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Implementation of Interdisciplinary Health Technologies as Active Learning Strategies in the Classroom: A Course Redesign

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Abstract

The number of health psychology courses offered in higher education institutions has dramatically increased over the past 30 years. Health psychology courses provide students a unique opportunity to learn about important public health issues and health disparities affecting our society from a biopsychosocial perspective. Prior research indicates that students taking these courses, many of whom are non-biology majors, often report feeling anxious about learning the underlying biological mechanisms that affect health outcomes, particularly as they relate to stress and disease. Therefore, innovative teaching strategies, such as the use of active learning approaches, are needed to promote student confidence and engagement in learning these interdisciplinary models of health. Despite rapid advancements and innovations in health technologies, few health psychology courses have integrated these technologies as a modality of active learning. This article describes the implementation of health technologies (e.g., biosensors, biofeedback equipment, wearable technologies) as an active learning modality and innovative teaching approach to promote student engagement and learning outcomes in an undergraduate health psychology course taught in the U.S. Eighty students from a minority-serving university participated in this pilot course redesign. Student responses to the use of health technologies in their course were very positive. A description of the course curriculum is provided and results from student responses and feedback are presented. Implications and recommendations for implementing these technologies and pedagogies in future health courses are also discussed, including university support for sustaining these high impact teaching practices.

Keywords

Active learning strategies; health technologies; health curriculum; curriculum development; public health; stress management; higher education

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Over the past 30 years, there has been a dramatic increase in the offering of health psychology courses among higher education institutions in the U.S., with approximately 70% of undergraduate programs now offering a health psychology course compared to 26% in the 1990's (Norcross et al., 2016; Perlman & McCann, 1999). These courses increase students' awareness of important public health issues and address interdisciplinary models of how biological, psychological, and sociocultural factors impact health promotion and disease prevention, health disparities in underserved communities, patient adjustment to various medical conditions, and the effects of stress on health. Of these topics, 96% of instructors rated the topic of how stress impacts health as being the most important to teach in health psychology courses given the well-established associations of stress with several prominent acute and chronic medical conditions across the lifespan, including birth complications, autoimmune disorders, and cardiovascular disease (McEwen, 2017; Panjwani et al., 2017). Learning about stress and its impact on health is also particularly relevant in higher education institutions as approximately 80% of college students report experiencing moderate to high levels of stress that has adversely affected their academics, ability to meet deadlines, and self-care (American College Health Association, 2021). As such, health psychology courses provide an ideal setting for students to learn how stress affects health from a biopsychosocial perspective, including an understanding of how the nervous, immune, and endocrine systems interact with psychological and environmental factors to impact stress-related health conditions. Given the interdisciplinary nature of these courses, studies suggest that non-biology majors, particularly underrepresented minority students, may feel anxious and less confident in understanding the underlying biological mechanisms that affect psychological health and stress-related diseases (McBride et al., 2020; Skogsberg & Clump, 2003). Therefore, innovative teaching strategies, such as the use of active learning approaches, are needed to promote student confidence and engagement in learning these interdisciplinary models of health and disease.

