Computer Programming: An Activity as Compelling as Game Play

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ABSTRACT

Game motif programming exercises (GM-Games) were developed to help novices develop complex client server game systems within their freshman year. GM-Games foster a strong work ethic in as much as they reproduce the challenges and excitement associated with game play; yet their purpose is the development of advanced programming skills. We have found that young people are just as interested in mastering programming skills as they are in mastering the shooting, racing or strategy skills required in many entertainment games. We describe in this paper how GM-Games imitate many of the aspects of game play.

Keywords: Software engineering, game development, GM-method, cooperative learning, independent study

1.0 INTRODUCTION

Small teams of freshman novice programmers [7] are capable of developing full commercial quality C++ or C# based multi-player client-server Gaming Systems. (Figure 1) We believe these achievements reveal that computer programming can be a compelling activity if the programming exercises and instructional method imitate game play.

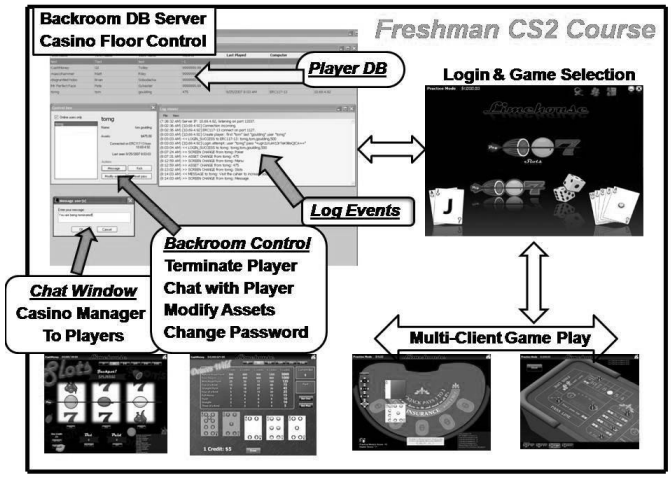
Programming exercises, called GM-Games are non-traditional exercises that provide the technical and software engineering foundations necessary to create complex game systems during the freshman year. GM-Games appear to accelerate learning when used with an inquiry based, neo-Socratic educational method called the Game Motif method (GM-Method). Consequently,

the GM-Games are created on an independent study basis.[8] Therefore, succeeding at a GM-Game extraordinarily difficult. Nevertheless, since these programming exercises develop skills directly and obviously relevant (Figure 2) to creating entertainment games the students are highly motivated to succeed.

We have modeled the game motif programming exercises and the manner in which they are taught in order to capture many of the aspects of entertainment games, which we call E-Games. Entertainment game are visually appealing. They require innovation. They give young people control of their own world [10]. The goal of an entertainment game is usually clear and easy to understand. Entertainment games require tenacity and skill to achieve high scores. E-Games do not require classroom lectures. One does not expect to take an examination after playing a game.

These same statements can be made about the GM-Games and the GM educational method (GM-Method) developed by the author.

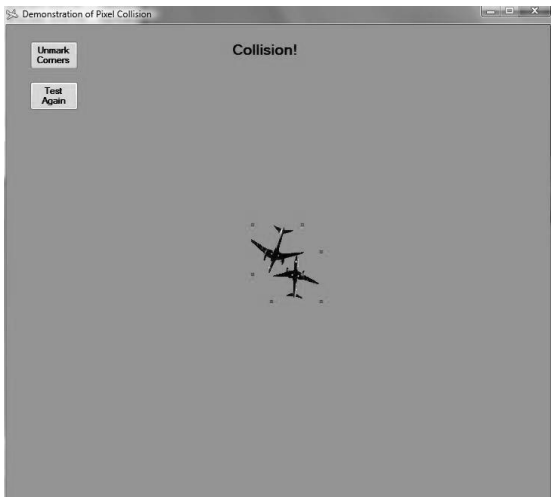
Figure 1
Freshman 2007
Limehouse Casino System
Multi-Game System with Account Management and Control



2. HOW A GM-GAME IS "PLAYED"

The primary goal of GM-Games is to develop programming skill at an accelerated rate. As much as possible, each "game" or exercise develops skills obviously relevant to actual game design. (Figure 2) Within the first two or three weeks, beginning programmers in CS1, are using nested loops, arrays, managed code and a whole range of OO principles to attack very knotty but visually interesting problems, all with minimal faculty assistance.

