Mary C. Stenson, Amy Olson,
College of Saint Benedict/Saint John's University

CUR Focus

Scaffolding Undergraduate Research in Integrative Health Science

Abstract

A pilot interdisciplinary program in integrative health sciences (IHS) is purposely designed to incorporate undergraduate research at each level, building upon the previous level as students progress through the program. Curricular goals and assessments for this program are scaffolded so that students learn to do research without feeling overwhelmed or intimidated. Goals for information literacy, disciplinary writing, inquiry and analysis, and communication are also embedded within the undergraduate research experiences throughout the IHS curriculum. By the time students reach their capstone research projects in their third and fourth years, they are prepared to develop and conduct their own independent projects because of their extensive previous research experiences. The stepwise approach guides students toward greater independence and higher expectations, culminating in the production of high-quality independent undergraduate research. The IHS major is currently approved as an advising track within the Integrative Science major with plans to formalize the track as a concentration in 2017.

Undergraduate research is a high-impact educational practice (Kuh 2008), which is defined to include characteristics such as active student engagement, development of reading and writing skills, analytical thinking, problem solving, and teamwork. Traditionally, undergraduate research is structured using an apprenticeship model (Zimbardi and Myatt 2014) in which undergraduates work with a faculty member and often have little background in research or the skills necessary for independent research. Beginning research students cannot anticipate or initiate action independently and must rely on faculty direction at each step of the research process. The faculty member typically does not have specific learning goals aimed at leading the student to new levels of independence, nor does the faculty member collect evidence of the student's ability to successfully complete tasks and apply experience to a new problem. Mercer (1994) describes these characteristics as distinguishing student research "help" from scaffolded research activities. Scaffolding within a project or curriculum must provide temporary support to students in order to lead them to increasing levels of independence as they progress through their academic programs.

Undergraduate research can be scaffolded throughout a curriculum to help students develop and master several learning goals simultaneously. Hammon and Gibbons (2005) define scaffolding as providing "temporary supporting structures to assist learners to develop new understandings, new concepts, and new abilities. As the learner acquires these skills, so teachers need to withdraw that support, only to provide further support for extended or new tasks, understandings, and concepts" (Hammond and Gibbons 2005, 8). A guided, stepwise approach to undergraduate research will help students develop skills necessary for quality independent research, as well as the necessary self-efficacy to work collaboratively with teammates and faculty mentors. A stepwise approach helps alleviate some of the uncertainty and intimidation that students may experience as they begin independent research. At the College of Saint Benedict and Saint John's University (CSB/SJU), we implemented a "pilot major" to expose students to the interdisciplinary nature of health, while focusing on undergraduate research and the integration of coursework from different disciplines.

Context

The College of Saint Benedict and Saint John's University (CSB/SJU) are separate, but coordinate, liberal arts institutions that are academically joined. They have a combined enrollment of approximately 4,000 undergraduates. Students interested in studying human health typically major in biology or biochemistry, but many students are interested in complementary health-related fields such as nutrition, exercise science, and psychology. Students often feel restricted by one major and are limited to a minor or a few selected classes in other disciplines rather than achieving the holistic interdisciplinary study of health they desire.

Four interested faculty members in the fields of nutrition, biology, and exercise science and sport studies (ESSS) collaborated to design an individualized major in integrative health science to help students understand the structure and function of the human body from multiple disciplinary perspectives. The major was intentionally constructed to promote a unique multidisciplinary, integrative approach to health that was not achievable within the context of any single discipline or major at CSB/SJU. The major was piloted as a track within an already-existing natural science major.

The six learning goals associated with the IHS major are described in Table 1. Our two primary goals in developing the major were to include extensive, scaffolded undergraduate research experiences and interdisciplinary integration points. Students who completed independent research with faculty prior to the formation of IHS indicated that they learned an exceptional amount, but found the process quite intimidating. Thus we intentionally designed the major to incrementally build research skills while developing a holistic view of human health.

