Northeastern

UNIVERSITY

Report of the Evaluation of

Evaluation of the Digital Maze Game:

Results of Implementation from Two College Courses

Bouvé College of Health Sciences
Office of Statistical Assistance

December 20, 2007

Prepared by:
Traci Ceccherini
Research Assistant
Supervisor: Prof. Emanuel J. Mason
Bouvé College of Health Sciences
Office of Statistical Data Assistance, and
Department of Counseling and Applied Educational Psychology
Northeastern University
Boston, MA 02115

Evaluation of Digital Maze Game

The main objective of this evaluation was to provide information regarding the utility of the Digital Maze Game as an instructional tool in science classes. Non-bias feedback was sought from a third-party evaluator, unrelated to the development of the game, in order to gain insight about the strengths and weaknesses of the maze game.

Background Information

The Digital Maze Game was created by Dr. Don O'Malley to serve as an instructional tool available to science instructors. The game is designed to enhance student participation in all science-based classes, and specifically, for classes that use lecture as the main modality of instruction. Dr. O'Malley had used this game in previous classes, but no formal data collection had occurred.

Description of Digital Maze Game

The Digital Maze Game is a versatile instructional resource that serves to increase student participation in class through discussion, as well as peak student interest in the topic through the stimulating method of presentation. The maze is presented to the students using computer-based technology. The goal of the game is for the student to exit the maze by successfully answering questions that represent the "main path" in the maze. Students can move off the "main path" if questions are answered incorrectly, and subsequently end up back at the beginning of the maze. The most challenging part of the maze is that students are unaware of whether or not they answer a question correctly. It only becomes clear to them that they have steered off-track once a question is repeated. However, it remains unclear which question was answered wrong.

Throughout the game, the students have the option to receive “tips”. These tips provide the student with useful information to exit the maze successfully. Tips can be related to the subject material or the student’s location in the maze game. Some examples of tips include, “You are off the main path” and “Six questions comprise the main path to exit the maze”. These tips inform students of their progress in the maze, but instructional tips can be incorporated as well to give assistance to answer the question at hand.

The Digital Maze Game challenges students to be confident in their answers and to know the material. It can be provided to the students as a class, small groups, or independently both in and outside of class. Its diverse methods of utility make it an attractive tool for instructors to use.

Implementation of the Digital Maze Game

During this evaluation, the Digital Maze Game was implemented into two college-level courses as part of the curriculum tools: a cell biology class, comprised mostly of upper-class college students, and two anatomy and physiology classes, made up of mostly first and second-year college students. Presentation of the Digital Maze Game occurred both in class and outside of class and utilized a variety of instructional strategies: large group discussion, small group work, independent work, and cooperative learning. Presentation of the material varied across the classes and sessions.

The cell biology class participated in the Digital Maze Game in class twice over the course of the semester and once as a take-home assignment. The anatomy and physiology classes utilized the Digital Maze Game once each as an in-class activity and once each as a take-home assignment.

The instructional method utilized for the Digital Maze Game relies heavily on reinforcement theory. The game is designed to reinforce students when correct answers are chosen. Students are expected to gain understanding of the specific facts as well as broad concepts covered during their assigned readings and in-class lectures, and this acquired knowledge is assessed in the game. Both presentations of the Digital Maze Game required both low and high levels of cognitive ability. Since the questions were presented in a multiple-choice fashion, students were required to recognize information previously learned, which is a low-level cognitive task. However, some questions in the Cell Biology class related to material that had not yet been covered in lecture or assigned reading. Therefore, these questions required the students to think critically and pull information from various pre-existing schemas to answer, requiring higher-level cognitive processing skills. By connecting this new information to prior knowledge, it is expected that encoding into long-term memory is facilitated. Additionally, since some questions are repeated throughout the administration of the Digital Maze Game, this rehearsal of information is another memory strategy that increases learning. A question that could be raised about whether imposition of the game format might compete with the learning material for a student's mental processing resources by challenging the student to think about "location" in the maze while answering the questions. This did not appear to be the case from students' comments and performance.

Cell Biology Presentation

During the first in-class session the Digital Maze Game was implemented, students were divided into teams of 4 to 5 students. The Digital Maze Game was presented as a competition, and motivational incentives were provided to whichever

group successfully completed the maze. Directions were provided to the students regarding how to play the Digital Maze Game. The Digital Maze Game was presented through a projector connected to a laptop computer, and was formatted using Flash Media. The second in-class Digital Maze Game was presented in the same manner, but instead of a competition, it was used to promote discussion among the students. During both in-class administrations, the Digital Maze Game began after the professor lectured for about half of the class period. Additionally, the instructor chose which group answered the questions in a round-robin fashion.

Anatomy & Physiology Presentation

The Anatomy and Physiology classes received the same presentation of the Digital Maze Game across sections. The Digital Maze Game was presented through a projector connected to a laptop computer, and it was formatted as a PowerPoint presentation. Students were given instructions on how to complete the Digital Maze Game. Given the large class size for both sections, students were asked to work in pairs to answer the questions presented. Each pair of students was then given a remote that corresponded with the laptop to punch in their response choice. The answer that was chosen by the majority of the class was the final answer and determined movement throughout the maze. After students read each question, a time limit of 30 seconds was set and visually displayed in the top left-hand corner of the projection. In the top right-hand corner, the number of responses received by the computer was recorded.

