2006), Urban planning (Squire, 2006)
Puzzles	Single play games, sometimes time restraint	Tetris series, Professor Layton series, Create, Bejeweled	Functional skills (Hasdai, 1998), Social skills (Tanaka et al.,2010), Cognition (Akhucnia et al., 2003)

to target the game to a specific group, or to a person with specific needs (e.g., 12- to 17-year-olds with Down syndrome or a 20-year-old male with vocational training needs). Consideration of the wide range of abilities and characteristics of players with disabilities and possession of a clear picture of the profiles of potential players (e.g., age, type of disability, gender, occupation, interests) will help the amateur developer shape realistic learning objectives.

To avoid the development of another conventional game that has little educational effect, the learning objectives must be carefully determined before the game is designed. These may come from the everyday curriculum of the practitioner, the individualized education program (IEP) of the target student, or the individual needs of the potential player. The learning objectives may be explicit behavioral goals, such as "to teach the player how to tie a shoe," or may be less explicit, long-term goals, such as "to improve the player's health" or "to help understand street safety rules." The objectives may be structured in multiple levels, sequences, or subjects.

One of the purposes of the example program, *Adventures on Coolong Island*, is "to train players to maintain/develop skills needed to work in an office." For learning objectives, the practitioner-developer can set the subgoals (a) to teach and train mail-sorting skills and (b) to teach how to photocopy documents.

Finally, after the target population and the learning objectives have been determined, research must be conducted to ensure that a similar game is not already available on the market. Game development requires a huge amount of effort and resources, so the best approach would be the use of an existing game if it meets the needs and objectives of the user. To determine whether the game is well designed for learning, a software checklist (Boone & Higgins, 2007) may be adopted for evaluation. According to the checklist, some of the features of good educational software include (a) interesting content that is relevant to the curriculum; (b) a variety of difficulty levels; (c) graphics that are not overwhelming or distracting; (d) outlining, questioning, and repetition that are used as instructional strategies; (e) simple and explicit directions; (f) provision of transfer strategies; and (g) feedback that is consistent, immediate, and obvious. These may be used as guidelines for the developer as well.

Step 2: Select Game Genre

A variety of different game genres currently exist. According to Rollings and Adams (2003), games can generally be categorized into the following types: action (including shooting), strategy, role playing, sports, vehicle simulation, construction and management simulation, adventure, virtual life, and puzzles. Among these genres, types of games that may be developed by an amateur game developer, and some examples of possible instructional games for the genre, are described in Table 1.

Genre selections should be based on the instructional objectives; the delivery methods; availability of funds; game development skills of the developer; and the ability, interests, and preferences of the player. To gain a better understanding of each genre, it is recommended that the

Concept paper

Target audience: Students aged between 14 and 17 with intellectual disabilities.

Game genre: Adventure & puzzle.

Target platform: PC & Mac.

Instructional objectives: The purpose of this game is to teach specific job skills to students with moderate intellectual disabilities.

Storyline:

After a storm at sea, the main character (player) is washed up on the shore of an island. The ship is wrecked. He/She needs to work on the island to earn money, buy ship parts, fix the ship, and go back home. There are several opportunities for work on the island. After he/she masters all the skills, earns money, and finishes rebuilding the wrecked ship, he/she is able to escape from the island.

Mini-games:

Farm work: Apple picking & packaging game, hydroponics game.

Office work: Mail sorting game, photocopying game.

Factory work: Pen assembly game, wood-working game.

Market work: Grocery-bag game, cafeteria game.

Figure 1. Example of a concept paper.

developer play games from a variety of genres to be in a better position to select a genre that would be appropriate for the game under development. There are no general rules for which genre best fits a particular curricular area, but ideas may be obtained from the references based on research offered in Table 1. Furthermore, for a first-time developer an effective strategy may be to use a benchmark game as a model. Finding an appropriate benchmark game can be accomplished by playing games. Some of the free game-play sites offering relatively simple games that may be referred to are Shockwave (www.shockwave.com), Bratz Games (www.bratzgrounds.com), Miniclip (www.miniclip.com), and FOG (www.freeonlinegames.com).

