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Grade 9 Astronomy Study: Interests of Boys and Girls Studying Astronomy at Fletcher's Meadow Secondary School

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Abstract

In this report, we discuss the interests of Grade 9 boys and girls studying astronomy at Fletcher's Meadow Secondary School in Brampton, Ontario. A total of 152 Grade 9 academic students were asked to rate their interest levels in various astronomy topics on a scale of 0–3, where 0 represented no interest and 3 represented a high level of interest. We also asked the students to rate all the in-class activities on the same scale. Our analysis of the data suggests that there are many similarities in interest levels in various astronomy topics between boys and girls. In addition, boys and girls expressed similar preferences for in-class astronomy activities with only minor differences, suggesting similar learning styles in astronomy for boys and girls at the Grade 9 level.

1. THE CHALLENGES OF TEACHING HIGH SCHOOL ASTRONOMY

Astronomy is an exciting unit in Grade 9 science for students and teachers alike. It is a great "hook" for introducing science as a multidimensional discipline. Astronomy promotes curiosity, imagination, and a sense of shared exploration and discovery. It has many everyday applications and is deeply rooted in the history of almost every society. Unlike other areas of science, which repeat in the high school years,

astronomy does not reappear in high school. For most students, Grade 9 science may be the only course to expose them to this extremely appealing modern science.

Teaching astronomy is, however, usually a great challenge for science teachers because many students do not have the sufficient background and conceptual skills to understand topics such as day/night cycles, the reason for the seasons, the formation of the Solar System, and the origin of the Universe. For example, a study of Israeli high school students' conceptions of astronomy concepts suggests that a great proportion of students have many misconceptions about the reason for the seasons, the cause of total solar eclipses, and the scale of the Universe (Trumper 2001). In addition, Comins (1995) identified many more factual misconceptions, such as: (1) the North Star, Polaris, is the brightest star in the night; (2) the asteroids in the asteroid belt were once part of a planet that was destroyed; and (3) the Earth's core is liquid. Furthermore, some high school students think that there are hundreds of stars in our Solar System and that spacecraft can fly faster than the speed of light. Many students have initial conceptions of astronomical phenomena, and as they grow up, their early ideas are likely influenced by erroneous information presented in everyday culture and mass media, such as science fiction films and TV series (Yair, Mintz, & Litvak 2001). Many misconceptions become so deeply rooted that they are carried into adulthood.

Teachers may also have misconceptions about similar concepts. A sample of 20 teachers varying widely in age, science background, and teaching experience were interviewed in one study (Mant 1993), which led to the conclusions that (1) the teachers did not have good observational knowledge of what happens in the sky, (2) many of the mental models of the Universe held by the teachers were not in accord with the scientific model, and (3) many teachers provided erroneous explanations for phenomena such as day and night, the seasons, and the phases of the Moon. In addition, teachers have misconceptions about teaching astronomy that discourage them from teaching this subject well, or teaching it at all (Percy 2006). For students to be attracted to astronomy, high school science teachers need more support in terms of knowledge about astronomy, teaching tools, and materials available to offer the best education to their students.

2. THE GOALS OF THE STUDY

The primary purpose of the study reported in this article was to determine what astronomy and space science topics are of most interest to students. Because astronomy is not a prerequisite for subsequent science courses taught at the high school level, there can be considerable flexibility in the choice of which topics to cover. Knowledge of which subjects are most attractive will help teachers to retain student interest while correcting many of their misconceptions and helping them develop imagination, scientific reasoning, and memory.

What students are interested in knowing about astronomy and what they think about the various in-class activities is an important consideration. Interest is a form of intrinsic motivation; students are more likely to be emotionally involved and engaged when they are interested in what they are learning. Interest is also a powerful motivator that can prompt learning of new content (Baram-Tsabari & Yarden 2007). Triggered states of interest can contribute to productive student engagement with learning. If students have a spark of curiosity about a topic or several topics, teachers can tap into that knowledge and captivate students' interests by designing meaningful and engaging assessment tasks. Topics that are particularly fascinating to students, such as black holes and extraterrestrial life, can provide a basis for acquiring new knowledge. For the curriculum to be relevant to the students and their lives, it should take into account students' interests.