Table 1. Learning Goals for Pilot Integrative Health Sciences Major

Goal	Students will...	Assessment of Goal
Goal #1 Information Literacy	Demonstrate the knowledge and skills necessary to identify, locate, evaluate, and effectively and responsibly use health related information.	Developed: Levels 1, 2, 3 Assessed: Capstone
Goal #2 Inquiry & Analysis	Understand and apply the scientific method by asking meaningful health related questions, generating hypotheses, collecting evidence, and testing hypotheses, to reach evidence based conclusion.	Developed: Levels 1, 2, 3 Assessed: Level 3, Capstone
Goal #3 Teamwork	Work proactively, constructively, and collaboratively with the team to achieve a common goal.	Developed: Levels 1, 2, 3 Assessed: Level 2 & 3
Goal #4 Scientific Writing	Effectively develop and express health science related ideas in writing.	Developed: Levels 1, 2, 3 Assessed: Level 3, Capstone
Goal #5 Integration of Disciplines	Integrate concepts and theories from multiple disciplines to enhance their understanding of human health.	Developed: Levels 2 & 3 Assessed: Capstone
Goal #6 Prepared Graduates	Use their broad academic foundation as preparation for graduate study in health related fields and/or to function competently in health related fields.	Assessed: Post-graduate survey

*Scaffolding levels listed under "Assessment" column are described more fully in Table 2.

The pilot IHS major consists of 57 credits. Students complete 25 lower-division credits and 28 upper-division credits, 20 of which must come from designated natural-science courses and eight of which must come from designated social-science courses, plus four capstone credits. The combination of natural and social science health courses would not be achievable in any single major. Because of limited faculty resources and budgetary constraints, the pilot was limited to 10 students per cohort. Students were invited to apply to the major after the spring semester of their first year. A competitive application and interview process was used to select the 10 students, who are officially accepted into the pilot at the beginning of their second year.

Undergraduate research is integrated into several components of the IHS curriculum in a step-wise fashion. Table 2 demonstrates the inquiry and analysis scaffolding throughout the IHS curriculum. As opposed to the traditional apprenticeship model of undergraduate research, our model increases student responsibility and research complexity at each level so students develop skills and understand the whole research process from beginning to end. Consequently, students are prepared at the capstone level to conduct their own independent research project. Our scaffolded model of undergraduate research offers students active research experience in guided small group settings before asking them to perform independent research.

All students interested in majoring in health fields are enrolled in Introductory Biology and Introductory Chemistry in their first year of college; those courses help them develop an understanding of the scientific method while reinforcing foundational scientific concepts. Students complete the first level of research scaffolding as they learn to develop logical, information-based questions and recognize assumptions present in scientific investigations and interpretation of the results (Table 2, level 1). During their second year, IHS students accepted into the Integrative Health Sciences program enroll in Health & Fitness (Table 2, level 2), an integrative course focused on the physiological and psychosocial dimensions of health. IHS majors enroll in the course as a cohort to help build a sense of community among the students who may feel as though they do not belong to any specific academic department. IHS students also build a community around the exercise science lab, which serves as a central meeting area for IHS students.

Health & Fitness is the first point of disciplinary integration in the IHS major. Students enter with breadth of knowledge from multi-disciplinary introductory courses, which they then apply to the study of health. The course is also the second level of research scaffolding, with the goals of developing students' skills in writing, research, teamwork, and communication. Students are assigned to lab groups,

Table 2. Selected Scaffolded Inquiry and Analysis Course Objectives*

Scaffolding Level/Course	Sample Course Objectives	Academic Strategies
Level 1 Goal: Practice developing scientific questions, introduce the steps of the scientific method with specific laboratory projects Course: BIOL 101	1. Apply critical thinking to solve biological problems by developing logical, information-based questions, interpreting data, and recognizing assumptions that are present in scientific investigations and interpretation of results 2. Practice asking questions and developing hypotheses 3. Practice data analysis and interpretation of figures	Small group, instructor-designed, laboratory projects
Level 2 Goal: Practice answering scientific questions with closely guided initiation to following the scientific method; some additional independence is allowed in method development, data collection and analysis Course: Exercise Studies and Sports Science (ESSS) 273	1. Synthesize information from scholarly sources to explain or define a scientific problem 2. Choose an appropriate methodology option to answer a given scientific question 3. Evaluate original data and effectively describe the results as they relate to a scientific hypothesis	Small group, mini-research projects and class-based survey research project
Level 3 Goal: Groups guided through the scientific method to ask and answer a research question; additional independence is allowed in choosing the research question, developing methods, and analyzing data Courses: ESSS 308/306 NUTR 330/331	1. Develop an appropriate research question and experimental design 2. Plan the sequential steps for a research experiment and accurately execute the experiment 3. Perform the necessary data collection 4. Analyze data/results using appropriate basic statistical methods 5. Interpret results and formulate conclusions, recognizing limitations of methods and sources of error	Small group, advanced research projects
Level 4 Goal: Students design and complete an independent research project with close faculty mentoring Courses: ESSS Capstone Nutrition Capstone	1. Formulate an appropriate research question based on interest and critical examination of the current literature 2. Design and implement a research project to answer a research question using appropriate experimental design and choosing appropriate statistical analyses 3. Discuss findings in detail, including implications of findings, relevant limitations, and suggested direction for future research	Independent research

