HAPS Curriculum & Instruction 2022 Laboratory Survey: Laboratory Activities and Learning Outcomes

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Abstract

In early 2022, the Human Anatomy & Physiology Society (HAPS) Curriculum & Instruction Lab Survey subcommittee launched the third survey of instructors for introductory undergraduate-level courses in human anatomy and physiology. This manuscript presents analyses of questions regarding the laboratory activities and learning outcomes (LOs) section of the survey and compares results to the first (2014) and second (2017) offerings of the lab survey. Laboratory instruction continues to be a valued component of anatomy and physiology instruction, although a greater variety of resources are now being used. New questions on curriculum development revealed that respondents utilize many techniques and resources to develop their curricula, though respondents at 2-year institutions report significantly lower levels of influence on their A&P curricula compared to respondents at 4-year institutions. Identification of anatomical structure LOs appeared to be prioritized over LOs for each structure's physiological role. Dissections, plastic model manipulations, use of human subjects for physiological experiments, and use of computer simulations have remained stable across all three surveys, although use of anatomical donors and computer simulations have increased over time. Collectively, we observed respondents developing intentional, outcome-directed changes to laboratory instruction while also being limited by historical practices at their institutions. Results also indicated that the COVID-19 pandemic has increased the speed at which instructors are making long-term curricular changes. https://doi.org/10.21692/haps.2023.018

Key words: anatomy, physiology, education, survey, learning outcomes, laboratory activities, COVID-19

Introduction

Science courses, such as Anatomy and Physiology (A&P), are unique because they require the development of coordinated lecture and lab activities to meet a cohesive set of learning objectives or outcomes (LOs) and goals spanning the duality of lecture and lab components of the course (Beck & Roosa, 2020; Hurtt & Bryant, 2016; McComas, 2005; Peacock et al., 2020). Specifically, several papers have identified the significance of laboratory education for helping students meet expectations of their undergraduate education (Finn et al., 2019; Griff, 2016; Henige, 2011; Hofstein & Lunetta, 1982; McComas, 2005). This significance is coupled with the acknowledged importance of A&P in the curriculum

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of healthcare professionals (Brown et al., 2017; Cheung et al., 2021), and may be the key to building student interest in learning A&P content (Casotti et al., 2008; Griff, 2016; Peacock et al., 2020; Pollock, 2022).

Instructors and curriculum designers with appropriate training and professional development opportunities can easily develop a laboratory curriculum to meet learning goals and objectives at a single campus (Hyson et al., 2021). However, designing laboratory curricula to align across multiple campuses (e.g., within a state's community college system or branch campuses of a single institution) can be more challenging, particularly when there may be little support for professional development opportunities and instructional philosophies vary across institutions. The Human Anatomy and Physiology Society (HAPS) has previously reported on efforts to document alignment among faculty toward a select few common learning goals in A&P courses (Brashinger, 2017).

To further assist in the commonality of educational goals, members of the Curriculum and Instruction Committee of HAPS undertook efforts in 1992 to codify a set of learning goals and outcomes that would be regularly updated, and that instructors at any institute of higher education could use to develop curricula that promote student success in A&P (Human Anatomy & Physiology Society, 2019). This effort aligned with those from other educators and researchers developing commonalities for teaching topics related to anatomical structures, common themes across topics, and the overall role of the laboratory experience in A&P instruction (Griff, 2016; Hull et al., 2017; Michael & McFarland, 2020). Together, these efforts indicate a desire to have a generalized guide on the essential components of an undergraduate A&P laboratory course, curricular objectives, and key activities. The goals from a generalized guide, however, can only be achieved when an individual instructor's ability to teach and instill a desire for learning the content are coupled with the students' intrinsic desire to learn (Finn et al., 2019; Hurtt & Bryant, 2016; Hyson et al., 2021).

Student-focused and outcome-driven education requires that students are prioritized along with learning activities designed to reach the desired outcomes. According to Whetten (2007), we are in the midst of an unfolding paradigm shift in higher education, from focusing on teaching to focusing on learning. One form of the learner-centered method of curriculum design is backward design which requires that educators determine what outcomes they want students to achieve and then carefully design the curriculum to include evidence-based course activities that allow them to work toward meeting the predetermined goals. In the backward design approach, attention is focused on the learner in the instructional design process, with the end-goal being deep understanding and lasting change (Tornwall, 2017). For backward design to be effective, educators must identify desired results, analyze multiple sources of data, and determine an appropriate action plan (McTighe & Thomas, 2003). Backward design also helps educators strategically plan activities that match learning outcomes to competency requirements and ensures that student knowledge reflects current practice (Maldonado, 2022). Additionally, backward design increases faculty accountability and relies on instructors to select assignments that measure student ability to meet learning objectives rather than solely assessing content knowledge (Martin et al., 2019).

The role of the educator within an institution can affect their academic freedom and ability to influence the curriculum. In a decentralized model of course design, the individual instructor is responsible for the design, update, and revision of the courses they teach whereas in a centralized course design model, a single set of course materials imposed at the college, department, or program level is used (Felber, 2021). In the centralized model, full-time faculty are responsible for determining course objectives, developing the curriculum and course materials, as well as updating the courses, while adjunct faculty members are limited to teaching the designed courses. Whereas full-time faculty members are usually salaried tenure or non-tenure track faculty hired by the institution, adjunct faculty members are employed on an as-needed basis and are expected to teach without the added responsibility of curriculum development, committee work, and scholarship. Part-time faculty might also be unable to participate in institutional activities, governance, student advising, curriculum development, and course content (Moorehead et al., 2015).

It is not always clear what should be used as the marker for a student's success, and this can even be more challenging in A&P courses where successful completion of the course(s) with a specific grade is required for entrance into multiple professional degree programs. In the past, a degree used to be indicative of a level of knowledge and intellectual ability as well as a passport to employment, but that may no longer be the case due to organizational changes and increased numbers of graduates (McPhee & D'Esposito, 2018). As such, success is now measured based on the ability of students to secure gainful employment *after* graduation. Assessments should therefore confirm students' learning ***and*** their ability to meet requirements necessary for employment. Increased administrative interest in assessments that compare student success rates across institutions has also resulted in increasing federal pressure on colleges to demonstrate their effectiveness (Braun, 2019). The individual A&P educator must weigh all these concerns and evaluate potential success by utilizing a combination of formative and summative assessments to determine student understanding of course content and achievement of learning objectives (Braun, 2019).

One way to achieve this goal is by careful selection and implementation of learning activities that will help students successfully master content knowledge and the skills

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necessary for excellence as healthcare professionals (Beck & Roosa, 2020; Brown et al., 2017; Casotti et al., 2008; McComas, 2005; McDaniel & Daday, 2017; Peacock et al., 2020; Zarifnejad et al., 2018). This effort starts by evaluating and including activities and techniques that seem ubiquitously used or have been shown to effectively build skills, foster student engagement, and improve mastery of A&P content (Beck & Roosa, 2020; Brashinger, 2017; Brown et al., 2017; Hurtt & Bryant, 2016; Peacock et al., 2020; Pollock, 2022; Price, 2020). Evaluation should also include the expectations for learning by the students, along with an examination of access to technologies within and outside the classroom (Cheung et al., 2021; Harrison et al., 2001; McDaniel & Daday, 2017; Persinger et al., 2021; Pollock, 2022; Stokes & Silverthorn, 2021). The latter point is essentially important given the implications of changing educational settings following the haphazard responses in public health to the COVID-19 pandemic of March 2020 through present day (Harmon et al., 2021; Stokes & Silverthorn, 2021).

Once activities have been identified, the next step is alignment of the lab curriculum with learning goals, objectives, and outcomes. This fundamental approach to course design is similar to what is seen in elementary and secondary education (Beck & Roosa, 2020; Griff, 2016; Hurtt & Bryant, 2016). This approach may be limited, however, without the professional development necessary to ensure proper alignment and control of curriculum development, or lack of student buy-in to the educational experience (Beck & Roosa, 2020; Finn et al., 2019; Hurtt & Bryant, 2016; Hyson et al., 2021; Peacock et al., 2020; Persinger et al., 2021; Pollock, 2022).

Alignment of learning outcomes, activities, and assessments is considered best practice in instructional design (Dick et al., 2001; Gronlund & Brookhart, 2009; Krathwohl, 2002). As such, we intend to evaluate what changes have occurred over the last decade in the development and alignment of undergraduate anatomy and physiology laboratory curricula. We will also assess how these changes have modified educational practices for the instructor and the institution, the selection of specific learning outcomes, and the choices of activities that students utilize to meet these goals within the laboratory portion of undergraduate anatomy, physiology, and A&P courses.

Materials and Methods

The second part of the HAPS 2022 lab survey contained 19 questions and focused on the learning outcomes, laboratory activities, and resources used by educators. Five of these questions were repeated from the 2013 (Brashinger, 2014a; 2014b) and 2017 (Brashinger, 2017) HAPS lab surveys, and one question new to the 2017 survey was repeated. The 2022 HAPS lab survey obtained Institutional Review Board EXEMPT status under 45 CFR 46.101(b) (#2) by The University of Mississippi's Institutional Review Board (IRB, Protocol #22x-129) in January 2022, and was open for responses from February to August 2022, with the primary period of volunteer respondent recruitment occurring in February, March, and May (Britson et al., 2023). Full details of survey development and revisions are presented in Britson et al. (2023).