Active learning has been supported by higher education institutions as a means of enhancing student learning experiences and consists of using multiple approaches (e.g., problem-based learning, experiential learning) to promote students' active engagement with course content to develop a deeper understanding of important course concepts relative to students receiving information passively from the instructor (e.g., traditional lecturing and memorization of key terms; Arthurs & Kreager, 2017). Studies have shown active learning to be effective in fostering student learning outcomes among college students across diverse backgrounds, majors, and health courses (Armstrong-Mensah et al., 2019; McBride et al., 2020; Theobald et al., 2020), particularly as they relate to improving student understanding, problem-solving and critical thinking skills, as well as interactions with their peers and faculty (Rotellar & Cain, 2016). One understudied modality of active learning in undergraduate health courses is the integration of health technologies. The application of technology to assess stress and health outcomes in empirically supported studies has grown substantially since the 1970's and has included the use of ambulatory blood pressure machines, biofeedback equipment, and more recently, wearable technologies such as activity trackers and biosensors to assess physical activity, sleep, and heart rate (Motti, 2020). Rapid advancements and innovations in these health technologies in the past few years has led to greater interest by educators in different parts of the world to apply their use in classroom settings to enhance students' learning experiences (Al-Emran et al., 2020). For instance, studies in Malaysia and Hong Kong have shown that the use of smart watches/activity trackers in the classroom help to improve students' e-Health literacy and learning (Sobko & Brown, 2019) and students who perceive these health technologies as being useful are more likely to use them to access class materials (Al-Emran et al., 2020). Another study in Australia provided undergraduate students majoring in cognitive and brain sciences with the opportunity to view their brain activity (i.e., EEG patterns using a portable headset) while completing a series of experimental tasks, with students reporting having a better understanding of theoretical concepts presented in class due to the use of this technology in the classroom (Alvarez et al., 2016). Despite the popularity of these technologies in Malaysia, Hong Kong, and Australia, few studies have examined their use in undergraduate health psychology courses in other countries including the U.S. Even fewer of these studies have focused on using health technologies to engage students in interdisciplinary models of stress and health.

This article describes faculty efforts to redesign an undergraduate health psychology course taught at a minority-serving, four-year, public university in the U.S. The primary aim of this pilot course redesign was to implement health technologies as an active learning modality to promote students' learning experiences and engagement and learning outcomes related to interdisciplinary models of stress and health. A description of the course curriculum is provided, as well as student responses to the impact that these health technologies had on their learning outcomes.

Method

Participants and Setting

Undergraduate students at a minority-serving public university in the U.S. who were enrolled in 'Psychology of Stress' participated in the course redesign (campus demographic profile: 42% Hispanic/ Latino, 21% Asian American, 4% African American; 58% women; 55% first generation students). Two sections of this course redesign were taught in spring 2020, with a total of 80 students (93% psychology majors; 7% liberal arts majors). The institutional review board (IRB) was consulted for this project and no review was required.

Course Description

Psychology of Stress is one of several upper division elective courses that undergraduate psychology students can choose to meet the requirements of the psychology major and has been a core course in the health psychology curriculum since Fall 2006 with an annual enrollment of 180 students. Given the content of the course, it is also taken by students outside of the psychology major that are particularly interested in health-related careers. Course material takes an interdisciplinary approach to understanding how stress can lead to adverse health outcomes through biopsychosocial mechanisms that include current theories and research methodologies spanning a wide range of health-related disciplines. This course provides students with an overview of stress, including its history, theoretical framework, physiology, measurement, management, and relationship with health outcomes. Stressors commonly experienced in our society are discussed, including individual differences in our responses to stressful stimuli, how these differences arise, and their consequences. Students complete several introspective assignments (including stress diaries, class practicums, and a personalized paper on their experiences with the material learned in class) that allow them to apply course concepts and gain insight into their own experiences of stress. In this course, students also learn about and become proficient in empirically validated stress reduction strategies that are commonly used across several diverse health populations and settings and practice applying these strategies in their own lives (see Table 1 for description of course objectives and student learning outcomes).

Course Redesign & Instructional Delivery

The course redesign took place in Spring 2020 for two sections of Psychology of Stress (40 students in each class section; total of 80 students) as part of a federally funded campus initiative focused on strengthening student training and education aimed at engaging underrepresented and underserved students in health-related research careers. As part of this initiative, faculty were provided with release time from one course to redesign their curriculum. The purpose of the course redesign was to give students an active learning experience that integrated new empirically supported health technology, research methodologies, and equipment that has been used to collect stress and health data across different at-risk populations (Motti, 2020; Urizar et al., 2020). More specifically, research methodologies representing the areas of engineering, biology, health science, and behavioral medicine were incorporated for different topics in the course syllabus (e.g., stress measurement, epigenetics, biological stress responses, muscle and sleep physiology) to provide students with classroom demonstrations and hands-on activities that were designed to strengthen their understanding of core course concepts. For example, ambulatory blood pressure cuffs and salivary biosensors were used at the beginning of the semester to familiarize students with the interdisciplinary methodologies used in research studies to test the association between stress and health as they also learned how to interpret their own blood pressure, heart rate, and alpha amylase (a stress hormone) levels. At mid-semester, students used an interactive website (https://learn.genetics.utah.edu/content/epigenetics/rats/) to learn about genetics and how genes respond to stress and health behaviors. They also took part in a class demonstration where they observed how one of their classmate's electroencephalogram (EEG) brain waves changed in response to a stress task versus relaxation.