*Information literacy, teamwork, and written and oral communication are similarly scaffolded throughout the curriculum.

which complete five mini-research projects throughout the semester. Because students at this stage still have very little research experience or exposure to research methods, the instructor provides specific research questions for each group. The research questions are framed in a way that allows very few methodology options and are focused on integrating different areas of health.

Each group is assigned a slightly different experimental research question, which exposes the entire class to different investigative methods. For example, one group investigates the effects of resistance training on post-exercise blood pressure, while another group investigates the effect of caffeine on resting blood pressure. Groups analyze the data they collect on their group members, form conclusions, and address the implications and limitations of their study in a 15-minute presentation to the class. Presenters are rated by classmates and the instructor on presentation skills, quality of background information, experimental controls, and quality of conclusions and implications, using instructor-generated rubrics.

One of the mini-research projects is conducted in conjunction with the Nutritional Biochemistry course. Both the Health & Fitness course and the Nutritional Biochemistry course use the same methods to investigate the effects of exercise, prior to a high-fat meal, on post-prandial triglyceride levels. Combining data between the two courses allows students to

work with a larger sample population and further integrate their knowledge from other courses and disciplines. The collaboration between the Department of Exercise Science and Sport Studies and the Department of Nutrition is further evidence of the interdisciplinary nature of the IHS major.

Students continue to develop information-literacy skills in Health & Fitness by evaluating background research relevant to their question. Students learn to utilize the literature to provide a theoretical argument for their research question and develop their ability to identify variables and experimental controls. Finally, students must develop their teamwork and communication skills to effectively work together to produce quality results. Teamwork is evaluated at two points during the semester, and each group member is given the opportunity to rate his or her group mates on effective teamwork. The group-based approach to research in the Health & Fitness course effectively introduces students to team-based research and encourages collaborative thinking. With small, guided research projects, students can focus on recognizing and controlling variables, analyzing data, and forming insightful conclusions.

Students are also introduced to survey and qualitative research methods through a class-based project examining how gender affects lifestyle behaviors that influence risks for chronic diseases. The class constructs and conducts a survey of their peers' self-reported health behaviors. The results are analyzed as a class, but each student individually writes a paper describing the results and forming conclusions. A draft of the final paper is graded, and students are given extensive feedback on writing style, content, and referencing. Small writing assignments are also used throughout the course to help students learn how to properly organize ideas and synthesize information. Extensive feedback by the instructor and individual meetings are useful for students to understand where they can improve.

IHS students enroll in one of four upper-division natural science courses (Table 2, level 3) focused on inquiry and analysis in their third year of coursework. All four courses contain the third level of research scaffolding. In these courses, students complete group research projects with more independence than in Health & Fitness. Groups of three or four students develop their own research questions and experimental design, but with close faculty guidance. The research questions must be relevant to the course's content. Each group composes a review of literature and a research proposal, which is submitted for IRB approval for use of human subjects in research, when appropriate. Students collect and analyze their data and orally present their results and conclusions to the class. These four courses provide an opportunity for students to assume more responsibility for the research process, developing their own research question and the complete design, while building their skills in inquiry, analysis, and scientific writing before initiating their independent research project.

