

PROJECT TITLE:

Wear it, Track it, Learn it: The Use of Wearable Devices to Support Healthy Behaviors and Active Learning of Physiological Concepts for Undergraduates in the Biomedical Physiology Program

PROJECT ABSTRACT:

To support future medical and healthcare providers in digital health literacy, as well as to foster self-awareness of personal health and well-being through lessons in physiology, the University of Georgia's new undergraduate major in Biomedical Physiology proposes to innovate our curriculum to include the use of wearable technology to learn physiological concepts in lecture and laboratory coursework. **This proposal focuses acquiring the technology required to monitor the physiological metrics of students, enhancing students' awareness of their physiology and how it affects their learning outcomes. In addition, this proposal will support the development of *scalable* and *affordable* options for wearable devices to be implemented in large classrooms based on individual- and team-based classes.**

PROJECT DESCRIPTION

What does the future of healthcare look like? The use of wearable devices can monitor of activity, sleep, and other out-of-clinic factors that can support in-clinic care (Dunn et al., 2018). Wearable devices have been shown to track and monitor a range of physiological variables associated with learning, from heart-rate variability (HRV) to electrodermal activity to movement (Liu et al., 2022). Physiological variables detected by wearable devices can be interpreted to infer emotional states, such as physiological arousal for emotions like fear and stress (Horvers et al., 2021). **Given what wearables reveal about physiology, our project aims to enhance student learning in a significant way through their novel use in classroom teaching and active learning.**

Wearables support healthy behaviors but are too expensive.

For college students, like the general population of users, wearable devices primarily monitor weight, activity, and sleep; however, the benefits of wearable technology have been documented for monitoring both physical and mental health. In one study, the vast majority of college student participants who used wearable technology (over 70%, $n = 146$) reported “that using the device took positive effects on their physical activity,” and nearly half reported that wearing the device actually increased their physical activity (Ráthonyi et al., 2019). In addition to physical activity, wearable sensors have been used to predict depressive episodes in college students with nearly 70% precision (Wang et al., 2018), suggesting that this could complement existing interventions in student care and outreach. While these previous studies have noted the value of wearable devices in supporting healthy behaviors in college students, non-users of wearable devices cited the primary factor limiting their broader adoption is that they are expensive (Kinney et al., 2019). **Therefore, wearable devices can support healthy behaviors, and there is a need for affordable options to make wearable technologies accessible for college students.**

Wearables support learning through somatically informed instructional design.

Our team is aware that simply having the technology available will not be sufficient to change behaviors. For instance, one study observed null effects for students who simply wore wearable devices relative to a control group participating in a credit-based physical activity instructional program (Kim et al., 2018). Meanwhile, leading edge research suggests that using wearables *in conjunction with* a curricular modules focused on their use can have positive outcomes. In a pre-print, Castro et al. (2022) studied the use of wearable devices to support physiology education and self-care. Students not only demonstrated integration of physiological concepts but also reported healthier habits (Castro et al., 2022). There is also work reviewing the process of curricular development with wearables through the process of “somatically informed instructional design” (Rajko, 2019). **Thus, we aim to intentionally integrate wearable devices as a learning technology tied to physiology course modules to foster self-awareness, healthy behaviors, and the instruction of abstract physiological concepts.**

From an in-class assessment, the vast majority of students agreed that wearables would support their learning.

To better understand student perspectives on using wearable, we gave a short assessment in the class we intend to design the project to serve (VPHY 3100/3107). 37 students responded to the survey. **95% agreed with the statement: “If the course covered the expense of a wearable device for the semester, I would be excited to wear one during class.”**

Over half ($n = 21/37$, 57%) responded “Yes” to the prompt “*I have a wearable device monitoring aspects of my activity and health.*” The majority (66%) made connections between lessons in class and data output from their wearables as described in open-ended responses:

*“I wear an Apple Watch nightly and sometimes daily for the purpose of evaluating my sleep and tracking my health while working out. I use **this data to evaluate the quality of my sleep and my cardiovascular health.**”*

“...after taking this course, I am more conscious about my health data.”

“I found connections between its output and what we learn in class.”

