

Running Head: MICRO GAMES IN E-LEARNING

Micro Games in e-Learning

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*Abstract:* A micro game is a small interactive representation with a game-like interface. It can be integrated into the e-learning course materials to provide a way for learners to engage directly with an instructional message. A set of micro games was developed and used in an online course for adult graduate students to determine patterns of usage and obtain student feedback. A design based research methodology was used for the study. The micro game study is part of a larger ongoing investigation of multimedia in e-learning. Data from the first round of testing for the micro game portion is provided and discussed. Implications for future research are described.

One of the challenges of online instruction is finding ways to make course materials engaging for learners. A benefit of the virtual classroom is that the technology used to deliver e-learning can be taken advantage of to support multimedia rich content. Multiple forms of dynamic and interactive representations may easily be integrated within the online course to enrich the learning experience. Interactive multimedia such as simulations and games are among the array of learning technologies that have become available for use on the online classroom. The purpose of this paper is to provide a short overview of instructional gaming, introduce the micro game as an interactive multimedia representation, and describe a research study currently in progress that involves the design and implementation of micro games in an online course.

### *Why a Gaming Approach?*

The rationale for a gaming approach in e-learning is based on several factors including motivation, potential learning benefits, and changing learner characteristics.

Motivational aspects of games include the enjoyment of play (Rieber, 1996) and the intrinsic appeal of engaging interactive environments (Dickey, 2005). Kelly (2005) noted the motivational power of gaming when describing how those who play games "...spend literally hundreds of hours mastering obscure details of new weapons systems in order to meet the motivating goals established by the artifice of the games" (p. 35). If this motivational power could be harnessed within learning environments a positive impact on student engagement and achievement is the likely outcome. Multiple learning principles achievable through video games have also been identified thus adding to the appealing prospects for games in education (Gee, 2003). The allure of games as instructional tools has inspired innovative research projects and new design principles for game-based learning such as those developed by the Games-to-Teach Research Team at the Massachusetts Institute of Technology (Squire & The Games to Teach Research Team: MIT Comparative Media Studies, 2003). These types of projects correspond with the emergence of the *gamer generation* who grew up playing video games. Gamers possess skills and belief systems that according to Carstens and Beck (2005) will require, "...finding ways to redesign educational and training curricula around their needs" (p.22). It appears that learners are evolving as a result of the impact of gaming.

*The Game Spectrum*

A good place to begin when considering the possibility of using games for instruction is to review the spectrum of existing games to look for a good fit to curricular goals. This can seem like a daunting task when approaching the vast selection of games currently available. Fortunately, games tend to fall within categories that have been identified and described by game-based learning experts. A review of some of these classification systems may be helpful in identifying appropriate models or genres of games that seem most appropriate for the learning environment. Aldrich (2005) has described several game templates including game shows, word games, card games, and board games. Some of these templates might be adaptable for instruction in the e-learning environment and some might not be. Another classification system that may be more closely aligned with virtual instruction is the set of eight genres of computer games described by Prensky (2001). These genres are listed in Table 1.

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Table 1  
*Eight Genres of Computer Games*

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Category	Description	Example(s)
Action Game	Classic arcade and home video games	Super Mario, PacMan
Adventure Games	Players travel through a simulated world	Myst, Riven, Zelda
Fighting Games	Players engage in a fight or battle	Mortal Combat
Puzzle Games	Puzzles or problems are solved	Tetris, Hangman
Role-Playing	A character or persona is adopted	Dungeons and Dragons
Simulation Games	Players fly, drive, or build things	Sim City
Sports Games	Engagement in simulated sports	Football, Baseball, etc.
Strategy Games	Take charge of a complex world	Civilization

Note. Adapted from Prensky (2001, pp. 130-131)

The spectrum of game models range from simple arcade games to complex virtual worlds. Massively Multiplayer Online Role Games and multiuser virtual environments lie on the complex end of the gaming spectrum and have sparked considerable interest in recent years. One of these called Quest Atlantis is a 3D multiuser virtual environment

that was developed specifically for use in the classroom (Barab, Thomas, Dodge, Carteaux, & Tuzun, 2005). It is a role-playing game where students collaborate to complete quests in a mythological context. The goal of the game is to help the Council of Atlantis restore lost wisdom. The game is coupled with real world activities and unit plans for teachers. It is an immersive educational experience designed to be engaging and inquiry based.