The level 3 courses, Kinesiology, Exercise Physiology, Nutritional Biochemistry, and Exercise Nutrition and Supplements, are inherently interdisciplinary. Students entering level 3 courses also have completed relevant health-related coursework in a variety of areas: biology, nutrition, exercise science, physics, psychology, sociology, or communications. The breadth of health-related knowledge and diversity of coursework previously completed add to the "integration of coursework" goal. Students bring their individual health-related knowledge to class and frequently comment that they enjoy working in teams with other students who can provide different perspectives. Students integrate previous coursework into the theoretical background and design of their research projects. Examples of the diversity of research projects chosen by students in the level 3 courses are shown in Table 3.

Students choose from one of three capstone options for the IHS major: independent research in ESSS, independent nutrition research, or a health internship. The health internship aims to further a student's skills in inquiry and analysis, but is not directly related to the scaffolding of undergraduate research. The two independent research capstones (Table 2, level 4) serve as the primary options for 84 percent of the students and complete the research scaffolding. The IHS research capstones are the culminating courses for many of the program's learning goals and are completed over three semesters, beginning in the spring semester of the junior year. The capstones also serve as the final interdisciplinary integration point.

Students in research capstones use their information-literacy skills to investigate previous research on their topic. Students compose a thorough review of the literature to develop appropriate experimental designs to answer their research questions. Formal research proposals are submitted to the IRB for research with human subjects, if necessary. Data are collected and analyzed by the student. Each student writes a research manuscript in the format of an appropriate discipline-specific, peer-reviewed journal, to demonstrate mastery of scientific-writing skills. Finally, students are required to present their results and conclusions at local or regional conferences, demonstrating mastery of their oral-communication skills.

Our capstone research process has three major distinctions. First, students are allowed to pursue their own research interests as opposed to being assigned a portion of the faculty mentor's research line. If students choose a topic outside

Table 3. Examples of IHS Capstone and Group Research Projects*

Course for Which Project Was Completed	Scaffolding Level	Project Title
Exercise Nutrition and Supplements	3	How do carbohydrate mouth rinses impact blood lactate levels and time to exhaustion following repeated cycling sprints at 80% of VO2 max?
Nutritional Biochemistry	3	Effects of caffeine (3mg/kg) on VO2max [collaborative interdisciplinary project between nutrition and biology departments].
Exercise Physiology	3	What is the effect of music on rate of perceived exertion and blood lactate during a 20 min treadmill run?
Kinesiology	3	The effect of running cadence on footstrike patterns
Nutrition Research Capstone	4	The effect of caffeine on mood and memory in females getting < 6 or > 8 hours of sleep
Nutrition Research Capstone	4	Prevalence of metabolic syndrome in a Division III football team
ESSS Research Capstone	4	Adequacy of exergames: Is just dance an effective exercise?
ESSS Research Capstone	4	Nutritional misconceptions and application of nutritional knowledge for wellness planning among collegiate females

* Each project draws from more than one natural or social science discipline, demonstrating the interdisciplinary nature of the study of health.

of the direct expertise of the capstone course's instructor, they are encouraged to seek the advice of other faculty members who may have greater insight into the area the student is studying. Second, students complete an entire research project, not simply one aspect or step of the process as is common in the apprenticeship model. Finally, the capstone projects are, by nature, interdisciplinary. IHS students choose health topics that involve two or more natural-science and/or social-science disciplines and, at the conclusion of their projects, are asked to describe how their interdisciplinary coursework influenced their independent research. Examples of previous research projects are presented in Table 3.

Challenges Overcome

We faced four major challenges in the design and implementation of the IHS pilot major: (1) starting a new major, (2) finding time for faculty mentoring, (3) selecting students, and (4) identifying students' misperceptions. The first challenge was the logistics of starting a new interdisciplinary major. This challenge was multifaceted. First, we identified key faculty in each disciplinary area who were committed to an integrative model of health education. As noted previously, faculty members in nutrition, biology, and exercise science and sports studies formed the four-person committee that designed the major. One individual volunteered to be the main coordinator of the pilot project, serving as program director, the contact person for academic affairs and students, and coordinator of the administrative duties associated with the pilot.

The addition of a new, interdisciplinary major was met with resistance from some academic departments where faculty members feared that weaker programs could be replaced if the IHS major was attractive to a large number of students. Some departments were concerned that if IHS became an official interdisciplinary major, some chronically under-enrolled courses in their departments would be cancelled if the number of students in their majors declined. Because of the competitive nature of the IHS pilot, high-quality students, in fact, were drawn to IHS from other departments.

