JOURNAL OF TRANSFORMATIVE LEARNING

The Journal provides a forum for perspectives on the practice and application of transformative learning. JoTL is an Open Access journal published by the University of Central Oklahoma at jotl.uco.edu.

The Role of Course-Based Undergraduate Research Experiences in Extending Transformative Learning to All Students

AMY B. HENDERSON
St. Mary's College of Maryland

EMEK KOSE
St. Mary's College of Maryland

Abstract

Meaningful undergraduate research experiences have traditionally been limited to elite students. Barriers on the student side, and incentive structures that reward faculty for mentoring high performing students, have served to maintain the status quo. As research confirms the multifaceted benefits derived from undergraduate research experiences, it is essential that they are extended broadly, so that a more diverse group of students can profit. This paper argues that shared elements of well-designed course-based undergraduate research experiences, including instructor scaffolding and collaborative dialogue, serve to both make undergraduate research more widely accessible, and foster the achievement of a transformative learning experience. This claim is supported by case studies of three different types of course-based undergraduate research opportunities that delivered transformative learning experiences to average students.

Keywords: Undergraduate research, transformative learning, experiential learning, high-impact teaching practices, economics, environmental and resource valuation, mathematical modeling, statistics

Introduction

Undergraduate research experiences have been championed as high-impact practices which foster the attainment of higher-order learning outcomes. Growth in the Council on Undergraduate Research (CUR), from its origins in the 1970's as a small group of private liberal arts chemistry professors, to an influential organization supporting and fostering undergraduate research in every discipline and type of academic institution, serves as a testament to the efficacy of undergraduate research. It remains an open question, however, whether these experiences also deliver transformative learning outcomes. We argue that well-designed undergraduate research experiences have the potential to deliver transformative learning outcomes, particularly when scaffolded within a course-based context.

Meaningful undergraduate research experiences have largely been limited to high performers (Siegfried et al. 1991; Bangera, Gita, and Brownell 2014; Seifert et al. 2014). Yet providing average students with the opportunity to create new knowledge can result in a transformative experience, and foster the attainment of higher-order proficiencies (Henderson 2016). Indeed, Seifert and colleagues found that the greatest benefit from these experiences may accrue to those in the bottom third of the critical-thinking distribution (Seifert et al. 2014).

Many factors contribute to the exclusion of students from undergraduate research opportunities, including barriers on the student side, as well as incentives that encourage faculty to limit research mentorship to high performing students. Some of these barriers disproportionately impact women, students of color, and first generation students (Bangera, Gita, and Brownell 2014). The exclusion of these groups will only serve to exacerbate existing achievement gaps. Given the transformational impacts associated with meaningful research experiences, it is imperative that the benefits of undergraduate research be extended to all students, not just a privileged subset. We argue that doing so effectively requires offering consequential research opportunities within a classroom setting.

This paper calls for the development of more course-based undergraduate research experiences, in order to extend the multifaceted benefits of undergraduate research to all students, not just high achievers. Doing so will also increase the likelihood of achieving transformative learning outcomes through undergraduate research, as engagement and dialogue with others have been shown to be key contributors to transformative learning (Feinstein 2004; Taylor 1998, 2007). We argue that it is imperative that the positive benefits of transformative learning be extended to all disciplines and all students, regardless of race, gender, or prior achievement.

In recent decades the dominant model of transformative learning has been that advanced by Mezirow (1991, 1996, 2009), but other conceptions—including the more subjective, even spiritual, focus articulated by Dirkx—have been influential as well (Dirkx 1997; Dirkx, Mezirow, & Cranton 2006; Friere 1971; Boyd & Meyers 1988; Pugh 2002, 2011). As research in the field increasingly moves towards investigating how best to foster a transformative learning experience, it is only natural that researchers explore proven high-impact teaching practices (Kuh 2008), such as service-learning and undergraduate research experiences (Kilgo, Ezell Sheets, & Pascarella 2015), to determine if such practices can also be potent tools for delivering transformative learning experiences.

Our approach to transformative learning is grounded in the work of Mezirow (1991, 1996, 2009), while also being influenced by the earlier work of Dewey (1938), which emphasizes the critical relationship between experience and learning. Building on this work, we argue that a key indication of transformative learning in quantitative fields is an essential shifting of the locus of motivation from external to internal. Furthermore, students who have experienced transformational learning within the context of undergraduate research demonstrate increased self-efficacy.

