Energy Literacy and Sustainability Topics in a High School Problem-Solving Competition

Sarah Pate[1], Quinn Langfitt[2], Trace Sendele[2], & Liv Haselbach[2]

[1] The University of Alabama, Tuscaloosa, AL; [2] Washington State University, Pullman, WA
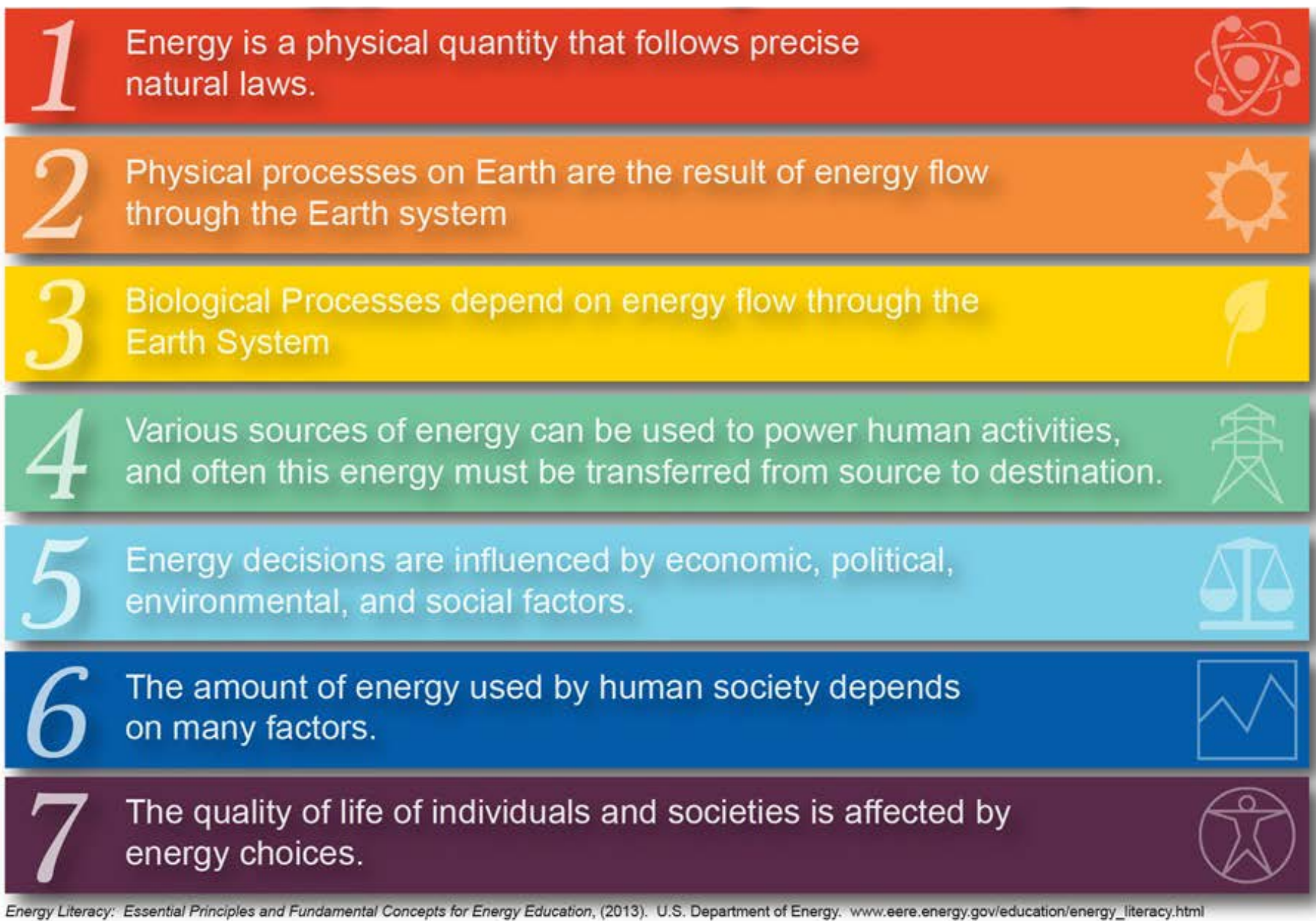
Background

The Alaska Airlines Imagine Tomorrow Problem-Solving Competition
- 9th year of annual high school energy competition
- Expanded to include other sustainability topics this year
- Students select an issue as a group
- Compete in one of the challenges:
  - Food, Energy & Water
  - The Boeing Aerospace Challenge
  - The NARA Biofuels Challenge
  - The McKinstry Built Environment Challenge
- Apply one of the following approaches to the project:
  - Technology
  - Design
  - Behavior