Resistance to interdisciplinary majors is not unique to our case. Hill (2013) suggests that the small size of faculties and increasingly limited faculty resources at small, liberal arts institutions creates resistance to interdisciplinary majors. Hill (2013) recommends involving departmental faculty with interdisciplinary and collaborative agendas to help assuage departmental concerns. We found this advice particularly helpful since our interested faculty members were able to communicate our plans to their respective departments and relay departmental concerns back to our advisory group. The faculty members involved in the pilot project were from the departments that potentially would see the greatest impact from the interdisciplinary major. Further, some academic departments would experience increased demand for courses included in the new major, adding staffing pressures. Experimenting with a new major and small cohorts of students before implementing an official major also helped us respond to resistance because we were able to: (1) gather data to demonstrate the effectiveness of the major; (2) determine student interest; (3) control demand for specific courses; and (4) manage demand on faculty in a program requiring intensive advising and mentoring. As we began the formalization process for the major, we worked closely with

all of the departments involved to be sure students had sufficient course options in various departments to limit added staffing pressures.

Additional questions regarding the first challenge involved where to house the interdisciplinary major and how to support it both with faculty and budgetary resources. Rather than attempt to have a stand-alone major with no departmental home, we opted to house the IHS major as a track within the natural science major. Fortunately, an individualized option within the natural science major already existed, so developing a designated track within that major was possible. We also needed to work within existing budgets and to be creative with lab usage, instrumentation, and faculty time. The exercise science and sport studies, biology, and nutrition departments share instruments to avoid unnecessary duplication, and, using a web-based calendar, they coordinate use of the exercise-science lab for lab-based research projects, as well as independent undergraduate research.

For example, the exercise science and sport studies department contributed exercise equipment and lab space, while nutrition and biology contributed metabolic and blood-testing equipment to the formation of the exercise-science lab. The collaboration described above between the Health & Fitness course and the Nutritional Biochemistry course is one example of how departments can work together to share resources. New student laboratory assistants were added to staff the exercise-science lab, assist with lab-based courses, and supervise data collection by undergraduate researchers. With the exception of student positions, however, the pilot project was completely "budget neutral."

The second challenge that we faced was finding time for faculty mentoring. Effectively scaffolding undergraduate research in the curriculum requires faculty time to mentor and collaborate with students. Time spent mentoring undergraduate research severely restricts available time and energy for faculty scholarship. The pressure of faculty scholarship for tenure necessitates a balance between faculty and student research. In response, faculty have adapted their research to incorporate areas that are of interest and also suitable for student research. Because students are given independence to develop their own topics, very few students choose research questions closely related to the faculty mentors' areas of research.

The third challenge we faced was how to select students for the pilot. We anticipated that the application process would be competitive. A list of eligible students was obtained from the registrar, and students were invited to apply to the major in June following their first year if they earned a B or better in two semesters of Introductory Biology. Interested students submitted a copy of their transcripts and a statement indicating why the IHS major was appropriate for their educational and career goals. Exceptional candidates were interviewed in person or via Skype. Interview questions probed the students' strengths and weaknesses, ability to work in teams, what they found most appealing about the IHS major, interests in research, and intellectual curiosity. Candidates were ranked based on all criteria and 10 were invited to enroll in the major.

The primary application revealed student interests, and the written rationale provided a sample of the students' writing abilities. The interview process gave us a valuable sense of the students' interests and strengths; however, it was not very quantitative, which made our decisions difficult to articulate to students. Two difficulties with this approach were the time-intensive nature of individual interviews and the need to conduct these interviews during the summer when most students were away from campus.

The application process was revised for the most recent cohort (2015-2016) of IHS applicants. The same criteria were used to identify potential candidates, from a pool of 43 applicants. Applicants were ranked according to GPAs and the top 16 students were invited to submit a secondary application, which included four essays. Students articulated why the major was a good fit for their educational and career goals and provided evidence that they understood the intent of the major. Responses were rated according to rubrics, and the 10 highest-scoring students were accepted. The new application format was not as insightful as the interview format, but was much less time-intensive and more quantitative. However, it became obvious that a more specific rubric was needed to distinguish among applicants.