Step 3: Write a Short Concept Paper

A concept paper is an outline or a summary of the game project. It should contain basic information about the game, such as potential audience, game genre, target platform, instructional objectives, and a rough storyline. For professional developers, the rationale behind writing the concept paper is to persuade investors to support game development (Rollings & Adams, 2003); whereas for teachers, the concept paper has a less formal and more personal purpose:

Its writing will help teachers start thinking about the game in detail, beginning the process of interweaving it with instructional objectives. The concept paper will also help to constantly remind teacher-designers of the purpose of the game, how the story will evolve, and the needs and characteristics of potential players.

The concept paper should include a storyline for the game. Good stories not only enhance the appeal of the game, they can also be powerful tools to help players become immersed and, hence, make the game-play experience more meaningful and interesting (Lindley, 2005). More information regarding game storytelling can be found on the Web, if a search is conducted using keywords such as "digital storytelling" and "game storytelling." As an example, the concept paper that was written for *Adventures on Coolong Island* can be seen in Figure 1.

Step 4: Create a Storyboard

The next step is to create a storyboard in which the ideas will be visualized in a communicative form. The storyboard should include detailed visuals and a script to explain how the game will be designed and played, and it can be created in a variety of different ways. The traditional method would

Figure 2. Progression from a PowerPoint storyboard (left) to the final product (right).
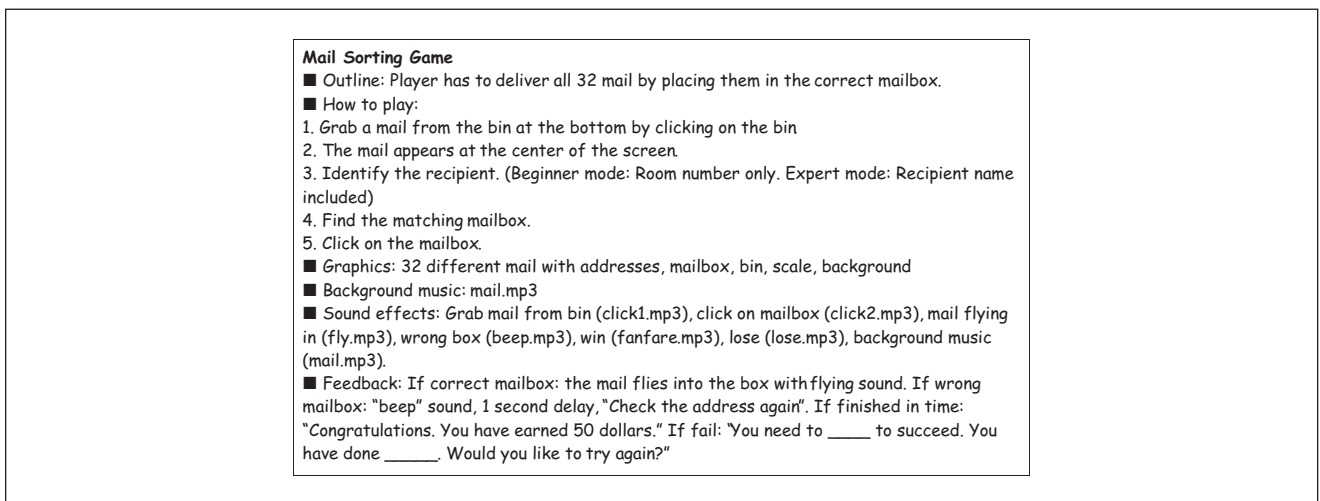

Figure 3. Example of a script.

be to hand-draw the scenes and write the script (Cristiano, 2007). However, use of PowerPoint or a similar presentation software is recommended for several reasons. First, PowerPoint allows the teacher-designer to use the Web to find and download existing images and use these in the storyboard so that the images do not need to be hand-drawn. This not only saves time but also means that the downloaded images may be easily moved around the PowerPoint slide to ensure optimum design. PowerPoint also has multimedia features, similar to those that will be used in the game, such as animation, sound, and hyperlinks. Indeed, simple games, for example, quizzes, puzzles, or simple math games, may be constructed using PowerPoint alone (Pitler, Hubbel, Kuhn, & Malenoski, 2007). There may also be times when the amateur-developer is required to present a game idea to other teachers, students, family members, artists, programmers, or potential investors/funders while it is under development. Having the storyboard PowerPoint-ready saves a lot of time and resources.

PowerPoint storyboard graphics do not have to be perfect—a rough sketch of the idea of the game would suffice for first-time developers. Figure 2 shows the progression from a storyboard created in PowerPoint to the final product.