Figure 2: GM-Pixel Collision Game



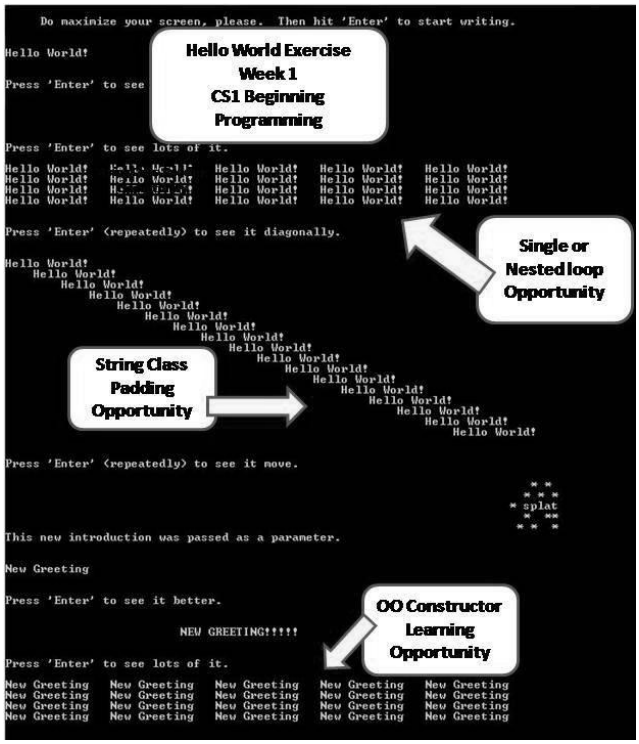
Only a GM-Game executable and a specification are provided to the student. The specification includes clues and hints as to the

technical knowledge that could be useful in solving the GM-Game. Students are referred to helpful textbook sections or web sites. Nevertheless, the students must independently mine these resources by searching for and extracting the knowledge they need without faculty guidance. Otherwise it isn't a game.

3.0 SCORING IN A GM-GAME

The GM-Game exercise is scored like any entertainment game. Performance matters. The GM-Game score is based on the code sophistication utilized in the student solution. Higher scores result from discovering and implementing more sophisticated solutions. For example, it should be observed that the GM-Hello World Game (Figure 3) can be solved using simple format and output statements. However, students want to discover and implement advanced solutions as soon as possible. Therefore, most will solve the GM-Hello World Game using nested control statements and a whole range of OO principles, none of which will have been discussed by the instructor. Students love the higher scores that they are awarded for success.

Figure 3
GM-Hello World Game



We find that students function as independently in game programming as they do in game play. They rarely request to see faculty code solutions. They become independent from faculty in a remarkably short period of time. This should be no surprise.

4.0 RESEARCH FOUNDATIONS

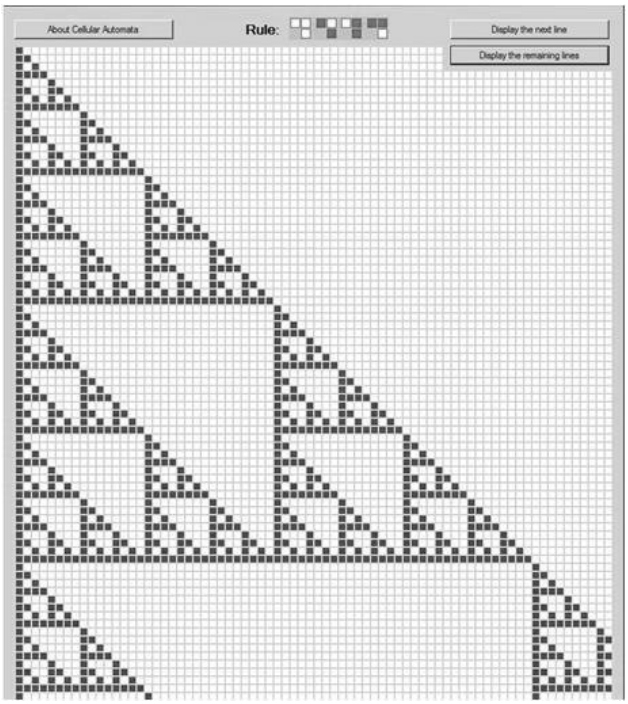
The manner in which GM-Games and the GM-Method are utilized in the classroom [6-9] simply represents another step in a long history of Socratic and active learning educational methods. The method is also an attempt to combine "game play" concepts and educational theory into the classroom experience.

