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Original Research Article

The Role of Experiential Learning on Self-Efficacy in Undergraduate Exercise Physiology Students: a Pilot Study

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ABSTRACT

Introduction: Self-efficacy is the confidence in one's own ability to complete specific tasks. The purpose of this study was to evaluate the effect of an experiential learning pedagogical intervention on the self-efficacy of pre-health professional undergraduate exercise physiology students. **Methods:** Six undergraduate exercise physiology students participated in an experiential learning opportunity conducting lactate threshold testing on collegiate rowers. The students conducted a pre-test knowledge assessment of lactate production and threshold testing followed by a traditional class lecture, lactate threshold testing practice, and formal lactate threshold testing of the female varsity rowing team. Post assessments included retaking the knowledge assessment of lactate production and threshold testing, a 15-question self-efficacy survey, and participated in a moderated focus group. **Results:** The average percent correct on the Lactate Quiz increased 11% from pre to post assessment, but this improvement was not significant ($p>0.05$). Self-efficacy survey results from the subjects indicated improvements in self-efficacy. The most common themes reported in focus groups were individual growth through field exposure, improvements in communication, and increased understanding of the material. Overall, students reported a high satisfaction with the modality of education and indicated they would encourage peers to participate in similar experiential learning opportunities because it was a novel method to solidify course material. **Conclusion:** This discipline-specific, mixed-methods pilot research determined the effectiveness of incorporating experiential-based curriculum to improve self-efficacy and content proficiency of pre-health professional undergraduate students.

KEYWORDS: Education, Practice-Based Learning, Student Development

Introduction

Self-efficacy refers to an individual's belief in their ability to successfully complete assigned tasks in specific situations. Increasing self-efficacy increases the probability that one's expected outcomes are the outcomes they can achieve [1]. Coined by social psychologist Albert Bandura, self-efficacy has been the subject of research across disciplines, including education

research which focuses on students' self-beliefs as a principal component of academic motivation. This work is grounded on the assumption that the beliefs students create, develop, and hold to be true about themselves are vital determinants in their success or failure in school. Indeed, academic self-efficacy is positively correlated to academic and work-related performance [2, 3].

In education, one method of improving students' self-efficacy is with experiential learning opportunities [4-6]. Experiential learning is a holistic learning practice in which cognitive processes are reinforced while performing content-associated tasks or, more simply stated, when individual experiences drive learning. Experiential learning models can create a link between the abstract information behind a procedure and the reality of the task. From experiential learning, medical students have shown increased success in task-based skills and similar work has caused dental students to seek more specialized education [4,5]. The pedagogical process of experiential learning has been described as a cycle that moves through concrete experiences, abstract conceptualization, reflective observation, and active experimentation to enforce learning. The first two steps emphasize conceptual understanding, while the latter two solidify concepts [7].

Experiential learning in academic courses serves to increase the self-efficacy of participating professional students [5]. Self-efficacy among students in the health professional fields is critical for successful acquisition of clinical skills. In this regard, experiential learning has been shown to improve self-efficacy in clinical fields [4, 8, 9]. Indeed, in clinical education, experiential learning and practical simulations have increased the self-efficacy of physicians, dentists, and physical therapists [4-6]. However, developing self-efficacy prior to matriculating into professional programs could better prepare these students for academic success. Incorporating experiential learning into pre-health professional undergraduate curriculum may help to achieve this outcome.

Proposing and incorporating changes to undergraduate curriculum should be grounded in evidence-based research. To assess the viability of curricular changes, discipline specific research is needed to determine whether experiential-based curriculum could improve self-efficacy and content proficiency of pre-health professional undergraduate students. This pilot study investigated the effects of experiential learning on the self-efficacy and learning of undergraduate Exercise Physiology students to inform departmental curriculum changes. Using a mixed-methods strategy, this pilot study assessed the effectiveness and applicability of an experiential model for undergraduate exercise physiology students with self-efficacy as the primary outcome.

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Methods

Participants

Six undergraduate exercise physiology students ranging from freshman-senior education status volunteered (one freshman, two sophomores, one junior, and two seniors) as subjects for this study. This education-based research study was approved by the Institutional Review Board (IRB 1809288247) at West Virginia University (WVU).