Specific courses of interest were expanded, as compared to the two previous surveys (Brashinger, 2014a; 2014b; 2017), to include laboratory instruction for human A&P essentials (1 semester); human A&P I and II (2 semester sequence); human anatomy only (1 semester); human physiology only (1 semester); and histology (1 semester). New questions were developed to focus not only on *what* activities and assessments are used in the laboratory but also *why* we use them. Questions exploring the identification, development, alignment, and selection of laboratory learning outcomes were asked as well as identification of how much influence individual educators have over the activities, assessments, and outcomes used in the courses they teach.

Questions asking about resources used in the laboratory were revised to remove reference to brand names or specific vendors and to add a description of the resource. This revision will benefit readers by removing the potential for bias for or against a brand or vendor and will enable the questions to be used in future surveys without the need for revision. New questions were also added to examine how the practical skill of identifying anatomical structures (Human Anatomy & Physiology Society, 2019) was assessed through the use of laboratory practical examinations. Since responses to part 1 (demographics) of the 2022 lab survey (Britson et al., 2023) are linked to parts 2 (activities and learning outcomes) and 3 (instruction during the COVID-19 pandemic) by respondent, we were also able to compare responses about lab activities and learning outcomes to demographic data. Frequency data and descriptive statistics were calculated for all survey questions. All statistical tests (e.g., t-tests, ANOVAs) were conducted using SPSSV27 software licensed to the University of Mississippi.

Results

There was a total of 176 responses to this survey (Britson et al., 2023), 105 responses to the 2013 survey (Brashinger 2014b), and 567 responses to the 2017 survey (Brashinger 2017).

Laboratory Priorities and Purposes

While there appeared to be a decrease in certainty about the stability of the future importance or prevalence of laboratory activities as compared to previous survey responses (Figure 1), there was no significant difference between the frequency of responses from 2017 and 2022 ($t = 4.9 \times 10^{-16}$; $df = 3$; $p = 3.182$). Frequency values for the 2022 response "unsure" were not entered into the paired, two-tailed t-test as it was not a response option in 2017. Respondents viewed

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laboratory curriculum and activities as essential to meet educational requirements for their program or degree (Table 1). Moreover, there was a general trend wherein laboratory activities and curriculum were seen by respondents as an essential avenue to allow for kinesthetic learning and to provide a means to excite students about topics related to anatomy and physiology. A majority of respondents saw laboratory activities as a means to expose students to a diversity of viewpoints and to new information as well as an avenue to support the development of critical thinking skills, along with reinforcing information covered in the lecture component of the A&P course (Table 2), particularly the interrelationship of structure and function. There was limited agreement on laboratory activities being essential for developing other skills necessary for the future goals of many students (i.e., ability to work in groups, understanding the clinical application of information, developing skills for scientific investigation).

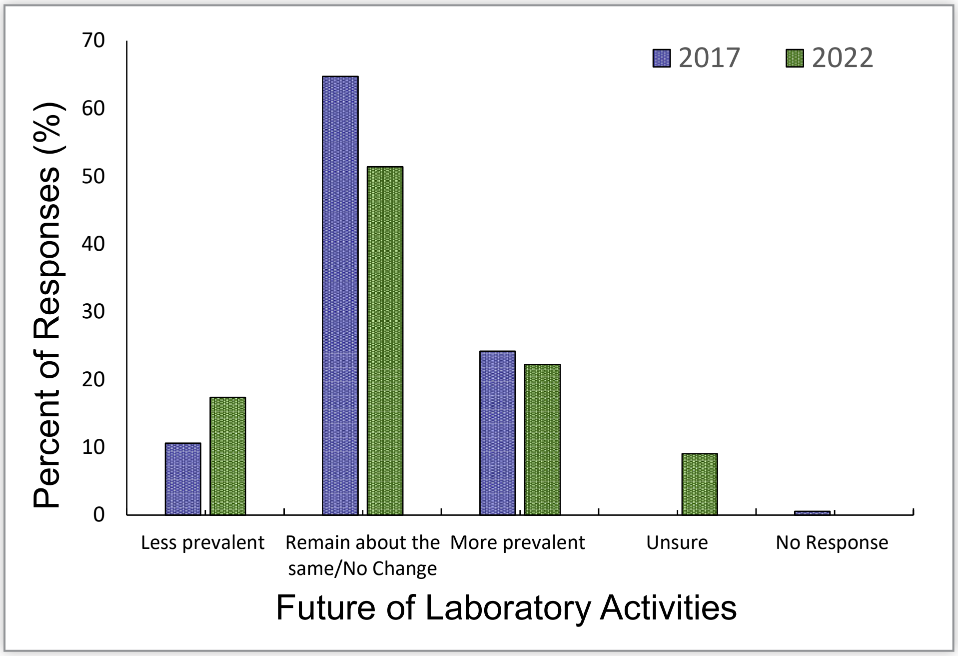

Figure 1. *Percent of survey responses from 2017 and 2022 when asked to choose the option that best answers the following question: Given the financial, space, and other priorities at your institution, do you expect in-person anatomy and physiology laboratory activities to become more or less prevalent in the next ten years?*

	Not a purpose of the lab experience	Has a purpose, but not essential to the lab experience	Absolutely essential to the lab experience
Meet program objectives/requirements	2 (1.12)	31 (17.4)	132 (74.2)
Meet degree objectives/requirements	7 (3.93)	47 (26.4)	111 (62.4)
Meet transfer objectives/requirements	29 (16.3)	48 (27.0)	85 (47.8)
Engage with students (e.g., student-instructor interactions)	4 (2.25)	33 (18.6)	127 (71.3)
Student engagement and student-student interactions	1 (0.56)	37 (20.8)	126 (70.8)
Excite students about A&P	4 (2.25)	56 (31.5)	102 (57.3)
Provide Tactile/kinesthetic learning opportunities	2 (1.12)	25 (14.0)	137 (77.0)
Expose students to new information or viewpoints	14 (7.87)	65 (36.5)	85 (47.8)

Table 1. *Frequency and percent of total responses (in parentheses) to the following survey question: "Using the scale provided, please rate your impression of the following PURPOSES of the A&P Laboratory experience.*

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	Not a purpose of the lab experience	Has a purpose, but not essential to the lab experience	Absolutely essential to the lab experience
Develop critical thinking skills	1 (0.56)	42 (23.6)	123 (69.1)
Develop scientific inquiry skills	8 (4.49)	72 (40.5)	85 (47.8)
Develop scientific laboratory skills	15 (8.43)	65 (36.5)	84 (47.2)
Develop literature research skills	75 (42.1)	70 (39.3)	20 (11.2)
Learn new content prior to lecture	44 (24.7)	81 (45.5)	38 (21.4)
Reinforce understanding of lecture content	0 (0)	27 (15.2)	138 (77.5)
Understand the interaction of structure and function	1 (0.56)	25 (14.0)	138 (14.0)
Understand the clinical application of information	12 (6.74)	85 (47.8)	66 (37.1)
Develop "soft skills" and ability to work in groups	5 (2.80)	73 (41.0)	87 (48.9)

Table 2. *Frequency and percent of total responses (in parentheses) to the following survey question: "Using the scale provided, please rate your impression of the following PRIORITIES of the A&P Laboratory experience."*

Laboratory Curriculum Development

A majority of the respondents indicated they are using a more holistic approach to developing a laboratory curriculum based on learning objectives that focus on a combination of backward design and course blueprinting along with specification grading (Figure 2). Additionally, a majority of the respondents indicated having at least some influence on the development of the curriculum at their institution (Figure 3). At the same time, a minority of respondents (10%) indicated that the curriculum and learning outcomes/objectives are given to them to follow, while another subset of the respondents indicated that there are no curriculum learning outcomes for laboratory education around which they could plan a curriculum.

A majority of respondents indicated that learning objectives used for developing the laboratory curriculum came from within the department (25%) or the institution (32%; Figure 4). There was no significant difference in the level of influence on learning outcomes ($F = 2.059$; $df = 6{,}157$; $p = 0.061$) due to job status (e.g., full-time, part-time, permanent, etc.), but there was a significant difference in the level of influence on learning outcomes ($F = 4.852$; $df = 4{,}159$; $p < 0.001$) due to institution type (e.g., 2-year institution, 4-year institution, etc.). Respondents at 2-year institutions reported a significantly lower level of influence as compared to respondents at 4-year institutions with or without a graduate program.

