

Exploring students' mental models of matter and energy transformation through lexical analysis of written assessments

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Why use written assessments?

- Constructed responses assessments, including written assessments:
- Allow students to represent their understanding in their own words (Keuchler and Simpkin, 2010)
- Give faculty greater insight into student thinking compared to multiple choice assessments (Birenbaum and Tatsuoka, 1987)
- Students treat constructed response and multiple-choice assessments as different cognitive tasks and prepare for them differently (Stanger-Hall, 2012)

Question 1

- A tropical rainforest is an example of an ecosystem. Which of the following statements about matter and energy in a tropical rainforest is the most accurate?
- Please choose ONE answer that you think is best.

- A) Energy is recycled, but matter is not recycled.
- B) Matter is recycled, but energy is not recycled.
- C) Both matter and energy are recycled.
- D) Neither matter nor energy is recycled.

Explain your answer.

Lexical Categories

Student Responses

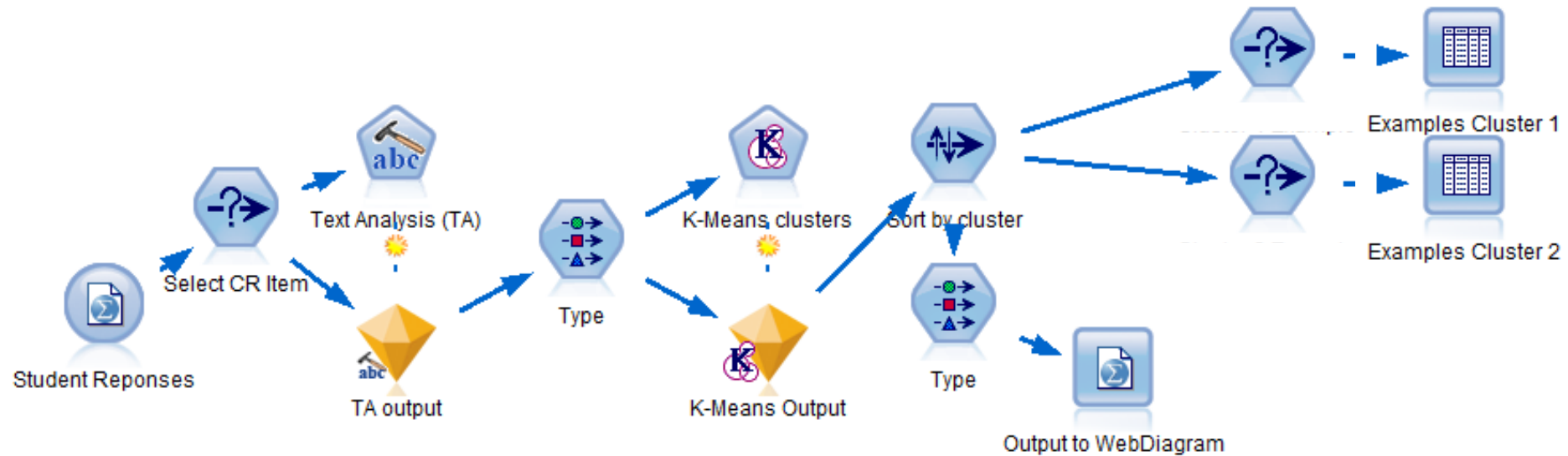
Category	Docs ▾	MatterEnergyQuestion (57) ▾	Categories
All Documents	85	The most accurate statement would be that both matter and energy are recycled. For example, an animal in the tropical rainforest consumes plants that produce energy by using sunlight, oxygen, and wat...	energy forest matter molecules/nutrients organism/plants sunlight
Uncategorized	0		
No concepts extracted	0		
energy	84		
matter	83		
organism	57		
molecules	47		
heat	47		
trophic groups	44		
cycling	35		
ecosystem	35		
sun	19		
forest	17		
process	12		
waste	11		
earth	10		
form	9		
food	7		
sunlight	7		
		B) Matter can be decomposed and recycled back into the environment, like a dead carcass or nutrient run offs. Energy however is lost, and although can be transferred, is not recyclable. From the prev...	energy matter molecules/nutrients organism trophic groups
		B) Matter is recycled, but energy is not recycled. Matter remains at a constant amount in an ecosystem, it does not disappear but remains in various forms. Matter exists in forms of carbon, nitrogen,...	energy matter organism cycling ecosystem form heat molecules/elements

Each response is classified into 0 or more categories

Matter can be decomposed and recycled back into the environment, like a dead carcass or nutrient runoff. Energy however is lost, and although can be transferred, is not recyclable.