Experimental design

The objective of this study is to evaluate how the use of the experiential learning model influences learning and self-efficacy of undergraduate exercise physiology students. The experiential learning task was for the students to perform a lactate threshold test on the WVU Women's Varsity Rowing Team. Lactate production and lactate threshold as it applies to athletic performance is taught in degree-required coursework, but lactate threshold testing is not practiced in a laboratory setting. Therefore, the effects of the experiential learning opportunity could not be attributed to previous mastery experiences. The students were assessed on their knowledge of lactate production as a response to performing lactate threshold tests as well as their confidence in their abilities to perform similar field-related tasks.

Undergraduate exercise physiology students were invited to participate in this pilot project through an email invitation sent through the departmental email roster. Students were studied over the course of two weeks. Evaluation of subjects was conducted in three phases: Pre-Assessment, designed to address base-line knowledge of lactate production; Intervention, in which subjects participated in various pedagogical modalities; and Post-Assessment, in which knowledge of lactate production was reassessed, and self-efficacy was evaluated. The Experiential Learning model was followed by progressing through the four different stages of learning: Conceptualization, Experimentation, Concrete Experience, and Reflective Observation.

Procedures

Pre-assessment

For pre-assessments, all subjects completed a 19-question, multiple choice Lactate Quiz that evaluated their knowledge of lactate production and lactate threshold. Questions were taken directly from the workbook required for the junior level Advanced Exercise Physiology course and varied from micro to macro-level concepts of lactate production. Subjects were not given access to their scores.

Intervention

After pre-assessment, students received the educational intervention in four phases: education, training, testing, and follow-up. In the education phase, or the conceptualization phase of learning, students received an in-person lecture on lactate production from a lactate threshold expert followed by a group discussion of relevant material and provided peer-

reviewed articles pertaining to lactate production and lactate threshold testing in rowers. The educational phase was conducted over two days, but review of provided material was encouraged throughout the training phase of intervention.

For the experimental phase of the learning cycle, students participated in a two-day training session that prepared them to administer a lactate threshold test on rowers. On the first day, subjects were familiarized with equipment and repeatedly performed methods and procedures under the supervision of faculty. The second day required students to perform the full testing protocol as both the subject and test administrator to solidify the experience and testing procedure. The testing procedure incorporated interaction with the test subjects including informed consent, explanations of the purpose of the test, and necessary instructions to subjects for a lactate threshold test.

As the cornerstone of their concrete experience, students conducted lactate threshold testing over the course of two days on 24 members of the WVU Varsity Women's Rowing Team under the supervision of exercise physiology faculty. Rowers performed an incremental lactate threshold test on a rowing ergometer. The data collected from the rowers by the students was compiled and given to the team as material to be used for their own training and development.

Upon completion of their experience, the students were then encouraged to reflect and ask questions regarding the experience. The follow-up and reflection were conducted during a moderated focus group, so students were provided an environment in which they could recapture what they had taken away from the experience, as well as provide qualitative data regarding the experience.

Post-assessment:
For post-assessments, students were given the same 19-question Lactate Quiz administered in the pre-assessment phase. A 15-question Self-Efficacy and Satisfaction Survey was administered using an online survey platform (Qualtrics, Inc. Provo, UT). Questions from a validated Community Service Self-Efficacy Scale included responses on a 7-point Likert scale to which students responded with their level of agreement to provided statements (Strongly Disagree – Strongly Agree) [10].

A focus group was conducted at the end of the experiment following a semi-structured protocol [11]. Led by faculty (second and senior author), the group responded to a series of 11 questions, with prompted follow-up questions. One team member served as the focus group moderator while the second researcher took comprehensive notes and transcribed them with 48 hours. The focus group discussion was digitally recorded so the researchers would be able to review the accuracy of the transcribed notes. The moderator who conducted the focus group checked all transcribed notes to ensure

accuracy and completeness. Both researchers reached agreement on the completeness of the transcribed notes.

Statistical Analyses

Descriptive statistics summarizing numerical data was analyzed using Microsoft Excel and reported as means ± SD. Differences between pre and post assessments were compared using paired, one-tailed t-tests. P values less than 0.05 were considered significant. For qualitative data, the transcribed notes were reviewed by two trained research assistants who independently coded the focus group responses for recurring themes and statements using Excel spreadsheets to manage the data. This coding was reviewed by the author(s) to validate the recurrent themes from the focus group responses. The recordings from the trained observer were evaluated by two independent researchers with a tie breaker (the authors) when necessary. The researchers discussed findings and data were constantly analyzed and compared to determine saturation of repetitive concepts (e.g. point at which no new information, trends, or themes emerge from data).