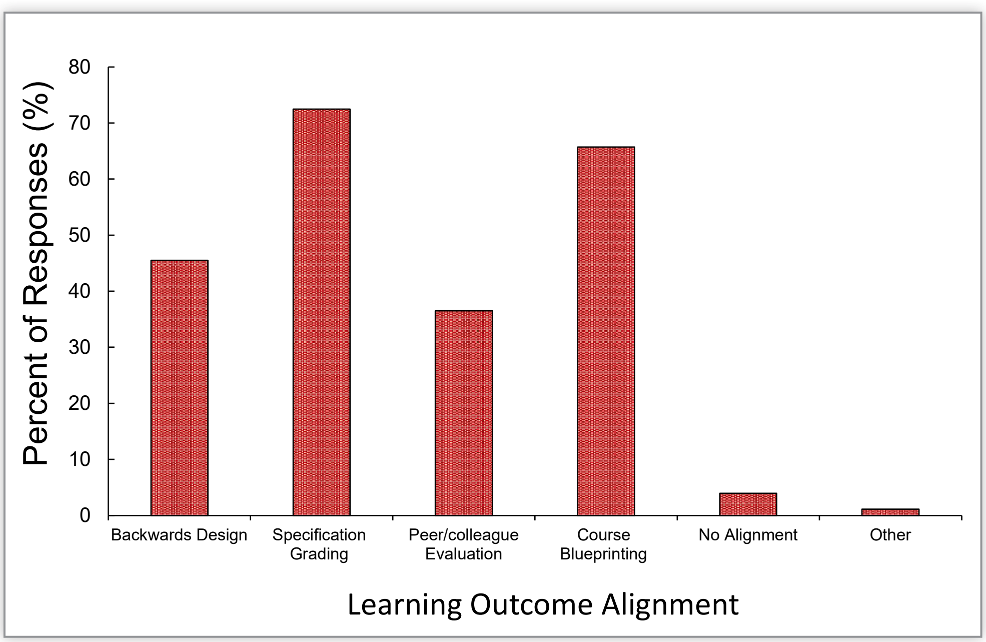

Figure 2. *Percent responses to the question, "How do you align the purposes and priorities listed with your laboratory learning outcomes? SELECT ALL THAT APPLY." Backward Design refers to designing a curriculum by setting goals before choosing instructional methods and assessments. Specification Grading is when students are able to repeatedly attempt assignment/assessment until a recognized standard has been achieved. Course Blueprinting refers to holistic mapping of all aspects of teaching and learning for a course.*

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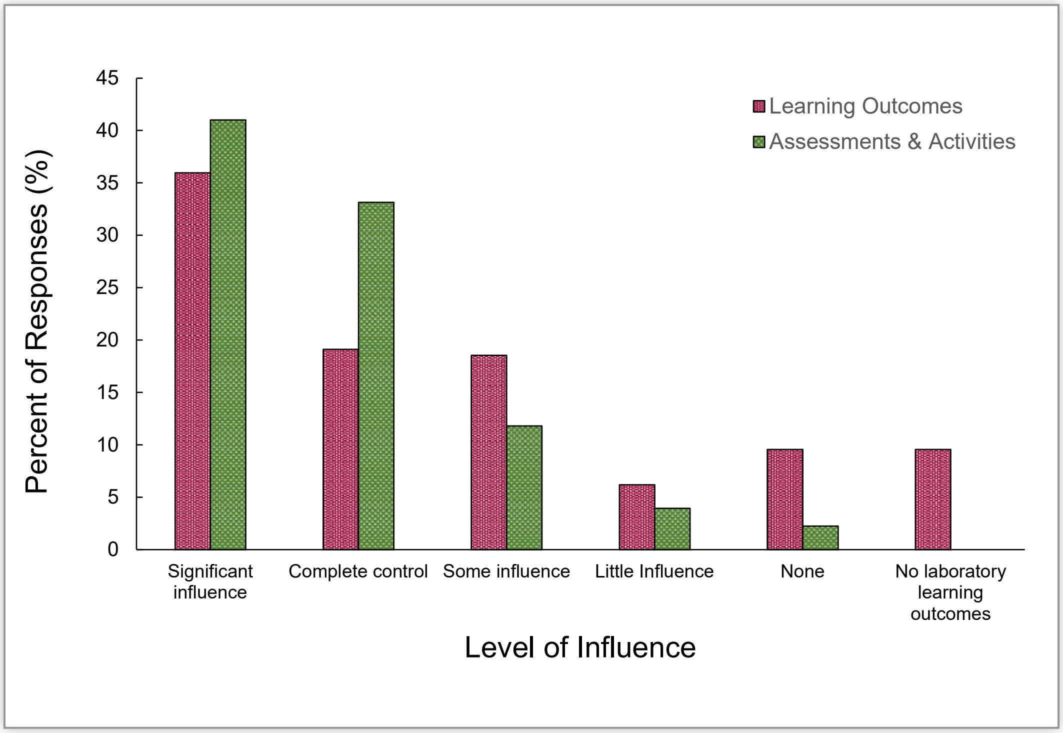

Figure 3. *Percent of survey responses for how much influence respondents have over the learning outcomes and activities and assessments in their course. For Significant Influence, respondents generate the learning outcomes, activities, and assessments but receive assistance and contributions from others. Complete Control refers to respondents' control over the learning outcomes, activities, and assessments. In Some Influence, respondents contribute to the development of the learning outcomes, activities, and assessments. In Little Influence, respondents contribute at a minimal level to the development of the learning outcomes, activities, and assessments.*

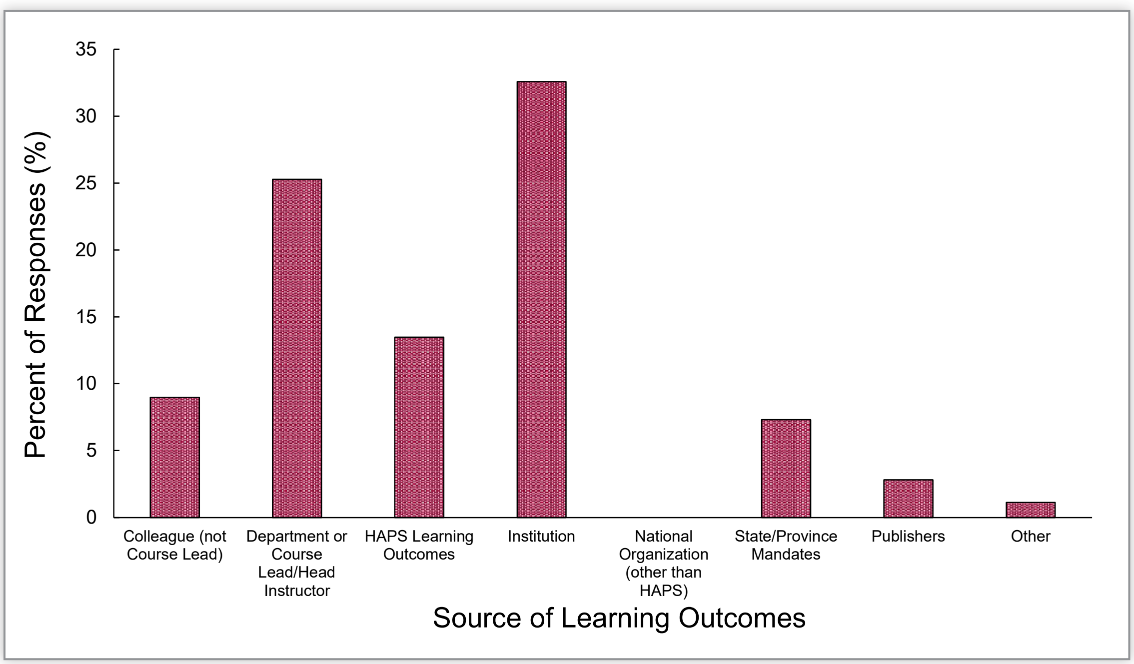

Figure 4. *Percent of survey responses to the question, "If your course's laboratory learning outcomes are provided to you, where do they come from? SELECT ALL THAT APPLY." Institution may refer to a single institution or group under a single administrative structure.*

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As seen in Table 3, the primary focus of the laboratory curriculum appears to be oriented toward HAPS learning goals 1 and 3, use of appropriate terminology, and identification of structures and functions, respectively. There is a lesser emphasis on explaining how systems maintain homeostasis, recognizing patterns of unification across systems, and applying knowledge to real world situations, HAPS learning goals 4, 8 and 7, respectively, with the least important goal appearing to be the ability to apply literacy skills to evaluate peer-reviewed resources (HAPS learning goal 10).

	Not Important	Somewhat Important	Important	Very Important and Essential
Use appropriate terminology to discuss anatomy and physiology.	1 (0.56)	6 (3.37)	20 (11.2)	133 (74.7)
Use appropriate laboratory tools and techniques to examine anatomical structures or physiological functions.	9 (5.06)	33 (18.5)	54 (30.3)	68 (38.2)
Identify anatomical structures and describe the complex interrelationships between structure and function.	3 (1.68)	4 (2.25)	27 (15.2)	127 (71.3)
Explain how body systems work together to maintain homeostasis.	6 (3.37)	21 (11.8)	44 (24.7)	86 (48.3)
Explain how variability in the human population produces ranges of values considered "normal" for body parameters.	24 (13.48)	44 (24.7)	64 (36.0)	30 (16.9)
Propose evidence-based hypotheses to explain physiological responses or the functions of anatomical structures.	27 (15.2)	58 (32.6)	43 (24.157)	32 (18.0)
Apply knowledge of anatomy and physiology to real-world situations.	5 (2.81)	31 (17.4)	58 (32.6)	65 (36.5)
Recognize and apply patterns that unify, organize, and simplify the abundant detail of anatomy and physiology.	5 (2.81)	33 (18.5)	58 (32.6)	63 (35.4)
Interpret and draw appropriate conclusions from graphical and other representations of data.	18 (10.1)	44 (24.7)	55 (31.0)	41 (23.0)
Apply information literacy skills to access and evaluate peer-reviewed resources.	56 (31.5)	54 (30.3)	32 (18.0)	17 (9.55)
Approach and examine anatomy and physiology issues from an evidence-based perspective.	29 (16.3)	44 (24.7)	57 (32.0)	29 (16.3)
Adapt information to effectively communicate with different audiences.	38 (21.4)	45 (25.3)	39 (21.9)	37 (20.8)
Recognize that our individual differences (ethnicity, gender, culture, etc.) shape our understanding of anatomy and physiology.	27 (15.2)	51 (28.7)	48 (27.0)	34 (19.1)
Foster respect for individuals across differences within educational and professional settings.	19 (10.7)	32 (18.0)	48 (26.966)	63 (35.4)

Table 3. *Frequency and percent of total responses (in parentheses) to the following survey question: "How important are each of the following HAPS Learning Goals to the development of your lab curriculum and learning outcomes?"*

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Additionally, there are distinct differences in the incorporation of learning objectives between those focused on anatomy and structural identification (Table 4) and those focused on physiology and homeostatic regulation (Table 5). There appears to be a greater emphasis being placed on identification of structures over the physiological role or its association to homeostasis within the laboratory curriculum.