Quest Atlantis, like other extensively complex games, took years of hard work by multiple individuals to create. It is not a simple matter to design and build this type of game. While innovative and exciting it cannot be used for all content areas and all groups of students. Not many innovations could make that claim. This introduces a quandary regarding game-based instruction. If an instructor is interested in trying a gaming approach they need to choose between selecting one that is already developed or creating their own. When the class is online the choices are limited to those that can be used in a virtual learning environment and support course objectives. In this situation the instructor may be interested in experimenting with game-based learning, but not have access to a suitable game that fits their specific curriculum. If they are new to game-based instruction and unsure of what might be effective it may be prudent to begin with small customized games that are quick to develop and implement. This provides a way to experiment with an array of game interfaces, designs, and strategies while exploring the potential value of game-based learning in the online course.

### *Introducing the Micro Game*


Micro games are small customized games designed to support instruction of discrete concepts and processes. They may be strategically placed within an online course to build interest or reinforce ideas that students routinely have difficulty mastering. A micro game can be used as an element of an instructional message, which is a form of communication composed of signs and symbols that is designed to foster learning. In this respect the micro game functions as an interactive multimedia representation that complements text, images, or other forms of media within the surrounding instructional content. This usage builds on previous work in instructional message design (Fleming & Levie, 1993) and multimedia instructional message research (Mayer, 2001).

An example of a micro game used within an instructional message is shown in Figure 1. This instructional message was written for an online graduate course in educational technology. The focus of the lesson was on the use of geometrical icons, or GEONS, to compose complex images in image editing software. Prior to this instructional message the students had read information about Gestalt psychology and pattern recognition. The instructional message was designed to introduce students to the concept of a GEON. The instructional message is composed of three types of representation. Text was used to define the term. Images were created to illustrate what the GEONS look like and how they form patterns. The GEON game allowed students to interact with the idea directly through a set of puzzles where they assembled parts to create a meaningful whole.


### What is a GEON?

A GEON is a geometrical icon or simple primitive shape described by Biederman (2000). When combined the brain will interpret a pattern if a meaningful one exists. Consider the images below. On the left is a group of GEONS that are arranged in random order. It almost looks like a face is formed in the *Geon Group*, but that is accidental. When these same basic shapes are rearranged we get a definite pattern. Do you see a person lifting weights under the *Geons Regrouped* heading?

**Geon Group**



**Geons Regrouped**



The GEON game was developed as a quick exploration of GEONS and pattern recognition. You have just read about GEONS in text and looked at a static image showing one example. Three more examples are available in this micro game. A micro game is a very small game that works like an interactive representation. It is meant to complement information found in the representational system it is placed in. A micro game may contain images, audio, video, interactivity, and feedback. When you click on the GEON Game image a new window will open with the interactive game. Try it out and see if you can solve all three puzzles. Then, when you go to the reading assignment and look at the project examples later you will have already explored this idea.

### GEON Game

In this game you will combine simple shapes called GEONS to make a more complex one. As you move the pieces around your brain should create a pattern from the combined pieces.

Intro  
Play

Figure 1: Instructional Message Containing a Micro Game

The GEON game contains an introduction with rules for play followed by three puzzles including a swan, a woman, and a movie camera. Each of the puzzles allows the user to drag and drop the pieces until a meaningful shape is formed. A sequence of screen shots from the GEON game swan puzzle is shown in Figure 2. In the first image on the left the geometric shapes are scattered on the game interface. When the user drags a piece near another piece that it does not belong with the feedback box displays an “Oops!!” message as shown in the center screen shot. If the user drags a piece near another piece that it should be connected to in some way the feedback box displays the “Close!!” message. The game was designed to reinforce the ideas presented in the text and images used to create the instructional message.

