STELLAR ASTRONOMY FOR HIGH SCHOOL EARTH SCIENCE STUDENTS: TEACHING BY USING ANALOGIES

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Introduction

High school students are required to understand the development stages of stars, the evolution of stars, and the processes occurring in stars. Stars and stellar evolution are abstract concepts which can be difficult to teach. Work has demonstrated analogical thinking and the implementation of analogies are powerful tools in teaching.

Background

- Ninety percent of all stars comprise what is known as the Main Sequence on the Hertzsprung-Russell (H-R) Diagram. The Main Sequence stars form a diagonal band across the H-R Diagram.
- The mass of a star is the largest determining factor in its lifespan.
- Low mass stars burn fuel very slowly, thus providing them with a long lifespan on the Main Sequence.
- High mass stars burn fuel very quickly, thus providing them with a short lifespan on the Main Sequence.
- The relationship between cars and gas mileage is analogous to stars and life expectancy (Figure 1 & Figure 2).

Figure 1: How low-mass stars are analogous to economy cars. From POGGE. Lecture Notes Graphic from The Ohio State University, Department of Astronomy. Reproduced by permission.

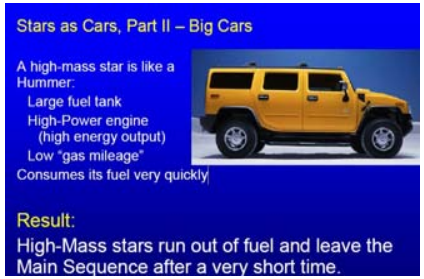


Figure 2: How high-mass stars are analogous to trucks. From POGGE. Lecture Notes Graphic from The Ohio State University, Department of Astronomy. Reproduced by permission.

- The life cycle of a Main Sequence star is similar to a human's life cycle, both are born, live a finite life, and eventually die (Figure 3).
- The Main Sequence of Stars is analogous to the Main Sequence of Cars (Figure 4).

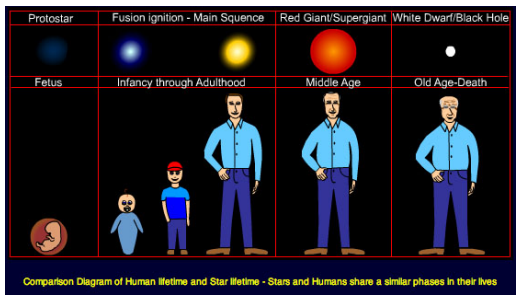


Figure 3: The life cycle of stars is analogous to that of humans. From CALLAHAN. Internet Graphic from the University of Utah, Department of Physics & Astronomy. Reproduced by permission.

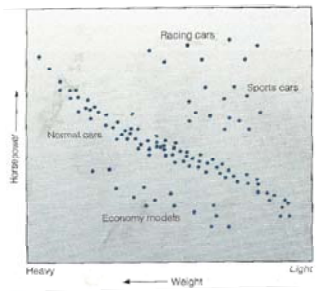
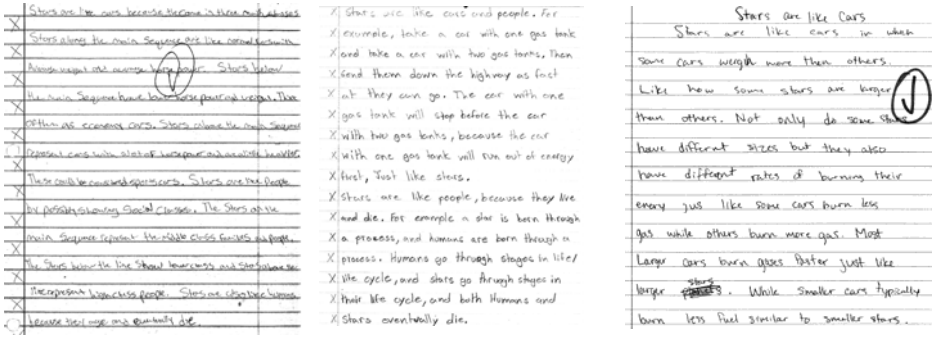


Figure 4: An imaginary H-R Diagram for cars is analogous to the H-R Diagram for stars. From SEEDS. *Horizons: Exploring the Universe*, 4E. © 1995 Brooks/Cole, a part of Cengage Learning, Inc. Reproduced by permission.

Procedure

This study was conducted to determine if it was feasible to utilize analogical thinking to teach high school earth science students about stars and stellar evolution. Approximately 135 junior and senior earth science students at the Miami Valley Career Technology Center in Clayton, Ohio were taught about stars and stellar evolution by lecture featuring a H-R Diagram. During direct instruction, a total of three analogies were used: 1.The fuel consumption of massive stars is similar to that of large cars, 2. Stars have a lifecycle like humans with a beginning and end, and 3. The H-R Diagram of stars is analogous to an imaginary H-R Diagram of Cars where the relationship between surface temperature and magnitude in stars is similar to the relationship between weight and horsepower in cars. At the conclusion of the lesson, all students were administered a quick write prompt ("How are stars like cars and people?") in order to determine the effectiveness of these analogies for understanding stars and stellar evolution.

Results



Figures 5, 6, and 7: Collins quickwrite responses submitted by three students.

Conclusions

Quick write prompts suggested that the analogies were useful in helping students to understand general principles of stars and stellar evolution. However, the analogies may have had limitations in helping students to understand core concepts such as how the mass of a star influences stellar evolution. Future research studies may help to determine the best methods and techniques of implementing analogies to teach about stars and stellar evolution. Additional studies will investigate the integration of technology such as stellar evolution software in conjunction with analogical thinking and whether both will enable students to fully grasp the development stages of stars, the evolution of stars, and the processes occurring in stars.

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