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Measuring Beyond-Biology Student Learning in a Biology Lab

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Although biology instructors' goals include helping students learn biology content and general science skills, lab activities may also help students grow in other ways. By connecting these broader learning objectives to a college or university's mission and making them more explicit, instructors and teaching assistants may help students, especially non-majors, find more relevancy and motivation to participate in lab, gain employable skills, and become life-long learners. Our campus' Student Transformative Learning Record (STLR, http://stlr.uco.edu; Walvoord, 2017), seeks to encourage, measure, and record students' transformative learning across 6 central tenets through their participation in curricular and co-curricular activities. This workshop explained how STLR connects student learning in biology lab to other classes, campus activities, and even non-university student experiences. Attendees brainstormed both the larger goals of student growth they could highlight in their labs and criteria to use on rubrics to measure these.

Keywords: TL theory, transformative learning, employable skills, life-long learners, digital badging, STLR

Introduction

Students in biology laboratory courses use research, collaboration, writing and other high-impact practices (Kuh, 2008). This sets up biology labs to be a great environment in which instructors can reach their goals of helping students learn biology and general science skills. Along with presenting some disorienting situations, especially to non-majors (e.g., dissections, uncomfortable topics to them like evolution), these lab activities may also help students grow in other ways. For instance, a student working through a chicken wing microbiology lab (Hoefnagels and Walvoord, 2006) will hopefully learn good serial dilution techniques and how to count colonies, and by explicitly prompting the student to critically reflect on the larger issues of *health* and the importance of *data in research*, she may transform her perspective on food preparation and the way she reads science news stories.

This process of being confronted with disorienting observations or results, questioning existing frameworks or assumptions, reflecting on how to change those frameworks to accommodate the new observations, and expanding (or completely shifting) one's perspective, are the the main components of Transformative Learning (Mezirow, 2010), an adult learning theory.

In biology labs, students are assessed on their understanding, and proper presentation of, biology content with grades and instructor feedback. Points for assignments act as extrinsic motivation to encourage growth towards lab learning objectives. Digital badging is another extrinsic motivation recently being used to promote student acquisition of specific skills (Seery et al., 2017). In a similar way, biology laboratory instructors could assess and motivate students' transformative learning, or expansion of perspective about overarching tenets, to encourage their life-long learning and grow their employable skills.

By identifying these broader learning objectives, explicitly stating them to students as course goals, prompting students to reflect on their growth in them, and giving students feedback through rubrics and/or badging, we can help students, especially non-majors, find more relevancy and motivation to participate in biology labs.

Transformative Learning is written into the mission of my institution and is the basis of the Student Transformative Learning Record (STLR, http://stlr.uco.edu), an initiative created at our campus to encourage, measure, and record students' growth in campus-wide curricular and co-curricular activities across 6 central tenets. This framework was first presented at ABLE as a poster in 2016 (Walvoord, 2017), so the paper below further explores how STLR connects student learning in biology lab to other classes, student affairs, and even non-university student experiences. Attendees at this

workshop at ABLE 2017 brainstormed the larger goals of student growth they could highlight in their labs, along with criteria to measure that growth.

Student Transformative Learning Record

Transformative Learning on our campus develops students' beyond disciplinary skills and expands their perspectives of their relationship with self, others, community and environment. We measure this growth in five of our Central 6 Tenets (those beyond *Discipline Knowledge*): Global & Cultural Competencies; Health & Wellness; Leadership; Research, Creative & Scholarly Activities; and Service Learning & Civic Engagement. These were chosen and defined through campus-wide input and through modification of the learning outcomes on the American Association of Colleges and Universities' VALUE rubrics (Rhodes, 2009).

Class assignments, out-of-class projects, student events, student groups, and even locations can be "STLR-tagged" with one or more tenets in which students are likely to experience growth. Student growth is assessed in each tenet at the levels of Not Achieved, Exposure, Integration, or Transformation based on a campus-wide rubric (Appendix A). Students who swipe-in at STLR-tagged events and locations with their student ID card are given an automatic Exposure-level credit, whereas most other activities require a student artifact (e.g., reflective paper and research poster) that is assessed using the rubric.

STLR rubrics are tied to a campus-wide competency structure on the back end of our learning management system (LMS) – Brightspace by D2L – such that recorded assessments are recorded in a database and fed to a Dashboard in the LMS. Students use this dashboard to track their progress in each tenet, and they can highlight their achievements on a STLR Snapshot (Appendix B) or ePortfolio that they can build and display to potential employers/graduate schools. Students earning a level of Transformation in one or more tenets receive a graduation cord in the associated tenet color to wear at their graduation ceremonies.