Energy Literacy Rubric
- Developed over the last four years for application to deliverables
- Evaluates applied energy literacy
- Correlated to the US Department of Energy's energy literacy principles
  - Principles have 6-8 subtopics as support
  - E.g. Subtopic 1.1 states "Energy is a quantity that is transferred from system to system."
- Applied to posters from Imagine Tomorrow Competition

DOE Energy Literacy Principles

1. Energy is a physical quantity that follows precise natural laws.
2. Physical processes on Earth are the result of energy flow through the Earth system
3. Biological Processes depend on energy flow through the Earth System
4. Various sources of energy can be used to power human activities, and often this energy must be transferred from source to destination.
5. Energy decisions are influenced by economic, political, environmental, and social factors.
6. The amount of energy used by human society depends on many factors.
7. The quality of life of individuals and societies is affected by energy choices.

Energy Literacy: Essential Principles and Fundamental Concepts for Energy Education. (2013). U.S. Department of Energy. www.energy.gov/education/energy_literacy.html

Sustainability Topics
- Posters determined as energy centric or non-energy centric
- Non-energy centric posters focus non-energy sustainability topics
- First year to see a large portion of non-energy centric posters

Objectives

- Evaluate the energy literacy of energy centric Imagine Tomorrow posters
- Identify any correlations between variables about the competing teams and the associated energy literacy score
- Determine topics high school students are interested in besides energy

References

US Department of Energy (DOE). (2014). "Energy Literacy: Essential Principles and Fundamental Concepts for Energy Education Version 3.0." *DOE/EE-1123.*
WordClouds.com. "Free online word cloud generator and tag cloud creator." Zygomatic, <http://www.wordclouds.com/> Accessed 13 July 2016.
Langfitt, Q., Haselbach, L., and Hougham, R.J. (2014). "Artifact-Based Energy Literacy Assessment Utilizing Rubric Scoring." *ASCE Journal of Professional Issues in Engineering Education and Practice,* 10.1061/(ASCE)EI.0000210, C5014002.
Langfitt, Q., Haselbach, L., and Hougham, R.J. (2015). "Refinement of an Energy Literacy Rubric for Artifact Assessment and Application to the Imagine Tomorrow High School Energy Competition." *Journal of Sustainability Education,* 8.

Acknowledgements

Sustainability Topics: Non-Energy Centric Posters

Methods

- One rater searched for poster main topics and key words and phrases
- Analyzed non-energy centric posters' subcategories (with and without energy components) separately
- Coded similar words into one common key word or phrase
  - E.g. Pollution: pollution, pollutants, contamination, and contaminants
- Generated word cloud and frequency table of key words for each subcategory
- Synthesized poster main topics into a table for all non-energy centric posters

Results

No Energy	
Word	**Frequency**
money	10
pollution	9
recycle	9
water	9
environmental	7
filter	7
disadvantages	6
food	6
global-warming	6
growth	6
waste	6

Figure 1. Word cloud of key words for non-energy centric posters containing no energy

Table 1. Frequency chart of most frequent key words for non-energy centric posters containing no energy

Some Energy	
Word	**Frequency**
money	10
water	9
pollution	7
impacts	6
solar	6
filter	6
food	5
environmental	5
electricity	5
efficiency	5

Figure 2. Word cloud of key words for non-energy centric posters containing some energy

Table 2. Frequency chart of most frequent key words for non-energy centric posters containing some energy

Poster Main Topics			
Topics	**Frequency**	**Topics**	**Frequency**
Water	15	Biochar	1
Agriculture	5	Education	1
Health	5	Environmentalism	1
Transit	5	Insulation	1
Housing	4	Outerspace	1
Recycling	4	Photosynthesis	1
Ecotoxicity	2	Raingardens	1

Table 3. Frequency chart of poster main topics for all non-energy centric posters

- Most common key words and phrases:
  - No Energy: *money, pollution, recycle,* and *water*
  - Some Energy: *money, water,* and *pollution*
- Most common main topics: Water, Agriculture, Health, and Transit

Conclusions

- Money, water and pollution are common key concepts students include in non-energy centric posters
- Students show interest in what could affect their lives

Energy Literacy: Energy Centric Posters

Methods

- Received photos of all posters from Imagine Tomorrow Competition
- Three raters scored all of the posters using the energy literacy rubric
- Compiled scores into a spreadsheet with associated variables
- Variables include:
  - Challenge
  - Approach
  - Project Setting
  - Returning Advisor
  - Advisor Teaching Subject
  - Student Gender
  - Student Grade Level
  - Returning Student
- Energy centric posters determined by Rater 1
- Analyzed energy centric posters for trends and statistical significance
- Analysis of results in progress

