

Teaching Astro 101 Using Only a Video Game, No Textbook, No Lecture

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Abstract

I present my experience teaching a standard introductory astronomy course using only a video game, no textbook, no lecture. Cost to students for the game (TheAstroventure.com) was \$40, about 1/4 the cost of a textbook. Students performed typically on typical exams for such a course. The workload was remarkably low, just holding office hours, maintaining a positive online narrative with students to motivate timely completion of assignments, and following up with the few students who did not do them. The engagement level was outstanding, with over 90% completing every assignment and only two students obtaining grades below a 'C' or withdrawing. The self-paced nature enabled a number of students in challenging situations (life-threatening hospitalization, parents of multiple children holding multiple jobs, course overload) to complete the course with good grades. Student evaluations reflected extremely high levels of satisfaction.

Motivation

American universities are continually under pressure to teach more students with fewer faculty, to reduce tuition, to improve learning outcomes, and to make learning easier. General education classes are under particular scrutiny. As required courses, many participants are only enrolled because they need the class to graduate, so they lack motivation. Attendance, student satisfaction, and learning outcomes are typically lower than in elective courses and courses required for the student's field.

A Course in a Game

Gamified courses are ubiquitous in corporate training, but little-known in academia. Here, I present my experience teaching introductory astronomy using only a video game, *The University of Mars*, developed by Prof. Jane Charlton and collaborators at Pennsylvania State University and published by her company, TheAstroventure.com. The cost to students at the time (Spring 2023) was \$40, about 1/4 the cost of a textbook with online learning exercises. Several universities use the game, notably Penn State, where about 90% of students enroll in it annually (5000 students per year). One professor teaches it and considers it a light load.

Game Play and Storyline

In the game, a student's character (they can name and personalize it) travels to Mars and studies at the university there. Some action is underground, some is on the surface, and some takes place as the characters travel around the Solar System, galaxy, and universe doing tasks and taking on challenges. At each stage, there is both factual knowledge and intuition. For example, time is proportional to distance traveled in each game section, starting with the solar system (yes, the students do break the speed limit). A platform running and jumping game with adjustable planetary radius and mass demonstrates gravity; the quiz is running the platforms for time. There is an excellent interactive 3D orrery and celestial sphere simulation that uses the different poles and orbits of Earth and Mars to drive home lessons about how planetary motions and seasons work. Teaching how the two effects work on two different planets makes it easier for students to understand that Earth's seasons are mainly due to axial tilt. Some sections include external reading on NASA and other websites, notably for the solar system.



The orrery in planetarium mode, with Mars's equator, showing the zodiac constellations.

Results: Remarkable!

In my initial section of 104 students, over 90% completed every assignment. Performance on typical introductory astronomy examinations was typical. The final grade distribution was A:46, B:47, C:9, D:0, F:1, W:1, a DFW rate under 2%. Subsequent, much-larger sections taught by others obtained similar results. The few low grades resulted from time pressure from other courses rather than a lack of motivation.

My effort was minimal, simply holding office hours online, keeping a steady motivational commentary going in the course's online chat to encourage students to follow the assignment schedule, and reaching out individually to students if they did not complete assignments. In-game quiz scores and game section completion updated in near real time to the university's course management system, so the students and I could confirm their progress was recorded correctly. I found the students to be astonishingly engaged throughout the course.

Flexibility for Students

The self-paced nature of the game and the large test bank allowed maximal time flexibility, enabling a student hospitalized in the first week of classes, who was conscious and lucid for fewer than four weeks, to earn a B+. It was the only class he completed, and it enabled him to keep his scholarship. Several students who were parents holding down one or more jobs stated that they likely could not have succeeded in a course with a fixed meeting time. One student completed the entire course in a ten-day marathon just before the semester started, enabling her to take a full load of other courses. She earned a B+, taking the mid-term and final examinations when they were administered.

Benefits and Limits

I do not suggest that all courses can be gamified, nor that this modality is ideal or even merely better for every student. A human instructor can respond to questions in real time and can engage the students in conversations with each other that motivate learning, exploration, and retention. Human instructors can go beyond the text if students are interested, and can answer questions about current events. Human instructors can also modify content in response to recent requests or student performance. Parallel sections to mine used a standard online format and an in-person delivery, so students self-selected into my section. However, the section filled quickly and the student evaluations I received were well above the department, college, and university means in every one of nine categories (53 respondents). In every category there were more "excellent" than "very good", more "very good" than "good", and at most two ratings of "fair" or "poor".



Greenhouse, underground entrance, shuttle.

The Future

Given the financial constraints in higher education, students' desire for more enjoyable learning, the need for time-flexible courses, and the evident effectiveness of this approach, I find this particular course and gamified learning in general to offer an attractive alternative that bears a trial run.