We were also curious what students who did *not* use wearable devices thought about using them to learn physiological concepts and what concerns they might have. Of the 16/37 students who reportedly did not use wearable devices, 100% ($n = 16/16$) agreed with the prompt “*Wearable devices can be a useful tool for learning physiology.*” Several open-ended responses from the people who did not use wearables felt that using them would support their learning:

*“I think using wearable devices would be an interesting hands-on approach to learning physiology. A lot of people, including myself, learn best kinesthetically, and so **being able to monitor one’s own health and seeing how bodily functions work through this perspective would help students grasp concepts.**”*

*“I think wearable devices **would be helpful in the cardiovascular system especially on the topics of blood pressure.** I currently don’t own one and would not use one unless someone bought one for me.”*

*“Wearing a device would be helpful for **making the content that we learn in class directly applicable to our lives.**”*

Our design process will take every precaution in ensuring student consent at each step of the development (for the engineering capstone students) and implementation (for the physiology students who opt into participating). For the engineering capstone students, we will mentor students to complete required CITI training for human subjects research and work closely with IRB to develop a data management plan that protects all users of these wearable devices. We believe this process is an essential component of learning the ethical ramifications of these technologies and to professionally develop future engineers as ethically-minded practitioners. For the physiology students, we will ensure students have alternative assignments available and minimize risk or coercion. **To ensure an inclusive and supportive environment, students who opt into using wearables to learn physiological concepts will be able to, and students who opt out will have an equivalent alternative learning assignment available (e.g., looking at generic data from wearable devices).**

Importance of project to unit and University goals

We have designed our project “*Wear it, Track it, Learn it*” to align and amplify the goals put forth in UGA’s Quality Enhancement Plan (QEP) on Active Learning, UGA’s Diversity, Equity and Inclusive Excellence Plan, and the University of Georgia 2020 Strategic Plan.

UGA’s Quality Enhancement Plan (QEP) on Active Learning

The ambitious plan to promote active learning across the campus can be supported through quality assessment. To complement the efforts of the Center for Teaching and Learning (CTL), and the teaching evaluation reform put forth by the DeLTA Project (see Krishnan et al., 2022), wearable devices can offer in-classroom measurements of student engagement and physiological arousal conducive to learning, monitor shifts over time and across lesson plans and activity types, and inform curricular and pedagogical reform. However, this vision could only be accomplished with the development of scalable and affordable model of wearable devices for large-enrollment classrooms.

UGA’s Diversity, Equity and Inclusive Excellence Plan

In alignment with Priority #1 to Building an inclusive living/learning environment that supports access and success for diverse students, we aim to make wearable devices an affordable option for students who would like to wear them. This vision aligns specifically with *Goal 1.3: Expand resources to promote inclusive learning environments*. Given the limitation shared by non-users that wearables were too expensive (Kinney et al., 2019), our design will be in service of broadening accessibility of this technology to support healthy behaviors and active learning.

University of Georgia 2020 Strategic Plan

Wearable devices offer an opportunity for integrative and applied learning to advance UGA’s first strategic direction: **Building on Excellence in Undergraduate Education**, specifically to support integrative and applied learning strategies in the classroom and beyond.

Specific courses benefiting from the project

At this stage, the direct beneficiaries of the Learning Technology Grant will be undergraduate students enrolled in the year-long (two semester) program of engineering Capstone Design courses and a subset who participate in the Essentials of Physiology (see Table 1, next page).

The Industry Capstone Projects Coordinator, Dr. Jorge Ivan Rodriguez, is the co-director of this proposal. We anticipate a team of 4-5 undergraduate students will need support for purchasing materials and piloting software, as well as funding to support mentorship from advanced undergraduate students in the UGA CREATE team. The course we envision integrating wearable devices to support the learning of physiological concepts is VPHY 3100/3107. Co-instructors of this course - Dr. Karen Wells, Dr. Paul Eubig, and Dr. Dax Ovid (the project director of this proposal) - have been accepted to participate in the highly competitive Active Learning Summer Institute (ALSI) organized by CTL to advance the Active Learning QEP. **The course re-design through ALSI will be amenable to this project proposal and will serve over 300 students per semester.**

Table 1. Overview of courses benefitting from LTG project support.

	Prototype Development	Curriculum Development
Course	Capstone Design MCHE 4910/4911	Essentials of Physiology VPHY 3100/3107
Description	Two-semester sequence that is project-based and focused on problem framing, stakeholder analysis, concept generation, and project management skills. The projects are designed to provide students with a major design experience in mechanical engineering prior to graduation.	The mammalian body as a single functional unit; studies include nervous, muscular, respiratory, circulatory, digestive, renal, endocrine, and reproductive systems. Co-instructors are participating in the Active Learning Summer Institute (ALSI) in summer 2023.
Number of students to benefit from LTG Project	4-5 students in an interdisciplinary and collaborative design team.	120 students who opt into testing wearables with new, proof-of-concept course modules.
Primary Learning Outcomes	Understanding the design process from start-to-finish. Ability to apply discipline specific material to the design of real-world projects. Awareness of professional ethics and responsibility, and safety.	Make connections between personal health and physiological concepts in nervous, muscular, respiratory, and circulatory. Discover ways to consider wearables in the future of healthcare and out-of-clinic care.