Evaluation Instruments

In order to assess the utility of the Digital Maze Game, three methods of evaluation were conducted: classroom observation, in-class survey, and take-home

survey. This evaluator conducted the classroom observations in order to provide objective feedback regarding the presentation of the Digital Maze Game.

This evaluator created the surveys in conjunction with Dr. O'Malley, creator of the game, to measure student opinion of specific aspects of the game. The students participating in the Digital Maze Game completed the surveys. In-class surveys sought information regarding the clarity of instructions to complete the Digital Maze Game, the clarity of the objective of the Digital Maze Game, and student opinions regarding the Digital Maze Game (see Appendix A). The take-home surveys examined the level of difficulty of the Digital Maze Game for students, as well as the level of agreement or disagreement regarding certain aspects of the Digital Maze Game (see Appendix B). All survey responses were anonymous.

Results

In-Class Observations

Cell Biology

The in-class observations of the Digital Maze Game provided an opportunity for objective view of the presentation of the game, as well as student response. In the Cell Biology class, the population was 26 students. The main method of instruction involved lecture with a few opportunities for discussion. The set-up of the classroom was relatively small with about 2 to 4 students sitting at long tables in rows. The material was presented through a projector; however, the format used for the Digital Maze Game did not lend itself to good visibility for all students in this arrangement. It was difficult for students to read the questions and answers, and so the instructor ended up reading the questions and response options to the class.

Additionally, verbal directions were given to the students in a circular fashion. Students appeared confused regarding the objective of the game and the process of completing the activity. The rotation of teams did not lend itself to the competitive game-like atmosphere the instructor was attempting to create. Students also became frustrated with returning to questions they had already answered without knowing whether they had received the correct answer or not. However, this frustration fostered discussion among the groups and enhanced critical thinking for each answer.

Anatomy and Physiology

During both implementations of the Digital Maze Game in the Anatomy and Physiology courses, the instructions were concise and direct. The instructor also informed the students that they would receive all of the questions with corresponding correct answers during the next class period in order to review questions they received incorrectly.

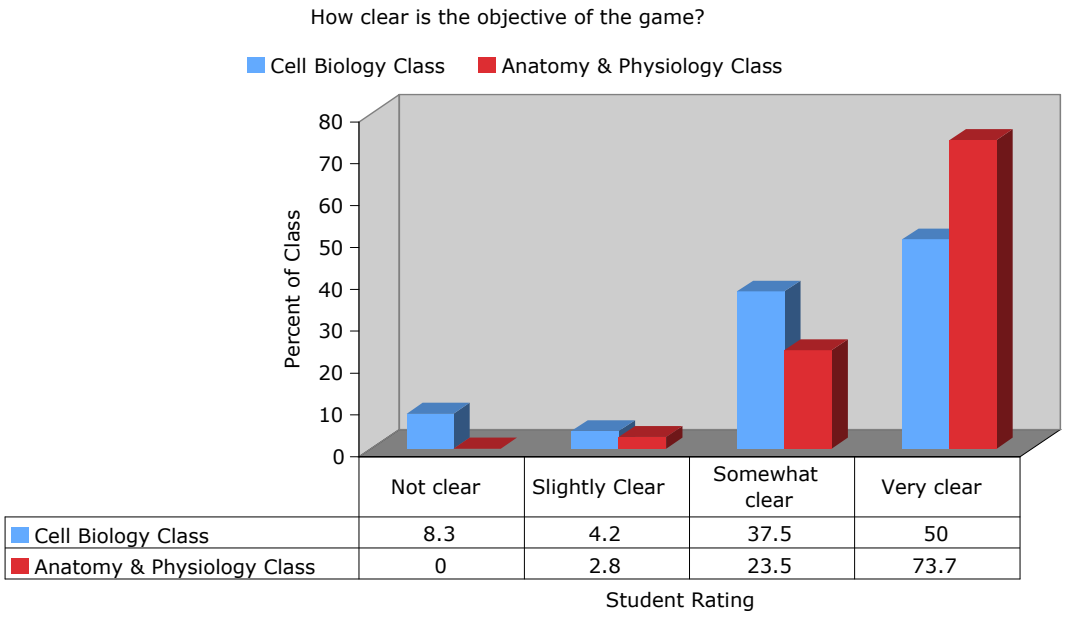
The class size for each cohort was about 80 students, and the main modality of instruction was lecture. The class set-up was a lecture hall designed as a stadium with students sitting at individual desks in one class and long tables arranged in rows in another. The presentation of the Digital Maze Game was displayed large enough for all students to view and was presented in a very clear manner. The use of a timer to monitor the length of time for each question provided consistent structure to the game. Another distinctive feature during these presentations was that tips were not provided for each question, but rather the game was formatted to prompt the students when they were on or off the main path at random times throughout the presentation. This provided very concrete feedback to the students regarding their progress through the maze.

Students also became frustrated with repeated questions, but the result was the same as the Cell Biology students. The classes engaged in more discussion and utilized their resources (class notes) to answer each question correctly and confidently.