	Incorporated and summatively assessed in lab	Incorporated but only formatively assessed	Incorporated, but not assessed in lab	Not incorporated nor assessed in lab
Use of appropriate anatomical terminology (Module A)	124 (69.7)	13 (7.30)	7 (3.93)	12 (6.74)
Histology (Cytology) (Module C, 7, 10; Module D)	117 (65.7)	14 (7.87)	5 (2.81)	19 (10.7)
Integument (Module E. 2, 3, 4)	102 (57.3)	19 (10.7)	10 (5.62)	21 (11.8)
Skeletal (Module F. 2, 3, 6, 7, 8)	126 (70.8)	13 (7.30)	1 (0.56)	13 (7.30)
Skeletal Muscle (Module G. 3, 7, 8, 9, 10)	126 (70.8)	14 (7.30)	1 (0.56)	13 (7.30)
Nervous System (Module H. 2, 3, 10, 11, 12, 13, 15, 16; Module I. 3, 4, 5, 6, 7)	124 (69.7)	15 (8.43)	1 (0.56)	13 (0.56)
Cardiovascular (Module K. 2, 6, 12, 13)	127 (71.4)	11 (6.18)	1 (0.56)	13 (7.30)
Lymphatic (Module L. 3)	78 (43.8)	22 (12.4)	8 (4.49)	42 (23.6)
Respiratory (Module M. 2)	123 (69.1)	14 (7.87)	2 (1.12)	13 (7.30)
Digestive (Module N. 1, 2, 3, 4, 5, 6, 7, 8, 9,10)	121 (68.0)	15 (8.43)	2 (1.12)	14 (7.87)
Urinary (Module P. 2, 3)	125 (70.2)	11 (6.18)	2 (1.12)	14 (7.87)
Reproductive (Module R. 2, 3, 6)	110 (62.0)	22 (12.4)	5 (2.81)	14 (7.87)

Table 4. *Frequency and percent of total responses (in parentheses) to the following survey question: "Indicate the incorporation and assessment of HAPS Learning Outcomes for anatomical identification of STRUCTURE AND FUNCTION that are generally associated with the development of laboratory curriculum that you are currently using."*

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	Incorporated and summatively assessed in lab	Incorporated but only formatively assessed	Incorporated but not assessed in lab	Not incorporated nor assessed in lab
Osmosis & Tonicity (Module C, 8)	56 (31.5)	21 (11.8)	16 (8.99)	55 (30.9)
Muscle Contraction & Strength (Module G. 5, 6, 8, 9)	52 (29.2)	26 (14.6)	27 (15.2)	43 (15.2)
EMG activity of muscle contraction (Module G. 4, 6)	32 (18.0)	21 (11.8)	23 (12.9)	70 (39.3)
Nerve Conduction Velocity (Module H. 7)	20 (11.2)	16 (8.99)	26 (14.6)	81 (45.5)
Tendon Reflex Response (Module H. 14, 15)	39 (21.9)	34 (19.1)	25 (14.0)	49 (27.5)
Reaction to external stimulus (Module H. 14, 15, 16; Module I. 2)	34 (19.1)	35 (19.7)	25 (14.0)	50 (14.0)
Processing of sensory information (cranial nerve/ special sense tests) (Module I. 4, 5, 6, 8, 9)	59 (33.2)	28 (15.7)	26 (14.6)	33 (18.5)
Heart Rate responses & ECG (Module K. 9, 10, 11)	84 (47.2)	27 (15.2)	12 (6.74)	24 (13.5)
Blood Typing Results (Module K. 5)	97 (54.5)	17 (9.55)	6 (3.37)	26 (14.6)
Blood Pressure Measurements (Module K. 10, 15)	82 (46.1)	28 (15.7)	15 (8.43)	21 (11.8)
Spirometer Measurements (Module M. 4)	77 (11.8)	26 (14.6)	18 (10.1)	26 (14.6)
Digestive Enzyme Activity (Module M. 12)	48 (27.0)	20 (11.2)	16 (8.99)	59 (33.2)
Urinalysis Results (Module P. 4, 8; Module Q 2, 6)	71 (39.9)	24 (13.5)	15 (8.43)	33 (18.5)
Heredity and Reproduction (Module S. 2, 3)	33 (18.5)	16 (8.99)	23 (12.9)	73 (41.0)

Table 5. *Frequency and percent of total responses (in parentheses) to the following survey question: "Indicate the incorporation and assessment of HAPS Learning Outcomes for interpretation of PHYSIOLOGICAL PROCESSES that are generally associated with the development of laboratory curriculum that you are currently using."*

Laboratory Activities

In a question that was new to the 2022 survey, the most common resources used for laboratory instruction for courses that were offered online prior to the COVID-19 pandemic were computer simulations and lab kits (Figure 5). Kits were either designed by the institution or available commercially. Questions that were asked on all three iterations of the HAPS lab survey assessed the use of resources for laboratory instruction in histology, anatomy, and physiology. While there were no statistically significant changes in the frequency of responses across the three surveys ($F = 0.155$; $df = 2,14$; $p = 0.857$), there were notable outcomes. For the first time in the 2022 survey, digital imagery was used more frequently than glass slides in optical microscopy (Figure 6). Computer-based microscopy simulations (e.g., virtual slide boxes) were used more frequently in the 2022 survey than in 2013 or 2017. Though decreasing in use, optical microscopy and print images continued to be common.

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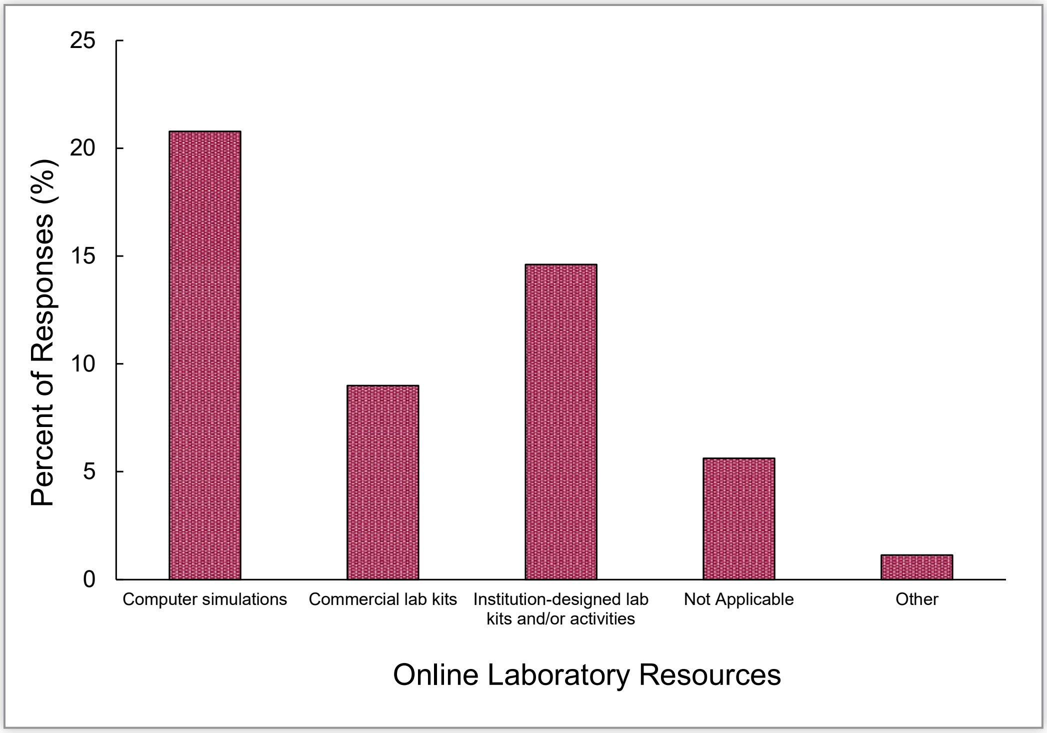

Figure 5. *Resources used for online laboratory instruction for courses that were online before the COVID-19 pandemic.*