Results

Each undergraduate class was represented in this study including two seniors, one junior, two sophomores, and one freshman. The average percent correct on the Lactate Quiz increased 11% from pre to post assessment, but this improvement was not significant ($p>0.05$) (Table 1). There was a 100% response rate for the Self-Efficacy and Satisfaction Survey and responses were exclusively positive (Table 2).

The focus group questions, and response themes are presented in Table 3. The most common themes reported in focus groups were individual growth through field exposure (defined as increased understanding of operations in their technical field because of their exposure to the field of clinical exercise testing), improvements in communication, and increased understanding of the material. Improvement in professional communication skills was reported by the participants due to the demand of having to work with peers in administering lactate threshold tests as well as communicate with the testing/research supervisors. The students also stated that the experience garnered a unique understanding of lactate production and metabolism.

Overall, there were positive perceptions of the experiential learning opportunity. The students reported that they felt the experiential process allowed for increased understanding and reinforcement of class material, *"[The experiment] has kind of like, refreshed my memory of it somewhat - not that I had forgotten completely about it, but the details for sure I forgot."* Participants reported that their self-confidence was increased through the study which was largely attributed to the field-exposure, *"…this is like the first real life situation we've been in for the majority of us, as a whole I think it went really well and I think it*

improved my self-confidence." Improvements in communication and leadership skills, which was attributed to the field exposure as well as being allowed to operate with some degree of autonomy, was highlighted, *"Maybe like leadership [is a life skill gained] because you gave us a lot of independence on the study..."* The participants also stated that they felt as if there was an increase in material comprehension due to the connection between the material provided and the goals of the lactate threshold test, *"I think it definitely deepened my understanding of what we're learning in the classroom, last year, I mean I only took the class a year ago and I forgot most of it, because it was all straight memorization and I passed the class with the grade to get you into graduate school but this made sense, you can apply it to real life, I'll understand it for a while."* Interestingly, upperclassmen especially felt the opportunity allowed them to learn and practice new skills without the fear of failing a class.

The students were asked to evaluate what they thought were the best and worst aspects of this specific study. All students disliked the timing of the lactate threshold testing, *"For sure the 5am wakeup [was the least favorite aspect of the experience]."* Students attributed the most beneficial aspects of the study to the interactivity and uniqueness of the experience, *"I like the whole interactive environment, it wasn't just me sitting behind a desk reading like an article and inputting stuff, it was just so hands on."* Other responses include the novelty and ability to work with a new sports-specific population.

When questioned on the long-term effects of involvement, students reported a higher interest in participating in research studies within the department, *"I think I'd like to get involved with future research opportunities"* as well as new interest in working with different populations and ages professionally. Many of the lower level students felt they could apply their newly acquired knowledge to future undergraduate classes. They also had a perceived a gain of professional communication and leadership skills, *"I mean I heard them talk about it a bunch but I'm sure I will apply this in the [core Exercise Physiology course] class and future curriculum. I think I will be able to apply… the professionalism and bedside manner and all that into my internship I'm about to start next semester."* Generally, they intended to apply the knowledge gained to future classes and their new skills to future internships and professions.

Overall students reported a high satisfaction with the modality of education and indicated they would encourage peers to participate in similar experiential learning opportunities because it was a novel, engaging method to solidify course material, *"[Experiential learning] like kind of teaches you…why were actually using this information and why it's important and I feel like I would recommend this to someone."*

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Table 1. Lactate Quiz Results.

