

Diverse STEM Voices, the Role of Conceptual Metaphors in Introductory Biology Courses



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Research Questions

1. When writing about values affirmation, how do undergraduate STEM students use metaphors as concepts?
2. What do these metaphors indicate about how students think and feel about learning in biology?

Introduction and Background

To retain diverse students in STEM fields, we need to engage interests and motivations in introductory science courses (Tanner, 2013; Dewsbury & Brame, 2019). For many first-generation college students, the strongest motivators to pursue STEM degrees are tied to prosocial values and cultural connections to their families (Jackson et al., 2016). A strategy called “values affirmation” can harness these motivators and support students who may experience negative stereotypes in academic settings (Jordt et al., 2017); however, the reasoning process and what students have to say about learning in these affirmations has not had a systematic framework for teaching and learning purposes. We propose the use of Lakoff and Johnson’s (2008) conceptual metaphor theory to help uncover the affective and attitudinal frames students hold about learning through their values. To that end, this study is interested in why metaphor matters and how biology classroom climates could be transformed by engaging student voices. This study surveys a corpus of students’ work for conceptual metaphors to illustrate how learning experiences and values have been internalized and shared. We propose that the inclusion of values assessment and the reflective processes of conceptual metaphors are part of maintaining a sense of belonging in STEM classrooms, particularly creating a space where minoritized students can engage community.

Research Design

- Conducted study at a public, research-intensive, Minority-Serving institution where a majority of the undergraduate population is first-generation.

School Demographic Profile (at time of data collection)	% of students
First-Generation	72%
Historically marginalized in STEM (American Indian, Black, Hispanic, Pacific Islander)	58%
Pell eligible	61%
Women : Men	62% : 38%

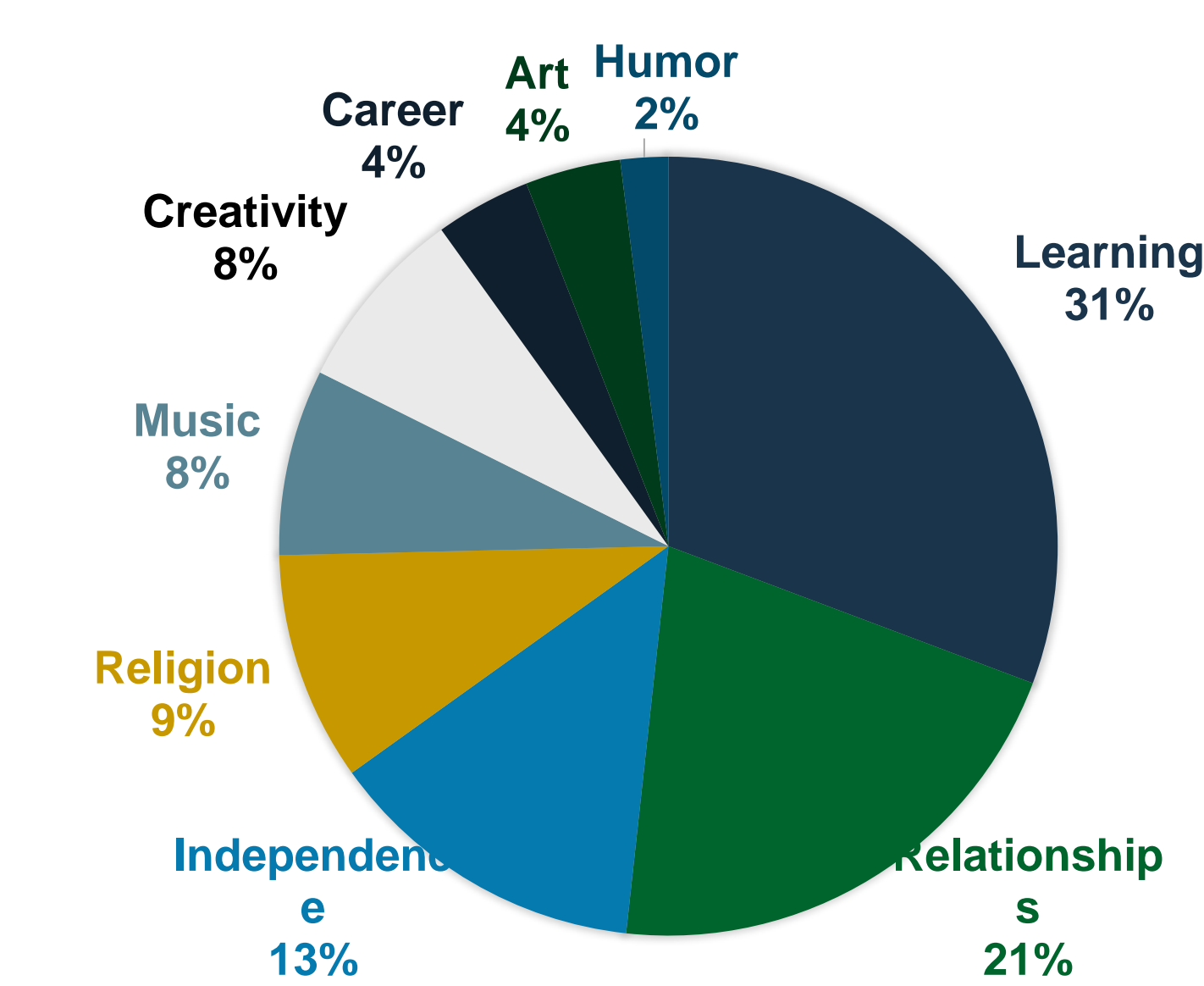
- Asked undergraduate students to prepare a written response to four prompts (shown below) in the first semester of a 2-semester introductory biology course for values affirmation (following methods of Harachiewicz, et al., 2014), expectations of themselves in the course and self-efficacy (following protocols of Camfield, 2016).