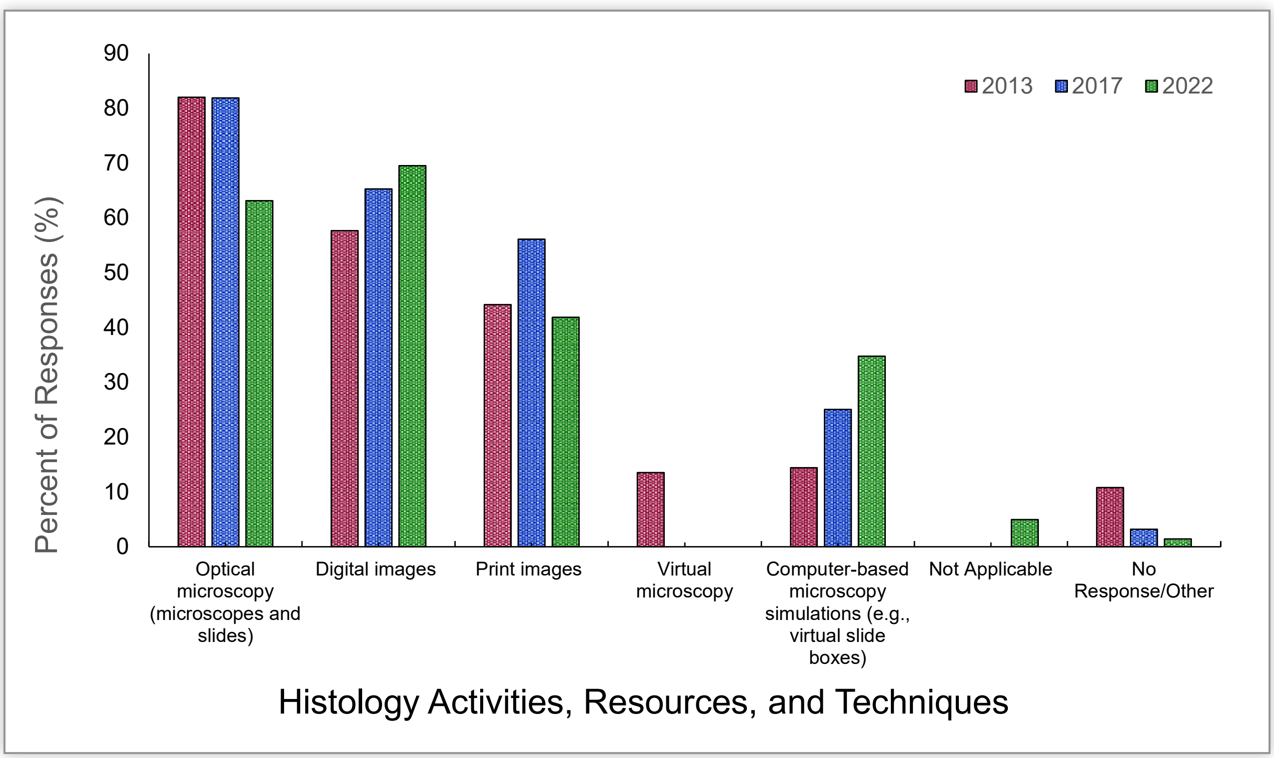

Figure 6*. Activities, resources, and techniques used in the laboratory for the study of histology across three iterations of the HAPS laboratory survey (2013, 2017, and 2022).*

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Preserved organ and preserved whole animal dissections continued to be the most common dissections performed in laboratories across all three surveys (Figure 7). There were no statistically significant changes in the frequency of responses across the three surveys ($F = 0.034$; $df = 2,15$; $p = 0.966$), but use of computer-based dissection has increased in each year the survey has been administered. Organs most commonly used for dissection included the brain, eye, heart, and kidney. Use of these four animal organs was the most frequent across all three surveys, and there were no statistically significant changes in the frequency of responses across the three surveys ($F = 0.457$; $df = 2,35$; $p = 0.636$; Figure 8).

Resources used for human dissection were variable across all three surveys, with anatomical donor dissection increasing from 7.2% and 7.4% in 2013 and 2017, respectively, and to 27.6% in 2022 (Figure 9), though there were no statistically significant changes in the frequency of responses across the three surveys ($F = 0.36$; $df = 2,13$; $p = 0.703$). Use of human subjects for blood pressure and cardiac function measurements and human tissue (e.g., cheek cells, blood) for physiological experiments decreased from 2013 to 2022, while use of computer simulations was at its highest level in the 2022 survey (Figure 10), but these changes were also not statistically significant ($F = 0.009$; $df = 2,20$; $p = 0.99$).

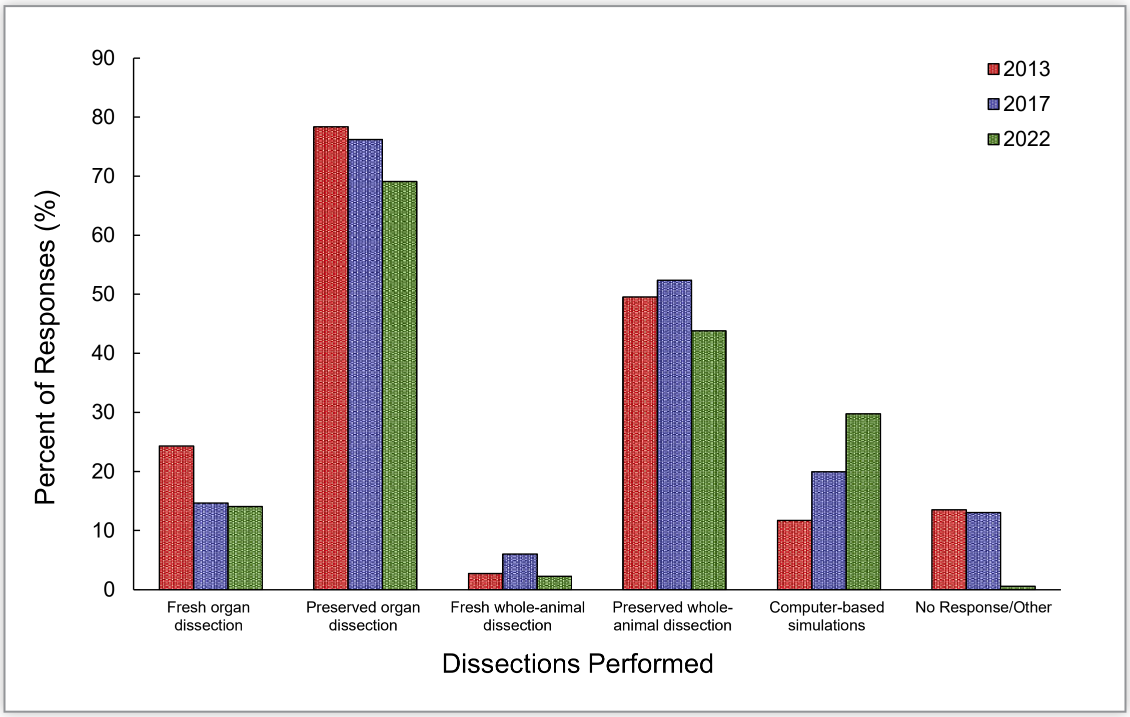

Figure 7. *Type of dissections performed in the laboratory across three iterations of the HAPS laboratory survey (2013, 2017, and 2022).*

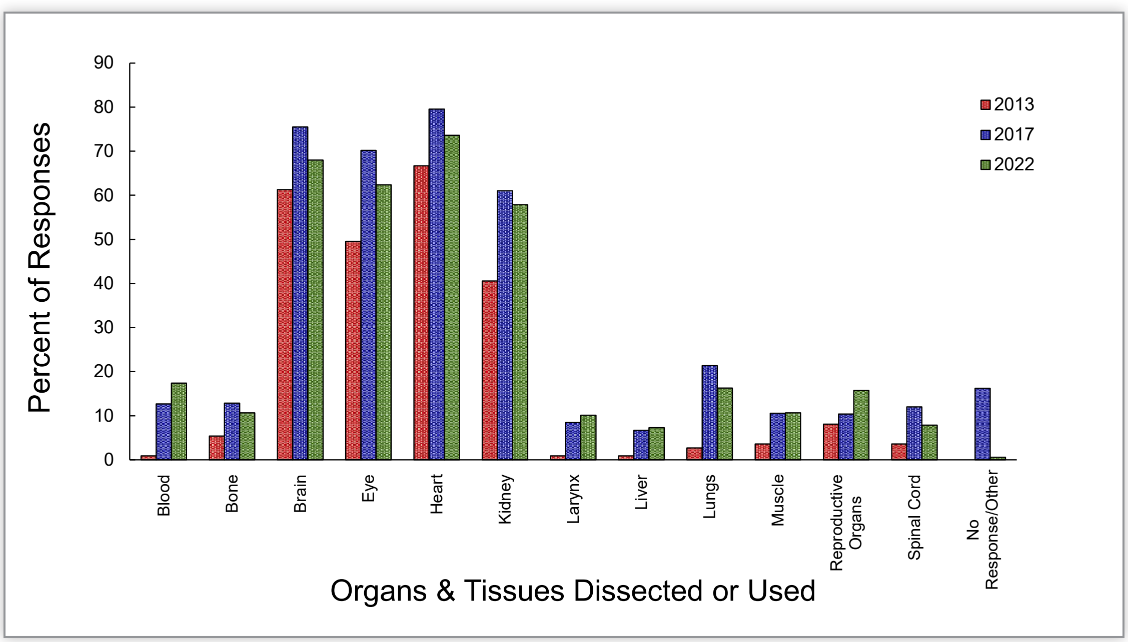

Figure 8. *Organ dissection or tissue use in the laboratory across three iterations of the HAPS laboratory survey (2013, 2017, and 2022).*