Step 5: Write a Detailed Script

The script, which is part of the storyboard, is the text that describes the visuals and actions in as much detail as possible. Script accompanies every scene, providing a consistent reference throughout game development. Therefore, the author should write a detailed script that includes specific instructions for sounds, movements, effects, actions, goals, transitions, and timings. Again, an advantage of PowerPoint is that it enables some features—such as linking a sound or embedding an action—to work in a similar manner to how they would in the game itself. This helps the amateur designer to have a realistic feel of the game. The more detailed the script can be, the better. Refer to Figure 3 for

Table 2. Special educational strategies in programmable words

Strategy	Programmable words for the script
Repetitive practice	40 apples must be packaged within the time limit of 90 seconds. If the player fails, the game character appears on the screen and explains why the player failed and ask if the player would try again.
Immediate feedback	When the player puts a fresh apple into the waste bin (wrong move), (1) a "buzz" sound signifies a wrong move; (2) the words "Do not trash fresh apples!" blinks on the screen three times within a 3-second time-frame; and (3) while the words are blinking, the player cannot take any action for the 3 seconds.
	When the player puts a rotten apple into the waste bin (right move), a "ding" sound will signify a right move.
Visual cues	On the map of the island, when the mouse is over a clickable image of a village, (1) the village is highlighted; and (2) available jobs in the village are displayed on the top side of the image.
Task analysis	The player can succeed in the mail-sorting game by following the correct order for the tasks: (1) take out the first mail by clicking on the bin; (2) read the name on the mail; (3) look at the name tags on the mail boxes; (4) find the mail box with the same name on the mail; (5) put the mail into that box.
Experience of success	The player is given a "practice mode" for each mini-game. In the cafeteria game, instead of serving the trays of 10 people in 2 minutes, the player serves the trays of three people with no time limit in the practice mode. When the player finishes the practice task, the words "That's how you do it!" appear on the screen for 3 seconds, and the "applause.mp3" sound file is simultaneously played for 3 seconds.
Individualized play	When the player clicks on the grocery bag game, she or he is given options to choose from in "practice mode," "novice mode," and "expert mode." In practice mode, the player must put 3 grocery items into the grocery bag in the correct order with no time limit. In novice mode, the player must put 10 grocery items into the grocery bag in the correct order within 3 minutes. In expert mode, the player must put 20 grocery items into the bag in the correct order within 1 minute.

an example of script for the *mail sorting* game from *Adventures on Coolong Island*.

The special education strategies that the developer may want to embed in the game should be worded in programmable forms. For example, if the game requires that the player practice a skill repetitively, rather than writing "practice apple packaging repetitively," it is more suitable to write, "40 apples must be packaged within the time limit of 90 seconds." If the player fails, the game character appears on the screen, explains why the player failed, and suggests that the player tries again. Examples of how the strategies can be scripted are provided in Table 2.

When writing the script for narrated words, attempts should be made to keep the words simple. There is a possibility that the player may quickly pass by, or pay less attention to, the text, and it cannot always be guaranteed that the player will have sound when playing the game. Therefore, it is advisable to keep the text and sound directions as brief as possible and to design the game so that the player can intuitively figure out how to play it with the least number possible of textual or auditory cues.

While keeping the words simple, embedding direct and explicit instruction where appropriate may be an effective strategy for players with disabilities. Research has shown that direct and explicit instruction within context-rich environments can result in positive learning outcomes (Bottge, Rueda, Grant, Stephens, & LaRoque, 2010; Gersten & Baker, 1998). Such instruction can be used in tutorials, walkthroughs, or verbal/textual cues within the game.

Gameplay speed should also be carefully controlled for the potential players. Commercial games are typically too fast to play for students with disabilities (Ossmann et al., 2008), so it is advisable to slow down the competition against time when designing a game for students who may have trouble with perception, movement, rapid response, or comprehension.

Although the game has been planned for a certain population with specific learning/training objectives, the provision of a few different options for these goals may also allow players outside of this population to benefit from the game. For example, *Adventures on Coolong Island* was primarily designed to teach occupational skills to teenagers with mild intellectual disabilities. However, addition of slower speed options and simplification of the tasks of the minigames has made the game beneficial to students with moderate intellectual disabilities. Furthermore, the simple addition of a "large screen" option may accommodate players with problems with visual or muscle control.