The present paper contributes to the nascent literature on the intersection of transformative learning and course-based undergraduate research by presenting results from course-based undergraduate research experiences in economics and mathematics. Each course involved authentic research experiences leading to the production of new knowledge. Critically, these courses were open to all majors, extending the benefits of consequential research broadly.

The course-based undergraduate research experiences reported on here confirm earlier findings that direct and active learning experiences foster transformative learning outcomes (Taylor 2007). We follow Henderson (2018) in defining undergraduate research experiences as those where: 1. the research question (and associated finding) is of interest to an audience beyond the classroom; 2. the scientific method, as practiced in the relevant discipline, is employed; 3. the outcome is not known in advance to either the student or the professor; and 4. findings are disseminated to a broader audience (Henderson 2018)

Course-Based Undergraduate Research in Economics and Mathematics

We present three case studies of course-based undergraduate research in mathematics and economics: environmental and natural resource valuation, mathematical modeling, and experiential statistics classes. All three are upper-level courses meant to develop students' higher-order proficiencies, including problem solving, oral and written communication, and the production of new knowledge. These classes were open to all majors, thus extending the benefits of consequential research broadly. In Dirkx, Mezirow, and Cranton (2006), Mezirow discusses contexts for transformative learning. All three cases we present have the social action, community, organizations, conflict resolution, citizenship, and mentoring contexts, which contribute greatly to the increased self-efficacy and deep-learning experienced by the students. The conflict resolution component is a central element of group work, as is the supportive dialogue within and across groups as students work collaboratively to see differently. These essential elements in supporting a transformative experience are natural components of a well-designed course-based undergraduate research experience, but are generally lacking in more traditional undergraduate research conceptualizations.

Direct and active learning experiences have been shown to be catalysts for transformative learning, particularly when those experiences involve personal engagement with an external community (Diduck et al. 2012). The experiential nature of these courses generates clear benefits for the students and is a key reason why they effectively enhance self-efficacy for students at all levels. Many of those drawn to quantitative fields like economics and math are "assimilators," people who are comfortable with abstract conceptualization and can consolidate learning through subsequent "observation and reflection" (Bartlett 1996, 148). Yet, research shows the majority of students learn best when provided the opportunity to grapple with concrete information from which they can construct meaning (Ziegert 2000). The learning theory literature also indicates that this inclination may be more pronounced within some groups, such as women and people of color, who are reported to learn better through concrete experiences and active experimentation than through abstract conceptualization (Bartlett 1996).

In each course-based undergraduate research experience detailed below, students transitioned from being externally motivated by the instructor or grades, to being internally motivated due to personal investment and interest in the research. In turn, the instructors experienced a significant improvement in their teaching. The interdisciplinary nature of the research projects allowed the instructors to utilize the resources they and students developed in other classes. For example, in mathematics, the instructor presents the undergraduate research produced by students in mathematical modeling and experiential statistics courses in subsequent Calculus classes. This has had a positive impact in recruiting and retaining students—particularly women and students of color—as seeing how mathematics is used to solve problems meaningful to students increases its relevance and motivates students to persist.

Too few students are afforded the opportunity to participate in transformative learning experiences. Below we provide models of three different types of course-based undergraduate research experiences which led to transformative learning outcomes. While developing meaningful course-based undergraduate research experiences does require a significant investment on the part of the instructor, sharing details of successful course models can reduce start-up costs and facilitate more wide-spread adoption.

Capstone Course with Community Engagement: Environmental and Resource Valuation

A course-based undergraduate research experience combining community engagement, structured teamwork, and concrete economic analysis made meaningful research accessible to average students, thereby, transitioning them from "learning economics" to "doing economics." In the process, students changed both their frame of analysis and sense of self. Three key elements of course design that proved instrumental to fostering transformative learning have been identified: 1. student-led design and execution of a concrete economic analysis; 2. community interaction; and 3. structured group work including reflective dialogue.