I'll describe an example of a biology assignment that is STLR-tagged, then give suggestions for how to apply a STLR-like setup even to an individual class, instead of the campus-wide level that I've described so far.

A Stellar Biology Assignment

Dr. Rebecca Williams at the University of Central Oklahoma created an assignment called "What about bees?" for her Biology 1 (majors) course through which they watched a TED talk about bee colony collapse, then answered about 14 content questions and a couple reflection questions. After being STLR-trained, she decided to add and explicitly state more learning outcomes of this assignment to include students' expanded perspectives on environmental health, their own health (*Health & Wellness*), and a possible outcome of civic engagement (*Service Learning & Civic Engagement*) to advocate for decreased pesticide use and increased community gardens.

Dr. Williams and I worked on some extra reflection questions to help students critically examine these topics as they related to the video, and to give her better artifacts through which to assess student growth. We also used the campus-wide STLR rubrics to create modified rubrics for each STLR level for the two tenets she identified (Appendix C).

Students submitted their assignments, and Dr. Williams assessed them using the STLR rubric based on the evidence they provided. The results were a richer assignment that lead to at least one student's complete transformation in perspective about interconnectivity of the environment and the importance of making informed choices in buying local produce, planting a home garden, and sharing biology information with friends and family (R. Williams, personal communication, March 2017).

STLR Writ Small

So far, this paper has discussed a campus-wide implementation of assessing student transformative learning. This session's attendees commented on their session reviews that getting whole campus, or at least department-wide, adoption of a process like this would be ideal. This would allow students to track growth throughout their undergraduate career and make it part of the learning culture. However, an individual instructor might need to adopt and adapt this setup for just a semester-long course. Mini workshop attendees were guided through this process and tools were suggested to help with it.

The first step is to look over the course syllabus and/or student learning outcomes for the course, lab, or projects. Then, identify the areas in which students might gain beyond-biology skills through those existing assignments and activities. These could be some named in the institution's mission, core values identified by the American Association for Colleges and Universities (https://www.aacu.org/value-rubrics), or they may align with the Central 6 Tenets used by the University of Central Oklahoma for STLR. Collaboration with department colleagues, instructors of other sections of the course, and teaching assistants may be helpful.

Once identified, reflect on and record what sorts of evidence a student might display to convince the instructor of their complete *transformation* in perspective on each core tenet identified; of their *integration* of each core tenet's frame of reference; of their *exposure* to the importance and need for growth in each core tenet; and of their lack of comprehension of the beyond-biology values (*not achieved*). This matches the process used to create the STLR rubric (Appendix A).

Third, develop critically reflective prompts that can be added to existing assignments to help students identify their pre-existing perspectives and skills in those

core areas and recognize growth or potential growth in them due to the activities assigned. Because this is an iterative process, this is often when an instructor may realize she or he would like to update the original assignment or activity to better engage the student and give them substance on which to reflect.

Now that beyond-biology tenets are identified, assignments updated, and rubrics created, all that is left is to find a way to track student achievement and explain this new type of learning and assessment to the learners. Tracking could be as simple as recording achievements in the gradebook, or the rubric could be embedded into a learning management system with each associated assignments. Instead of an A-F or percentage grading scheme, the assessment should be updated to a 0-3 or to the levels of Not Achieved, Exposure, Integration, and Transformation. Those students achieving transformation in one or more tenets could receive a printed certificate, listing the one or more tenets attained, in a special ceremony. Alternatively, educators can work with their campus Information Technology to integrate one of the Mozilla OpenBadges issuers (OpenBadges, 2016), or some other software, into their LMS or to use as a standalone product.

Explaining this new form of assessment to students is difficult, but examples and prior student testimonies are helpful.

Conclusion

Offering students the opportunity to connect their biology lab education to broader, life-long goals and inner transformation may reinvigorate instructor teaching and student learning. The framework described in this paper can be used in an individual class, across a major, or can be scaled campus- or system-wide.

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About the Author

Mark E. Walvoord is an Assistant Director of the University of Central Oklahoma's (UCO's) Student Transformative Learning Record (STLR). He received his B.S. in Biology and his M.S. in Zoology and maintains his connections to biology through adjuncting introductory biology and field ecology courses, working on biology textbook side projects, serving on the board of directors of the Association for Biology Laboratory Education, and advising the Center for Wildlife Forensics and Conservation Studies at UCO. Mark also serves on the boards of directors of *Partners for Madagascar* and *Joiners*, non-profits seeking to improve opportunities for the people of Madagascar.