- 1) In the space below, write down the two or three values that are most important to you (from a list of 12) and describe in a few sentences periods in your life when these values were important. Focus on your thoughts and feelings.
- 2) Review the values you selected and list the top two reasons why these values are important to you.
- 3) What are your expectations for yourself in this course? (How do you plan to prepare for class, for exams, etc.?) Do these expectations relate to the values above? If so, what is the relationship?
- 4) Please describe your strengths and weakness as a biology student, using examples from your past experiences in science classes (or elsewhere) to support your self-perception.

- De-identified and assigned random IDs to 50 written reflections with student consent. (IRB #18-09)
- Reviewed students’ responses and prepared preliminary codes to identify both conceptual metaphors (Lakoff & Johnson, 2008) associated with students’ values and students’ emotion (Kort, Reilly & Picard, 2001).
- Used a qualitative research tool (Nvivo) to upload students’ written responses, add code tree, and code responses.
- Refined code tree and re-evaluated coding.

Results

Frequency of Metaphors Associated with an Affirmed Value



- Learning and Relationships were the two values chosen most by students and had the most metaphors associated with them.
- Seven other values (independence, religion, music, creativity, career, art and humor) were also associated with metaphors.
- Out of 12 values, three values (athletic ability, government, and social group) were not associated with any metaphors.

Most Prominent Conceptual Metaphors Associated with Learning and Relationships

Metaphor	# of Metaphoric References	Examples
Journey	93	<ul style="list-style-type: none"> • With the influence on developing my academic interests and future goals, I began to value the journey of learning and obtaining knowledge. (F18-7665) • My personal relationships are what drive my emotional half to be the best person I can be for both myself and others. (F17-1676)
Natural Resource	55	<ul style="list-style-type: none"> • I am a driven and persevering individual, but I must improve on my ability to collaborate with my peers and mentors as well as ensuring that my knowledge stays fresh in my mind. (F18-7665) • The top two reasons why these values are important to me are that I want to learn and help my community flourish and decrease the amount of illness and disease we have today. (F17-4527)
Building	51	<ul style="list-style-type: none"> • I believe a healthy relationship with friends and family is very important because we will need a solid foundation to succeed. (F17-4844) • From this, I can say that my weakness is learning minute details, but understanding broader concepts comes more naturally to me, eventually building into smaller branches that form the whole. F17-9743
Force	33	<ul style="list-style-type: none"> • Although I do see myself struggling, I expect myself to push through. (F18-5817) • We need to constantly look at who’s in our life and whether they are holding us back or promoting our success. F17-4844
Gift	20	<ul style="list-style-type: none"> • Learning and having the opportunity to be able to gain knowledge seems priceless to me as well. F17-7720 • My second value that is most important to me is my relationship with family because they are my most precious people. F17-3021