In-Class Surveys

Both quantitative and qualitative data were collected on survey instruments. Twenty-one students participated from the Cell Biology class, while 176 students participated from both sections of the Anatomy and Physiology classes. The quantitative data was coded into a graphical display of student responses and will be discussed first.

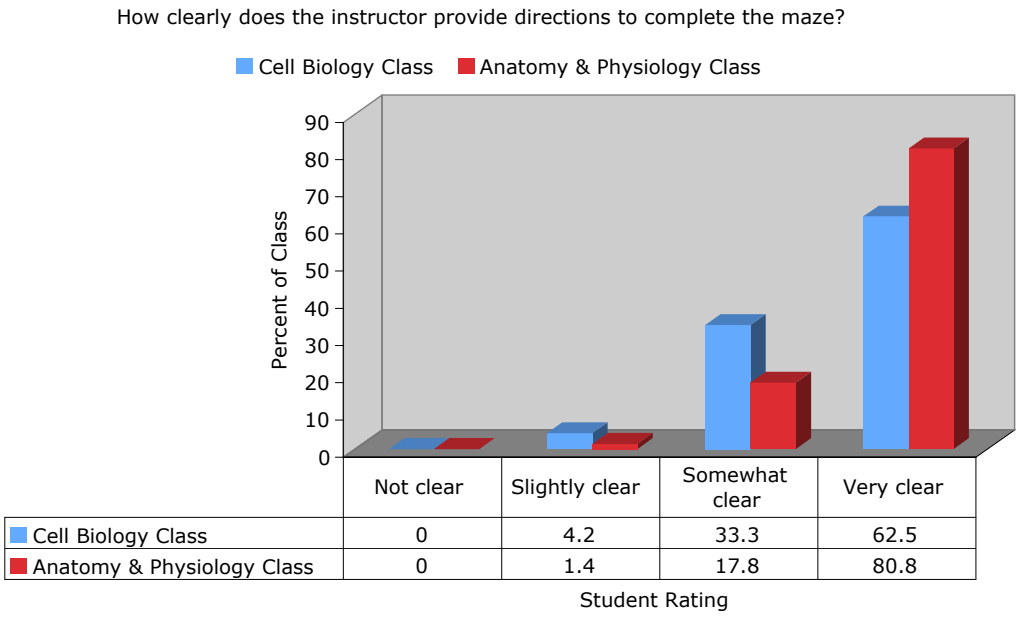
Figure 1. Objective of the game.



Students in both classes endorsed high ratings regarding the clarity of the objective of the game (ratings mostly in the somewhat to very clear range). This indicates that the Digital Maze Game is a friendly tool that is not difficult for students to follow given that most people have completed a maze in some form throughout their lives. However, it is pertinent to note that a higher percentage of students in the Anatomy and

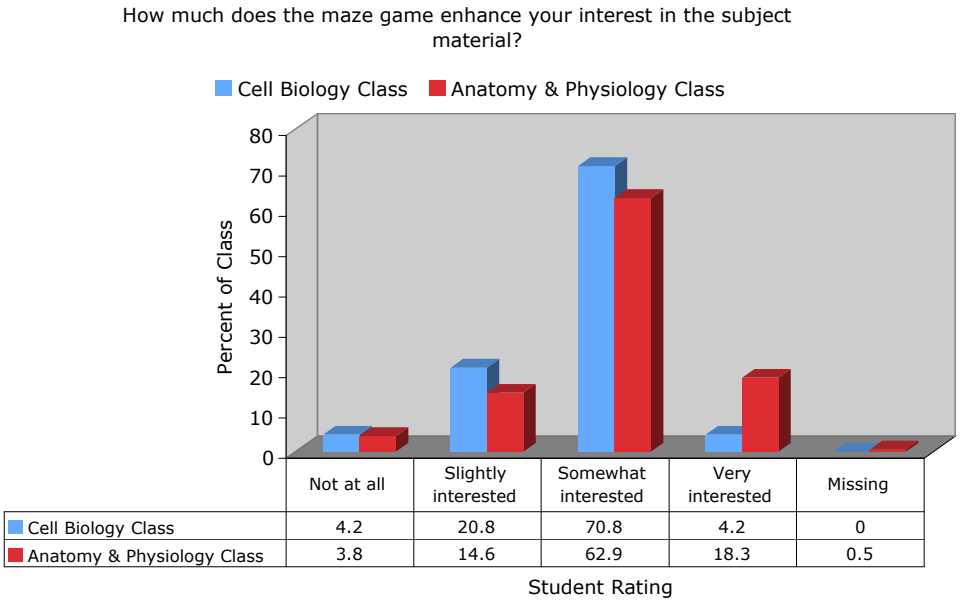
Physiology classes endorsed the rating of "very clear" (75%), while only 50% of students from the Cell Biology class endorsed this rating.

Figure 2. Directions from the instructor.



The results of this question are similar to the previous in that more students from the Anatomy and Physiology class endorsed a higher rating (81%) than the Cell Biology class (63%). This indicates that the instructions provided to the students in the Anatomy and Physiology class were easier to understand than those from the Cell Biology class, which corresponds with observation findings.

Figure 3. Enhanced interest in subject material.



