

# Mily's World: A Coordinate Geometry Learning Environment with Game-like Properties

Dovan Rai, Joseph E. Beck, Neil T. Heffernan  
Computer Science, Worcester Polytechnic Institute  
{dovan, josephbeck, nth}@wpi.edu

**Abstract.** *Mily's World* is a learning environment for coordinate geometry that has game-like properties, that is, elements of games that are engaging such as cover story, graphical representation, and animated feedback. This paper proposes that adding game-like properties to a computer tutor results in more student engagement and interest in the material. However, in addition to taking instructional time away, adding such properties imposes new limitations and difficulties in constructing content. Therefore, we have taken a measured and minimalist approach to making the original environment more game-like by weighing each additional component in terms of retaining all the learning features of a tutor and minimizing the new limitations, while exploiting the benefits of games.

**Keywords:** educational game, motivation, authentic activities, educational datamining, visualization, endogenous fantasy

## 1 Introduction

Although games are engaging to motivate students, they tend to take up time that could have been used for instruction and have been empirically shown to be less effective than intelligent tutors when it comes to learning gains [1]. Hence, instead of completely integrating educational content into a game framework, we instead choose to incorporate into the tutor those features of games that are motivational but do not overly detract from learning. Based on this choice, we created *Mily's World*, a learning environment for coordinate geometry with *game-like properties*. We define game-like properties as elements of games that are responsible for their engaging nature such as points and rewards, graphics, fantasy, interactive feedback, speeded trials, leveling up, etc. Our reason for taking this viewpoint is that we wish to make computer tutors more engaging and game-like, but do not want to start by trying to design an educational game. Instead, we are taking a measured and minimalist approach by incrementally making a complete tutor more game-like by weighing each additional component in terms of retaining all the learning features of a tutor and minimizing the limitations, while exploiting the benefits of games. Our hypothesis is that the sweet spot of educational efficacy and engagement is closer to computer

tutors than it is to educational games. Therefore, we feel that a strategy of gradually and incrementally adding game-like properties to a tutor is productive.

*Mily's World* has a series of 8th grade (approximately 13-year olds) coordinate geometry problems wrapped in a visual cover story. Mily, a 9-year old girl, is the protagonist who has a puppy and some friends with whom she plays soccer. Students are engaged in many different math-related tasks. For example, they calculate slopes and coordinates to create a doghouse (see Fig 1), find the coordinates of a position to place the socks where the puppy cannot reach them, calculate slopes and equations of the path of the ball as Mily and her friends play soccer. Similar to a classic ITS, students will receive tutorial help as they stumble on problems and misconceptions. *Mily's World* has endogenous fantasy [2], that is, the students genuinely have to use their math skills to solve the story problems.

### Why “tutor with game-like properties” rather than educational games

In addition to taking instructional time away, the cognitive overload can be a major limitation. We have taken a strategy to minimize extraneous details when it gets in the way of effective learning, making a balance between stimulation and overload. We have used the following two strategies:

**Simple game-like environment:** Regular games can afford to have new and complex environments with complicated rules. But for educational games, the goal is for students to learn the content, and so students should not be overwhelmed by too many details. **Minimalist visual presentation:** The presentation should be simple and intuitive so that it helps to off-load details rather than overload working memory.

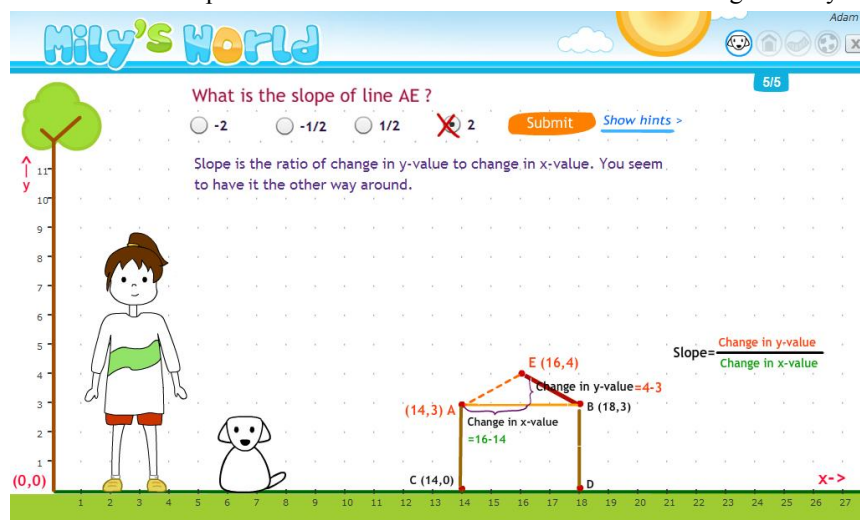


Fig 2: Screenshot: *Mily's World*, doghouse problem

### Game-like properties, emotional interest and cognitive interest

Games arouse sensory and emotional interest. We propose that the carefully integrated game components can make math problems more meaningful and

challenging and also aid in more easily understanding the content, and thus arousing cognitive interest [5]. Based on our content, we have included some game-like properties. Though a lot of education materials have the properties listed below, we call them game-like properties based on their interactivity, fantasy and concreteness.

**Authentic activities:** Learning is more efficient and effective when it is embedded in realistic and relevant contexts [3]. In *Mily's World*, students are engaged in everyday activities like building a doghouse, playing soccer and solving mathematical problems along the way.

**Visual representation:** Successful problem-solvers build mental models from word problems. Graphics not only add appeal but they can help develop mental models, thus reducing the burden on working memory and processing [4].

**Storyline:** If we use a coherent cover story, it gives more holistic approach to learning and in practical term the initial story context can be reused for multiple problems, thus saving student effort.

**Animated immediate feedback:** With visual immediate feedback, students can tell what the error was and how it relates to the correct solution. For instance, the puppy can chew socks if they are placed at wrong coordinates.

**Badge collection:** Students can collect badges after completing each problem set, which give them sense of achievement and progress.

## Evaluation

Sixty six 8<sup>th</sup> grade students used the system who had also used Assistment, a web based tutor. Although the students were not totally enthusiastic about Mily (20% said they liked it, another 20% said they did not like it and 60% said they find it ok), they still preferred it over Assistment (52% preferred *Mily's World*, 13% preferred Assistment and 35% had no preference). We also analyzed how different student subpopulations receive the new intervention, and that found that the students who find real-world examples and pictures helpful for solving math reported liking Mily more. In next study, we want to make more robust measure of engagement and compare learning gain with the gain from regular tutor.

## References

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