Appendix A

STLR ACHIEVEMENT LEVEL DESCRIPTIONS

STLR STUDENT TRANSFORMATIVE LEARNING RECORD

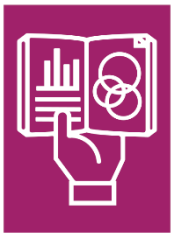
UCO UNIVERSITY OF CENTRAL OKLAHOMA

Transformation: The student provides strong evidence of a learning experience that resulted in profound growth or a major shift in values, beliefs or perspectives in the tenet(s), and this may be evident through changes in behavior, speech, or ability.

Integration: The student can clearly articulate an understanding of the learning activity as it relates to the tenet(s) and its value for her/his life. The student is questioning, planning, or beginning to expand upon previously held understandings of self, community, behavior or environment.

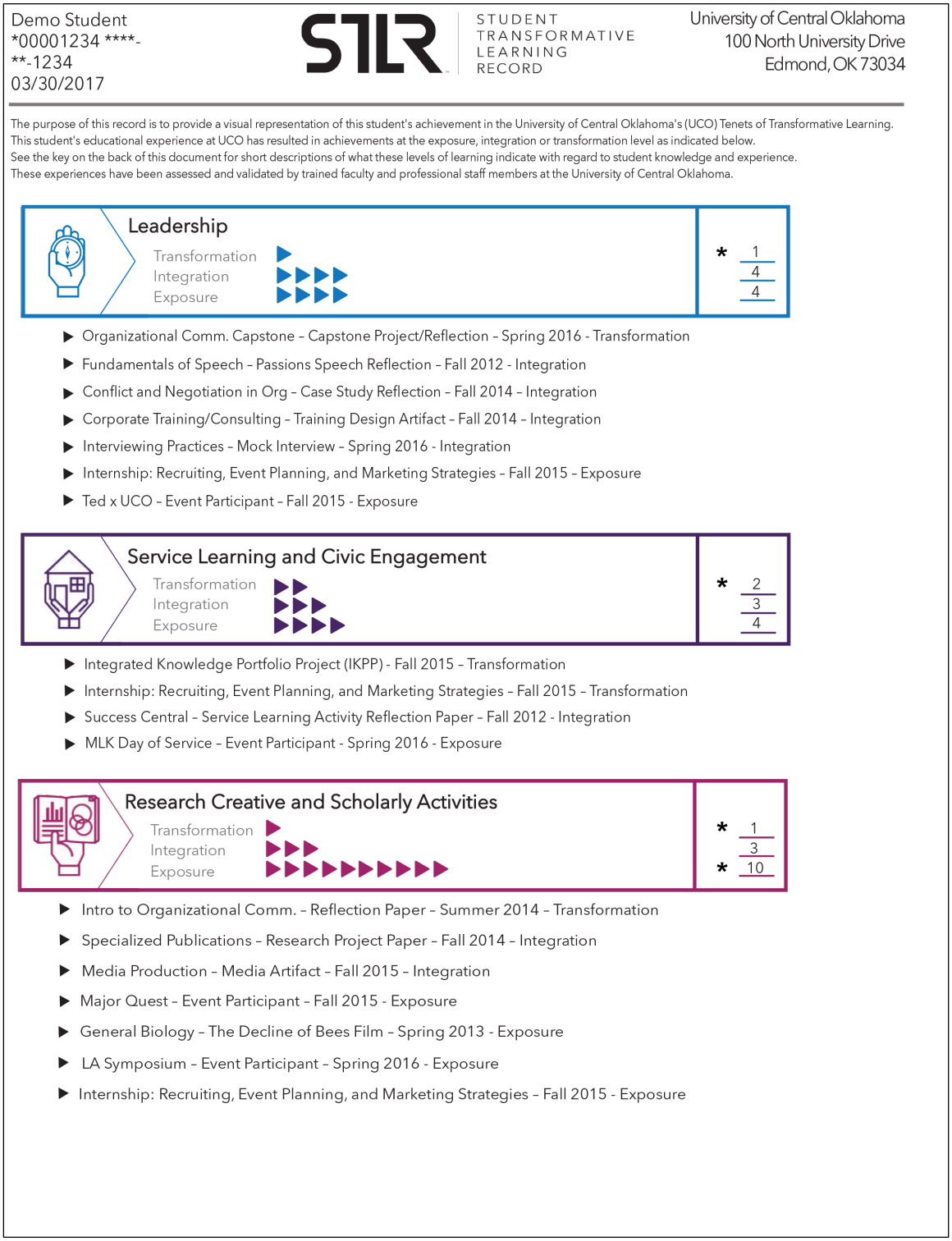
Exposure: The student displays a willingness to learn and grow by participating in the activity. She or he has an awareness of her or his current perspectives related to the tenet(s) and may be developing an understanding of what the tenet(s) entail(s).