A second goal of the study was to determine whether boys and girls have similar or different interests and preferences regarding the types of learning exercises that are used in class. The underrepresentation of women at all levels of Canadian astronomy is a longstanding problem. Although women make up half or more of the general population, they constitute only a tiny fraction of professional astronomers (Reid & Matthews 2004). There is a need to attract women and minorities to scientific careers and to prepare them for jobs in astronomy and elsewhere (Percy 2006). By exploring girls' interests, preferences, and learning styles, teachers can contextualize and personalize some of the formal science curricula, which could be empowering for girls. It is imperative that teachers extend their instructional repertoire to create learning environments that encourage and challenge girls to construct knowledge and apply it to everyday phenomena. An important question to consider for educators is: To what extent does their instructional repertoire encourage gender equity in the science classroom?

Some researchers suggest that the emphasis on gender differences reinforces stereotypes that girls may lack scientific aptitude (Hyde & Linn 2006). Some educators may emphasize gender differences, and this rests on the assumption that psychological gender differences are large and exist in numerous domains (Hyde & Linn 2006). However, educators also need to increase awareness of *gender similarities*. Whatever the case may be, teachers should be sensitive to gender issues and should communicate that sensitivity to their students to make them feel safe, challenged, and involved in their interactions with one another (Bennett & Rolheiser 2001).

3. ASSESSING INTERESTS AND PREFERENCES OF BOYS AND GIRLS IN GRADE 9 ASTRONOMY

3.1 Sample and Procedure

A team of science teachers at Fletcher's Meadow Secondary School (FMSS) in Brampton, Ontario, conducted a specially created 21-item Likert-type survey to assess interest levels of boys and girls in various Grade 9 astronomy topics. A total of 152 students in the academic stream were asked to record their level of interest, on a scale of 0–3 (0 = *not interested*, 1 = *somewhat interested*, 2 = *interested*, and 3 = *very interested*), in 21 astronomy topics at the end of the unit. The topics and the results of the survey are given in the appendix.

Some of the topics covered in the course were characteristics of planets, stars, and constellations; the composition of the Sun; formation of black holes; the Big Bang theory; historical stories about space, space exploration, and the International Space Station; and living in space. Students were allowed to add topics to the list, but few did. After the questionnaires were completed, they were sorted by gender, and each item (astronomy topic) was analyzed separately by adding all students' responses to an item and determining the average value of the responses. If the average for an item in the survey was a 2 or 3, it was considered a topic with a high level of interest. On the other hand, if the average was less than 2, it was considered a low-level-of-interest item. These data were represented on a bar graph for an easier comparison of the interest levels between boys and girls.

Using a 12-item Likert survey, exactly the same procedure was followed for determining each gender's preferences for the various in-class astronomy activities. The 12 common activities that were performed in all Grade 9 classes were: a Moon crash-landing assignment; a moons in the Solar System research and presentation assignment; construction of the model of the Solar System; making the star map; collecting

sunrise and sunset data; creating space art; a virtual tour of the International Space Station; and a micro-gravity simulation activity. We also included space videos, a Pluto reading assignment, a Sun scavenger hunt reading activity, and general PowerPoint presentations.

Validity evaluation of the two Likert surveys consisted of an internal consistency evaluation using the Cronbach's alpha reliability test and the Spearman-Brown formula. The Cronbach's alpha values for both interest and preferences surveys ranged from 0.81 to 0.89, and Spearman-Brown values ranged from 0.77 to 0.93. The surveys were considered consistent and reliable.

3.2 Analysis of the Results

3.2.1 Interest Levels of Boys and Girls

When the responses to interest surveys of 64 boys were averaged, it was found that boys' highest levels of interest were in the following topics: formation of black holes, extraterrestrial life and UFOs, and living in space (eating, sleeping, exercising, and working). Each topic had similar average levels of interest; thus, there was no obvious preference for any one of these high-interest-level topics. A total of 88 girls responded, and when their responses were averaged, we found that girls' highest levels of interest were in the same topics as boys; the one exception was that the girls expressed a much lower interest level in learning about black holes. Our data therefore suggest that there are many similarities and only minor differences in the interest levels of boys and girls in Grade 9 astronomy.

Both genders expressed a low level of interest in the following topics: historical stories about space exploration, contributions of famous astronauts to space science, space technologies, and the composition of the Sun. It is interesting to note that male and female students taking the Astronomy 101 course at the University of Toronto in Mississauga, Ontario, reported low interest levels in the same topics as the Grade 9 students at FMSS, and both genders expressed high interest levels in topics such as origin of life, and space travel and exploration (J. R. Percy, personal communication, November 29, 2007). The differences in interests between males and females in Astronomy 101 were more prominent than those between males and females in Grade 9 science. This may suggest that differentiation in interest levels for boys and girls in astronomy may occur later in their high school years, or perhaps the major differences in interests arise in students' postsecondary years.