As can be seen, the majority of students in both classes endorsed the rating of "somewhat interested" when asking if the maze game enhanced student interest in the subject material.

The remaining items on the in-class survey included narrative data from students. The majority of students (91%) enjoyed the maze game and would suggest using it in their own (92%) and other science classes (91%). Eighty-four percent of students reported extra credit as good motivation for winning the game. Other ideas included prizes, candy, sample questions from an upcoming exam, and contingencies for number of extra credit points received (i.e. more points for students who do not get off the main path). Students also enjoyed the competition and found the idea of playing a game motivating.

The students also provided information that would enhance the Digital Maze Game. Fifty-five students reported that more visual stimulation would be beneficial; ideas

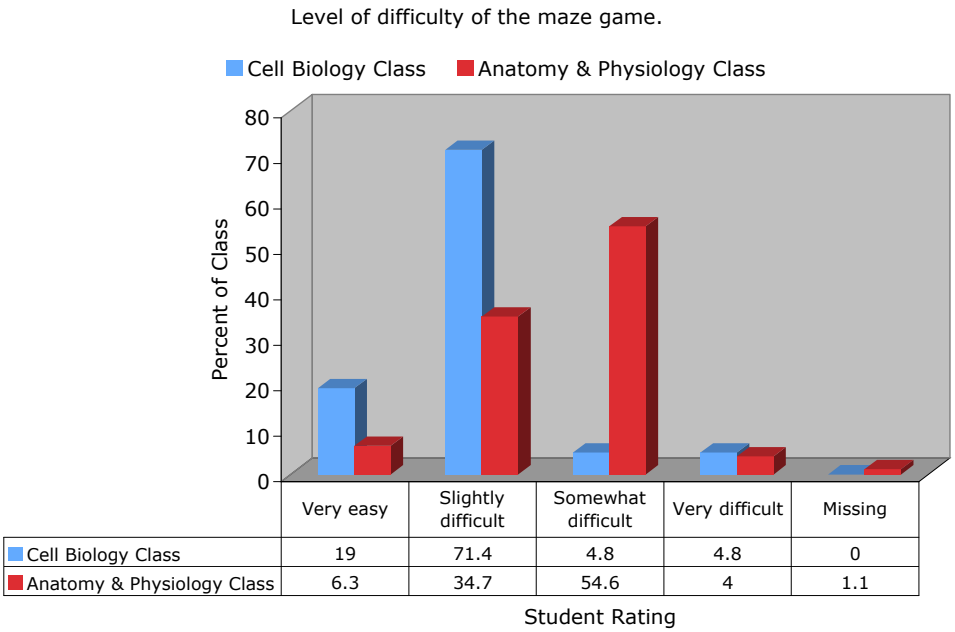
included presenting an image of an actual maze (this was done in the cell biology class, but not the anatomy and physiology class), more colors, variety of fonts, and other graphics/animations. Eleven students requested more tips be included in the game, while three students wanted tips related to the questions instead of the location within the maze. Nineteen students from the Anatomy and Physiology classes thought the Digital Maze Game would be better utilized in a small group setting. Eighteen students thought additional questions would enhance the game. Additionally, 54 students reported the need for direct, immediate feedback regarding whether or not the chosen answer was correct or incorrect, while eleven students thought a summary of questions and answers provided at the end of the game would be helpful. Other comments included having more time to complete the maze and providing additional assistance after a certain number of repeated questions. Seventy-one percent of students agreed that the maze game does clarify certain topics covered in class, while a the remaining students felt the maze game in conjunction with the teacher's explanations provided good clarification, did not think the Digital Maze Game clarified the information without feedback about the correct answers, or felt as though the Digital Maze Game informed students of which areas they still needed to study.

Specific feedback from the Cell Biology class included incorporating additional technology into the class to facilitate organization of game. The suggestions involved having the students work in groups to complete the maze on one laptop per group, and whoever completes the maze first is the winning group. Other suggestions included modifying the method of responding and providing more clear instructions.

Students in the Anatomy and Physiology class thought that providing more direct feedback after a question was answered incorrectly would enhance the Digital Maze Game. These students also found the Digital Maze Game interesting and enjoyed having the visual display of a timer. Many students suggested having a visual representation of a maze and the location of where the class was within the maze. The students seemed to be split about whether they enjoyed looping back to previously viewed questions; many students enjoyed this aspect of the game, while many other students found this to be a frustrating component of the game.

Take-Home Surveys

Figure 4. Level of difficulty of the maze game.