The R. L. Moore Method

R.L. Moore was one of the 20th Century's strongest and most successful proponents of a Socratic method called the discovery method. [15] Well over 1600 PhD mathematician descendents have emerged to be a part of the enduring legacy of Professor Moore's work. During the 40 year period 1915-1954 descendents of R. L. Moore were producing journal articles at a 50 to 150% higher rate than graduates from virtually every other educational institution [11] How was this possible? Moore summarized very succinctly the philosophy leading to this amazing performance by his students: 'That student is taught the best, to whom is told the least.' [4] We have incorporated these ideas into GM-Game development.

Similarly, we have incorporated the R.L. Moore philosophy of independent study for content mastery. We are not alone in this regard. Other educational researchers have confirmed that effective courses are those that are designed to enhance student self direction and self study. When faculty use GM-Games and GM-Method their 'expertise in teaching lies not so much in … subject knowledge …as in her/his focus on student learning' [5] We believe that instructors should participate in technical discussions with students [3], but almost never propose solutions. Too much assistance destroys the challenge and diminishes the enjoyment of mastering exercises such as the Cellular Automaton GM-Game (Figure 3) assigned in Week 3 of the CS1 course.

Figure 4
Cellular Automaton



So we also have adopted R.L Moore perspective that "the instructor plays the role of coach, mentor, collaborator, guide, and occasional cheerleader". [16]

Cooperative and Active Learning Methods

Cooperative learning has also received a great deal of favorable attention in the last several decades Used initially in the K-12 grades, small group active learning methods caught on in higher education in order to encourage student engagement in

the learning process. [17] Cooperative learning is a defined instructional design in which small groups work together toward a common goal. [4] In the case of GM-Games, the common goal is the development of skills that will lead to complete games systems development. Our experience confirms the truth discovered by many other researchers. Students who discuss and explain solutions to one another learn by doing so. Students love to talk about games and game development.

Teamwork

Good teamwork, one of the fundamental requirements in a successful workplace, also seems to be one of those strategies which can lead to more meaningful student experiences. The positive interdependence that develops among GM-Game developers seems to be one of the primary reasons for student success. [13] The research literature also suggests that a student's feeling that he/she is liked and accepted by fellow team members is also essential. [17] Performing well on a team is the best way to be accepted in a professional or academic setting. In fact, it is known that peer acceptance is so important that a student's performance tends to gravitate toward the achievement levels of his or her close friends. [2] Teamwork has been shown to foster energy, enthusiasm, commitment and content retention when students master the material in order to benefit others. [9]

Games in Education

The use of GM-Games for STEM education is not about entertainment. Nor are GM-Games about using entertainment to teach basic knowledge. There have been many attempts to use the entertainment aspects of game play for instructional purposes, but there is little proof that entertainment develops problem-solving skill. [12]

The game creation industry faces enormous obstacles trying to create entertaining games that can play a meaningful role in an educational setting. Nevertheless, partnerships between industry and academia continue to be created in an attempt to blend math and science content with game play. [10]

One widely embraced approach to games in education involves creating programming environments or languages that teach beginning programming concepts. *Alice* is perhaps the most promising of these initiatives. [1] 'Electronic Arts Inc., has recently entered into an agreement to further the development of Alice 3.0. a popular, object-oriented, Java-based computer-programming environment created by Carnegie Mellon researchers. Some experts say that when the transformation is complete, the new programming environment will be in position to become the national standard for teaching basic software programming.' [1]

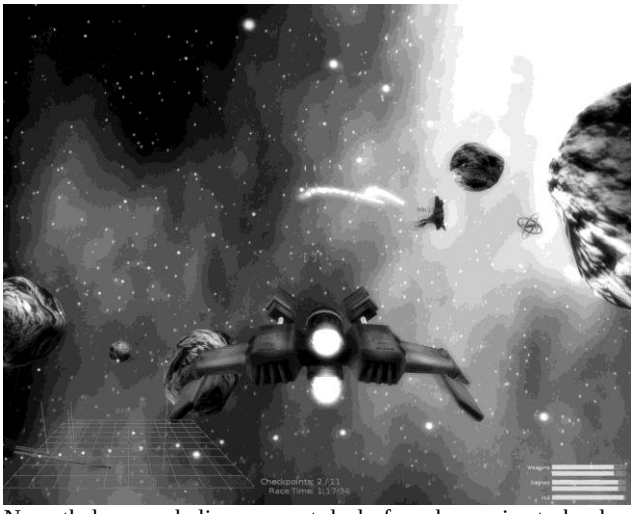
Nevertheless, our educational focus is on complex systems development. Our goal is teaching virtual novices how to develop complex games in the programming languages used by software development professionals.