As a capstone experience, the course was targeted to senior-level students, but was open to anyone who had completed the foundational work in economics, which includes the 200-level economic statistics course. None of the enrolled students had previously taken an advanced statistics course. The class consisted of twelve students, five female and seven males, a typical ratio in economics at liberal arts colleges. A strength of a concrete, experiential course such as this one, is the impact it can have on an average student. None of the enrolled students were among the elite—the top 10% of economics majors. In fact, key metrics show that the sample of students enrolled in the course fell just below average relative to the population of senior economics students: average SAT score, mean GPA within economics and overall mean GPA were all lower than the population average (Henderson 2016). Thus, the course was truly serving the typical economics student, not the high achievers in the discipline.

The concrete form of analysis employed was contingent valuation methodology (CVM). CVM is a survey-based stated preference methodology commonly used to inform policy-making decisions. None of our students had done extensive work with CVM, thus the opportunity existed to learn a new methodology through investigation of the literature, modeling a life-long learning process. Additionally, CVM is a concrete form of economic analysis which produces data. The expectation is that having generated the data themselves, students will be eager to see what the data reveal, and thus will be intrinsically motivated to further develop their statistical capabilities. Further, their ownership of the data will make them more open to reexamining their previously held beliefs and perspectives, as well as revising those beliefs in light of newly acquired data. Finally, there is a natural fit between contingent valuation analysis and local policy, creating a ready constituency for the outside presentation of findings. Other concrete methodologies with which students are unfamiliar prior to the course, and which are well documented in the literature, would also work well, and could be chosen based on the professor's area of expertise. In this instance, though the instructor was familiar with the CVM literature, she had not personally conducted survey-based research, thus was learning along with the students, modelling life-long learning.

The scope of the course is ambitious for a single semester. The timeline had to be carefully developed to include the following essential elements: 1. Student engagement with the academic literature to identify best practices; 2. Student identification of the policy issue; 3. Student ownership of the contingent valuation survey process, including instrument design, survey deployment, and processing of returns; 4. Review and execution of statistical methods including database construction, data handling, programming, descriptive statistics, and linear regression; and 5. Presentation of findings in both written and oral form, including sharing those findings with community stakeholders.

Topic Selection

Making the transition from learning economics to doing economics, and in the process transforming both one's way of seeing the world, and sense of self-efficacy in the world, requires that motivation transition from an external locus to an internal locus. Having students collaboratively select the research topic fostered investment in the project and augmented internal motivation. Students started the process of topic investigation in small teams of three. An iterative pitch process was employed to achieve buy-in from all 12 students on a single policy issue. The class collectively evaluated proposals through constructive dialogue. Students discussed whether the issue was meaningful to the local community, suitable for valuation via CVM, and whether sufficient information could be obtained in a timely fashion to craft a survey instrument consistent with best practices. Students ultimately identified the issue of deer vehicle collisions (DVC) as a local community problem and developed a policy proposal to reduce DVCs.

Following topic selection, the class worked as a cohesive unit on this single policy issue. Some tasks were still assigned to small groups, but everyone was collaborating on the same research project. Overall, the process worked well, not only for the stated purpose of issue selection, but, also for consolidating mastery over material encountered in the literature (for greater detail on the selection process, see Henderson 2016).

Survey Instrument Development

The development of the survey instrument involved small-group work, individual or pair-based work, in-class collaborative work, and out-of-class collaborative work. Careful scaffolding of group work during early stages was essential for productive and thoughtful engagement, necessary conditions for transformative learning. Having access to a variety of successfully deployed survey instruments was critical during this stage, as were the models provided by the Champ et al. (2002), Whitehead (2006) and Whitehead et al. (2009) articles, along with the associated survey instruments provided by the authors. Instructors employing alternative concrete methods should take care to curate source materials which provide adequate scaffolding.

After the survey instrument and focus-group consent forms were submitted to the Institutional Review Board (IRB), our class hosted a guest speaker with expertise in conducting focus groups. Students took full ownership over focus-group script development, as well as the arrangements to recruit focus-group participants and secure appropriate meeting space. Moving in the world as community-organizing agents increased self-efficacy and internal motivation.