Step 6: Create the Graphics

Graphics in typical two-dimensional (2D) game design should largely be understood as comprising two levels. In this article, 2D is emphasized because 3D graphics require a considerably more sophisticated level of graphic design skills. The two levels of graphics in 2D games refer to those that are *static* and those that are *not static*. Static images are background images and cut scenes, which the player will

Table 3. Types of graphics and description

Graphic	What it is	Things to consider
Background	The static scene in the back	Context of the game is expressed through the background graphics. The color and images of the background should not interfere with visual attention while playing.
Cut scenes	Short scenes that are displayed at the beginning, during, or near end of game to tell story or tutorial	Cut scenes should be kept to a minimum, as they could interfere with flow of game. Inclusion of information essential for game play only is recommended.
Characters	Human or nonhuman beings	Character can be the player himself or herself or can be used as friendly/hostile agents to tell the story.
Objects	Small images that stay over the background	Objects are usually small images that could be manipulated.
Items	Prizes, coins	Items are small objects that are targets of collection.
GUI	Point keeper, timer, buttons, shortcuts	Game user interface must not interfere with game play.

have no power to manipulate or move. Graphics that are not static are those that comprise the remainder, and that will be layered on top of the background. Characters, objects, items, text images, and the game user interface are the graphics that are not static. Static background images generally tend to be larger in screen size than nonstatic images. Table 3 explains each of these graphics along with examples from *Adventures on Coolong Island*.

There are three ways to obtain graphics for the game. First, royalty-free graphics can be downloaded from the Web. These free graphics sites are abundant, and useful key words when searching for them are "royalty free images," "royalty free graphics," "free backgrounds," "free images," "free GIF," and "free JPG." The majority of types of image files can subsequently be imported into the game-making tool, but JPG and GIF tend to be smaller in file size, which will make the game faster for play. These images are free to use, provided that the user does not commercialize the game. Second, some graphics often are included with the software development tool selected to create the game (refer to Step 8: Put Together Using Game-Developing Tool). The graphics provided by these programs are likely to be more game-appropriate than those downloaded from the Web. However, because these graphics are limited in number and are available to all users of the program, the images may lack originality. Third, graphics can be created by the developer by (a) using graphics software, such as Photoshop or Illustrator; (b) using the drawing tools embedded in the game-creation software; or (c) hand-drawing original images, scanning them in, and retouching them with one of the graphics software programs. The advantage of this third option is that it will guarantee the originality of the graphics, but the disadvantage is that it will take up extensive time and workforce.

Boone and Higgins (2007) suggested that graphics in well-designed educational software for students with disabilities should not be overwhelming or distracting. To decide the appropriate level of graphics, it may help the amateur-developer if the graphics are categorized as follows:

1. essential for game-play (e.g., items, tools, graphical user interface [GUI]);
2. not essential for game play, but necessary for context (e.g., background); and
3. not essential for game play or context.

Depending on the age, characteristics, and needs of the student, priority should be given in order of 1 (*the most*) to 3 (*the least*). For example, if the game is intended for a preschool child with upper-body muscle-control difficulties, the designer should focus on Category 1: the graphics should be simple, few, and be large on screen. If the game is intended for a teenager with autism learning to interpret complex social cues, there will likely be many complex graphics from Categories 1, 2, and 3, which should result in a more realistic game. During the user test (see Step 9: User Test), observation will allow the developer to see whether the amount, size, and location of the graphics are appropriate for play. The graphics may be fine-tuned after initial development of the game, by trial and error.

Step 7: Shop for Sound

Research into the role of sound in game play has just begun, but based on that which has been conducted on film media audio, sound in a game can be a major way to communicate with players (Sonnenschein, 2001). Background music can signify, without text, the context of the game and the

Table 4. Websites for Sounds

	Types of sounds	Web address
Websites to download sounds	Free background music	http://www.sakari-infinity.net/
		http://www.partnersinrhyme.com (also has sound effects)
		http://www.flashkit.com/loops/
	Paid background music	http://www.opuzz.com/
		http://www.premiumbeat.com
		http://melodyloops.com/
	Free sound effects	http://www.pacdv.com/sounds/index.html
		http://www.a1freesoundeffects.com/
		http://www.freesound.org/
		http://www.grsites.com/sounds/
	PC	Mac
Programs to edit sounds	WavePad Sound Editor	Garage Band
	Cool Record Edit	iMovie
	Gold Wave	WavePad
	Audacity	Audacity
		DSound Pro

narrative. Music may also trigger an emotional response during game play, creating states of tension and relaxation that make the game-playing experience both enjoyable and believable, and enable the player to become deeply immersed in the game (Zehnder & Lipscomb, 2006). Sound may be especially important for players with disabilities, because it can communicate without the need for text, and the perception of sound language is more immediate than reading. Sound is one of the most efficient and universal ways to provide feedback and information about a game.

