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ARTICLE

Active Learning and Community Engagement: Pedagogical Synergy through the "Mobile Neuroscience Lab" Project

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The Mobile Neuroscience Lab is a project that facilitates combined pedagogical strategies of active learning and neuroscience outreach as a service learning component of a physiological psychology course. The overall project goals were to improve science knowledge, foster oral communication, and encourage positive science attitudes and beliefs. Of these goals, positive science attitudes and beliefs were assessed. During active learning, university students completed hands-on activities corresponding to the physiological psychology course. Following, during the neuroscience outreach activity ("learning through teaching"), university students and middle school students engaged in small group activities (one university student to five middle school students) using the same hands-on activities. Assessment of the perceived benefit of the active learning showed that university and middle school students responded favorably to the hands-on activities. Students' science attitudes were also assessed (Hillman et al., 2016) using a pre-test, post-test design. Data showed that the neuroscience activity did not change middle school science attitudes and beliefs (p > .05), possibly as the science attitudes and beliefs were already positive (moderate to high) prior to the outreach activity. However, qualitative data showed that the aspect of the neuroscience outreach activity that most assisted the middle school students in their learning was seeing the brain, touching the brain, and social interaction with the university students. Overall, the pedagogical strategies of active learning, and "learning through teaching", were received with enthusiasm by university and secondary education students. Future studies will include classroom teachers' assessment of these hands-on activities.

Key words: active learning, learning through teaching, service learning, community engaged learning, student attitudes

Hands-on activities used in the neuroscience curriculum are often described separately from outreach in the neuroscience education literature. For example, recent reports describe hands-on activities of how to record action potentials from earthworms (Kladt et al., 2010), classically condition bees (Van Nest, 2018), and study behavior in Drosophila (McKellar and Wyttenbach, 2017). In contrast, activities for neuroscience outreach may be developed independently from the aforementioned hands-on laboratory activities, sometimes by students as part of a class project, or by faculty in collaboration with students (Deal et al., 2014, Vollbrecht et al., 2019). Thus, descriptions of neuroscience activities that students learn in the classroom or laboratory (i.e., "see one/do one") and then teach in the community as an outreach activity (i.e., "teach one"), *using the same equipment,* are not commonly reported in the literature. The synergistic strategy of active learning, and community outreach as a service learning component of a course, have several pedagogical (e.g., students have additional practice with neuroscience concept), and practical benefits (e.g., time, cost). The current report is multi- purposed. Primarily, we aim to describe active learning activities in a lecture-based physiological psychology course *(Goal 1)*, and neuroscience outreach ("learning through teaching") as a service learning component of the physiological psychology course *(Goal 2)*. Additionally, the equipment needed to support these pedagogical strategies is included *(Goal 3)*. Finally, assessment of active learning, and development of those assessment strategies, is also reported *(Goal 4)*. These four goals may be relevant to neuroscience educators interested in the synergistic pedagogical strategies of active learning and "learning through teaching" during neuroscience outreach. This report may be of particular interest to neuroscience educators employed in an environment without a mechanism to support purchase of classroom materials/consumable supplies, or those teaching neuroscience concepts without a laboratory to support active learning. The "Mobile Neuroscience Lab" is truly mobile. That is, equipment and activities can be set up, and taken down, in a 50 minute class period, in any classroom assigned to the instructor within the university setting. The portability of equipment and activities is also beneficial during neuroscience outreach.

Broadly, active learning is any activity that "engages students in the learning process" (Prince, 2004, p. 223). Engaging students through hands-on activities and demonstrations increases the level of understanding reached (Hake, 1998) and general cognitive development (Prince, 2004; Pascarella and Terenzini, 2005; Michael, 2006). Widely discussed in STEM fields, the benefits of active learning are well established, however, barriers yet exist in its adoption in the university classroom (Deslauriers et al., 2019). Some findings show that there is a disconnection between what students subjectively describe (i.e., learning less in active learning classrooms), and objective test scores showing improved learning. Thus, another purpose of the current study may be to address students' subjective concerns, by associating active learning in the classroom with a service learning/community outreach activity, that could be popular among some college students, administration, and university public relations.