Anticipated overall impact

UGA is primed to support active learning with the recent QEP. Current scalable options for instructors to gain real-time input on student engagement are limited to self-reported surveys and personal observations. Multimodal designs are more accurate than any one strategy alone (Horvers et al., 2021). Wearables could contribute to this landscape by offering continuous monitoring of physiological arousal to support best practices in active learning. If we succeed in developing a scalable and affordable model, this project has the potential to contribute to a campus-wide endeavor. Wearables offer opportunities for students *across disciplines* to engage with the same learning technology, which can build an interdisciplinary community and shared experiences for digital health.

MEASURES OF SUCCESS

This proposal focuses on supporting undergraduate students in two courses: the engineering capstone design project I/II(MCHE 4910-1) and introductory physiology (VPHY 3100/3107).

Undergraduate students in MCHE 4910-1 will be supported in developing a scalable and affordable prototype for a wearable device that can be used in classrooms. The Learning Outcomes for MCHE 4910-1 correspond to the Accreditation Board for Engineering and Technology (ABET) Outcome shown in brackets:

- Understanding the design process from start-to-finish process [1, 2, 5, 6]
- Ability to apply discipline specific material to the design of real-world projects [1, 2, 6]
- Ability to identify and acquire new knowledge as a part of the problem-solving/design process [7]
- Awareness of the stakeholders, design reviews, standards & project management [2, 3]
- Ability to function on multidisciplinary teams and an appreciation for the contributions from individuals from multiple disciplines [5]
- Ability to communicate effectively with widely-varying backgrounds [5, 2]
- Awareness of professional ethics and responsibility, and safety [4]
- Appreciation of the role that their discipline can play in social, economic, and sustainability contexts [2]

Learning Outcomes for MCHE 4910-1 will be assessed through progress reports, project proposal, design notebook, final report and presentations, as well as the usability and cost of the final product. Because wearables are constantly upgraded and often cost prohibitive, we anticipate students will be able to develop a “bare bones” prototype that will (1) work sufficiently well and (2) be affordable for wide-scale adoption in physiology courses.

The undergraduate students in VPHY 3100/3107 will be supported in learning physiological concepts with widely-available but more expensive models of wearable devices. The Learning Outcomes for VPHY 3100/3107 will be revised following the revamp from the Active Learning Summer Institute (ALSI) in summer 2023. We anticipate our Learning Outcomes in using wearable devices in learning physiological concepts align with core concepts in physiology (Michael & McFarland, 2020), specifically topics related to (1) Homeostasis, (2) Physical Properties of Matter, (3) Scientific Reasoning, and (4) Systems Integration. The measures of success for the course modules and student experience with wearables will be assessed through surveys. Impact on learning can be assessed through (1) the course level exams and/or (2) the program-wide assessment protocol developed by the Human Anatomy and Physiology Society (HAPS). Impact on students’ perceptions of the learning experience can be assessed through surveys (as we conducted for a simple needs-assessment for the proposal). The project director is a Discipline-Based Education Researcher and has experience in survey development and validation. 3 undergraduate students who have completed VPHY 3100/3107 will be invited to contribute on a curriculum design team to develop modules using wearable devices. 7 students have already shared their contact information with the project director and will be interviewed to ensure there are diverse perspectives on the curriculum design team.

Beyond our immediate context, we envision publishing the lesson plans and course modules for using wearables in physiology courses for instruction through the peer-reviewed journal *Course Source*. The director of the project (Dax Ovid) is currently on the team developing the learning

framework for this journal and will be well-equipped to contribute. The undergraduate course design team would be co-authors on this published lesson plan, building professional experience in evidence-based curriculum development.

STATEMENT OF UNIT-LEVEL SUPPORT

The Department Head of Physiology and Pharmacology, Dr. Gaylen Edwards, is aware of and fully supports this project and our efforts in revamping VPHY 3100/3107 through CTL's Active Learning Summer Institute (ALSI). Laboratory and office space is provided for students to work on their capstone project.

The College of Engineering has successfully expanded the Capstone Design Program to support eight undergraduate degree programs. Students can apply for \$700 project funding. The College's Experiential Learning Labs (the Fab Labs, excluding the Machine Shop student area) are accessible 24/7 for students who complete the required training. Specialized equipment in the engineering machine shop is available for students under appointment request and the appropriate staff supervision.