Three types of sounds may be required for the game: background music, sound effects, and human vocals. For background music and sound effects, the developer may either use sounds of his or her own or download some from the Web. There are free sounds and music available online. Table 4 gives a list of sites at which necessary sounds can be searched for, found, and subsequently saved to the hard drive of a computer. These sounds may be subsequently linked to the game by use of a game-creation tool. It is recommended that *.mp3 file formats are used to reduce total game file size, although other formats would also work well. For human vocals, one of the free programs listed in Table 4 may be used to record and/or edit a human voice. To reduce noise level, high-quality microphones should be used and recording should be conducted in a soundproof room.

Step 8: Put Together Using Game-Developing Tools

Several game-development software programs are available free. A list of these programs, and the websites from which they can be downloaded, is presented in Table 5.

Most of these programs use a drag-and-drop interface that allows users with no professional programming knowledge to weave the ready-made sounds, images, and built-in actions together into a game format. Please note that regardless of how user-friendly and intuitively designed these software programs may be, the developer must be prepared to spend significant time in learning to put these tools to good effect. It is therefore practical to first become familiar with these tools and learn how to use them before designing an important game project, to have a clearer understanding of what can and cannot be done. There are many self-teaching tutorials and discussion boards associated with these programs, and these are available both online and offline. A list of these tutorials is also included in Table 5.

There are other game-making programs available for which payment is required. Most of the free programs listed in Table 5 offer an alternative version for which a fee must be paid but that include a greater number of functions. Programs such as Adobe Flash and Macromedia Shockwave are user-friendly, yet powerful, multimedia tools that could be used for developing games, and games created with these tools could also be accessed online. Although the capacity to use these tools does not require an in-depth knowledge of programming, sufficient time and effort in learning how they are used must still be expended.

The game-weaving tool allows the developer to combine graphics and sounds to create action, play, and story. If the storyboard was planned carefully and the script was written thoroughly, the developer would have every graphic and sound that is required to develop the game. However, first-time developers are likely to need more graphics and sounds as the game is being created. It may even

Table 5. Game developing tools for nonprogrammers

Software	Price	Types of games capable	Software platform	Game platform
Game Maker	Free[a]	Platform, Shooter, 2D RPG, Multiplayer, Construction and Management Simulation Games, Maze, 3D, Driving	Windows and Mac	Windows and Mac
		Download: http://www.yoyogames.com		
		Tutorial: http://www.yoyogames.com/make/tutorials		
RPG Maker	Free[a]	Role Playing	Windows	Windows
		Download: http://www.rpgmakerweb.com		
		Tutorial: http://www.rpgrevolution.com/tutorial/ abeginners%27-guide-torm2k3_84.html		
Adventure Maker	Free[a]	2D/3D RPG, Puzzle, Maze	Windows	Windows, PSP, iPhone, iPod Touch
		Download: http://www.adventuremaker.com		
		Tutorial: http://www.entropy-art.com/adventuremakertutorial/		
Gamestar Mechanic	Free[a]	Platformer, Shooter, Maze, Puzzle	Windows and Mac	Windows and Mac
		Download: http://gamestarmechanic.com		
		Tutorial: http://d1uoa9d4t4btfa.cloudfront.net/1.19c/pdfs/Gamestar_ Mechanic_Learning_Guide_v1.1.pdf		
Game Salad	Free[a]	2D games	Mac	Mac, iPhone, iPad, web
		Download: http://gamesalad.com		
		Tutorial: http://www.youtube.com/gamesaladcookbook (video)		

[a]Paid versions, which contain more functions, are also available.

occasionally be found that the story or structure of the game needs to be changed. It is always possible to go back and redesign the elements of the game if necessary, but these changes will be time- and resource-consuming. Therefore, attempts should be made to plan ahead as much as possible.