Hands-on activities contrast with the traditional approach to teaching college courses where professors impart knowledge that students absorb (Bonwell and Eison, 1991; Edgerton, 2001). Following this traditional approach, the in class experience for students in a course primarily involves listening to lectures. While lectures are a necessary element of effective teaching, when used alone, they do not promote a higher understanding of course material (Pascarella and Terenzini, 2005). That is, students may be able to comprehend the material sufficiently well to pass an exam, but not well enough to apply that knowledge in other situations (Barkley, 2009). According to Edgerton (2001), understanding involves the ability to explain an idea, provide evidence to support an idea, find examples, and apply ideas in new ways. Such benefits led the American Psychological Association (APA) to recommend active engagement by students in academic work, and the use of group activities, in their principles for quality undergraduate education in psychology (Halpern, 2010). The APA also recommends that students have opportunities to apply what they learn in undergraduate courses through experiences such as volunteer activities and service learning (Halpern, 2010).

Similarly, the Association of American Colleges and Universities (AACU) includes service learning and community engagement as high impact educational practices (AACU, 2022). Service learning refers to an educational approach where students are involved in hands-on learning projects in which knowledge is applied to the benefit of the community. Levesque-Bristol et al. (2011) defined service learning as "a teaching strategy that offers students opportunities to learn both in the classroom and in the wider world." In a second example, Astin, the founding director of the Cooperative Institutional Research Program and Higher Education Research Institute, proposed the Theory of Involvement (Astin, 1984), which describes student involvement in higher education. This theory is based on three elements of input and five postulates of involvement. One of these postulates is that what a student gains from involvement is directly proportional to the extent to which they were involved. For example, when a student applies their learning to real-world problems, it makes that learning more durable. Finally, Kielsmeier (2013), founder of the National Youth Leadership Council and the Center for Experiential Education and Service-Learning at the University of Minnesota, states that service learning also impacts how education and schools see students from "resource users, recipients, and victims" to "contributors, givers, and leaders".

The immediate and long-term benefits of service learning have been debated throughout the years. Through service learning projects, students have the opportunity to experience growth and acquire skills that they can use. Some of these include interpersonal and personal leadership skills, critical thinking and problem-solving skills, self-knowledge, spiritual growth, civic-mindedness, career benefits, and changes in personal efficacy (Astin, 1984; Eyler and Giles, 1999; Fox et al., 2015). Finally, service learning can lead to diversity awareness and facilitate the interaction of individuals from different cultures (Eyler and Giles, 1999).

Thus, the Mobile Neuroscience Lab Project combines many of the aforementioned benefits of active and service learning for students. Along with hands-on learning and "learning through teaching", the goals of the Mobile Neuroscience Lab Project included fostering science knowledge, oral communication in university and secondary education students, and positive science attitudes and beliefs. We predicted that the active learning activities would have positive perceived benefits for university and middle school students. We also predicted that the science attitudes and beliefs of middle school students would be positively affected by the neuroscience outreach.

METHOD

Participants

Generally, the outreach project has involved 40 university (graduate and undergraduate) students trained in the use of active learning neuroscience equipment and four faculty. The Mobile Neuroscience Lab Project was initially funded through a strategic initiatives grant to foster community engagement from the university's Office of Academic Affairs. *(Goal 3)* When our strategic initiatives grant concluded, over 330 students in the local area received neuroscience education through hands-on activities (Year 1). An additional 750 middle school students participated in outreach events in Year 2 and Year 3, for a total of over 1,000 students in the local geographical area.

Specifically, description of the sample of middle school students included in the assessment of science attitudes and beliefs during neuroscience outreach follows. Collection of these data was determined to be exempt by the Institutional Review Board at anonymous review. Demographic data were collected from middle school students in Year 2 (n = 139; 49.6% male; 55.4% White, 10.0% Native American, 21.5% other, 10.8% preferred not to answer) and Year 3 (n = 137; 40.1% male; 45.9% White, 14.1% Native American, 17.8% other, 13.3% prefer not to answer). Demographic data from university students (N = 16) were not collected because of the potential of dual-role conflict (corresponding author was also the course instructor).