For the last third of the semester, the COVID-19 pandemic occurred, which required the class format to change from an in-person, face-to-face class to a synchronous online class where students met with the instructor using a videoconferencing platform. During these weeks, the instructor demonstrated how different biofeedback equipment [i.e., heart rate monitor, electroymyograph (EMG) sensor] could be used to test the effectiveness of stress reduction strategies they had learned in class. More specifically, the instructor connected these devices to their ear or arm to show changes in their heart rate and muscle tension in real time. Finally, wearable technologies (i.e., EEG headband, EMG sensor, accelerometer) were used to show students the methodologies used to assess sleep physiology and how health behaviors can be captured in real-time to test their effects on stress and health. To incorporate these new health technologies in the class, the instructor applied for departmental funds to purchase some of the equipment and reached out to faculty in other departments to help conduct workshops or borrow equipment. The changes to the course to address each learning outcome are outlined in Table 2.

Results

Student Responses to the Course Redesign

Students completed two anonymous class evaluations during the semester. The first evaluation was conducted immediately following the class in week 3 (Theoretical Models of Stress) where a faculty colleague in the Department of Chemical Engineering was invited to demonstrate how their biosensor equipment could measure the stress hormone alpha amylase in real time using saliva to help determine one's risk for diabetes. As part of this demonstration, students were taught how to collect their saliva during class. They then mixed their saliva sample with an iodine solution to prepare a solution for the biosensor equipment to read their alpha amylase level and risk for diabetes. The timing of this class demonstration early in the semester was ideal as students were learning about the body's physiological responses to stress in relation to different health outcomes. Of the 80 students who completed the post-workshop evaluation, 95% indicated that the instruction was effective, 88% said the workshop instructions were clear, 77% said they were confident in using the biosensor, and 83% indicated that the workshop was helpful in learning concepts discussed in class. As one student stated, *"It was fun! I enjoy learning about technology and look forward to the advancement of identifying Type 2 diabetes through analyzing saliva."*

At the end of the semester, students also completed a second evaluation to assess how important each of the health technologies/research methodologies were in helping them learn important class topics (5-point Likert scale of 'Very Unimportant' to 'Very Important'; see Figure 1), as well as to what extent course objectives/learning outcomes were met (5-point Likert scale of 'Strongly Disagree' to 'Strongly Agree'; see Figure 2). Of the 43 students who completed the end-of-semester online evaluation, 85% to 95% reported that the new health technologies/research methodologies implemented in the course redesign were important/very important in helping them learn class topics. As one student noted, *"I thought all technologies used were great and very helpful. Using the technology that is actually being used in current research is very cool and helpful to get a better grip on what we are learning in real time."* Students also provided feedback on how to incorporate more health technologies in future courses with one student stating, *"I would like to see more technologies in general. It would be great if we could have our saliva [samples] analyzed for telomere length and the stress 5-HTT gene given what we learned about them in class in how they affect our health. I think that would be very neat."* Other students indicated that although the virtual demonstrations of some of the technologies were helpful when the class had to switch to an online course due to the COVID-19 pandemic, they wished they were able to use them to learn more about their health. As described by one student, *"For an in-person class, I think it would have been really cool to use the Fitbits and see everyone's data, and maybe have a discussion on individual differences stemming from that. However,* *it was still really helpful to see how the technology works [virtually] and how it can be incorporated into daily life."*

In addition, 93% to 100% of students reported that course objectives/learning outcomes were met. As one student noted, *"Overall, I think the assignments and technologies already integrated into the class did more than enough to help us meet the class objectives…the continued incorporation of previous topics into new ones really made it easy to learn the material."* The course redesign also had a positive impact on final grades with 88% of students earning an A or B. Finally, 77% of students reported that the course had stimulated their interest in engaging in health research.