In summary, it seems that educators mostly lament that there is very little of educational value coming from attempts to bridge the entertainment-education chasm. We believe the problem with bridging this divide rests on the fact that many attempt to make education entertaining. Our focus has been on achievement not entertainment.

5.0 THE FUTURE OF GM-GAMES

There are approximately 20 special CS1 and CS2 GM-Games in existence today. After completing the 20 GM-Games, most student novice programmers should be able to undertake the development of a complete game System of their own design. Building on this foundation, small teams can develop very complex 3-D games (Figure 5) in C++ or C# long before they graduate from college.

Figure 5
XNA Based Aurora Sector



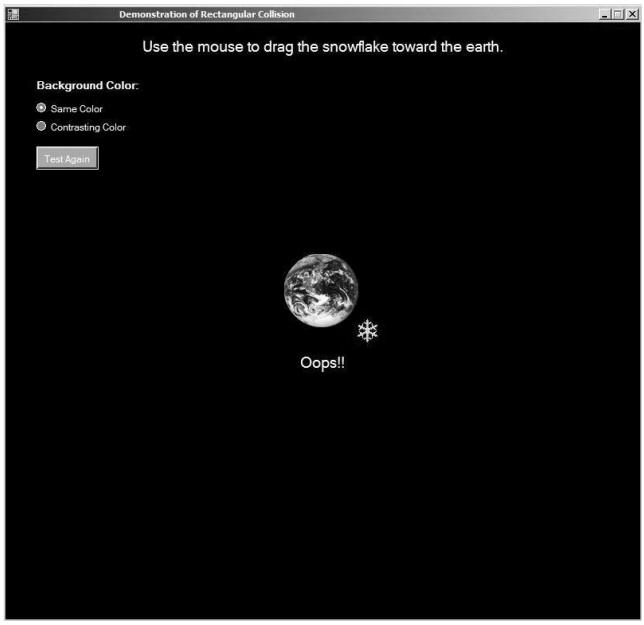
Nevertheless, we believe a great deal of work remains to be done if our hope of developing GM-Games and a modified GM-Method for use in middle and high schools is to be realized. Currently faculty code solutions for GM-Games are posted and revealed to the students only after student solutions have been independently crafted and scored. These faculty solutions incorporate advanced coding concepts and exhibit the experience of a mature logician. To be useful in middle and high schools, GM-games with reduced complexity and elementary code solutions will be needed. For example, circle or rectangular collision GM-Games (Figure 6) should be achievable by middle school and early high school whereas pixel collision, (Figure 2) one of the GM-Games for college freshman would be far beyond their mathematical sophistication.

There is a great deal of interest and support available to researchers who are interested in developing new methods and tools that can positively impact educational outcomes for America's K-12 and college students. American students are falling far behind in mathematics and science achievement and we constantly hear from America's corporate leaders that they cannot find adequately trained staff. The National Science Foundation and US department of Education are supporting new educational initiatives which focus on this national problem. Similarly, the Microsoft Research Corporation, the Microsoft XNA Product Group and Electronic Arts Corporation have supported many game based educational research endeavors.

Many of these educational research initiatives, based around game development, are showing promise. In our case, we believe the advent of a simplified, but technically rich, experientially diverse and widely available family of GM-Games, when used with a neo-Socratic educational method, can help many realize

high achievement. The 250% increase in computer science majors at some colleges suggests that ultimately high achievement not entertainment is what students are looking.

Figure 6
GM-Rectangular Collision



6.0 CONCLUSION

Game play is energizing and exciting to students. We have seen that educational goals structured as games foster enthusiasm and a strong work ethic. Passion for game development and the hope of employment in the game industry provide a strong incentive to succeed. Undoubtedly the hope of working in the game industry is fueling the rapid growth in enrollments at many colleges.

We believe that the success of GM-Games and the GM-method of education suggests that entertainment might not be the primary incentive behind student enthusiasm for game play. GM-Games could hardly be called entertainment and yet we find students undertaking these games with energy and passion. We believe achievement is as important to teenagers as entertainment. We also believe teenagers love autonomy and prefer to work without intervention, supervision or faculty lectures. We frequently observe that students prefer to take their questions to other students rather than to faculty members.

7.0 REFERENCES

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