Materials

We chose active learning equipment to support activities that demonstrate neuroscience concepts to a broad educational range of middle school, high school and higher education students (Marzullo and Gage, 2012; Shannon et al., 2014. (Goal 1) Middle school students are often the focus of STEM outreach activity to enhance future career option development (Hillman et al., 2016; Vollbrecht et al.,

Figure 1. University students "learning through teaching". Photo credit: Brett Groehler © 2017

2019). The Mobile Neuroscience Lab contains equipment from Backyard Brains (2022), including Spikerboxes, along with sheep brains (Carolina Biological, 2021), play dough, paper brain caps (Teacher Enrichment Initiatives/CAINE, 2009), plastic human brain models (Samso®), electrophysiology recording caps (Electro-cap International, Inc.), and iWorx – (HK-TA Human Physiology Teaching Kits). Sufficient equipment was purchased to allow for use in classroom group activities (i.e., 4-6 students/ group).

Procedure

Action steps in the development of the Mobile Neuroscience Lab Project included grant funding and equipment purchase, community education partner identification, active learning with university psychology students in the university classroom, and outreach activity to middle school students ("learning through teaching"). (Goal 3) We also identified assessment measures on perceived benefits of active learning (Burdo, 2012) and attitudes toward science (Fitzakerley et al., 2013; Hillman et al., 2016). (Goal 4)

Active Learning

University students participated in active learning activities in university physiological psychology courses. The activities corresponded to the physiological psychology textbook for the university course (Kalat, 2019, Chapters 1-3,7,8, and 12). The active learning classroom activities included labs on action potentials, neural conduction velocity, EMG, sheep brain dissection, virtual operant conditioning, and electroencephalogram (EEG). Each active learning session was introduced by ten minutes of lecture. For example, the action potential lecture a) reviewed the action potential material from the textbook, b) included an overview of experimental setup (Backyard Brains, 2022), and c) introduced learning objectives of the hands-on activity. Following the active learning session (self-guided with step-by-step handout and instructor/research assistant support), students completed a reaction paper course assignment in which they described the activity, connected the activity to provided literature and the textbook, and designed an experiment that extended the activity that they conducted. (Goal 1)

Neuroscience Outreach ("Learning through Teaching")

Prior to an outreach event, new UMD Psychology Outreach Team members (i.e., physiological psychology students) completed active learning training with experienced student outreach leaders. Students who completed training received a long-sleeve maroon t-shirt with university and project logos (see Figure 1). They wore the t-shirt during the community engagement activity to identify them as team members.

Implementation

Neuroscience outreach activities are summarized in Table 1. The middle school outreach was the largest yearly outreach event. During the outreach event, the university students completed neuroscience outreach to seventh grade life science students in one middle school (*n* = ~250 students/year), all in one day. Seventh graders rotated through these classrooms according to their class schedules so that the amount of time each middle school student participated in the outreach was 50 minutes. University students were arranged into two teams to accommodate the simultaneous instruction in two life science classrooms. The team lead in the classroom was either a graduate student or faculty member. During the first year, there was a mix of large and small group activities. The current format of the neuroscience outreach activity (i.e., Year 2, Year 3) involved small group instruction only. We emphasized anatomy, physiology, and laboratory exercises in these outreach programs with middle school age groups in mind. A description of the neuroscience outreach event to middle school students follows.

Large Group Instruction

In Year 1, the large group instruction completed by faculty included a brief overview (7-10 minutes) of nervous system structure and function. The lecture was designed as an introduction to the brain cap and sheep brain dissection activities. The lesson addressed state standards for seventh grade life science students (Minnesota Department of Education, 2009; 2019), "structure and function of living systems" and to facilitate questioning about "aspects of the phenomena they observe". During the large group instruction, slides from the university faculty member were placed on the smartboard by the middle school classroom teacher. The figures (Myers, 2014) included a) the central (brain and spinal cord) and peripheral (sensory and motor nerves) nervous systems, b) the four lobes of the cortex

			Activity		
Outreach Opportunity(#)	**Students, Grade**	**Secondary Student: UMD Student**	**EMG**	**Sheep Brain**	**Cap**
1-2: High School	*n* = 35, grade 11-12	15 to1	X	X	X
3-4: Middle School	*n* = 1000, grade 7	5 to 1		X	X
5: UMD Honors	*n* = 40, grade 1-7	6 to 1	X		X
6: UMD Social Justice	*n* = 15, grade 7	5 to 1			X
7: Elementary School	*n* = 30, grade 3-5	4 to 1	X	X	X
	n = 30, grade K-2	2 to 1	X	X	
8: UMD Psychology Club	*n* = 17, UMD Undergrads		Human-Human Interface		
	***N* = 1,167**				