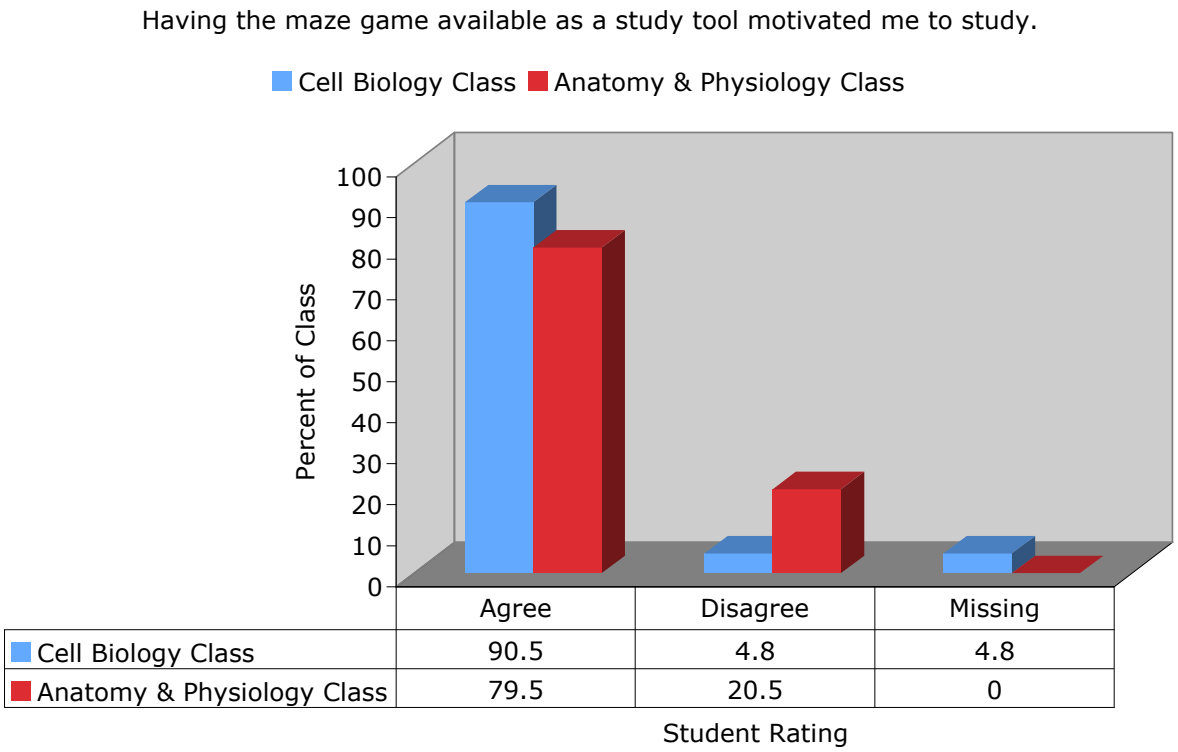


	Very easy	Slightly difficult	Somewhat difficult	Very difficult	Missing
Cell Biology Class	19	71.4	4.8	4.8	0
Anatomy & Physiology Class	6.3	34.7	54.6	4	1.1

As can be seen, the majority of students in the Cell Biology class found the game to be slightly difficult, while half of the students in the Anatomy and Physiology class found the game to be somewhat difficult. The level of difficulty falls within the zone of proximal development, given where the majority of the scores lie (in the slightly to

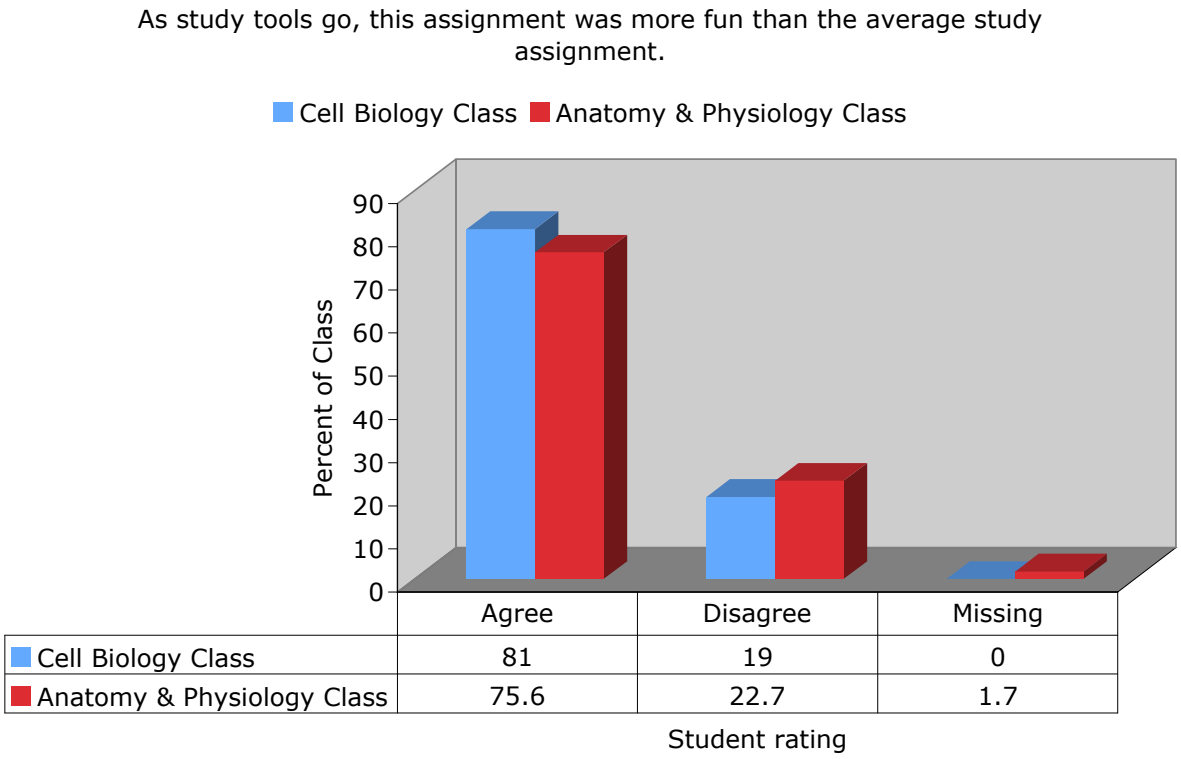
somewhat difficult range), which is optimal for learning, as instructional materials should not be so easy that students are bored, nor too difficult so that students become frustrated and lose motivation to participate.