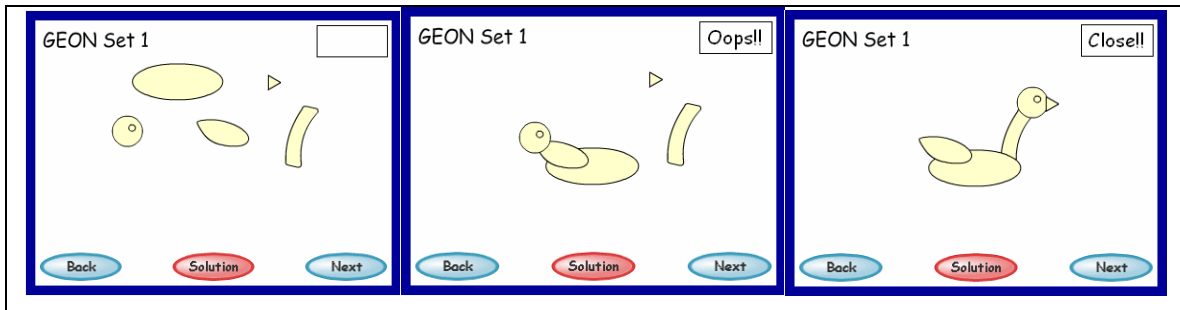


Figure 2: Screen Shots from the Swan Puzzle in the GEON Game

Micro games as interactive representations can be designed to serve a specific function within the system of representations contained in the instructional message. Ainsworth (1999) described three functions of external representations that can be applied to the micro game. Any representation may complement, constrain, or construct others within the representational system. The representation complements when providing information in a different form, it constrains when minimizing misinterpretation of information, and it constructs when helping the learner generalize the information being presented. Micro games may be used to achieve one or more of these functions within the representational system of an instructional message in an active way due to direct engagement with the interactive features.

The visual imagery, interactivity, and feedback included in a micro game can provide multiple coding of information consistent with theories of multimedia learning and dual coding (Paivio, 1990; Reed, 2006). Of course, the effectiveness of a micro game depends on the design of the game, the instructional message, and the ability of learners to

understand the game and how it relates to the rest of the message. Interactive representations have been the focus of previous research geared toward exploring how they may or may not support learning (Sedig & Liang, 2006). One difficulty students sometimes have when working with learning materials featuring multiple representations is the inability to translate between those representations (Ainsworth, Bibby, & Wood, 2002). It has been suggested that support should be provided to assist learners with an understanding of the representations and how they relate to each other in order to maximize the benefits of dynamic representational systems (Bodemer, Ploetzner, Bruchmüller, & Häcker, 2005). There is much more still to be learned about the design of effective representational systems for different content areas and learners. This field of study is particularly beneficial in e-learning where students access instruction through a computer interface.

#### *Description of the Study in Progress*

The use of micro games in e-learning is part of a larger ongoing study involving the use of multimedia in e-learning that began during the summer of 2006. This study involves the design, implementation, and evaluation of several forms of multimedia including videos, simulations, and micro games. These media objects are designed to support instruction in online graduate level courses in educational technology. Students are geographically distributed and attend class asynchronously. Instructional materials, including the micro games and other multimedia, are posted on a Web server for anytime access. This study arose from a desire to learn the extent to which students were engaging with course materials which required considerable time investments to develop. The research questions currently under study are as follows:

1. How may technology be used to collect usage and evaluation data for micro games that are accessed through the Internet?
2. To what extent will micro games be used by online students?
3. Will technology on the student end of the online course support the micro games?
4. How will students rate the effectiveness of micro games for learning?
5. What types of comments will students provide regarding their experience using micro games as part of the e-learning experience?

### *Methodology*

A study of micro games as interactive representations within instructional messages for e-learning fits easily within the paradigm of the emergent generation of research that has been proposed in recent years. For example, it has been argued that emerging research in multimedia learning ‘...should lead to a comprehensive framework of principles at the micro-level for the design of effective multimedia learning systems’ (Samaras, Giouvanakis, Bousiou, & Tarabanis, 2006, p. 20). It has also been suggested that this research should focus on instructional design of media that is effective across multiple contexts. A suitable approach for this type of investigation is *design based research*, which is also known as the *design experiment* (Brown, 1992; The Design Based Research Collective, 2003; Collins, Joseph, & Bielaczyc, 2004). In design based research an innovative instructional design may be implemented as a design experiment within the messy world of an authentic learning environment to investigate its effectiveness. The basic process of design based research is cyclic and passes through stages of design, implementation, analysis, and revision. Long cycles, called macrocycles contain smaller microcycles (Jonassen, Cernusca, & Ionas, 2007) so that each cycle produces information to be applied to the design for the next cycle. For an online course the macrocycle might be a full semester and a microcycle could be each weekly assignment during that semester. Context becomes a variable in design based research so that a design may be tested in multiple environments to identify not only that it works, but also where and with which types of learners.

A virtual form of design based research was adopted for the micro games in e-learning study and for the larger study that it is a sub set of. This decision is supported by recent literature describing the value of design based research for the study of technology-enhanced learning environments (Wang & Hannafin, 2005). This is also supported by Rieber (2005) who wrote that, ‘... one of the most promising research methodologies for the study of interactive multimedia is the design experiment (p. 561). The design based research methodology provided a way to design micro games for the context of the specific course and then test them within an authentic context.