Table 1. Summary of outreach activities. The combined pedagogical strategy of active learning and learning through teaching with the University of Minnesota Duluth (UMD) "Mobile Neuroscience Lab" portable equipment allowed the team to efficiently respond to requests from student groups and university strategic initiatives. The UMD honors was an on-campus tabling organized by university honors students for those experiencing long-term or recurrent homelessness housed in a non-profit apartment complex. The UMD Social Justice was a tabling organized by an on-campus group to bring middle school students to campus. EMG Spikerbox (Backyard Brians, 2016), Sheep brains (Caroline Biological), Paper Brain Caps (Teacher Enrichment Initiatives/CAINE, 2009), Human-Human Interface (Backyard Brains, 2022).

(frontal, temporal, parietal, occipital), c) functional areas of the cortex (primary motor cortex, primary somatosensory cortex, primary visual cortex, Broca's area, Wernicke's area), d) sagittal section through the human brain, and e) neuron chemical and electrical transmission (Backyard Brains, 2022). These figures were introduced by the faculty member so that students completing the paper brain cap had received an orientation to the central and peripheral nervous system.

Paper/Pencil Brain Cap Activity

Following the large group brain anatomy and physiology discussion, students completed the paper/pencil brain cap activity (Teacher Enrichment Initiatives/CAINE, 2009). This activity was chosen as it was developed by UT-HSC for use with middle school students during outreach. The paper brain cap is also approximately anatomically accurate and includes cerebellum, brain stem and vertebral column. Finally, the paper brain cap does not involve technological aspects that could be problematic during outreach. To facilitate timely completion, the paper brain cap was already cut out prior to the middle school visit.

During the completion of the paper/pencil brain cap activity, the middle school students separated the cut out brain cap into three piles (i.e., cortex, brain stem/ vertebrae, cerebellum). Following, the functions located in each of the four lobes of the cortex were described. These included frontal lobe (e.g., planning, judgement, speaking, muscle movement), parietal lobe (e.g., primary somatosensory cortex for touch, body position), temporal lobe (e.g., primary auditory cortex, needed for hearing), and occipital lobe (e.g., primary visual cortex). The middle school students wrote these functions on the back of the paper brain cap corresponding with the appropriate lobe. They also colored the lobes with colored pencils. The paper brain cap was assembled by taping together the left and right hemispheres, temporal lobe, cerebellum, brain stem, and vertebral column.

Sheep Brain Activity

A sheep brain dissection small group activity (one university student to five middle school students) was then performed. Specifically, during the sheep brain dissection, the faculty member placed a sheep brain on a dissection tray, and distributed this to the university student who was with the five middle school students. The middle school classroom teacher distributed plastic gloves to the university and middle school students. The university student then completed the sheep brain dissection (Carolina Biological, 2021). During the dissection, the university student referred to a brain and spinal cord specimen lab terms list (available from the corresponding author) and the slides from the nervous system overview (printed in color). The slides were covered in plastic protective sheeting.

We've also used a small group format for the neuroscience outreach. During the small group instruction, the paper/pencil brain cap and sheep brain dissection are led by the university students. Prior to the small group instruction, university students introduce themselves to the class with the goal of providing middle school students with information about higher education and potential vocations. The university student introductions included major, minor, year in school, and hometown. The university students also perform the nervous system overview described above.

(Goal 2)

Assessment Measures

Perceived Benefits of Active Learning

Perceived benefits of the active learning classroom activities in university and middle school students were assessed with a 5-item scale (adapted from Burdo, 2012). Each item was measured on a 5-point Likert scale (1 = Strongly Disagree, 5 = Strongly Agree). Higher scores indicated greater perceived benefits of the hands-on activities. Example items included, "The hands-on activity (or demonstration) improved my knowledge of the topic," and, "The hands-on activity (or demonstration) was a better learning experience for me than other types of teaching methodologies I've had in other courses." Internal consistency for university (α = .89) and middle school (α = .84) students was excellent. We also included write-in items of what students liked and disliked about the activities.