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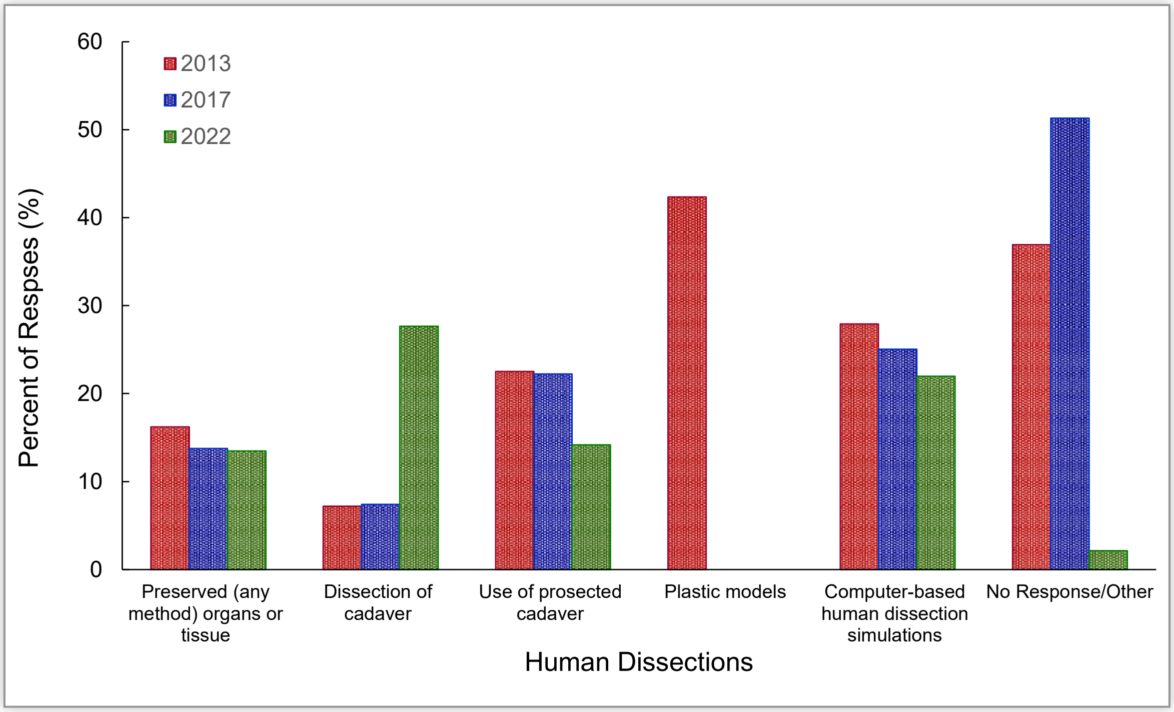

Figure 9. *Resources used to study or conduct human dissection in the laboratory across three iterations of the HAPS laboratory survey (2013, 2017, and 2022).*

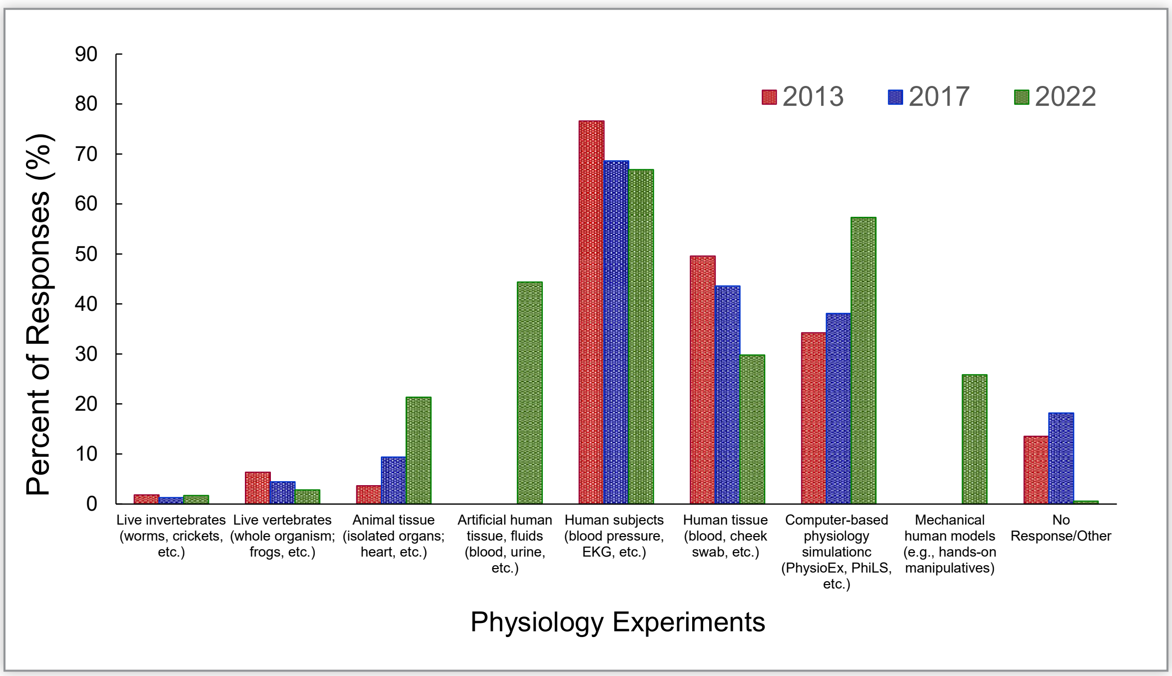

Figure 10. *Resources used to study or conduct physiological experiments in the laboratory across three iterations of the HAPS laboratory survey (2013, 2017, and 2022).*

Laboratory Assessments

Most respondents reported having complete (33.1%) or a significant level (41%) of control over the selection of assessments for laboratory activities (Figure 3). These values were similar to the frequency of respondents having significant or complete influence on the selection of learning outcomes for the laboratory as described earlier in the Results section. There was no significant difference in the level of influence for selecting lab activities and assessments ($F = 1.539$; $df = 6{,}156$; $p = 0.169$) due to job status (e.g., full-time, part-time, permanent, etc.), nor was there a significant difference in the level of influence for selecting laboratory activities and assessments ($F = 1.442$; $df = 4{,}158$; $p = 0.223$) due to institution type (e.g., 2-year institution, 4-year institution, etc.).

Publisher-provided content, use of Bloom's taxonomy, and course blueprinting methods (holistic mapping of all aspects of teaching and learning for a course) were the

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most frequently used resources for developing laboratory assessments (Table 6). Laboratory practicals (74.7%), individual assessments (written quizzes or exams, 73.5%), and pre- and post-lab assessments (quizzes or exams; 57.3%) were those used most frequently by survey participants (Figure 11). A variety of resources were used for administering laboratory practicals, with plastic models and bones as the most common (78.6%, Figure 12). Cumulative testing on multiple modules/body systems, where each assessment included questions on all content from the beginning of the course, and question stations, where students walked around the laboratory to complete the practical, were the most common methods for administering laboratory practicals at 85.9% and 79.7%, respectively (Figure 13).

Publisher-provided materials and reference Bloom's taxonomy levels provided for assessment questions	61 (34.3)
Course Blueprinting methods (holistic mapping of all aspects of teaching and learning for a course) to develop assessments	37 (20.8)
Specification Grading (students are able to repeatedly attempt assignment/assessment until a recognized standard has been achieved) to develop assessments	28 (15.7)
Backward Design methods (designing a curriculum by setting goals before choosing instructional methods and assessments) to develop assessments	28 (15.7)
I don't follow a specific method in developing lab assessments and primarily focus assessments on recall and identification	35 (19.7)
I don't determine assessments; they are provided to me	13 (7.3)
Other	3 (1.69)

Table 6. *Frequency and percent of total responses (in parentheses) to the following survey question: "Please complete the following sentence "I utilize ___________." to tell us how you DEVELOP ASSESSMENTS used in your anatomy and physiology lab curriculum. SELECT ALL THAT APPLY."*

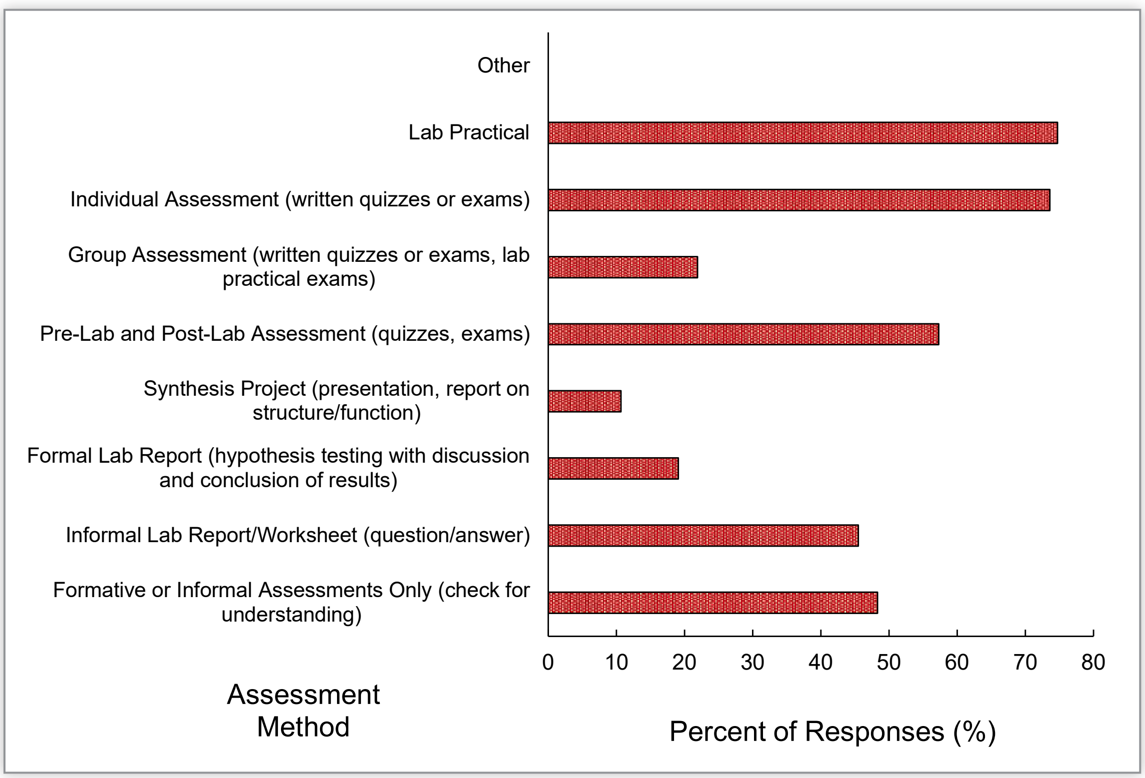

Figure 11. *Types of assessments used in laboratory instruction of anatomy and physiology.*