By Tenet	Transformation	Integration	Exposure	Not Achieved
	The experience led to the student's new identity as a global citizen, and she/he now seeks interactions and growth from diverse communities and cultures.	The student's perspective has expanded to value different cultural worldviews and she/he is able to articulate a sense of identity in a global context.	The student displays an openness to learning about global and cultural differences and/or took part in an activity where she/he was exposed to worldviews of other cultures.	The student has not *yet* provided evidence of openness to or awareness of the concepts listed in exposure for this tenet.
	The experience has profoundly shifted the student's commitment to physical, spiritual, emotional, intellectual, environmental, financial, occupational, and/or social health as demonstrated by care of self, others, or environment.	The student displays an increased prioritization of one or more of the eight dimensions of wellness, can identify areas of weakness, and/or has developed (or is developing) a realistic plan for intrinsic growth in one or more of these areas.	The student is exposed to one or more dimensions of wellness, displays a willingness to learn about them, and/or can identify her/his current perspectives on one or more of the areas.	The student has not *yet* provided evidence of openness to or awareness of the concepts listed in exposure for this tenet.
	The student has developed her/his identity as a leader due to the experience, and actively seeks to empower others/teams and/or advance a cause or causes.	The experience has led the student to recognize her/his leadership qualities; and/or desire to use her/his influence to empower others/teams and/or advance a cause or causes.	The student is open to improving her/his views of leadership and/or participates in activities where she/he observes others using their influence to empower others/teams or advance a cause or causes.	The student has not *yet* provided evidence of openness to or awareness of the concepts listed in exposure for this tenet.

	The experience prompted a major shift in the student's perspective about the unknown, such that she/he now values curiosity, seeking answers, multiple methods for solutions, risk-taking, communicating the complexity of multiple view-points. The student may have developed a new identity as a researcher, artist, or scholar producing new knowledge or works.	The student can now recognize barriers to seeing her/himself as a researcher, artist, or scholar; she/he has developed a plan to continue expanding her/his identity as a problem solver; and/or the student is starting to expand her/his appreciation of diverse methods, outcomes, and interpretations.	The student was exposed to primary research, scholarly activity in their field of study, or creative works; and/or the student can articulate the connection between the learning experience and some aspect of the research, creative or scholarly activities tenet.	The student has not *yet* provided evidence of openness to or awareness of the concepts listed in exposure for this tenet.
	The experience has prompted a major shift in the student's attitude; and/or she/he now views service and civic action as a rewarding use of time for personal growth and/or to contribute to addressing community challenges by initiating action with a diverse team.	The student's experience led to new insights related to civic identity and to possible solutions to addressing social issues. She/he now desires to serve, be more involved in a diverse community, and/or improve confidence in self as a change agent.	The student took part in, or heard results of, a service or civic activity and/or is able to voice her/his perspective on the importance of these activities to her/himself and society.	The student has not *yet* provided evidence of openness to or awareness of the concepts listed in exposure for this tenet.

Appendix B

STLR Snapshot example



Demo Student
*00001234 ****-
**-1234
03/30/2017

STLR STUDENT TRANSFORMATIVE LEARNING RECORD

University of Central Oklahoma
100 North University Drive
Edmond, OK 73034

The purpose of this record is to provide a visual representation of this student's achievement in the University of Central Oklahoma's (UCO) Tenets of Transformative Learning.
This student's educational experience at UCO has resulted in achievements at the exposure, integration or transformation level as indicated below.
See the key on the back of this document for short descriptions of what these levels of learning indicate with regard to student knowledge and experience.
These experiences have been assessed and validated by trained faculty and professional staff members at the University of Central Oklahoma.

Leadership

Transformation ▶
Integration ▶▶▶▶
Exposure ▶▶▶▶

* 1
4
4

- ▶ Organizational Comm. Capstone – Capstone Project/Reflection – Spring 2016 - Transformation
- ▶ Fundamentals of Speech – Passions Speech Reflection – Fall 2012 - Integration
- ▶ Conflict and Negotiation in Org – Case Study Reflection – Fall 2014 – Integration
- ▶ Corporate Training/Consulting – Training Design Artifact – Fall 2014 – Integration
- ▶ Interviewing Practices – Mock Interview – Spring 2016 - Integration
- ▶ Internship: Recruiting, Event Planning, and Marketing Strategies – Fall 2015 – Exposure
- ▶ Ted x UCO – Event Participant – Fall 2015 - Exposure