The fourth challenge we faced was identifying and correcting student misperceptions. Students initially underestimated the amount of time that independent research can require, and procrastinated and then became frustrated. We learned to be much more intentional about discussing the learning goals, helping them achieve research milestones in a timely fashion, and providing support and encouragement along the way. We also encouraged the students to help and support each other.

Another student misperception stems from the flexibility of the major itself. There is a core structure within the IHS major, but more flexibility and independence than most majors provide. Some students interpreted this flexibility as a lack of structure and the freedom to change their minds frequently about course selection or research. We now are more deliberate about explaining the overall IHS structure and how students' planned course schedules and research

lead to the accomplishment of program goals and students' personal goals. Changes requested from the planned course schedule should be carefully considered with faculty advisors and make sense given students' goals and career paths, and not simply be changed to provide easier options.

Lessons Learned

We learned several key lessons over the course of six student cohorts regarding the development of an interdisciplinary health major, and how best to scaffold undergraduate research within a curriculum. The design of a pilot program was essential to help us develop the major and work through details with small cohorts of students. Accepting 10 students per cohort kept a potentially popular new major manageable as we navigated several issues. One concern we had was how to build a community among our students since they were not housed in any one department. Starting with an integration course that all students in each new cohort enrolled in together was pivotal to creating a bond among the students before they progressed into more challenging coursework and more independent research. Students reported a greater sense of community and readiness to complete independent research when they progressed through the major in the intended sequence. The exercise-science lab also created a community among IHS students where juniors and seniors could mentor younger students.

We learned that it was important to provide students with hands-on experience during each step of the research process, even in the beginning stages of learning how to do research. Students in Health & Fitness were allowed to choose their own methods, even if within a very narrow scope, and take ownership of the research while learning to navigate the process. At the sophomore and junior levels, students were encouraged to gain additional research experience outside of the IHS courses by assisting IHS capstone students and/or faculty. IHS students proved to be high-quality research assistants; several students co-authored research presentations with upper-class students or faculty outside of their coursework.

We learned that faculty/student individual meeting times were essential throughout the capstone courses. Meeting weekly with research students was time-consuming, but useful for evaluating progress and assigning short-term goals to keep students on track. Students' reflections on their experiences in the form of a class blog were also useful when the required blog posts were directed toward specific reflection questions. Students' comments on their peers' posts helped facilitate discussion among students if the entire class did not meet regularly. We also learned that asking students to set their own deadlines for completing parts of the research process and holding students accountable for those deadlines was useful for avoiding procrastination. Students' ability to set and meet deadlines was integrated into the grading for each research capstone.

Three semesters is the minimum time necessary for our students to complete the research capstone. The capstone option in the Department of Exercise Science and Sport Studies was originally divided over two semesters, and the students struggled to complete their projects. The three-semester option was more practical so both research capstones now total four credits and are divided over three semesters.

Finally, we learned that limiting the number of capstone students is necessary to give students a quality research experience. Research capstone courses typically enroll eight to 12 students. Mentoring independent undergraduate research is time-intensive for faculty, as noted, so limiting the number of students enrolled was critical. We suggest limiting the capstone enrollments by requiring strict prerequisite courses that incorporate prior scaffolding levels or by employing a capstone-application process. Depending on the size of the program, other inquiry and analysis options may be offered at the capstone level to limit the number of independent research projects per faculty member.

Research capstones could be reserved only for those students attempting to earn distinction in the major. For example, we offer an internship option for students who are more interested in gaining additional clinical experiences. The challenge with the internship is integrating a learning goal related to inquiry and analysis. Additionally, to help ease the faculty workload for independent research projects, we encouraged students interested in the same topics to work together so that they might help each other collect and analyze data even though they explore separate aspects of a complex question.

Assessment Outcomes

Course and learning outcomes in the program are assessed by individual academic departments. The natural science major, of which IHS is a track, will implement official assessment during the 2016-2017 academic year. Learning goals will be assessed in Health & Fitness, level 3 courses, and capstones. Currently, we informally assess IHS learning goals in research capstones, and similar rubrics are used in the two capstone courses; however, we continue to make adjustments to the pilot program, and we have not completed any formal assessment of learning goals. Since many of the IHS courses are interdisciplinary, non-IHS majors also enroll in the courses. Much of our course assessment data contains scores from IHS students who completed the intended undergraduate

research scaffolding, as well as students from other majors who have not. For example, in 2012-2013 and 2013-2014, the ESSS department included two level 3 IHS-scaffolded courses and one IHS level 4 course in the yearly departmental assessment, in addition to one non-IHS course. Three department faculty members randomly selected group and individual research projects from each course with either an inquiry and analysis or a writing objective. Modified rubrics from the Association of American Colleges and Universities (AAC&U) were used to assess students' skills in inquiry and analysis and in writing.