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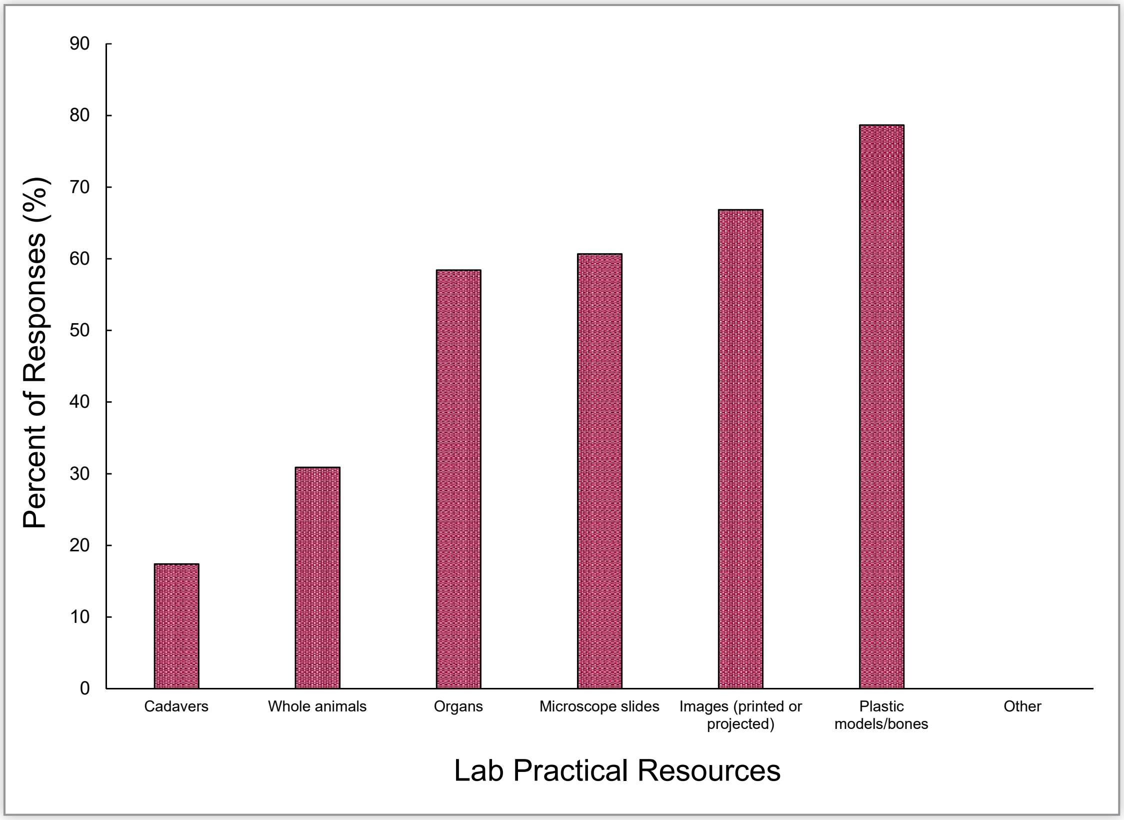

Figure 12. *Resources used in the administration of laboratory practical examinations in anatomy and physiology.*

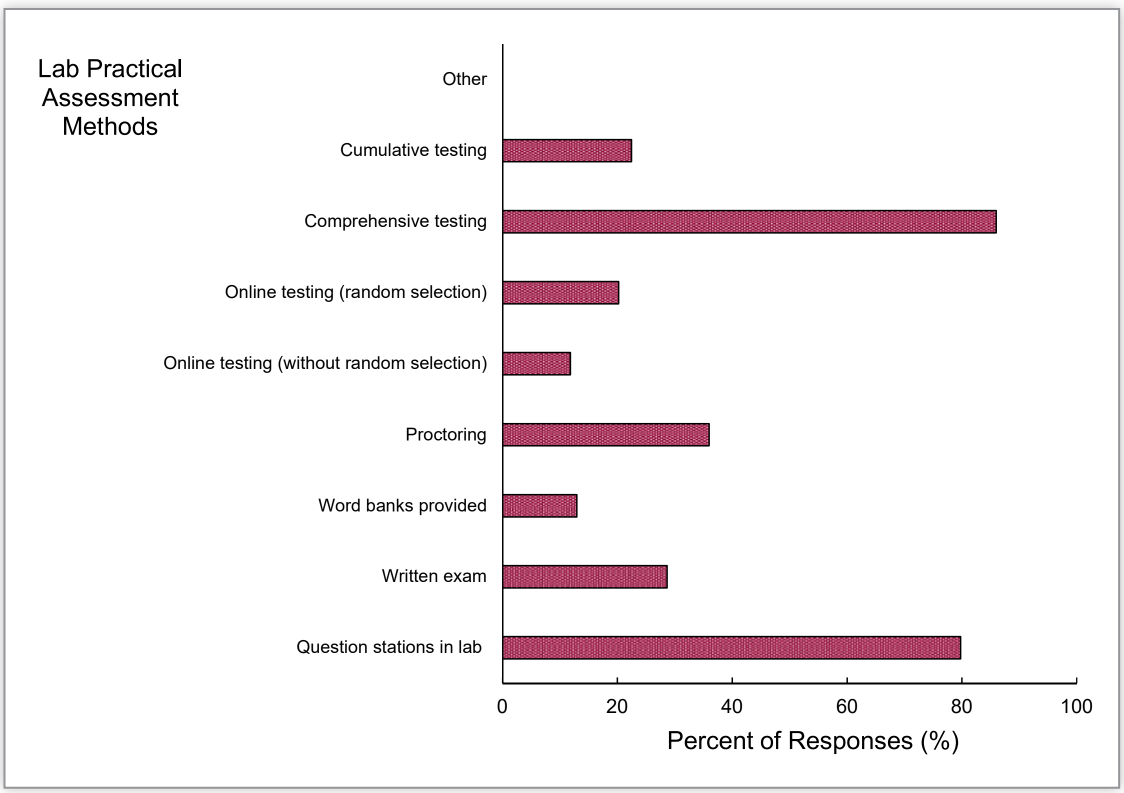

Figure 13. *Methods of assessment for laboratory practical examinations in anatomy and physiology.*

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Discussion

Recent trends in curriculum development have incorporated the educational approaches of backward design and course blueprinting (Coderre et al., 2009; McLaughlin et al., 2005; Patil et al., 2015). In backward design lessons are focused on the learning objectives of the course that in turn allow for course blueprinting [e.g., mapping each LO to a specific activity and assessment and incorporating the difficulty of the assessment for weighted calculation of a student's grade and improved student success (Beck & Roosa, 2020; Behrendt et al., 2020; Villarroel et al., 2018; Whetten, 2007)]. This trend is often partnered with an increased chance for students to experience authentic learning activities and assessments that provide multiple avenues for better retention of content (Behrendt et al., 2020; Casotti et al., 2008; Finn et al., 2019; Henige, 2011; Hurtt & Bryant 2016; Villarroel et al., 2018). As educators, including these authentic learning experiences is inherent to our laboratory curriculum, meaning that A&P education should provide students with the appropriate educational environment to meet this new trend in educational priorities (Beck & Roosa, 2020; Brashinger, 2017; McComas, 2005). Furthermore, when A&P instructors utilize clearly defined and explained expectations (e.g., goals and LOs) following a backward design or blueprinting (Coderre et al., 2009; McLaughlin et al., 2005; Patil et al., 2015) form of curriculum development, students are provided even greater opportunities to show growth and gain the success expected of them in both understanding content knowledge ***and*** applying that knowledge through measurable skill development (Beck & Roosa, 2020; Davis & Autin, 2020; Griff, 2011; White & Maguire, 2021).

To meet this desired outcome in curriculum development, either within an individual course or across aligned courses, instructors need some control over how they incorporate LOs and how they allow students to demonstrate they have met a particular LO (i.e., assessments). Most respondents indicated that they have this level of control solely for themselves, or by extension, through their institution or department. With this control over intended goals and LOs, instructors (individually or in collaboration with colleagues within their department) are able to develop a learning environment that allows students to master and apply content knowledge through skills development to meet the laboratory LOs appropriate for the course [i.e., A&P I, A&P II, anatomy-only, physiology-only, 1-semester A&P (Beck & Roosa, 2020; Davis & Autin, 2020; Emory, 2014, Griff, 2016; Ismail, 2020; Maldonado, 2022; Villarroel, 2018; White & Maguire, 2021)].

Survey responses indicated that this pattern of control is more common for instructors at 4-year colleges or universities versus 2-year institutions. One may be tempted to speculate that this difference is driven by the educational expectations of instructors and directives of the distinct institutions, or worse an implicit bias of tiered higher-educational experience (e.g., 4-year institutions are perceived as higher quality than 2-year institutions, etc.). It is more likely, however, to be an artifact of the demographics of respondents (Britson et al., 2023) and the propensity to have multiple instructors, of varying backgrounds and pedagogical expertise, teaching multiple sections of common courses (i.e., A&P I, A&P II, anatomy-only, physiology-only, 1-semester A&P) at, and across, 2-year college campuses necessitating a more extensive and collaborative approach to overall curriculum development (Felber, 2021; Hyson et al., 2021; Whetten, 2007). Moreover, there can be requirements for curricular alignment enabling easy transfer of credit hours (Whinnery & Peisach, 2022) or a common course numbering system at 2-year colleges relative to the 4-year colleges or universities, leading to a greater acceptance for insight and input into LO and curriculum development in the higher-education environment. These requirements may necessitate utilization of common course LOs that individual A&P instructors must integrate within their curriculum to ensure each of the various sections of the common course offer similar learning opportunities. These requirements for alignment must be balanced with ensuring instructors are given the professional and academic freedom to teach the content they see as most appropriate. This balance appears to be viable because once LOs are selected for curriculum alignment, almost 75% of survey respondents have a significant or a complete level of freedom to select assessments for the laboratory activities used.