3.2.2 Preferences of Girls and Boys for Various In-Class Activities

A possible explanation for the relative lack of interest in the mentioned topics among this group of students may lie in the choice of instructional strategies and in-class activities used to teach students about contributions of famous astronauts to space science, and other low-level-of-interest topics. We hypothesized that there will be some relationship between students' interest levels in various topics and the in-class activities and lessons that were used to teach and assess the acquisition of content. This hypothesis is based on research that supports the connection between engaging, hands-on activities, and triggered states of interest and improved learning of new content (Baram-Tsabari & Yarden 2007).

The data from our surveys indicate that both boys and girls expressed a high preference for various space videos, of which Bill Nye was among the favorites. It was not surprising to find out that boys and girls in Grade 9 enjoy watching videos in class. It was interesting to see that there was a correlation between certain space videos—in particular, the short clip about living on the International Space Station from

NASA's multimedia gallery (http://www.nasa.gov/multimedia/index.html)—and the students' interest levels in this topic, thus supporting our hypothesis. In addition to finding various videos interesting, the Grade 9 girls at FMSS also found the following activities enjoyable and thus indicated a high-level of preference: the micro-gravity simulation activity, construction of the model of the Solar System, and space art. It was apparent that the girls preferred creative and hands-on space activities. The boys also expressed a relatively high preference for the same activities, with one striking difference: the girls enjoyed the micro-gravity simulation activity a lot more than the boys did. In this activity, the students were asked to screw a nut on the bolt while wearing hockey gear and balancing on an exercise balance ball. The Grade 9 teachers reported that the girls were a lot more eager to participate than the boys. Overall, however, we found many similarities in the types of in-class activities that boys and girls prefer at the Grade 9 level.

The least enjoyable activities for both boys and girls included reading and responding to Pluto articles, collecting and analyzing sunset and sunrise data, and the Sun scavenger hunt reading activity. These three activities focused greatly on reading and writing. Our data suggest that students may need extra support in activities that involve critical thinking and critical literacy skills. Achieving greater success in critical literacy may be possible by embedding literacy strategies into activities that students find the most enjoyable. Astronomy is an ideal discipline that lends itself to helping students develop their literacy (and numeracy) skills. The study by Ratay et al. (2003) suggests using articles from magazines such as *Scientific American* and *Astronomy* to teach current science topics and to reinforce reading and writing skills.

4. IMPLICATIONS OF OUR STUDY: ENHANCING TEACHING AND LEARNING

Although it is nearly impossible to adhere to the individual interests of each of the students in a large class, there are ways to incorporate students' interests into the science classroom. The findings from our surveys have implications for the way that we structure our unit plans, plan daily lessons, and set up our classrooms. By understanding students' interests and preferences for various in-class activities, teachers can differentiate instruction by allowing choices, which will, we hope, create a higher level of interest and motivation for both boys and girls.

The Grade 9 teachers at FMSS may have to devise different ways to teach students why Pluto is no longer a planet or what the composition of the Sun is. Instead of giving students articles to read or assigning pages from the textbook, which our students found unmemorable, teachers could ask students to select their own article or generate their own questions. By selecting their own reading material, students have the opportunity to choose an article that may interest them. In addition, student-generated questions allow students to craft their own problems and engage in self-directed investigations. Question-driven problem-based learning is based on what the students are interested in, and it is driven by students' need to answer their own questions (Baram-Tsabari & Yarden 2007). The teacher's role as a facilitator of learning is crucial in molding students to become self-directed and lifelong learners.

Further implications of our study suggest that teachers may adopt a common theme to tie many of the astronomy concepts together. For example, because both girls and boys find living in space and the International Space Station to be the most interesting topics, teachers could design multiple in-class activities in which students work together over the course of the unit to build their own space colony. The students should piece together knowledge and understanding of various concepts—such as distances in space, physical features of planets, conditions for life, and many others—to come up with a culminating

space colony project.

Student achievement and success are at the heart of our profession, and it is for this reason that we chose to engage in this study. This study has provided us with insight into how our students perceive astronomy and what we can do to help them experience this subject with the greatest enjoyment. Results of many studies indicate that students' interests are important for the in-depth comprehension of many concepts. Equally important is the use of teaching and learning strategies; thus, a possible direction for future research involves looking into how various instructional strategies, coupled with students' interests, can help improve students' achievement in astronomy.

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APPENDIX

Click here for the appendix in PDF.

Appendix URL: http://aer.noao.edu/auth/Krstovic.Survey.pdf

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