PERSONNEL CONTRIBUTIONS

Dr. Dax Ovid (Assistant Professor, Department of Physiology and Pharmacology, dax@uga.edu) will serve as the project director and will play a significant role in the project development and implementation. Specifically, Dr. Ovid will supervise and mentor the capstone project team, guide the Center for Research Engineering And Technology Exploration (CREATE) team, and will develop and assess the accompanying course modules to integrate physiological concepts and active learning with wearables.

Dr. Jorge Ivan Rodriguez (Industry Capstone Projects Coordinator/Instructor, College of Engineering, jorger@uga.edu) will act as the co-director. In his capacity as the project coordinator, Dr. Rodriguez will support the capstone engineering students in project design and development of the prototype over the course of the LTG Project.

There will be a team of 4-5 undergraduates in the team for the engineering capstone project. Additionally, Dr. Ovid has 7 undergraduates who are currently enrolled in VPHY 3100/3107 and expressed interest in collaborating to develop course modules, emphasizing physiological concepts in relation to wearables. Lastly, the CREATE team has 3 advanced undergraduates and 1 research engineer who will mentor the team for the engineering capstone project and see the project through to completion.

BUDGET JUSTIFICATION

To develop the course modules and proof-of-concept, we propose to purchase **120 wearable devices to use in class and pilot curricular modules using wearable devices to connect self-reflection, self-awareness, and physiological core concepts**. A research-grade and somewhat affordable option we found was Garmin vivosmart 4, which can collect accurate interbeat interval data with its PPG sensor as well as “all-day stress tracking, relaxation breathing timer, VO2 max, and Body Battery™ energy monitor” (from product website). These

devices will allow us to understand which measures are most relevant for a classroom setting and for teaching physiological concepts. In the case that interest to opt-into using wearables exceeds 120 students, we will prioritize students who do NOT have access to or currently use a wearable device.

Additionally, LTG will support undergraduates who are involved in either (1) the physiology student curriculum design team to develop the lesson plans for VPHY 3100/3107 or (2) the capstone project team of engineering students, who will develop and test a prototype of a more affordable wearable device that can be used in classrooms. LTG would greatly support this work by providing funding for the CREATE Team and capstone student support for purchasing materials.

We are invested in making this project happen with support from LTG. The faculty mentors Drs. Ovid and Rodriguez have included time in the budget, along with funds to support 2 of the 3 undergraduate physiology students in the curriculum team through Dr. Ovid's start-up funds.

In total, we request \$24,950 to purchase hardware and to support undergraduate students in developing curriculum and engineer a wearable prototype in the coming academic year.

BUDGET

Item	Quantity	Total Cost	\$ Requested from LTG	\$ Provided by other sources
Wearable Devices (Garmin vivosmart 4)	120	\$15,600	\$15,600	\$ -
Undergraduate physiology student curriculum design team (5hrs/week, \$13/hr, 15 weeks per semester, 2 semesters = \$1,950)	3	\$5,850	\$1,950	\$3,900
CREATE Team (\$20/hr, 10hr/wk, 12 weeks)	1	\$2,400	\$2,400	\$ -
Capstone Support (a multidisciplinary) team of 4-5 undergraduate students with engineering faculty mentorship),	1	\$5,000	\$5,000	\$ -
Faculty Mentor (Ovid, 1.5 months)	1	\$13,125	\$ -	\$13,125
Faculty Mentor (Rodriguez, 0.75 mo)	1	\$6,250	\$ -	\$6,250
			\$24,950	\$23,275

TIMELINE

Year Month	Objective or Goal	Course(s) Involved
2023 July - August	Develop modules on physiological concepts and wearable devices for students who opt in and opt out of using wearables in class.	VPHY 3100/3107
2023 September - December	Students in engineering capstone design program will conduct review of literature on wearables in classroom settings and identify possible models, begin design phase (under mentorship of directors).	MCHE 4910
2023 September	Invite student participants to use Garmin wearable devices (prioritizing Biomedical Physiology majors).	VPHY 3100/3107
2023 October	Pilot course modules with Garmin wearables, assess student perceptions and learning outcomes with surveys.	VPHY 3100/3107
2023 November – December	Review pilot assessments and revise course modules based on formative and summative evaluations.	VPHY 3100/3107
2024 January-Ma rch	Work with CREATE team to mentor undergraduate engineering students to develop initial prototypes of affordable wearable devices for classroom use.	MCHE 4911
2024 March	Revise and implement course modules with Garmin wearables, assess student perceptions and learning outcomes with surveys.	VPHY 3100/3107
2024 April	Engineering Capstone Design Showcase presentation of prototypes.	MCHE 4911
2024 April- May	Draft and submit course modules (lesson plans and assessments) to peer-reviewed journal <i>Course Source</i> , present findings on campus and at conferences (e.g., American Physiological Society).	VPHY 3100/3107

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