Science Attitudes and Beliefs

Science attitudes and beliefs were assessed either using the 14-item BrainU questionnaire (adapted from Fitzakerley et al., 2013) or the 28-item My Attitudes Toward Science (MATS) scale (Hillman et al., 2016). Each item on both of these assessments was measured on a 5-point Likert scale (1 = Strongly Disagree, 5 = Strongly Agree). Higher scores on either assessment indicated more positive science attitudes and beliefs. Example items from those assessments included, "I usually understand what we are doing in science class," (BrainU) and, "People do not need to understand science because it does not affect their lives" (MATS). Internal consistency was acceptable on the BrainU (α = .69) and excellent on the MATS (α = .92). An 8-item subscale on school science attitudes and beliefs was calculated from the BrainU assessment (α = .76). Subscales on attitudes toward school science (14 items; α = .87), desire to become a scientist (2 items; α = .79), and value of science to society (12 items; α = .87) were calculated from the MATS assessment. (Goal 4)

Assessment Timeline and Procedure

Perceived Benefits of Active Learning

University students completed the assessment of perceived benefits of the active learning in their physiological psychology course (adapted from Burdo, 2012) following the completion of each active learning activity, Year 1. As scores did not vary between activities, assessment Year 3 occurred after the completion of all active learning activities (6-8 weeks into the semester). Middle school students completed the assessment immediately following outreach in Year 1 (administered by the neuroscience outreach team) and within the week following outreach in Years 2 and 3 (administered by the middle school classroom teachers). Write-in items were included in Years 1 and 3. Given the length of the questionnaires and to avoid biased responding, classroom teachers administered the assessments in Years 2 and 3.

Science Attitudes and Beliefs

Middle school students' science attitudes and beliefs were assessed using the BrainU questionnaire (adapted from Fitzakerley et al., 2013) immediately following outreach (post-test only) in Year 1 (administered by the neuroscience outreach team). The MATS scale (Hillman et al., 2016) was administered in Year 2. The MATS assessment was conducted both one week before and within one week following outreach in Year 2 (pre-test, post-test). Science attitudes and beliefs were only assessed in middle school students.

RESULTS

Perceived Benefits of Active Learning

University Students

In Year 1, university students rated each activity immediately after completing each activity in their psychophysiology course, (n = 7, M = 19.87, SD = .38, scale range 1-25) using the active learning scale (adapted from Burdo, 2012). In Year 3, after completing all of the activities, *university students* reported favorable perceived benefit of the active learning, (n = 9, M = 22.77, SD = 2.63, scale range 1-25). Data were not collected for Year 2.

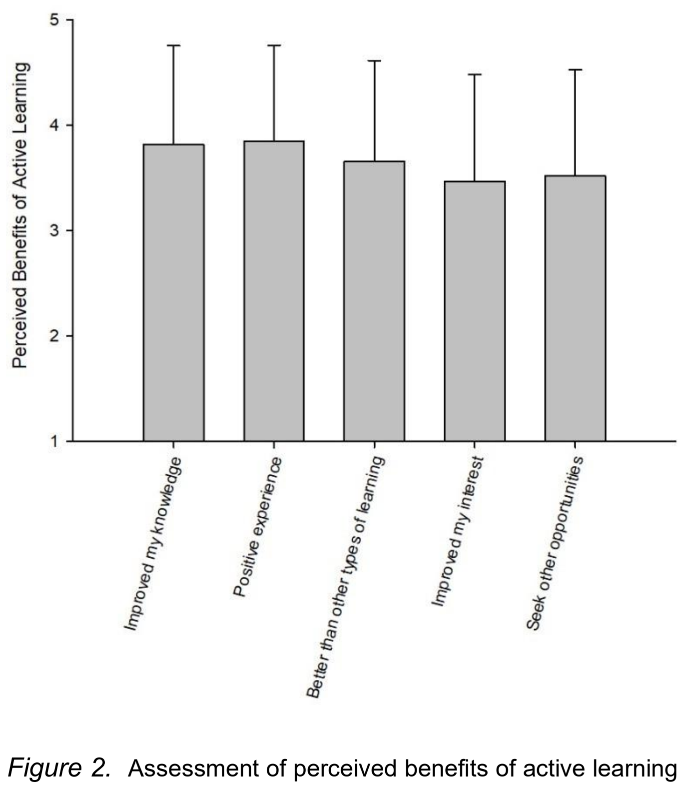

Figure 2. Assessment of perceived benefits of active learning in neuroscience outreach to middle school students 2016-2019, n =372 (adapted from Burdo, 2012). Neuroscience outreach included large and small group instruction. Data showed that middle school students reported favorable response to the outreach activities. Error bars represent SEM.