Question	# of Students answered correctly	
	Pre-Test	Post-Test
What is the end-product of Anaerobic Glycolysis?	2	1
How is lactic acid produced?	3	4
During strenuous exercise, energy demands exceed oxygen supply or its rate of utilization the rate of hydrogen added to NADH exceed the processing rate of the respiratory chain leading to:	4	4
When is lactic acid produced? (Select all that apply)	3	6
Produced in the muscle cell, lactic acid rapidly diffuses into the blood where it is buffered to form:	3	6
When does blood become more acidic?	5	6
Lactic acid and pyruvate can be converted to glucose by a process known as the:	1	1
The Cori Cycle is a biochemical process in which the lactic acid released from active tissues is taken to the _____ via the bloodstream and converted to glucose.	1	3
Which of the following are true of the glucose made from the Cori Cycle? (Select all that apply)	2	2
The most rapidly accumulated and highest lactic acid levels are reached during maximal exercise that can be sustained for 60 to 180 seconds.	4	4
What adaptations can contribute to increased lactic acid removal from the muscle cell? (Select all that apply)	2	1
Blood lactate accumulates and rises in an exponential fashion at about XX - XX% of the healthy, untrained person, maximal capacity for aerobic metabolism.	2	4
Trained athletes can often perform at XX - XX% of maximal capacity for aerobic metabolism before significant increases in blood lactate occur.	2	2
For a trained individual the threshold for lactate buildup (termed blood lactate threshold) occurs at a higher percent (%) of the athlete, aerobic capacity. Possibly due to:(Select all that apply)	2	3
Lactic Acid in the blood is buffered by _____ which generates CO2 which stimulates ventilation.	1	2
Lactate threshold describes the highest VO2 exercise intensity with less than a(n) X mM/L increase in blood lactate above resting level.	1	4
Onset of Blood lactate accumulation (OBLA) would be lower (onset is earlier) during:	4	5
Lactate Threshold is useful for predicting:	0	1
Well trained athletes have shown that after they perform maximal short-term exercise, their blood lactate level is 20-30% higher than untrained subjects. What could this be attributed to? (Select all that apply)	5	4
TOTAL EXAM % CORRECT	43.86%	55.20%

Table 2. Self-Efficacy and Satisfaction Survey.

Agree or Strongly Agree	% Response
Because of this internship experience, if I choose to participate in experiential/service learning in the future, I will be able to make a meaningful contribution.	80%
Because of this internship experience, in the future, I will be able to find experiential/service opportunities which are relevant to my interests and abilities.	100%
Because of this internship experience, I am confident that, through experiential/service learning, I can make a difference in my community.	100%
Because of this internship experience, I am confident that I can help other individuals by participating in experiential/service-learning activities.	100%
Through experiential/service learning, I can apply my knowledge in ways that solve real-life problems.	100%
Because of this internship experience, I am confident that in future experiential/service activities I will be able to interact with relevant professionals in ways that are meaningful and effective.	100%
By participating in experiential/service learning, I can help people help themselves.	80%
I am confident that I will participate in experiential/service- learning activities in the future.	100%
This internship opportunity increased my awareness of the larger EXPH community.	80%
This internship opportunity helped me better understand how the community can benefit from EXPH professionals.	100%
This internship helped me reflect on my life and goals.	100%
This internship has increased my interest in doing further service.	100%
I would recommend this internship experience to my friends.	80%
My experience with the community agency was positive.	100%
My experience with this internship experience has been positive.	100%

Table 3. Focus Group Questions and Responses.

Question	Response Themes
How did this service-learning project improve your knowledge and understanding of what you have learned in your required EXPH courses?	Increased understanding; reinforced class material; new perspective/exposure
How did this service-learning experience change your self-efficacy in terms of applying what you have learned in your required EXPH courses to "real-life" situations?	increase in material comprehension; allowed for learning and practice without the fear of failing a class; gained new skills
What "life experience" have you gained by participating in this service-learning opportunity? How has this changed you?	Increased self-confidence; individual growth through field exposure; improvements in communication; time-management; research experience
What new skills or abilities do you think you have developed form this service-learning project? Academic, applied, professional development?	improvements in communication: team-based and professional communication (translating scientific concepts to a lay audience); leadership skills due to operating autonomously
What was the best part of this program?	Interactive; hands-on; different than typical classroom or laboratory-based learning; working with new population
What was your least favorite part of this experience?	Early morning (5am) testing
How has this experience shaped your future goals, plans, or career interests?	More interest in pursuing research; some interest in sports performance or working with other ages
How will you apply what you have learned from this service-learning project moving forward?	Apply knowledge to future classes; apply skills in profession
Why might you encourage your peers to participate in a service-learning program? Why might you discourage them from participating?	Novel method to solidify course material; applied experience; engagement with faculty
Did incorporating different teaching methodologies make a difference as opposed to just learning from a textbook?	Engaging; requires application

Discussion

Using a mixed-methods research approach, this pilot study assessed the effectiveness and applicability of an experiential model for improving self-efficacy in undergraduate, pre-health professional exercise physiology students. The theory of experiential learning is defined as a cyclical, stepwise process in which an experience is transformational and creates knowledge for the students [7]. The use of this pedagogical process to supplement traditional course instruction methods through exposure to concrete and reflective experiences designed to reinforce and solidify learning concepts throughout the process. The use of experiential learning and problem-based learning models have become prevalent among graduate and clinically focused degree programs to increase understanding of material and the efficacy of completing field-specific tasks. In this pilot study, the students indicated that this process improved their self-efficacy while also improving the understanding of the correlation between abstract information and the applicability of that information to field-related tasks. The use of a mixed-methods process promoted key findings that would not have been identified had a strictly quantitative analysis been conducted. Therefore, this pilot study provided data as reference to potentially influence departmental decisions regarding the curriculum of these undergraduate students.