Category	Words & phrases in student responses
• Matter • Energy • Organism • Decompose • Cycling • Loss	• Matter • Energy • Dead carcass • Decomposed • Recycled • Recyclable • Lost

Analysis Stream in IBM SPSS Modeler



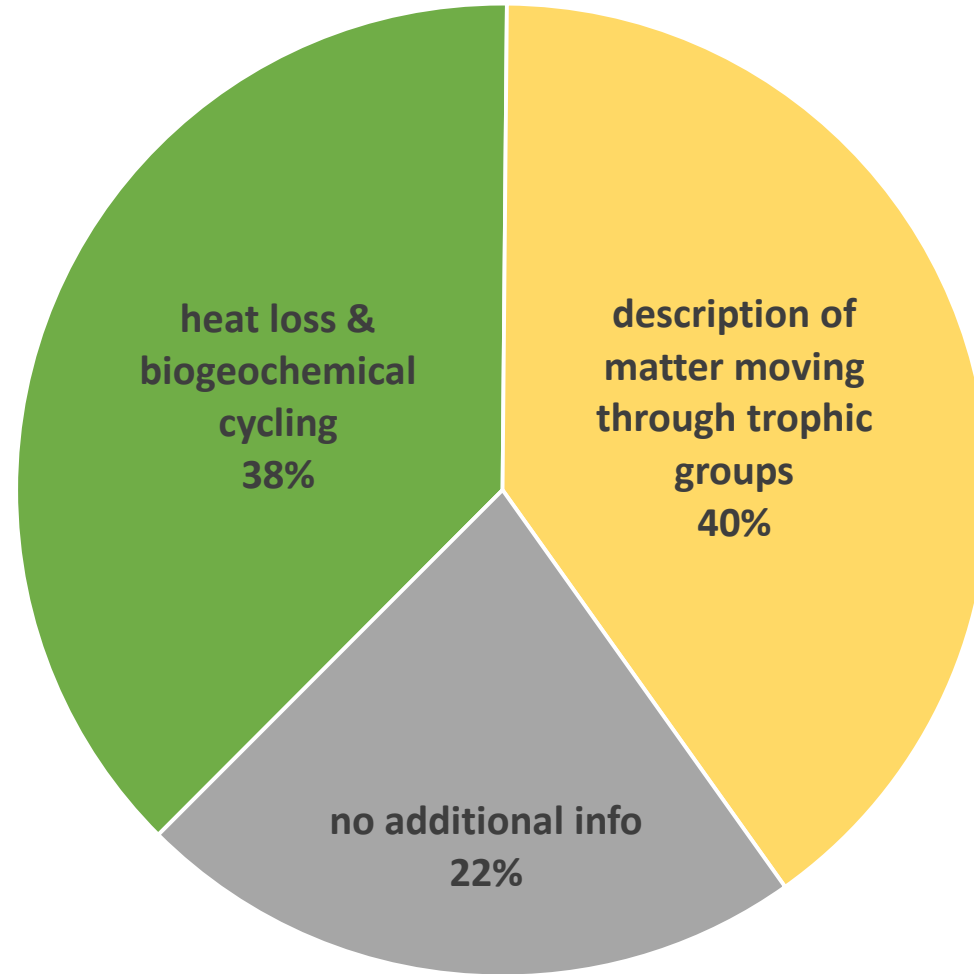
- Connects text and cluster analyses
- Generates output for report
- Facilitates rapid analysis of new data sets

Question 1

- A tropical rainforest is an example of an ecosystem. Which of the following statements about matter and energy in a tropical rainforest is the most accurate?
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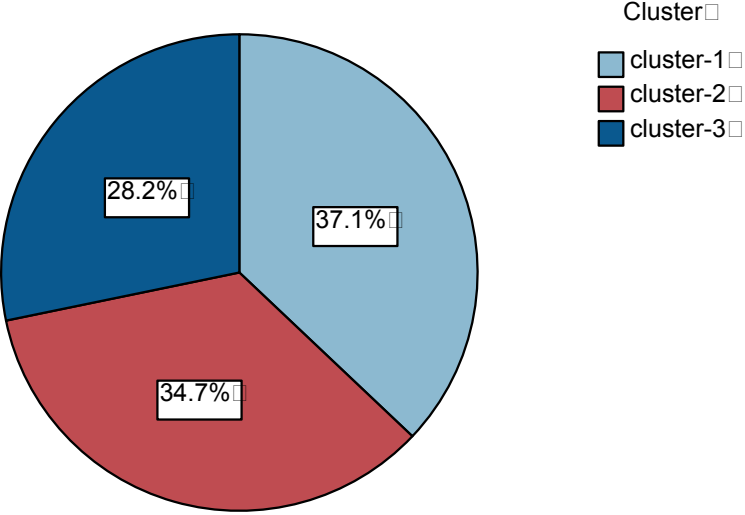
A) Energy is recycled, but matter is not recycled.	4%
B) Matter is recycled, but energy is not recycled.	83%
C) Both matter and energy are recycled.	13%
D) Neither matter nor energy is recycled.	0%

Explain your answer.