Students’ Affective Expression in Learning Metaphors

Axis	-1.0 Very unpleasant	-0.5 Unpleasant	0 Slightly Unpleasant Slightly Pleasant	+0.5 Pleasant	+1.0 Very Pleasant	
# Metaphors/Affect						
Anxiety-Confidence	Anxiety 0	Worry 0	Discomfort 3	Comfort 0	Hopeful 14	Confident 0
Boredom-Fascination	Ennui 0	Boredom 0	Indifference 2	Interest 13	Curiosity 8	Intrigue 3
Frustration-Euphoria	Frustration 0	Puzzlement	Confusion 8	Insight 111	Enlightenment 14	Epiphany 0
Dispirited-Encouraged	Dispirited 0	Disappointed	Dissatisfied 15	Satisfied 8	Thrilled 4	Enthusiastic 0
Terror-Enchantment	Terror 0	Dread 1	Apprehension 3	Calm 10	Anticipatory 2	Excited 0
Total	0	1	31	142	42	3

- Students predominantly expressed positive emotions in their learning metaphors as most fell into the slightly pleasant columns.
- The *Insight* emotion featured most heavily as students expressed learning metaphors suggesting tempered epiphanies about their learning.
- Overall, students did not express strong emotions in their metaphors, whether negative or positive.

Conclusions

- Students identified learning and relationships as the values of greatest importance to them.
- Students’ focus on the relationship value may point to opportunities to activate classroom relationships for greater engagement and learning.
- Conceptual metaphors are rich expressions of cognition and affect that can help to shape a connected and inclusive STEM classroom.
- Students are approaching their undergraduate learning in an introductory biology course with both realism and optimism, even with prior learning challenges.

Recommendations

- Assign short, low stakes writing assignments in STEM courses to provide space for student reflection about learning.
- Build an inclusive, centralizing course climate bringing all students together around learning with obvious and planned activities to include a variety of student perspectives.
- Engage in interdisciplinary collaborations with STEM faculty and Humanities faculty to listen to student voices and language use in STEM courses.

Interdisciplinary Research Team



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References

- Camfield, E. K. (2016). Mediated-efficacy: Hope for “helpless” writers. *Journal of Developmental Education*, 39(3), 2-11.
- Dewsbury, B., & Brame, C. J. (2019). Inclusive Teaching. *CBE—Life Sciences Education*, 18(2), fe2.
- Harackiewicz, J. M., Canning, E. A., Tibbetts, Y., Giffen, C. J., Blair, S. S., Rouse, D. I., & Hyde, J. S. (2014). Closing the Social Class Achievement Gap for First-Generation Students in Undergraduate Biology. *Journal of Educational Psychology*, 106 (2), 375-389.
- Jackson, M. C., Galvez, G., Landa, I., Buonora, P., & Thoman, D. B. (2016). Science That Matters: The Importance of a Cultural Connection in Underrepresented Students’ Science Pursuit. *CBE—Life Sciences Education*, 15(3), ar42.
- Jordt, H., Eddy, S. L., Brazil, R., Lau, I., Mann, C., Brownell, S. E., King, K., & Freeman, S. (2017). Values Affirmation Intervention Reduces Achievement Gap between Underrepresented Minority and White Students in Introductory Biology Classes. *CBE—Life Sciences Education*, 16(3), ar41.
- Kort, B., Reilly, R., & Picard, R. W. (2001). An affective model of interplay between emotions and learning: Reengineering educational pedagogy-building a learning companion. *Proceedings IEEE International Conference on Advanced Learning Technologies*, 43-46.
- Lakoff, G., & Johnson M. (2008). *Metaphors we live by*. University of Chicago Press.
- Tanner, K. D. (2013). Structure Matters: Twenty-One Teaching Strategies to Promote Student Engagement and Cultivate Classroom Equity. *CBE—Life Sciences Education*, 12(3), 322-331.