The experience of conducting focus groups ignited a passion for the project. In every focus group, teams encountered local citizens who cared deeply about the DVC issue. Focus group participants took the process seriously and expressed strong opinions on both the issue and the survey instrument. Students thus had the opportunity to engage in productive and challenging dialogue with community members, members of their small group, and the broader class. The impact of this experiential component, which entailed direct engagement with the community, was consistent with previous findings from the literature—it increased engagement and intrinsic motivation for all students and created a personal connection with complex academic material.

Survey Deployment and Analysis

Engagement in dialogue with focus group participants convinced students that their project was truly relevant to the local community and motivated them to assiduously follow best-practices in deploying the survey. Survey deployment is a hands-on process that requires organization, attention to detail, and problem solving. Drawing on these skills provided students who struggled with earlier assignments their own opportunity to shine. Additionally, the assembly-line approach, and the satisfaction of seeing the completed packages go out in the mail, helped to forge a team identity for the class as a whole.

There was a tremendous amount of excitement when responses began to arrive. Students arrived at the next class early, eager to see the returns for themselves. A profound curiosity about what they could learn from the data they had worked so hard to collect drove some students to do far more programming than was formally required; a clear indication that the locus of motivation had shifted from external to internal.

Presentation of Findings

Students presented the results of their findings to local policy makers including the County Administrator, President of the County Commissioners, and the Director of Public Works and Transportation. In addition to preparing presentation slides, students developed folders of materials for the officials, including a white-paper, graphs, and charts. Though not everyone served as a formal presenter, all students participated in answering officials' questions after the presentation.

The event had a powerful impact on the students. Upon entering the County Commissioners' meeting room, a hush fell over the students. They were initially intimidated, as the grandeur of the room drove home the point that this was to be a serious, professional, presentation. The change in the students over the next hour was visible, as their carriage and demeanor changed. They engaged professionally with the public officials, whose genuine interest—demonstrated by their detailed questioning regarding the research findings—confirmed the relevance of the students' work to the broader community, and established that they had, indeed, created new knowledge.

Mathematical Modeling

The senior-level mathematical modeling course described below provides a course-based undergraduate research experience open to all majors. Essential elements of course design that contribute to transformative learning outcomes include collaborative dialogue, critical engagement with the relevant academic literature, and student determination of the research project. Additionally, well-designed scaffolding of the research process opens this consequential research experience to a broad range of students.

Mathematical modeling is about the representation of physical, biological, and other real-life phenomena by mathematical "models" to better understand and make predictions about these meaningful phenomena. It can be argued that modeling is the quintessential aspect of applied mathematics, and therefore, as students begin to master model, they become practitioners of applied mathematics.

Mathematical modeling is a senior-level elective course offered by the Mathematics Department every two years. Linear algebra and differential equations are pre-requisites for the course which is usually taken by students at the junior or senior level. The class size ranges anywhere between 6 and 20 students. Modules covering models addressing issues related to epidemiology, climate change, social networks, social justice, environment, mathematical oncology, and classic literature have all been employed. In each module, the basic principles, field specific background information, and required mathematical methods are introduced.

The modeling process in its entirety is a transformative learning experience. Modeling begins with an awareness of, and curiosity about, a real-world phenomenon. It is essential to understand the relationships and laws that govern a phenomenon in order to define the relevant set of assumptions and critically assess them. The recognition that there can be new ways to approach a problem, potentially leading to the discovery of new knowledge, motivates the act of modeling. It requires questioning existing models and their assumptions. Once a mathematical model is created, it must be checked against existing data for validation. Finally, a validated model may be used to make change in the world. Since a large part of modeling is applying principles of earlier models to new issues—such as imagining traffic as a water wave, thus revealing the possibility of utilizing water flow or fluid dynamics methods to solve a rush hour traffic problem—it encourages the modelers to be open to new ways of seeing.

The traditional learning outcomes of the class include: being able to model physical processes with discrete and continuous methods by making necessary assumptions and then translating them to mathematics, solving said systems to make predictions about the future of the process at hand, improving the existing models by calibrating them, and finally, communicating mathematical findings in written and oral form. The assessment for student work is based on homework assignments, a midterm project and a final project with oral presentation and written paper components. The first half of the class involves critically reading 15 mathematical papers and analyzing them, reproducing various findings in some. In each of the four offerings of this course, a reference librarian was invited to provide instruction on information literacy, finding reliable sources, and creating an annotated bibliography.