Figure 5. Having the maze game available as a study tool motivated me to study.



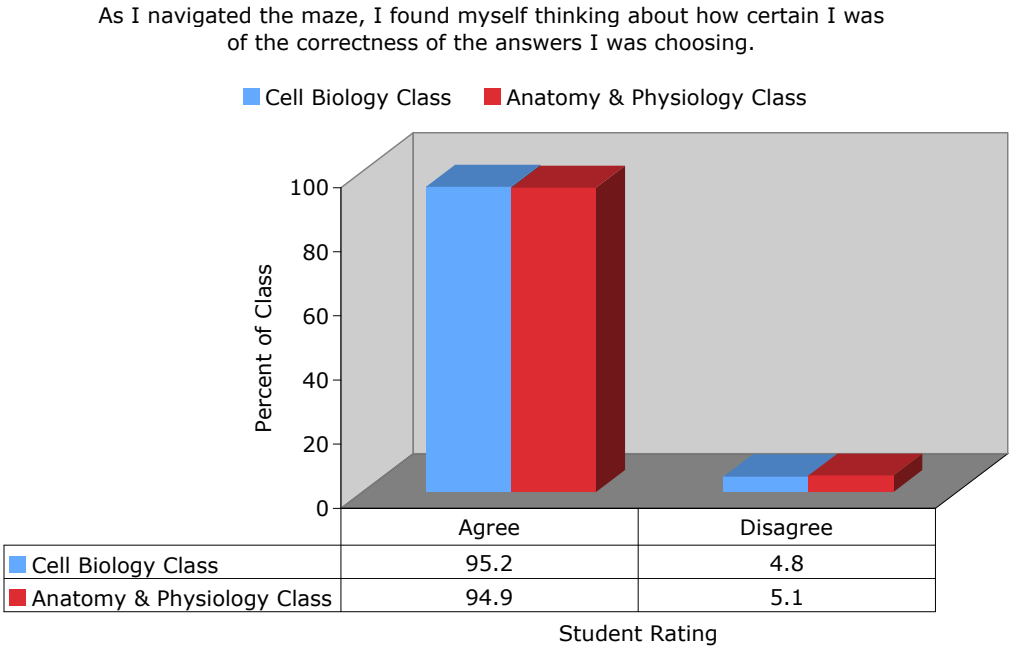
An overwhelming percentage of students in both classes agreed with this statement, which is a powerful indicator of the utility of the Digital Maze Game to increase the time students spend studying course material.

Figure 6. As study tools go, this assignment was more fun than the average study assignment.



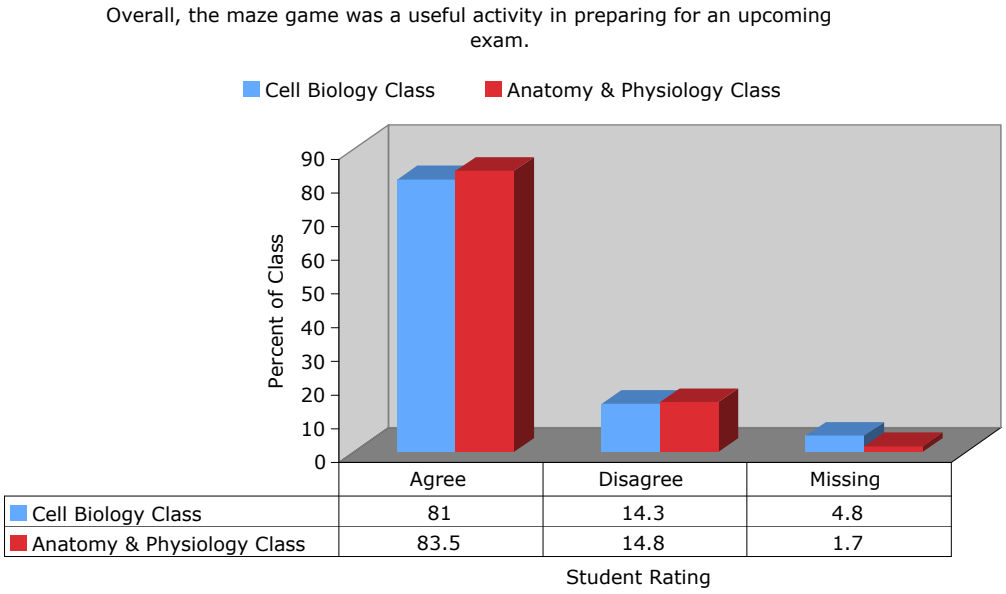
Eighty-one percent of students in the Cell Biology class and 75.6% of students in the Anatomy and Physiology classes agreed that the Digital Maze Game was more fun than the average study assignment. Responses on this question, coupled with responses from the previous question (having the maze game motivated me to study), provide even stronger evidence of the attraction of the Digital Maze Game as a resource to study course material.