In formulating curricula, instructors strategically plan learning activities that develop competencies to ensure student knowledge reflects what is currently understood to be true (Maldonado, 2022). This approach allows for integration and utilization of identified content standards (i.e., core concepts and HAPS LOs) into the laboratory curricula for A&P courses (i.e., A&P I, A&P II, anatomy-only, physiology-only, 1-semester A&P) and guides individual lessons (Human Anatomy & Physiology Society, 2019; Hill et al., 2017; Hull et al., 2017; Michael & McFarland, 2020). This emphasis toward core concepts and standardized LOs can be coupled with a focus on meeting HAPS Learning Goals (Human Anatomy & Physiology Society, 2020). Within this line of thought, we saw a common perspective among respondents in which selection of goals and priorities for curricular development moved toward a more holistic approach to teaching both anatomy and physiology components within the laboratory curriculum. This perspective also allows instructors to maximize time and effort on conferring knowledge while simultaneously exciting students about human anatomy and physiology.

To excite students about human anatomy and physiology and their A&P courses, instructors must move from using the laboratory learning environment for reinforcing lecture content to other educational outcomes and skills that might stem from the laboratory environment in a science-based course (Casotti, 2008; McComas, 2005). Simply reinforcing

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content may create an implicit bias in students that lecture is more important to their learning than laboratory experiences. To counter this perception, instructors should overtly emphasize the value of laboratory experiences for providing students with alternative modes of learning such as kinesthetic activities, scientific experimentation, and increased interactions with peers and the instructor. Complementing traditional lecture modes of learning (e.g., think-pair-share) with these types of laboratory experiences and clear expectations and understanding of learning goals promotes more authentic learning which improves retention (Behrendt, 2020; Henige, 2011; Hurtt & Bryan, 2016; McComas, 2005), resilience, and internal motivation for continued education in students, particularly for those who have expressed a fear of failure (DeCastella et al., 2013; Finn et al., 2019; Vaughn et al., 2021).

Coupled with this desire to promote retention of terminology and understanding the interrelationship of structure and function, respondents expressed that the priorities and purposes of their laboratory curriculum placed a greater focus on providing students with more opportunities to meet the anatomy-focused LOs versus physiology-focused LOs and/or LOs based on problem-solving, critical thinking, or homeostatic regulation. This greater emphasis in the laboratory curriculum on identifying structures preferentially to physiological roles and the association of those roles to homeostasis should prompt us to reflect on whether the purposes of our laboratory curricula benefit the students by allowing them to maximize their potential for understanding the human body. A possible rationale for this discrepancy in the lab curricular focus may be related to the need to have students identify structures and build their vocabulary to explain their understanding, as shown in Table 3 and 4. This emphasis encourages students to acquire knowledge (when combined with the availability of anatomical models, dissectible materials and/or anatomical donors) by providing a dedicated space to reinforce the anatomical identification and understanding of anatomy and structural relationships (Chapman et al., 2017; Yammine & Violato, 2016). Additionally, some instructors might inadvertently reinforce this discrepancy by focusing more of their lecture curriculum on homeostasis, and how homeostasis operates across systems, rather than including homeostasis in a lab. In this scenario, instructors develop a lab curriculum focusing on anatomical resources to identify structures, with lecture sessions devoted to physiological concepts, the integration of systems, and the application of information to real-world scenarios.

Moreover, this focus may be an indirect byproduct from the perception that anatomy is an ‘impossible’, challenging, and content-heavy course for undergraduate students. When pre-loaded with this perception, students may be quickly overwhelmed by the number of structures, functions and terminology that must be mastered (Sparacino et al., 2019) and fail to engage with activities focused on physiology LOs. Instructors may also inadvertently reinforce this this perception by devoting the majority of laboratory time to the identification of structures and detrimentally limit coverage and exploration of many of the other concepts within the totality of the A&P curriculum. Even though there seems to be a greater emphasis on anatomical LOs, the general trend for incorporating LOs related to the ability to conduct basic cardiopulmonary testing and muscle physiology persists when compared to previous versions of this survey (Brashinger 2014a; 2014b; 2017).

It is speculation that the perception of difficulty in mastering anatomical information, as shown in tables 3-4, warrants devoting more time to identification skills in an already overloaded laboratory schedule. Decreased time in the lab curriculum focusing on physiology versus the anatomy concepts could also be due to the difficulty of performing some experiments, the accessibility of resources for others, or the lack of resources and time necessary to complete high quality lab activities to test physiological responses. Moreover, some instructors may more easily integrate publisher materials into the total curriculum in lieu of laboratory instruction with little impact on the educational outcomes. Additionally, student receptivity to and engagement with the activities used to teach physiology concepts might contribute to the inclusion or exclusion of physiology from the laboratory curriculum. These contributing factors, along with limited instructional resources, deserve additional investigation to determine if there are direct causes that can be addressed in future curriculum development and refinement.

Another aspect of A&P laboratory curriculum development is the selection of resources used to reinforce concepts. Of interest is the general consistency across the various resources being used by instructors, regardless of institution. This makes us wonder, ‘why is resource use so consistent?’ Is consistency linked to pedagogy and effectiveness for students learning and retention? Alternatively, is consistency linked to some form of convenience for selecting resources (i.e., excessive similarities across suppliers, repeating what has always been done, following suggestions from other instructors)? The approach of A&P lab instruction can differ amongst institutions, and even between instructors within an institution who have a common curricular focus. This difference may come from variations in the perceived importance of some topics over others (Tables 1 through 3), or from varying levels of institution demographics Britson et al., 2023) and expertise with specific topics where instructors may or may not have the pedagogical skills needed to apply information to a real-world situation. For instance, some might feel more confident teaching application of muscle physiology to real-world scenarios but less so for urinary functions. Compounding this difference is variability in the amount of content application and integration of systems

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existing between A&P lab textbooks and the possibility that instructors may not know where to obtain information to teach applications that are lacking in resources available to them (Margaris & Black, 2012).

To address these questions about consistent resource use, we must first stipulate that the general purpose of the lab classroom is to provide educational hands-on experiences to students (Casotti et al., 2008; McComas, 2005). These experiences are a foundation for increased engagement in education that leads to more authentic learning opportunities for the student (Hurtt & Bryant, 2016; Johnson & Gallagher, 2021). As such, the increased use of similar resources (Figures 6-8) might mean that instructors are attempting to create similar learning opportunities based on similar learning goals. Additionally, compared to previous versions of this survey, there is a shift towards a greater use of digital and virtual resources. This shift might reflect the openness of instructors to integrating technology into their A&P classroom, since students are becoming more reliant on these technologies in educational settings (Cheung et al., 2021; Harrison et al., 2001; McDaniel & Daday, 2017; Ostrin & Dushenkov, 2016; Persinger et al., 2021; Pollock, 2022; Stokes & Silverthorn, 2021).

The similarity in preference for laboratory materials (e.g., plastic models, microscope slides, digital histology, simulations) across instructors may also indicate a preference for laboratory resources supported by educational textbook publishers and supply companies. While anecdotal, a cursory review of various A&P textbooks and their respective digital platforms suggests that there is little variance across major publishers and their suggested resources. Though apparent standardization might limit instructor choice of resources, it may also decrease stress on laboratory support staff (e.g., lab coordinators, student TAs, laboratory student workers) when setting up and breaking-down the lab room between different sections of the course. Additionally, the increased use of models for anatomical investigation and digital resources, in lieu of wet labs, may provide financial benefit to the institution by reducing expenses that would otherwise be incurred to conduct dissections or wet labs across multiple sections of the A&P courses.

Also, a perception of limited options and the impression of having little control in curriculum development may inhibit some instructors from exploring secondary types of resources or developing individualized options for laboratory instruction (Felber, 2021; Moorehead et al., 2015). However, there are recent movements by some instructors to investigate less costly and simpler means to provide equivalent learning opportunities to students (Price, 2020). This movement indicates that the use of a similar resource might not be due to a pedagogical advantage but rather to a limited awareness of alternatives, a consideration that warrants further investigation.

Conclusions

A&P instructors manage many challenges while guiding students to successful outcomes in their coursework. Institutional limitations of funding, physical resources, standardized curricula, and enrollment demands must be balanced with implementing evidence-based pedagogical practices, maintaining expertise in current course content, and creating connections between students and learning outcomes. When these challenges are successfully met and balanced, the authentic learning experience created not only teaches but transforms the learners as students, citizens, and future healthcare professionals. It is our goal that A&P instructors can use the results from this survey to assess their own A&P courses in comparison to those of their colleagues. Reflecting on the similarities and differences in curricula should aid instructors in identifying pedagogical practices that are less effective versus those that may be more effective at meeting learning goals and outcomes of A&P curricula. These comparisons are even more important as we reflect on how we, as A&P instructors, responded to changes in the educational environment and the additional challenges of teaching stemming from the COVID-19 pandemic presented in the third manuscript of this series.

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