Prior to the final projects, students work on mini-projects that the instructor provides. Those are inevitably shaped by the instructor's interests, while also introducing students to a variety of different approaches to modeling. This scaffolding has been effective, since most students have not had prior research experience that required them to both select a research topic and develop a mathematical model relevant to the problem.

Although students have full freedom to choose both their midterm and final projects, the instructor has found providing a list of potential topics helps students to connect the modeling process to their own interests and lived experiences. When the students are free to choose their own research problems, it forces them to think about the issues they care about, examine their existing beliefs and assumptions around those issues, approach issues from new perspectives, and finally look at the phenomena from a mathematical perspective. As the work progresses, they need to determine what kind of simplifying assumptions they can make without compromising the essential features of the problem, what kind of mathematics they will need to use, and maybe more importantly, will they be able to answer the question they initially set out to answer? Each of these fundamental steps of mathematical modeling gives them an opportunity to understand the issue at a deeper level, develop a more open frame of reference, and take ownership of their projects.

Going into the final projects, students have eight weeks to define their problem, develop the model, draw conclusions and prepare a written and oral presentation. The final projects are done in groups of two since the projects require careful study of existing models, creative imagining and adaptation to suit their chosen problem, rigorous computation, and significant writing. During the problem identification stage, as well as while researching context, assumptions, and mathematical approaches, dialogue among the group members is essential. Weekly progress reports provide an opportunity for groups to present their progress, as well as struggles, to the class and receive feedback. This allows collaborative dialogue that facilitates an opening of perspective for all class members. Additionally, the class community becomes invested in each group's work, which reinforces larger-group cohesion, supporting transformative learning. The final reports are the first production of scientific writing for most students in the class. The structure of the course scaffolds this experience by incorporating a peer-review process, which further enhances the investment in one another's work.

Some examples of former final research projects are: "Oysters in Chesapeake: Are We Going to Have Any?", "Differential and Stochastic Models for the Ebola Outbreak,", "Analyzing the Gateway Hypothesis in Drug Use", "Anchoring the Geographic Profiles of Serial Murderers," and "Determining Crime Hotspots." One of the students who worked on the "Oysters in Chesapeake" project described the research experience as solidifying her identity as a mathematician. She later became a high school math teacher and reported that her experience in modeling an open-ended problem encouraged her to design similar experiences for her own students to help strengthen their creative problem-solving skills. Another project, "Mathematical model of the effect of poaching on Loxodonta cyclotis (forest elephant) populations," was developed by one student who aimed to show that poaching was not sustainable for elephant populations. The mathematical model did reveal that the elephant population under analysis was going to go extinct in less than a century, but contrary to the student's expectations the effects of poaching did not change based on the targeted sex of the elephants. This unexpected outcome highlighted the importance of using mathematical modeling to reveal the underlying structures which may not be obvious or intuitive, and thus the importance of being open to changing previously held beliefs.

The feedback for this course is overwhelmingly positive. In addition to students requesting to pursue their research in the form of an independent study the following semester, there has also been an increase in students applying for REUs in applied mathematics. The vast majority of students report increased confidence in their ability to use mathematical tools in meaningful ways.

Experiential Statistics: Service-Learning Courses in Economics and Mathematics

The authors collaboratively developed a service-learning based undergraduate research course centered on statistical methods. Well-designed service-learning courses have been shown to deliver a range of positive learning outcomes, including enhanced civic engagement, increased openness to alternative experiences and perceptions, greater awareness of context, increased ability to examine previously held assumptions and revise as appropriate, and deep learning which persists, and can be applied in different contexts (Markus, Howard, & King 1993; Eyler, Giles, & Braxton 1997; Sax & Astin 1997; Mabry 1998; Novak, Markey, & Allen 2007; Warren

2012; Celio, Durlak, & Dymnicki 2011). One section of the course was housed within economics, while the other was housed within mathematics. Most elements of course design were consistent across sections.

The course was designed to serve (pre-screened) local non-profit organizations by providing statistical consulting services. The instructors recruited partner organizations over the preceding summer and used a multi-stage screening process to identify organizations likely to benefit from a consulting partnership. Those that passed this initial screening were then required to submit a formal research proposal and description of available data. Ultimately six partner organizations were selected—three for each section of the course.