Average assessment scores for components of both learning goals are outlined in Table 4, which describes the four subsections assessed by the three faculty members for each learning goal. In addition to the inquiry and analysis and writing assessments, graduating ESSS students were surveyed in the spring of 2013 and those who participated in undergraduate research indicated that the curriculum prepared them well for their undergraduate research, helped them develop important professional skills, and deemed the supervision and support that they received as helpful and adequate. In 2014, graduating ESSS students indicated that departmental courses helped them develop their ability to write effectively.

Table 4. Assessment of IHS and Non-IHS Students' Inquiry and Analysis and Writing Skills*

Inquiry and Analysis Assessment	Score (Mean out of 3)
Topic selection/research questions	2.5
Existing knowledge, research and/or views	2.5
Research design	2.13
Analysis and discussion	2.5
Disciplinary Writing Assessment	**Score (Mean out of 3)**
Purpose/thesis	2.16
Content/conceptualization	2.42
Organization/writing	2.5
Language/grammar/spelling/mechanics	2.0

*Assessment by the Department of Exercise Science and Sport Studies. Course scores also include those of students not enrolled in the IHS program.

We have tracked student research outcomes and post-graduate plans to date, and we have the outcomes of research capstones for three cohorts that have graduated. However, many IHS students also produced high-quality research in collaboration with faculty outside of classwork. IHS students have co-authored two peer-reviewed publications; 10 of them have authored or co-authored poster presentations at national conferences; and 33 have authored or co-authored 26 poster presentations at regional professional conferences.

IHS graduates were admitted to a variety of professional and graduate programs. Of the 25 graduates, seven are currently in medical school, six in physical therapy programs, three in physiology masters programs, one in physician-assistant school, two in dental school, and six are working in healthcare fields. IHS graduates report feeling that they were well prepared for graduate study and that their undergraduate research experiences helped distinguish them when applying to graduate school. Based on our graduates' outcomes, we are confident that the IHS major and the undergraduate research scaffolding have prepared our graduates well for healthcare careers and advanced study.

Conclusions

Health science is inherently interdisciplinary and lends itself to a wide variety of possibilities for scaffolding integrative undergraduate research. We believe our model is easily transferable to other institutions, especially within an existing health science major. We recommend starting with a pilot major or small cohort of students so as to identify and adjust to potential challenges. Additionally, identifying areas for student engagement, even at the beginning stages of scaffolding, encourages students to be more invested in the research process and helps build their self-efficacy as they progress toward more independent research. We believe our model is sustainable, but only with a limited number of students. Larger cohorts would require additional faculty and budgetary support to sustain independent capstone research.

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Mary Stenson,
College of Saint Benedict/Saint John's University,
mcstenson@csbsju.edu

Mary C. Stenson is an associate professor of exercise science and sport studies at the College of Saint Benedict and Saint John's University in Saint Joseph, Minnesota, where she worked with three colleagues to develop the pilot major in integrative health science launched six years ago. She has an active research program in which she collaborates with students and supervises eight to 10 independent undergraduate research projects per year. Many of her students have presented their results at regional and national professional conferences. Stenson is a member of the institutional review board and the Undergraduate Research Advisory Committee. Stenson earned a BS in biology from Niagara University and an MS and PhD in exercise physiology from Springfield College.

Amy Olson is a professor in the Department of Nutrition at the College of Saint Benedict and Saint John's University, where she has taught for 33 years. She has collaborated with 90 students on research projects using a student-centered approach. Her students are involved in all aspects of the research—the development of the research question, writing the proposal, seeking approval from the institutional review board, recruiting subjects, data collection and analysis, and presenting the results on campus and at professional meetings. She has served on the institutional review board for 11 years and in 2010 won the Linda Mealey Faculty/Student Collaborative Research and Creativity Award. She earned her degrees at The Ohio State University.

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