Self-efficacy

The objective of this pilot study was to assess the applicability of an experiential-learning model to exercise physiology undergraduate curriculum. Confidence, self-efficacy, and reported preparedness of students is related with academic improvement and success [12-14]. The student subjects reported increased feelings of self-efficacy post-intervention and academic performance, as assessed by the Lactate quiz, increased 11%. While this was not statistically significant, it is likely due to the small sample size. Additionally, this may be explained by the educational distribution of the participating students as half of the cohort were sophomores or freshmen, meaning they had not yet received curriculum on lactate production and lactate threshold. For the purpose of this pilot study, an 11% increase in quiz scores is considered a relevant improvement in academic performance of undergraduate exercise physiology students.

According to survey responses, the pedagogical model did improve the reported self-efficacy of the students who participated. This was supported by focus group responses in which students reported themes of feeling more confident and prepared to handle field-

related tasks after completing the experiential learning opportunity. These statements support previous findings of experiential learning improving self-efficacy of professional students and specialists [4-6]. Like that of experiential learning increasing the self-efficacy of that of physical therapy, dental, and medical students, the survey responses indicate that the experiential learning model can be applied to increase the self-efficacy of exercise physiology students. The array of disciplines that see an increase in self-efficacy secondary to the implementation of an experiential learning model may indicate that this model can be applied across many disciplines. The application of an experiential learning process that effects primarily pre-health professional undergraduates may further increase the self-efficacy and academic confidence of those whom transition from an undergraduate education in Exercise Physiology to a professional program. Ideally, the increased self-efficacy of undergraduate students would be maintained when transition to professional programs are completed. The present pilot study suggests that incorporating experiential learning opportunities into the curriculum improves subject mastery and self-efficacy of undergraduate, pre-health professional exercise physiology students.

Communication Skills

An unforeseen outcome of this pilot study was the reported improvements in communication skills, including students' ability to communicate professionally and in a work-related environment. This finding that experiential learning models can improve the communication skills of participating students is supported by previous research [15]. The students attributed the most improvement in communication to working directly with the WVU Women's Rowing team and each other in a team setting. These reports suggest that the concrete experience portion was the most valuable to the students.

Interest in Further Research

Another unanticipated finding from the focus group discussion was the students' desire participate in additional research opportunities. The experiential learning model as it was applied to these students seems to have piqued an interest in being involved with research, which is often regarded as the forefront of academics. Previous findings support this increased interest in learning opportunity engagement, as well as increased interest in their respective academic areas [16, 17]. The experiential learning model may be a successful model by which to promote interest and potential student engagement in academic-specific research opportunities.

Conclusions

To our knowledge, this is the first study to evaluate the use of an experiential learning model on the effects of self-efficacy in an undergraduate, pre-health professional exercise physiology cohort. However, this pilot study was not without limitations. Firstly, the sample size was small, and the educational background of the participants limited the applicability and generalizability of these findings. There was no long-term follow up determining whether the improvements in self-efficacy and academic performance persisted. Lastly, self-efficacy was evaluated using surveys and focus groups. Future measurements may include pre and post-intervention self-efficacy task-specific evaluations.

In this pilot study, all students reported improvements in self-efficacy and an increase in mastery of the evaluated academic material. Further, quantitative assessments found a relevant increase of 11% on academic performance outcomes. This discipline-specific, mixed-methods pilot research determined the effectiveness of incorporating experiential-based curriculum to improve self-efficacy and content proficiency of pre-health professional undergraduate students. Recommendations to the division's undergraduate curriculum committee will be to incorporate similar experiences into the curriculum moving forward. Future research should include a more robust experimental trial of this protocol applied to a larger sample of students. Additionally, expanding this work to other universities or institutions with different student demographics and social/economic backgrounds is warranted and could provide valuable insight into the field of experiential learning and self-efficacy in exercise science.

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