Step 9: User Test

It is highly recommended that the game be tested with a variety of players, both during its development and after its completion (Saffer, 2009). To ensure that the game can be played by the intended audience, testing should be conducted using players from this population. It is also usually advisable to test the game on a general audience to ensure that it makes sense, can be played, and is entertaining. Therefore, it is recommended that both adults and children of a similar age to the target audience be included in the test. Table 6 describes some of the questions that may be asked, or that should be kept in mind, during observation of the user tests. Students with disabilities may often find it difficult to articulate their experiences and opinions. In such instances, observation should be the primary method for collection of user experience data.

Data collected from user tests can be reflected in the game design. Minor modifications, such as placement and size of objects, game control, sound effects, and game play

Table 6. What to look for during user tests

Type of audience	Questions to ask (or observe)
Target audience	Is the game too hard or too easy?
	Is the game play logical to the player?
	Is the mouse control appropriately designed for the player?
	Are there any visuals and sounds that disturb the game play?
	Do the players seem to learn what it was intended they should learn?
General audience: Adults	Is the game play logical?
	Is the game play interesting?
	Would you let your children play the game? Why or why not?
General audience: Typical children	Is the game play logical?
	Is the game play interesting?
	What do the players learn from game play?
	Compared to other games they have played, what do they suggest is changed?

speed, are relatively easy to adjust. However, major modifications, such as changes to the game plot, story, or structure, may sometimes be required. If so, the developer should attempt to modify them using the resources at his or her disposal.

A checklist of the game-development process is summarized in Table 7. Although the table depicts the process as

Table 7. A checklist of game-development process

Steps	Questions to ask	Needed materials
1. Decide target audience and learning objectives.	Who is the game for? What are the learning objectives? Are there any similar games already available?	
2. Select a genre for the game.	Does this genre best fit the interest/abilities of my target audience and the learning objectives?	
3. Write short concept paper.	On what platform will the game be played? What genre will I adopt? What is the story? What are the tasks?	Word processor
4. Create a storyboard.	What are the major scenes/events/tasks essential for gameplay?	PowerPoint
5. Write a detailed script.	What happens in each scene/task/game? How is the game played? What actions are required of the player? What reactions/feedback will be given to the player? What sounds and graphics are needed?	PowerPoint
6. Create graphics.	Will I create the images or use existing ones? What are the images that I need?	Graphics program (pencil/paper, scanner if needed)
7. Shop for sound.	What sounds do I need?	Sound editor
8. Put together with game-developing tool.	What can and cannot be done with this software? What graphics/sounds/modifications to the game are needed?	Game development program
9. Test on potential users.	Is the game interesting and playable? Does the game fulfill its purpose? What needs to be tuned?	Questionnaire

linear, Steps 6, 7, 8, and 9 may be intertwined and cycled through recursively multiple times.

Conclusion

Finally, with regard to assessment, several different methods can be used to evaluate student learning from game-play, and these are influenced by the objective of the game. Therefore, if the aim was to teach simple knowledge, such as multiplication tables or historic facts, then the assessment may be embedded within the game, or the game results (e.g., scores) may be used for reference (e.g., Goodman, Bradley, Paras, Williamson, & Bizzochi, 2006). If the aim was to teach certain skills, practical knowledge, or behaviors (e.g., objectives from IEP), then tests in both knowledge and a behavioral context would be meaningful (e.g., Coles, Strickland, Padgett, & Bellmoff, 2007). Last, if enhancement of physical functions was the aim of the game, then the measurement of actual physical function before and after training would be important (e.g., Deutch et al., 2008). Many students with disabilities experience difficulties with transfer and generalization, so additional teaching or training may be necessary after game-play. Games, however realistically simulated they may be, are still learning tools and cannot completely replace real-life learning.

The development of a game may require greater personal commitment and resources than the development of a website (Englund, 2009) or the use of ready-made virtual manipulatives (Bouck & Flanagan, 2010). However, with the tools that are now available for nonprofessionals, games may be developed with home computers and a low/no budget. Furthermore, because research has shown that such effort can be meaningful and effective (Coles et al., 2007), those teachers, clinicians, parents, and practitioners who are likely to best know an individual child's needs, strengths, weaknesses, preferences, and goals can be powerful agents in the development of games for the education and training of students with disabilities.

Declaration of Conflicting Interests

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Note

1. The author is producer and director of the educational material, *Adventures on Coolong Island*. The game was developed in both Korean and English.

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