Figure 7. Time spent on each question.



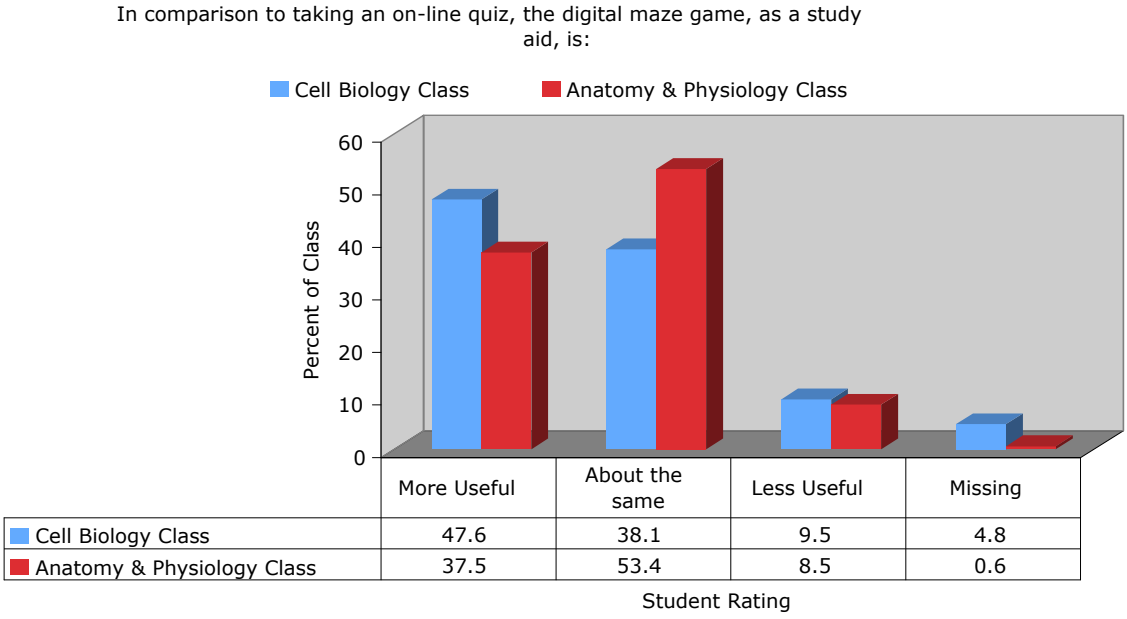
Close to 95% of the students from both classes agreed with the statement "As I navigated the maze, I found myself thinking about how certain I was of the correctness of the answers I was choosing". By spending more time on a question, students are expending more cognitive energy, which allows more opportunity for encoding to occur. Theoretically, this encoding will move the information from short-term memory into long-term memory, thus increasing the amount of material retained.

Figure 8. Useful study tool for upcoming exam.



Students in both classes agreed with the statement that the Digital Maze Game was a useful activity in preparing for an upcoming exam. This reiterates the utility of the Digital Maze Game as a resource to students when preparing for exams.

Figure 9 Digital Maze Game compared to an on-line quiz.



This graph demonstrates some differences of opinion among the student participants in the Digital Maze Game. Forty-seven percent of the Cell Biology class described the Digital Maze Game as more useful when compared to an on-line quiz to prepare for an upcoming exam, while 38% said it was about the same as taking an on-line quiz, and about 10% described it as less useful. The data is similar for the Anatomy and Physiology classes where about 38% of students found the game more useful, 53% said it was about the same, and 9% described it as less useful.

Students also provided narrative information on the take-home assessment instruments. Some feedback was similar to that given during the in-class surveys with students wanting more direct, concrete feedback on their response choices. One useful suggestion made by a student in the Cell Biology class involved restarting the maze when an incorrect answer was chosen: “Perhaps wrong answers should lead to a restart of the game every time, or lead to a square where there is no option to continue.” Many students in the Cell Biology class felt more informed about what to study for the exam, and areas of weakness on which they should focus . A few students thought the take-home Digital Maze Game was too short to help study for an exam, while other students found it extremely useful and fun.

The Anatomy and Physiology classes enjoyed the interactive nature of the Digital Maze Game, and some students noted that the repetition helped them to learn the material. Many students also felt they were more informed about possible exam questions and structure of wording in an exam question. Some students thought the Digital Maze Game was helpful because it forced them to read the material sooner than they may have, and suggested using it throughout the semester to ensure students are reading the

material. Many students found the Digital Maze Game to be more fun than an on-line quiz and commented that, “Even though the material is similar, the presentation is more interesting in the maze.”

Test Results

Dr. O’Malley provided some of the data from his students’ mid-term exams. He compared the percent correct of the material covered in the Digital Maze Games to the overall percent correct of the mid-term. The results suggest that the Digital Maze Game did enhance student retention of the material with a 90.3% correct on material covered on the Digital Maze Games and a 75.1% correct overall; however, further research should be conducted to support the validity of this finding.