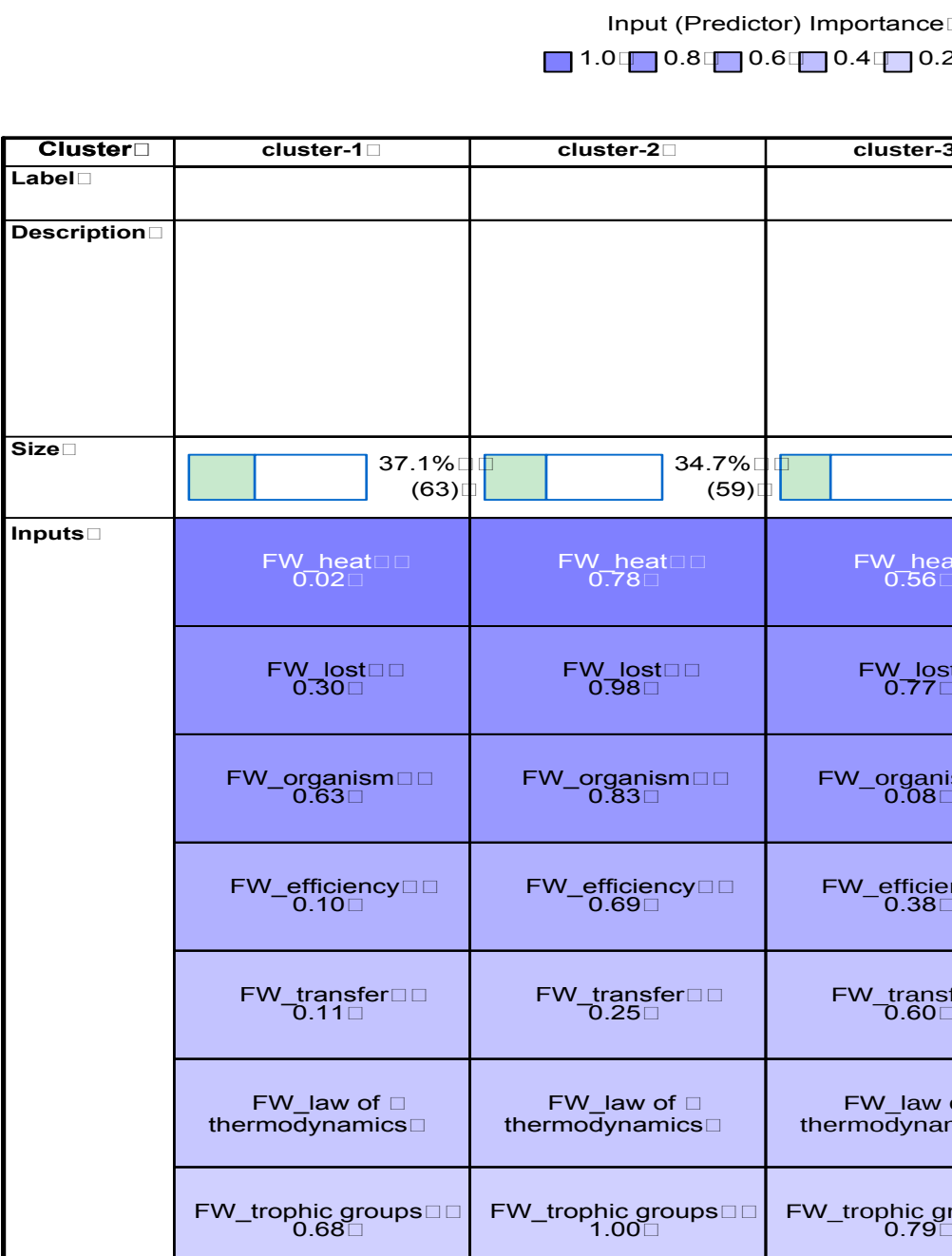
Scientific Ideas	Percentage
Heat loss	69.4
Description of matter moving through trophic groups	40.0
Energy inefficiency	38.8
Biogeochemical cycling	27.1
Non-scientific Ideas	Percentage
Energy converted into Matter	11.8
Matter converted into energy	8.2

Cluster Sizes



Size of Smallest Cluster	48 (28.2%)
Size of Largest Cluster	63 (37.1%)
Ratio of Sizes: Largest Cluster to Smallest Cluster	1.31

Clusters



Scientific Ideas	Percentage
Energy lost	67.6
Available energy decreases at higher trophic levels	54.7
Heat lost	43.5
Energy/Heat lost during transfer	42.9
Energy allocated to metabolism and growth	31.2
Second Law of Thermodynamics/Entropy	18.8
Non-scientific Ideas	Percentage
Surface interpretation	12.4
More energy consumed at higher trophic levels	10.6
Matter Energy Interconversion	4.7

Acknowledgements



Kelli Hayes
Andrea Espina

Automated Analysis of Constructed Response Research Group (AACR)
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This work was supported by the National Science Foundation (Grant DUE 1022653). Any opinions, findings and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the National Science Foundation.