Discussion

Despite the rapid advancements and innovations in health technologies in the past few years, few undergraduate health courses have integrated these technologies as a modality of active learning. This article describes faculty efforts to redesign an undergraduate health psychology course at a minority-serving university in the U.S., with the aim of implementing health technologies as an active learning modality to promote students' learning experiences and engagement in a course focused on teaching interdisciplinary models of stress and health. Student responses to the course redesign were very positive, with 85% to 95% of students reporting that the integration of these health technologies was important/very important in helping them meet the learning outcomes for the course. Specifically, students (93% psychology majors) indicated that the opportunity to use or view health technologies, such as ambulatory blood pressure machines, biofeedback equipment, biosensors, and activity trackers helped them to better understand the research studies they were learning about in class as well as help them feel more confident in understanding the underlying biological mechanisms that affect psychological health and stress-related diseases. These results are similar to a recent study of undergraduate students in Hong Kong who used activity trackers to complete a personal health project for a 'Physical Activity and Health' course and reported that using this technology helped them with their learning of the course content (Sobko & Brown, 2019). Together, these results provide preliminary support for the use of health technologies as an active learning modality to teach non-biology majors interdisciplinary models of health. Further, these results suggest the need for mixed methods studies to further examine how to best incorporate these health technologies in health courses across different international contexts and to better understand how they may improve student engagement, confidence, learning, understanding and recall of course content, and class performance. Results of such studies may vary by the technology used (e.g., biosensors, biofeedback equipment), the time-period examined (i.e., immediately following the course vs. longer-term effects over time), and the population studied (e.g., by undergraduate major, underrepresented minority status, or country).

Limitations

Several limitations merit mention. First, this course redesign was implemented by only one faculty member as part of a federally funded campus pilot program focused on strengthening health-related student training and education, therefore, these results were not compared to another class section that did not incorporate the course redesign, thereby limiting comparison of student outcomes across faculty, course content, and teaching styles. Second, the ‘Psychology of Stress’ course was an elective in the psychology major, therefore, these results may not be generalizable to students in other majors who did not take the course. Third, the onset of the COVID-19 pandemic during the semester caused a shift in teaching the course virtually and may have contributed to the 54% student response rate to the end-of-semester class evaluations, which is consistent with the response rates found for other online classes (30%−60%;Chapman & Jones, 2017).Finally, thiscourse redesigndid notassesswhetherstudents demonstrated a significant change in their engagement, confidence, or mastery of class learning outcomes given that baseline data was not collected to compare to post-course evaluation data. Such prospective assessments would enhance our understanding of the impact that the implementation of health technologies in the classroom can have on student learning outcomes and performance over time.

Conclusions

The findings of this course redesign have important implications for future health pedagogy, as several national organizations (e.g., Association of American Colleges and Universities, American Psychological Association, National Research Council) have called for the incorporation of public health into undergraduate education to promote the development of students’ critical thinking, problem-solving, quantitative reasoning, communication, and interdisciplinary literacy skills (APA, 2013; Ramirez, 2020; Wykoff et al., 2013). Specifically, exposure to interdisciplinary health models provides students with a greater understanding and appreciation for how disciplines from different fields work together to address important public health issues and disparities that impact our society from a biopsychosocial perspective. Such classroom experiences can serve as high impact practices that have previously been shown to profoundly affect student engagement and retention in higher education, health-related research, and health-related careers, particularly among underrepresented and underserved student populations (Finley & McNair, 2013; Kilgo et al., 2015). As such, our results suggest that health technologies can be implemented in undergraduate health courses as a high impact practice in minority serving institutions to promote student engagement and experiential learning of interdisciplinary models of stress and health.