Conclusions

Overall, the students in both classes received the Digital Maze Game well. They seemed to find the interactive nature of the game interesting and a “refreshing” change from the normal routine. The student ratings support the Digital Maze Game as a good motivator to study course material, useful activity to prepare for an upcoming exam, and more fun than the average study guide or task. Additionally, using the Digital Maze Game enhanced student interest in the course material.

The Digital Maze Game seems versatile and has the potential for successful implementation in a variety of different modalities, including the tools used to format the program. The presentation is flexible enough to allow for successful implementation in both a small Cell Biology comprised of mostly upper class students and large lecture-style Anatomy and Physiology classes made up of first and second-year students. Not only is the Digital Maze Game a great resource within the classroom to reinforce material

covered in lecture in an interesting manner, but it also seems to be a useful study agent for students. It provides students with insight to areas they may need to spend more time on as well as potential questions from an upcoming exam. The Digital Maze Game may be an excellent tool to use as a measure of student progress throughout the course as an in-class activity or a take-home assignment. Instead of utilizing summative methods of evaluation (tests and quizzes), teachers can determine which concepts students are still struggling with through this fun, interactive instructional tool.

Plans for the future of the Digital Maze Game encompass many of the suggestions provided through student feedback. Both time-dependent and path-dependent help are features that are in the works to enhance the Digital Maze Game. Additionally, a maze-editing tool may be developed to allow instructors to modify the program to better fit their needs, as well as a grading component that would send immediate, specific feedback to teachers on individual student progress.

Specific recommendations to refine and enhance the Digital Maze Game include:

⇒ Concise, clear verbal instructions, coupled with a visual representation, to complete the Digital Maze Game. These instructions should be presented in an easy-to-follow format.

⇒ Ensure that the visual representation of the Digital Maze Game is easy to read for all students; fonts should be large and equipment that fosters a clear, visible projection should be used.

⇒ Instructions should be created to coincide with the various methods of implementation within different class configurations (e.g., small labs, large lecture groups, cooperative learning classrooms) to facilitate teacher set up and utilization.

⇒ Concrete feedback regarding each student's individual success with the take-home maze should be provided at the end of administration.

⇒ In-class utility of the Digital Maze Game should provide more direct feedback to students regarding which question was answered incorrectly.

⇒ Visual presentation of the Digital Maze Game should be enhanced through various formatting (more colors, diverse fonts, etc.) and graphic augmentation (animation, clip art, etc.). These visual additions will increase the modularity of instruction, which in turn will reach a wider audience of students.

- A picture of the actual maze the students are trying to work through would improve the Digital Maze Game. This would allow students to make more informed decisions regarding incorrect choices to repeating questions.

⇒ More structured implementation of the Digital Maze Game as a competition between small groups.

- Utilize alternate methods for student response such as the use of buzzers.
- Each small group has access to computer with Digital Maze Game, and whichever group finishes first with the least amount of errors wins.

Appendix A

We want your feedback!

Please provide honest answers to the following questions.

1.) How clear is the objective of the game?

1	2	3	4
Not clear	Slightly clear	Somewhat clear	Very clear

2.) How clearly does the instructor provide the directions to complete the maze?

1	2	3	4
Not clear	Slightly clear	Somewhat clear	Very clear

3.) How much does the maze game enhance your interest in the subject material?

1	2	3	4
Not at all	Slightly interested	Somewhat interested	Very interested

4.) What factors can the instructor use to motivate you to want to win this game?

5.) How much does the maze game clarify the topics covered in class and/or the assigned reading?

6.) Would you suggest using the maze game occasionally in this class?

7.) Do you think the maze game would be useful in other science classes?

8.) Did you enjoy playing the maze game?

9.) What, if anything, would you change about the maze game?

10.) What are some aspects of the maze game that you particularly liked?

Please provide any other comments you have regarding the maze game here.

Appendix B

Evaluation of Digital Maze Game

We would like your assistance in evaluating the utility of the Digital Maze Game as a teaching supplement. Please answer the questions below based on your experience with the maze game, and bring this sheet to your next class.

- Using the scale below, please rate the level of difficulty of the take-home maze assignment from 1 (not difficult) to 4 (extremely difficult). **RATING: _____**

1	2	3	4
Very easy	Slightly difficult	Somewhat difficult	Very difficult

PLEASE AGREE OR DISAGREE WITH THE FOLLOWING STATEMENTS BY CIRCLING YOUR RESPONSE:

- Having the maze game available as a study tool motivated me to study.

  Agree **Disagree**

  Comments?

- As I navigated the maze, I found myself thinking about how certain I was of the correctness of the answers I was choosing.

  Agree **Disagree**

  Comments?

- As study tools go, this assignment was more fun than the average study assignment.

  Agree **Disagree**

  Comments?

- Overall, the maze game was a useful activity in preparing for an upcoming exam.

  Agree **Disagree**

  Comments?

- In comparison to taking an on-line quiz, the Digital Maze Game, as a study aid, is:

  More Useful **About the Same** **Less Useful**

  Comments?

Please provide any additional comments/critiques/questions you have regarding the maze game assignment on the reverse side of this page. Thanks for the help! ☺