Service Learning and Civic Engagement

Transformation ▶▶
Integration ▶▶▶
Exposure ▶▶▶▶

* 2
3
4

- ▶ Integrated Knowledge Portfolio Project (IKPP) - Fall 2015 – Transformation
- ▶ Internship: Recruiting, Event Planning, and Marketing Strategies – Fall 2015 – Transformation
- ▶ Success Central – Service Learning Activity Reflection Paper – Fall 2012 - Integration
- ▶ MLK Day of Service – Event Participant - Spring 2016 - Exposure

Research Creative and Scholarly Activities

Transformation ▶
Integration ▶▶▶
Exposure ▶▶▶▶▶▶▶▶▶▶

* 1
3
* 10

- ▶ Intro to Organizational Comm. – Reflection Paper – Summer 2014 – Transformation
- ▶ Specialized Publications – Research Project Paper – Fall 2014 – Integration
- ▶ Media Production – Media Artifact – Fall 2015 – Integration
- ▶ Major Quest – Event Participant – Fall 2015 - Exposure
- ▶ General Biology – The Decline of Bees Film – Spring 2013 - Exposure
- ▶ LA Symposium – Event Participant – Spring 2016 - Exposure
- ▶ Internship: Recruiting, Event Planning, and Marketing Strategies – Fall 2015 - Exposure

Appendix C

UCO Biology I
What about bees?

Dr. Rebecca Williams

Watch the video: *Marla Spivak: Why bees are disappearing* from Ted Talks. The web address is http://www.ted.com/talks/marla_spivak_why_bees_are_disappearing.html.

Answer the questions below as they pertain to the video.

1. Why are bees important to our food supply?
2. Why is the interaction between bees and flowers a mutualistic relationship?

[and several more…]

Once you have answered all of the above questions use the questions below to write a personal reflection as it pertains to the video. You do not have to answer every question. These are just writing prompts to help you get started.

1. Do you think there is anything else you can do to help bees (besides what was mentioned in the video)? If so what? If not, why not?
2. Did this video change your views about bees, agriculture, food production, or scientists? Why did it change your views? If not, what are your views on those topics and why?
3. Do you think most citizens are aware of the crisis bees are facing? Who is responsible for educating these citizens? Why? How?
    a. If you were the mayor of Edmond, OK what might you do to help educate people about bees? What kind of laws might you write to help solve the problem of colony collapse disorder?
4. Why do you think environmental issues such as this one receive very little attention from the media and politicians?
5. How might your attitude toward bees change if you lived in a foreign country?
6. Describe your typical lunch. How do you think your typical lunch would change if bees disappeared?

Potential areas of growth:

What about bees?

Dr. Rebecca Williams
Rubric for STLR Tenets

Health and Wellness

Transformation	Integration	Exposure
The student has completely changed his/her behavior to help bees in some meaningful way. They may be telling their friends about the effect of colony collapse disorder on environmental health (in person or through social media/blogs), starting a bee-friendly garden or hive, posting signs on campus about bees, changing their major or degree focus, getting involved with an environmental group etc. Look for the student taking action instead of just talking about action that needs to be taken.	Student can discuss bees as a keystone species in the environment (how important they are to environmental and human health and why). The student mentions how they might change their behavior or choices to influence bees in his/her everyday life. He/she could also mention the importance of bees to humans' nutrition and how humans might be able to improve the bees' current situation.	Student discusses bees as an important part of the environment. There is no mention about the influence he/she has on bees in his/her everyday life.

Civic engagement

Transformation	Integration	Exposure
Student encourages others in their community to help bees by educating them about the issues (writing blog posts, social media posts, hosting a table in the student union, starting a student group etc.), or by starting a bee-friendly community garden and recruiting volunteers to elicit community support to make policy changes. Student may also give evidence of writing his/her mayor, legislators or others in government to change laws to help bees; organizing a peaceful protest; or taking some other action to influence laws and policies surrounding this topic.	Student realizes that bees play an important role in the world economy and they could be a part of the solution to the problems bees are facing. They discuss plans involving the local or world community to encourage breeding and survival of the bees. They may have found applicable local, state, or federal laws that have an effect on these issues.	Student realizes that bees play a role in the world economy and that governmental policies can influence the environmental impact on these insects.

Mission, Review Process & Disclaimer

The Association for Biology Laboratory Education (ABLE) was founded in 1979 to promote information exchange among university and college educators actively concerned with teaching biology in a laboratory setting. The focus of ABLE is to improve the undergraduate biology laboratory experience by promoting the development and dissemination of interesting, innovative, and reliable laboratory exercises. For more information about ABLE, please visit **http://www.ableweb.org/.**

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