Despite the increased availability of health technologies for public use, several factors need to be considered before promoting instructor implementation and evaluation of these technologies in the classroom. Three primary considerations are related to cost, time, and training to support instructors’ efforts to redesign their courses. It is recommended that higher education institutions offer funding mechanisms and professional development opportunities to provide the infrastructure needed for instructors to implement these technologies in their courses. For the ‘Psychology of Stress’ class, release time from one course was provided as part of a federally-funded campus initiative for faculty to have the time needed to redesign their curriculum. Despite the available release time, no funding was available to purchase the equipment needed, which is often cited by instructors as a primary barrier to implementing technology in their classes (Bower et al., 2016). To address this barrier, institutions can help to connect faculty across different departments (e.g., Psychology, Biomedical Engineering, Health Sciences) to share low-cost alternatives to the equipment, training, and knowledge required for instructors to redesign their courses. This form of institutional support can result in the creation of long-term interdisciplinary collaborations, joint projects, and campus community that optimize the educational experiences and academic outcomes for students.

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Karissa Miller, PhD. Dr. Miller is an Assistant Professor in the Department of Psychology at California State University, Long Beach. Her research focuses on the psychosocial determinants of cardiovascular disease (CVD) risk, with a particular emphasis on the pathways (endocrine, autonomic) through which health disparities in CVD may arise. She is particularly interested in threat appraisal and examining how individual differences in attention to threat might contribute to socio-demographic health disparities. She has taught undergraduate courses in Health Psychology, Psychology of Stress, and Research Methods, as well as graduate seminars in Health Behavior Interventions and Research Methods.

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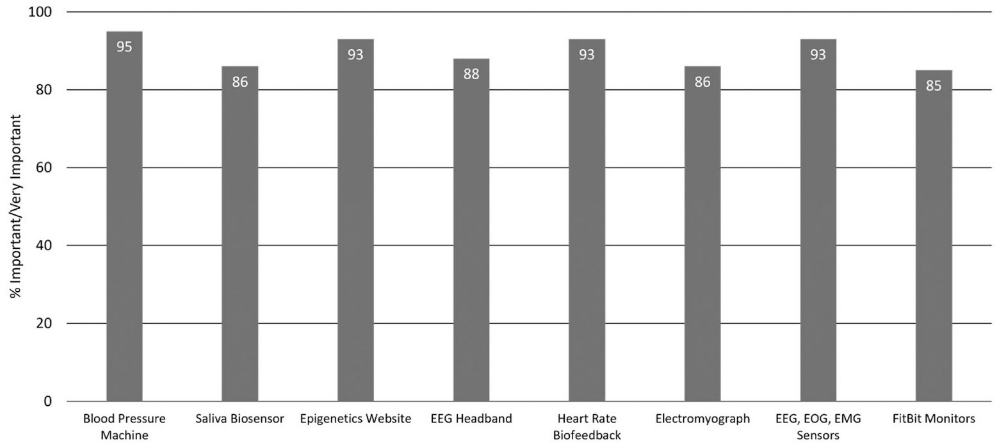

Figure 1.
Importance of Each Research Methodology/Technology in Helping Students Learn Class Topics.

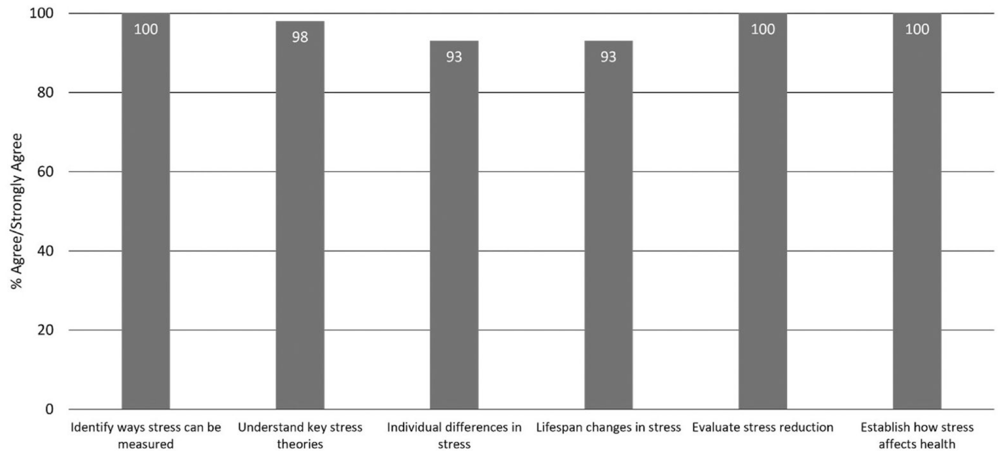

Figure 2.
Extent to Which Students Agree that Course Objectives/Learning Outcomes were Met.