The pre-requisite for the economics section of the course was a lower-level statistics course; there was no similar pre-requisite in the mathematics section as statistics is not a required course in the mathematics major. There was no application process for students—the course was open to all students who met the (low) pre-requisite. Because students entered the course with varying levels of statistical competency, the first eight weeks of the course devoted a considerable amount of time to statistical instruction and syntax programming. Individual homework assignments and exams, worth a combined total of 25% of the economics course grade and 40% of the mathematics course grade, ensured that all students developed the required statistical competencies.

Early in the semester, students reviewed organization proposals to familiarize themselves with the mission of each organization, the research question(s) the organization sought to address, and the type(s) of data initially available. Students submitted essays at the end of the second week providing a detailed justification for their preferred client organization. Honoring research interests as much as possible, while also considering student strengths and weaknesses, instructors formed balanced consulting teams (three students per team in economics, five per team in mathematics).

Once consulting teams were formed, each group was provided access to the data that had been developed by the client organization. Teams re-examined the client proposals in light of the available data and began preparing for their initial client meeting by conducting outside research. Engaging with client data and proposals motivated students to master the statistical techniques necessary to complete a quality analysis. Motivation increased further following students' initial meetings with their client organizations.

Consulting teams were required to submit weekly project management reports which provided organizational structure and accountability, as well as creating opportunities for self-assessment and reflection. Details regarding the program management reports can be found in Henderson (2018). Each team met multiple times with their organization partner, with at least one meeting held on site at the non-profit.

Every team successfully created new knowledge that was useful to their partner organization. Teams produced white papers and methodology reports for clients and publicly presented their findings in a forum attended by community stakeholders and client organizations. Two different clients requested that their student consultants travel to present their findings at the organization's annual board meeting, experiences that further enhanced students' sense of self efficacy.

Conclusions

Well-designed course-based undergraduate research experiences incorporate elements such as instructor scaffolding and constructive dialogue that support students in working collaboratively to examine existing assumptions, consider alternative framings, validate alternative approaches empirically, and ultimately see differently. These components of course design are key to delivering transformative learning outcomes to students of all backgrounds. This paper has provided examples of three different types of course-based undergraduate research opportunities that incorporate these components of course design, empowering average students to enjoy transformative learning experiences. Course-based undergraduate research experiences should be offered more broadly, so that the profound benefits associated with undergraduate research generally, and transformative learning experiences specifically, can be extended to all students, and no longer reserved for a select few.

References

Bangera, G., & Brownell, S. E. (2014). Course-based undergraduate research experiences can make scientific research more inclusive. *CBE Life Sciences Education, 13*(4), 602–6. doi:10.1187/cbe.14-06-0099

Bartlett, R. L. (1996). Discovering diversity in introductory economics. *Journal of Economic Perspectives, 10*(2), 141–53.

Boyd, R. D., & Meyers, J. G. (1988). Transformative education. *International Journal of Lifelong Education, 1*(7), 261–84.

Celio, C. I., Durlak, J., & Dymnicki, A. (2011). A meta-analysis of the impact of service-learning on students. *Journal of Experiential Education, 34*(2), 164–81. doi:10.1177/105382591103400205

Dewey, J. (1938). *Experience and education*. Edited by Macmillan. New York, N.Y.

Diduck, A., Sinclair, J. A., Hostetler, G., & Fitzpatrick, P. (2012). Transformative learning theory, public involvement, and natural resource and environmental management. *Journal of Environmental Planning and Management, 55*(10), 1311–30. doi:10.1080/09640568.2011.645718

Dirkx, J. M. (1997). Nurturing soul in adult learning. *New Directions for Adult and Continuing Education,* 74, 79–88.

Dirkx, J. M., Mezirow J., Cranton, P. (2006). Musings and reflections on the meaning, context, and process of transformative learning: A dialogue between John M. Dirkx and Jack Mezirow. *Journal of Transformative Education*, *4*(2), 123–39. doi:10.1177/1541344606287503

Eyler, J., Giles, D. E., & Braxton, J. (1997). The impact of service learning on college students. *Michigan Journal of Community Service Learning, 4*(1), 5–15.