Middle School Students

See Figure 2 for Year 1-3 aggregated data. Middle school students reported a favorable response to the active learning activities (assessment adapted from Burdo, 2012) following outreach in Year 1 (M = 19.46, SD = 3.13, scale range 1-25), Year 2 (M = 17.68, SD = 4.22, scale range 1-25), and Year 3 (M = 18.26, SD = 3.37, scale range 1-25). Write-in comments from Year 1 indicated that the middle school students liked the hands-on activities (brain cap and sheep brain activities), $\chi 2$ (3, n = 250) = 24.42, $p < .01$, and did not like the large group verbal instruction, $\chi 2$ (3, n = 250) = 46.21, $p < .0001$. Write-in comments from Year 1 also indicated *that middle school students* liked touching the brain (42.9%), seeing the brain (16.7%), coloring the paper brain cap (14.3%), and interacting with the *university students* (26.2%) (percentages calculated out of the total number of comments, n = 84). Qualitative data from Year 3 indicated that the aspect of the neuroscience outreach activity that most assisted middle school students' learning was touching the brain (17.1%) and social interaction with the *university students* (42.1%).

Science Attitudes and Beliefs

In Year 1, *middle school students* (n = 111) reported moderately positive science attitudes and beliefs on the BrainU assessment (adapted from Fitzakerley, 2013; M = 49.45, SD = 5.76, scale range 1-70). BrainU school science subscale attitudes and beliefs were also positive, (M = 28.60, SD = 4.68, scale range 1-40).

In Year 2, pre-test data indicated that middle school students were more likely to have a moderate attitude toward science prior to the neuroscience outreach activity, χ^2 (2, n = 139) = 34.11, $p < .0001$, on the MATS assessment (Hillman et al., 2016). The attitude toward science (M =95.87, SD = 17.27, scale range 1- 140) did not change following the neuroscience outreach activity (*M = 95.47,SD = 18.16,* scale range 1- 140*), t(288) = .195, p = .845, d = -0.02*. Similarly, there were not significant differences from pre-test to post-test on subscale data for the MATS (see Figure 3).

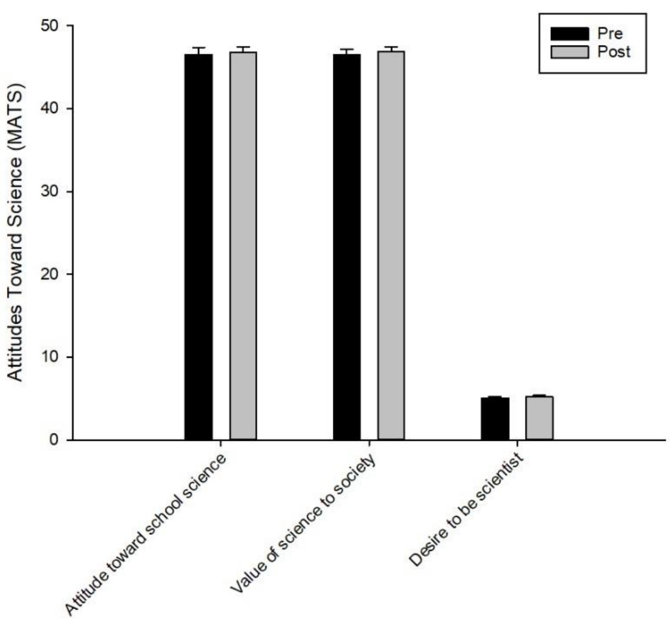

Figure 3. Assessment of science attitudes and beliefs MATS subscales in middle school students 2018-2019, n = 139 (Hillman et al., 2016). Differences between pre- and post- assessment were not significant, $p > .05$. Subscales include Attitude toward school science (14 items; range 1-70), Desire to become a scientist (2 items; range 1-10), and Value of science to society (12 items; 1-60). Error bars represent *SEM.*

DISCUSSION

The Mobile Neuroscience Lab is a project that was designed to engage university students in both active learning and community engaged learning. Initially funded through a university strategic initiatives grant, the project has involved 40 university students and has introduced over 1,000 K-12 students to neuroscience concepts including neuroanatomy and neurophysiology. Assessment results show that active learning and "learning through teaching" are pedagogical strategies that are received with enthusiasm by university students. Outreach activities designed to provide informal science experiences using hands-on activities may have a positive impact on science attitudes. In the current study, however, we did not observe a change in science attitudes in *middle school students*, perhaps as science attitudes were already moderately positive.