Table 1.

Syllabus with Course Objectives & Topics Covered, ‘Psychology of Stress’, Spring 2020.

Course Objective 1: Recognize how stress can be measured & identify key theories explaining our stress response
Week 1: Class Overview / Definitions & Sources of Stress
Week 2: Stress Measurement
Week 3: Theoretical Models & Science of Stress
Week 4: Elements of the Stress Response / Controllability
Course Objective 2: Establish how stress affects health & illness through physiological & behavioral mechanisms
Week 5: Stress & Disease / Psychoneuroimmunology
Week 6: Sleep Problems & Management
Week 7: Health Behaviors & Stress
Course Objective 3: Construct arguments addressing individual differences in stress responses across the lifespan
Week 8: Epigenetics & Stress
Week 9: Individual Differences in Stress Responses
Week 10: The Power of Perceptions / Managing Emotions
Week 11: Social Support, Relationships, & Communication
Course Objective 4: Evaluate and report on several empirically based stress reduction strategies
Week 12: Modifying Thoughts / Mindfulness
Week 13: Diaphragmatic Breathing / Guided Imagery
Week 14: Progressive Muscle Relaxation / Autogenic Training
Week 15: Positive Psychology / Complementary & Alternative Medicine

Table 2.

Redesign of 'Psychology of Stress' Course Aims, Strategies, & Class Activities.

Class Topic	Aims	Strategies	Class Activities
Course Objective 1: Recognize how stress can be measured & identify key theories explaining our stress response			
Week 2: Stress Measurement	• Collect baseline stress levels using wearable technologies	• Students assess their resting heart rate & blood pressure; demonstrate stress reactivity	• Use of ambulatory blood pressure machine in response to acute stress
Week 3: Theoretical Models & Science of Stress	• Identify phases of our biological (fight or flight) stress response	• Class demonstration of sympathetic nervous system activity (HPA & SAM axes)	• Use of biosensors to assess alpha amylase to identify diabetes risk
Course Objective 2: Establish how stress affects health & illness through physiological & behavioral mechanisms			
Week 6: Sleep Problems & Management	• Illustrate how chronic stress leads to sleep problems and altered sleep stages	• Class demonstration of how chronic stress affects different sleep measures	• Use of EEG headband and EOG & EMG sensors to assess brain wave activity & eye and muscle movement
Week 7: Health Behaviors & Stress	• Explain how exercise, nutrition, & sleep affect biopsychosocial health outcomes	• Class demonstration of how wearable technologies can assess health behaviors	• Use of accelerometers (Fitbit monitors) to assess exercise and sleep patterns
Course Objective 3: Construct arguments addressing individual differences in stress responses across the lifespan			
Week 8: Epigenetics & Stress	• Understand how stress & health behaviors regulate gene expression	• Students see how a mother rat's nurturing behavior affects their pup's epigenome	• Use of interactive website to show how genes respond to stress and behaviors
Week 10: The Power of Perceptions	• Outline cognitive-appraisal model of coping to explain how individuals' perceptions can increase their health risk	• Class demonstration of how stress may lead to faster brain activity associated with poor health	• Use of EEG headband to compare electrical activity of the brain during stress vs. relaxation
Course Objective 4: Evaluate and report on several empirically based stress reduction strategies			
Week 13: Diaphragmatic Breathing	• Evaluate whether breathing through the diaphragm can improve health outcomes	• Class demonstration of the influence of diaphragmatic breathing on heart rate	• Use of biofeedback equipment (heart rate)
Week 14: Progressive Muscle Relaxation	• Describe how the central nervous system stimulates the motor unit during stress	• Class demonstration of how muscle fibers contract from electrical brain impulses	• Use of electromyograph to show how muscle fibers contract and relax