The process used in the micro games study followed the general design based research approach. The design and data collection procedures were developed to work within the

virtual learning environment, which posed several challenges. Setting up a research study in the context of an online course is like working in a virtual black box. Therefore, the study was geared toward not only exploring the micro games, but also testing data collection procedures. Usage tracking and voluntary evaluations were used to obtain data that would help to answer the research questions. It is not possible to control variables in a real-world online course so the study needed to be structured to embrace, rather than be hindered, by this unavoidable factor. The process used for this study was developed and piloted with the following procedure:

1. *Craft the Design:* Three micro games were developed using Adobe/Macromedia Flash Professional software. The Cell Collapse game was developed to teach an HTML coding skill that students in past semesters had struggled to learn. The Pathways game was designed to teach students how to write Web site addresses based on the folder structure in the Web page authoring software they used in class. The third micro game was the GEON game already described in this paper. All three games were designed to support the surrounding instructional messages.
2. *Test the Design:* Server side script was written in the PHP language to collect usage data and click data from two of the games. Data was collected automatically on the Web server in a delimited text file that could be imported easily into a database. The micro games were integrated in three different online lessons to help support the instructional goals for those lessons. A hyperlink to the evaluation survey was provided on the top of each micro game Web page.
3. *Analyze the Data:* After the lessons containing the micro games has been completed the data was inspected. A design based research journal was recorded during all phases of design and data analysis for ongoing data interpretation.
4. *Build Theory:* The theory that students may need additional help learning how to interpret representations was supported. There was some support for the motivational aspect of gaming for some learners but more study is required.
5. *Revise and Retest:* The Pathways game was revised to provide additional information for students to understand the symbolic representations used in it. Another round of testing will help to reveal whether or not this helps students enjoy and benefit from the game.

*Data From the First Macrocycle*

One of the goals of this study was to determine whether or not usage data could be collected from students in an authentic way. To do this the micro games were embedded in Web pages containing server script. The script required students to login with a group designation rather than as individuals. This approach allowed differentiation between groups such as students, visitors, or faculty members who might visit the site. Since students could visit with a group designation they could not be identified individually. This protected their anonymity and prevented any possibility of students feeling coerced to participate for the sake of their grade in the class. Students could use the media or not without penalty. This provided a more authentic look at how students typically engage with course materials.

A link to a short evaluation form was available at the top of each Web page containing the media so that students could submit feedback. A copy of this survey instrument is available in the appendix at the end of this document. An interesting note should be added here. The survey instrument was developed in such a way that it cleared the fields after submission. In order to alert students that their data had actually been sent a pop up window with a thank you was presented. The pop up window contained a cartoon character developed with lip sync software so that it would talk to them and thank them for submitting an evaluation. Each week the thank you character was changed. Some weeks the character would tell a joke and other weeks a simple thank you would be extended. It was hoped that the novelty of the animated talking character would motivate users to continue submitting feedback. No mention was made of this character in the survey instructions or course materials. More research needs to be done to learn whether or not this was motivational for any of them, however, some students did send email to ask how the talking cartoon characters were created.

Usage data collected during the first implementation for the three micro games has been summarized in Table 2. The number of students who were enrolled at the time are listed. The number of times each game page was opened is available under the access count column. Click data was collected upon completion of the first two games. This data could only be obtained if the entire game was completed. The completion count shows these numbers. The Cell Collapse game was apparently repeated since it was

accessed 39 time, yet 42 completed games were recorded. Interestingly, the GEON game was only accessed 12 times despite the fact that 20 students were enrolled in the course. This is surprising considering that the game was embedded directly in the introduction to the course assignments for the week. The research question pertaining to student usage of the micro games is partially answered through the data in Table 2.

Table 2  
*Usage Counts for Three Micro Games During First Implementation*

Game	Students in Course	Access Count	Completion Count
Cell Collapse	23	39	42
Pathways	23	23	13
GEON	20	12	NA

Another question that was explored during this study was related to the technology students were using to access the micro games. There is little control over the technology used by students on their end to open course materials. The PHP server script collected information about the Web browsers and operating systems used by students to open the micro game Web pages. This information is shown in Table 3. The Internet Explorer Web browser on the Windows operating system was used by students more than any other system. There were some Macintosh and a small number of Linux users as well. This information is helpful when developing micro games due to the potential for technological problems on the user end. The micro games were developed with a technology that should work on all of the systems shown in Table 3 provided the latest version of the Flash player is installed on the student machine. It is hoped that students are not prevented from accessing the micro games due to incompatibility problems.