While the project initially proposed three goals, fostering oral communication, science knowledge, and science attitudes and beliefs, after consultation with a science educator (Year 2), we chose to focus on assessment of science attitudes and beliefs. This decision was guided by the availability of a validated instrument (MATS), and the scientific background of the first author (i.e., validity of attitudes and beliefs in predicting subsequent behavior). Additionally, self-reported positive attitudes and beliefs strongly predict future behavior (e.g., Goldman et al., 1999). Subscales of the MATS (Hillman et al., 2016) including attitude toward school science, desires to become a scientist and value of science to society could potentially be used in longitudinal studies to investigate if middle school science attitudes and beliefs are predictive of future career choice.

The excellence of the community partners as science educators is evident in the already high pre-outreach data that we collected in Year 2 showing an average of 4 out of 5 for most items (MATS). We suspect that the already positive attitudes toward science accounted for the lack of a pre-post outreach difference that we observed in Year 2. For example, the middle public school students had experiential knowledge of the scientific method and were already engaged in their science fair projects. Alternatively, one interaction with university students per year may not be enough to change knowledge or attitudes toward science (see Dierking et al., 2003). However, literature also supports that students remember high impact hands-on activities well after the event has occurred (VanderStoep et al., 2000). The delivery mode and time of the day may also explain our results. Qualitative data in the current study showed that middle school students preferred interacting in smaller groups with the university students earlier, versus later, during the school day (unpublished data).

Community partner selection was important in the success of this work. Some, though not all, of our community partners had advanced science or education degrees, and were like-minded in the validity of the "learning through teaching" as a pedagogical strategy. A limitation of the current work is that classroom teachers were not surveyed about their view of the outreach activity. Future studies will include a teacher survey (e.g., Fitzakerley et al., 2013).

Concerning university students, additional revision of the assessment strategy is needed to capture the enhanced engagement of university students and its effects on their university experience. The enhanced engagement could also be measured through attendance at the outreach event. The authors do not have recruiting shortage for the neuroscience outreach activity (either students or faculty). The activity is popular with students. Assessing the enhanced engagement of university students in their classes, through attendance data, could also be a next step. A second limitation is that science knowledge was not objectively quantified and these results are focused on self-reported data of science attitudes and beliefs. After consultation with the science educator (Year 2), the decision was made to focus on science attitudes and beliefs because of the utilization of the same assessment measure (Burdo et al., 2012) in both the middle school and university students. These results differ from those of other active learning reports (Deslauriers et al., 2019) as we did not measure science knowledge in the current report, but rather focused on the perceived benefits of active learning (Burdo et al., 2012). Future studies, particularly including university students, will use available assessment data to quantify science knowledge prior to, and following, the outreach event.

Qualitatively, university students responded most positively to the "learning through teaching" as a pedagogical strategy when the middle school students had received instruction in the scientific method and were involved in some type of directed research of their own (e.g., science fair project). Although the large outreach event occurred in the fall, continuing communication with community partners throughout the year also facilitated our success. For example, university students were judges for a large regional science fair, seeing some of the same teachers and students who they engaged in outreach. We are grateful to the community partners who allow this work to continue.

The sustainability of the current project also contributed to its success. While technology and strategic initiative grants were needed to begin the project (funds to purchase materials needed for teaching), funding currently supports travel to the outreach site, conference attendance (undergraduates) to present outreach data, and the team t-shirts. Decision makers saw the project as an efficient use of resources as the equipment was used for more than one purpose (i.e., active learning and community outreach).

In summary, the Mobile Neuroscience Lab Project facilitates combined pedagogical strategies of active learning and community engagement. Both university and secondary education students respond favorably to the pedagogical approach, and report positive benefits of the active learning activities. The neuroscience outreach also fulfills a high- impact educational practice of service learning in undergraduate education (Association of American Colleges and Universities, 2022). The project has contributed to the visibility of the university through favorable media coverage. Most importantly, the small group format allows for a low-distraction learning environment for middle school students to interact with the university students. Thus, neuroscience outreach may positively enrich the educational experience for middle school students, such that those who may not otherwise be considering the possibility of a college education, may apply and attend one day.

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