Feinstein, B. C. (2004). Learning and transformation in the context of Hawaiian traditional ecological knowledge. *Adult Education Quarterly, 54*(2), 105–20. doi:10.1177/0741713603260275

Friere, P. (1971). *Pedagogy of the oppressed*. New York, N.Y.: Bloomsbury.

Henderson, A. (2016). Growing by Getting Their Hands Dirty: Meaningful Research Transforms Students. *The Journal of Economic Education* 47 (3): 241–57. doi:10.1080/00220485.2016.1179146.

Henderson, A. (2018). leveraging the power of experiential learning to achieve higher-order proficiencies. *The Journal of Economic Education, 49*(1), 59–71. doi:10.1080/00220485.2017.1397576

Kilgo, C. A., Sheets, J. K. E, & Pascarella, E. T. (2015). The link between high-impact practices and student learning: some longitudinal evidence. *Higher Education, 69*, 509–25. doi:10.1007/s10734-014-9788-z

Kuh, G. D. (2008). *High-impact educational practices: What they are, who has access to them, and why they matter*. Washington, D.C.

Mabry, J. B. (1998). Pedagogical variations in service-learning and student outcomes: How time, contact, and reflection matter. *Michigan Journal of Community Service Learning*, Fall, 32–47.

Markus, G. B., Howard, J., & King, D. C. (1993). Integrating community service and classroom instruction enhances learning: results from an experiment. *Educational Evaluation and Policy Analysis, 15*(4), 410–19.

Mezirow, J. (1991). *Transformative Dimensions of Adult Learning*. San Francisco, CA: Jossey-Bass.

Mezirow, J. (1996). Contemporary Paradigms of Learning. *Adult Education Quarterly, 46*, 158–72.

Mezirow, J. (2009). Transformative learning theory. In *Transformative Learning in Practice*, edited by J. Mezirow and E.W. Taylor, 18–31. San Francisco, CA: Jossey-Bass.

Novak, J. M., Markey, V., & Allen, M. (2007). Evaluating cognitive outcomes of service learning in higher education: A meta-analysis. *Communication Research Reports, 24*(2), 149–57.

Pugh, K. J. (2002). Teaching for transformative experiences in science: an investigation of the effectiveness of two instructional elements. *Teachers College Record, 104*, 1101–1137.

Pugh, K. J. (2011). Transformative experience: An integrative construct in the spirit of Deweyan pragmatism. *Educational Psychologist, 46*(2), 107–21. doi:10.1080/00461520.2011.558817

Sax, L. J., & Astin, A. W. (1997). The benefits of service: Evidence from undergraduates. *The Educational Record*, Summer/Fall, 25–32.

Seifert, T. A., Gillig, B., Hanson, J. M, Pascarella, E. T., & Blaich, C. F. (2014). The conditional nature of high impact/good practices on student learning outcomes. *The Journal of Higher Education, 85*(4): 531–64. doi:10.1353/jhe.2014.0019

Siegfried, J. J., Bartlett, R. L., Hansen, W. L., Kelley A. C., McCloskey D. N., & Tietenberg, T. H. (1991). The economics major: Can and should we do better than a B- ? *AEA Papers and Proceedings, 81*(2), 20–25.

Taylor, E.W. (1998). Transformative learning: A critical review.

Taylor, E. W. (2007). An update of transformative learning theory: A critical review of the empirical research (1999 – 2005). *International Journal of Lifelong Education, 26*(2), 173–91. doi:10.1080/02601370701219475

Warren, J. L. (2012). Does service-learning increase student learning?: A meta-analysis. *Michigan Journal of Community Service Learning*, Spring, 56–61.

Ziegert, A. L. (2000). The role of personality temperament and student learning in principles of economics: further evidence. *The Journal of Economic Education, 31*(4): 307–22.

Author's Note: Amy B. Henderson is an Associate Professor in the Economics Department at St. Mary's College of Maryland. Emek Kose is an Associate Professor in the Mathematics Department at St. Mary's College of Maryland.

Citation: Henderson, A. B., & Kose, E. (2018). The role of course-based undergraduate research experiences in extending transformative learning to all students. *Journal of Transformative Learning, 5*(2), 48-59.