Table 3  
*Web Browsers and Operating Systems Used to Access Micro Games*

Game	Windows		Macintosh		Linux
	Internet Explorer	Firefox	Safari	Firefox	
Cell Collapse	23	10	6	0	0
Pathways	14	3	4	2	0
GEON	8	1	0	0	3

Note. No browser type was available for the Linux users.

Results from the short feedback survey are summarized in Table 4. Only four surveys were submitted for each micro game. All respondents indicated that they were students

in the instructor's class. Effectiveness ratings all ranged from fairly to highly effective. Most respondents indicated no technical problems and one reported minor problems, although no further information was provided in the comments. All students indicated that they were using high speed Internet access to view the game pages.

Table 4  
*Survey Results for Micro Game Evaluations*

Game	Evaluations	Student	Effectiveness	Technical Problems	High Speed Access
Cell Collapse	4	4 Yes	4 Fairly	4 None	4 Yes
Pathways	4	4 Yes	3 Highly 1 Fairly	4 None	4 Yes
GEON	4	4 Yes	3 Highly 1 Fairly	3 None 1 Minor	4 Yes

Note. A copy of the survey instrument is available in the appendix.

A few brief comments were submitted with the feedback from the surveys. These provide a small amount of additional information related to student perceptions about the micro games. The comments are listed below for each of the three micro games.

Cell Collapse micro game comments:

1. "Fun but short."

Pathways micro game comments:

1. "I found the graphics a little hard to follow - but maybe that means I need more practice!"
2. "Excellent! Makes you think and helps to visualize."

GEON micro game comments:

1. "I had to use the solution button on the movie projector game. It made sense once I saw the solution but it seemed a little too simplistic with the simple shapes provided. I believe that practice with this game would make one better as one learned to recognize simple shapes within more complex ones."
2. "Fun!! Really brought the principles to life!"
3. "That was harder than I expected it to be ;-)"

In general these comments were positive. The first comment for the Pathways game led to a revision of the game to add an introduction where the meanings of the graphics were explained better. The next implementation may reveal whether or not this helped students understand the game better.

### *Discussion. and Implications*

A description of the first round of a study involving the design and implementation of micro games for e-learning was described in this paper. Micro games are new to the researcher who is also the designer and instructor in the courses where they were tested. An extensive massive multiplayer game was too elaborate to build for simple exploration of the gaming approach. Micro games still require time to conceptualize, design, and develop, but they can be created in a few hours or days. This makes them feasible to develop for exploration of the gaming approach. Three micro games were developed and tested using the design based research approach. It was revealed that in most cases the micro games were used and the data collection process appears to be working. Unfortunately, the evaluation data was minimal. The small amount that was obtained provided some information for revision of the games.

The micro games in e-learning study is still new and may be expanded in multiple ways. To date only three games have been tested. It would be beneficial to develop an array of micro games on varied topics. Several styles of games could be tested to determine which are the best fit for different course objectives and different learning contexts. Then, a set of game templates could be created as reusable objects where content can be added in order to save development time.

An additional expansion of this study would be to couple design based research with experimental studies using the same materials. In this way variables can be systematically controlled and studied in the lab. Then, those same variables can be introduced to the real-world classroom to study the effects of varied contextual influences on them. Through this process much could be learned about the addition of micro games to e-learning. There is plenty of room for exploration in this field of study.

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## Appendix: Survey Instrument for Micro Game Feedback


**Feedback Form**  **Dynamic Media Objects in E-Learning Study**

The purpose of this questionnaire is to obtain feedback about the games used in the online course you are enrolled in. Outside reviews from people who are not enrolled are also invited. The information collected from this form is anonymous and cannot be tracked back to you. The data will be used for research purposes. By completing and submitting the form you are agreeing to allow your responses to be used as part of a research study. Your feedback is highly valued and will be used to help answer questions about the effectiveness of dynamic media objects in e-learning.

Please press the **Submit Feedback** button when you are finished.

1. Are you currently taking an online course from Dr. Chareen Snelson? (Note: If you are not in one of Dr. Snelson's courses you are invited to complete the feedback form. )
  - Yes
  - No

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2. Which game are you providing feedback for?
 

Please select a game from the list. 

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3. How would you rate the simulation in terms of effectiveness in helping you learn?
  - Highly Effective
  - Fairly Effective
  - Not Effective
  - Unsure How Effective

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4. How would you describe any technical problems encountered while playing the game?
  - There were no technical problems.
  - There were minor technical problems.
  - There were major technical problems.
  - The game could not be used.

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5. Did you access the game through a high speed Internet connection?
  - Yes
  - No

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6. Do you have any comments? Please type them below.

**Submit Feedback**