Energy Literacy Rubric

|	Points			
Dimension	**0**	**1**	**3**	**5**
Issue	Not addressed	Identify the issue	Frame the issue	Professionally frame the issue
Solution	Not addressed	Identify solution to the issue	Discuss a solution	Develop appropriate solution
Impacts	Not addressed	Identify broader Impacts	Discuss broader impacts	Examine broader impacts
Stakeholders	Not addressed	Identify stakeholders	Consider stakeholder perspectives	Understand and address stakeholder perspectives
Technical Concepts	Not addressed	Identify technical concepts	Discuss technical concepts	Examine technical concepts as they relate to the project
Outside Information	Not addressed	Identify basic info from outside sources or that this information exists	Discuss information from outside sources	Examine information as it relates to the project

Selected Preliminary Results
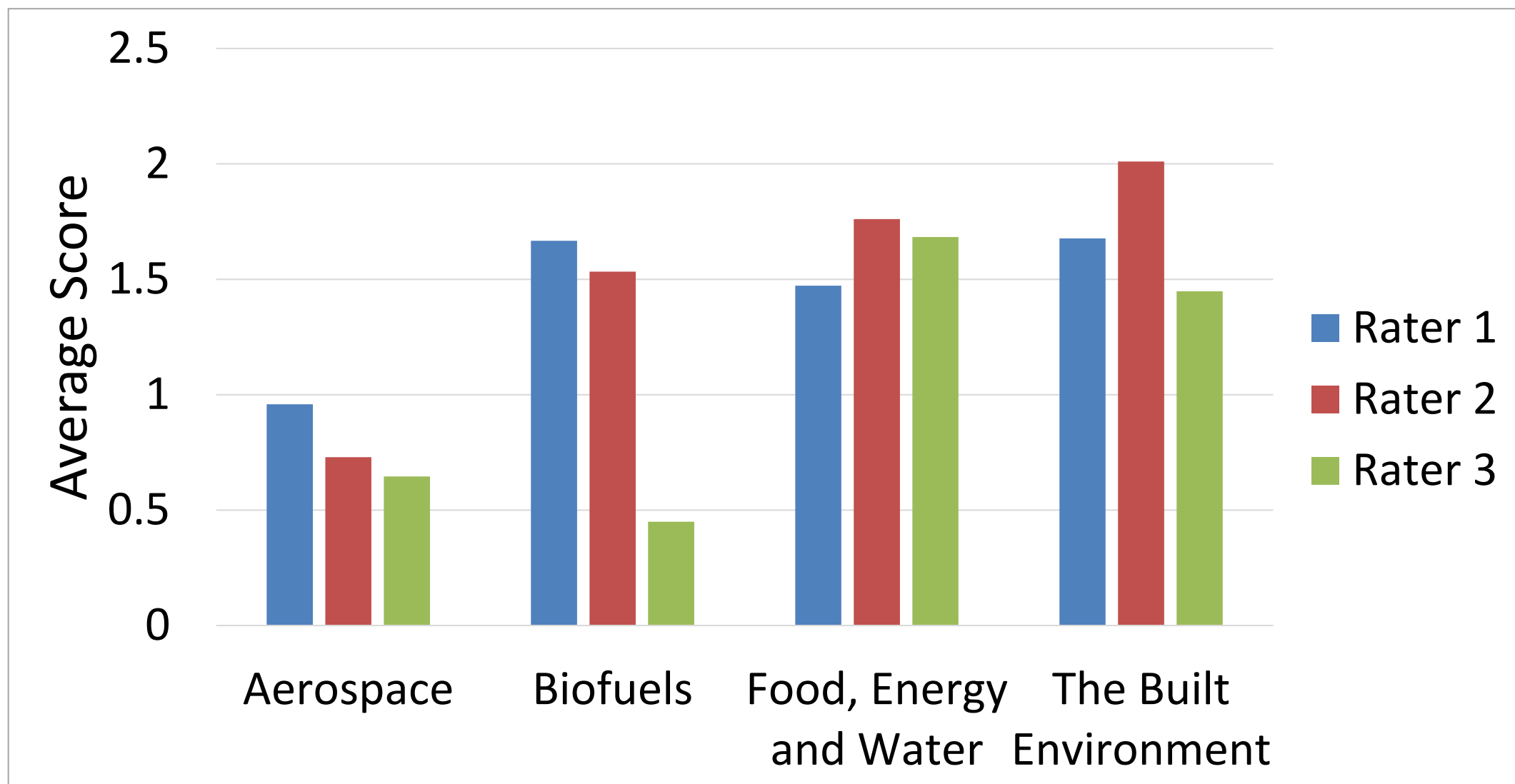
Figure 3. Average scores given by each rater separated by challenges
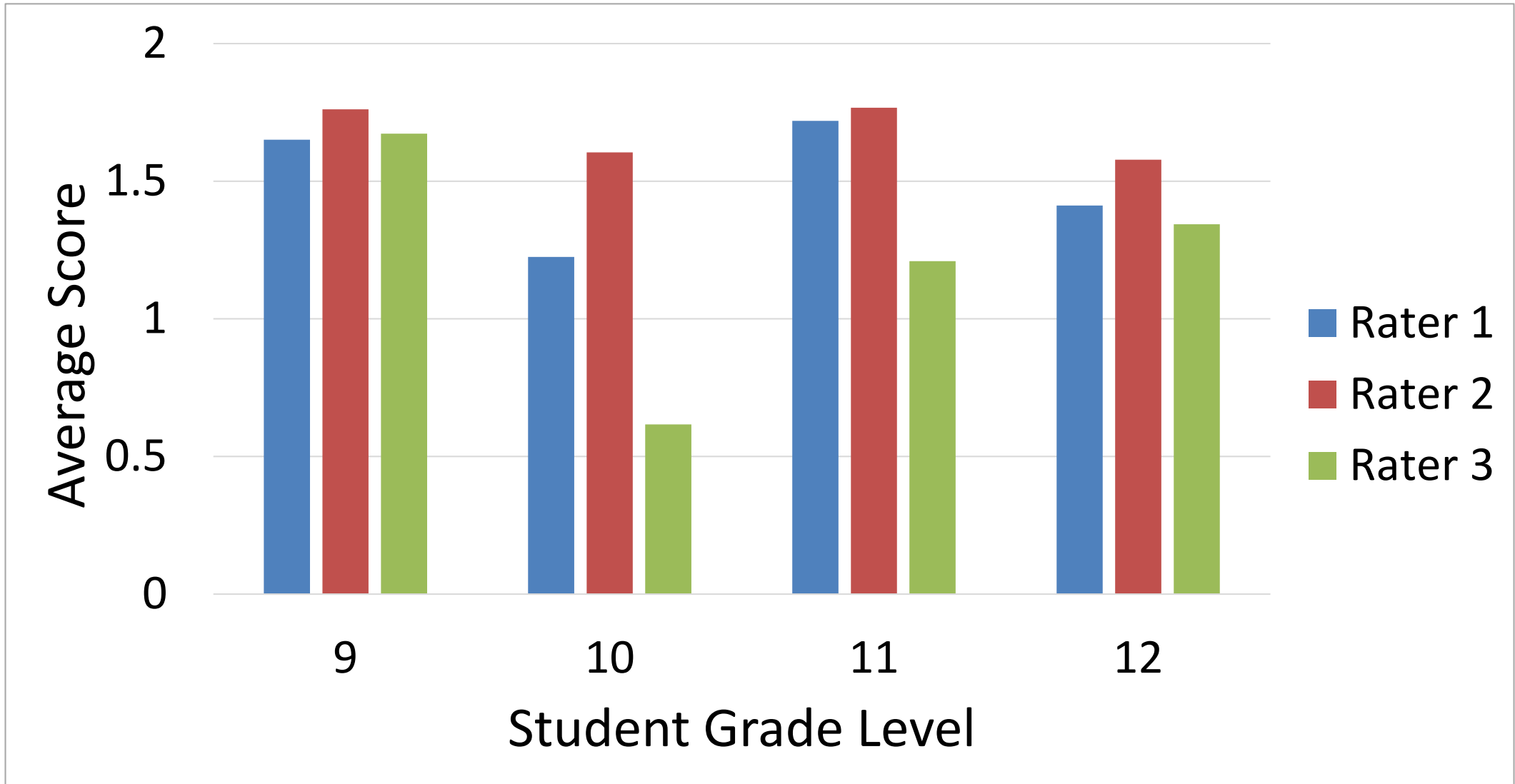
Figure 4. Average scores given by each rater separated by grade level

Preliminary Conclusions

- Posters submitted in the Food, Energy and Water and the Built Environment generally received higher average scores
- 9th and 11th grade students generally received higher average scores