But science is international! Finding time and space to encourage intercultural learning in a content-driven physiology unit

Sarah J. Etherington
School of Veterinary and Life Sciences, Murdoch University, Perth, Western Australia, Australia

Submitted 15 November 2013; accepted in final form 21 January 2014

Etherington SJ. But science is international! Finding time and space to encourage intercultural learning in a content-driven physiology unit. Adv Physiol Educ 38: 145–154, 2014; doi:10.1152/advan.00133.2013.—Internationalization of the curriculum is central to the strategic direction of many modern universities and has widespread benefits for student learning. However, these clear aspirations for internationalization of the curriculum have not been widely translated into more internationalized course content and teaching methods in the classroom, particularly in scientific disciplines. This study addressed one major challenge to promoting intercultural competence among undergraduate science students: finding time to scaffold such learning within the context of content-heavy, time-poor units. Small changes to enhance global and intercultural awareness were incorporated into existing assessments and teaching activities within a second-year biomedical physiology unit. Interventions were designed to start a conversation about global and intercultural perspectives on physiology, to embed the development of global awareness into the assessment and to promote cultural exchanges through peer interactions. In student surveys, 40% of domestic and 60% of international student respondents articulated specific learning about interactions in cross-cultural groups resulting from unit activities. Many students also identified specific examples of how cultural beliefs would impact on the place of biomedical physiology within the global community. In addition, staff observed more widespread benefits for student engagement and learning. It is concluded that a significant development of intercultural awareness and a more global perspective on scientific understanding can be supported among undergraduates with relatively modest, easy to implement adaptations to course content.

internationalization of the curriculum; intercultural awareness; global perspective

GOALS associated with internationalization of the curriculum (IoC) are now ubiquitous in mission statements and/or graduate attributes proposed by universities (17, 23). The concept of IoC has moved beyond inducting international students into the dominant culture of the host institution to the wider mission of preparing all students to engage successfully with the culturally dominant culture of the host institution (1, 27). Notwithstanding these documented benefits of IoC, there remains a disconnect between university-level aspirations and the implementation of curricular change at the discipline level (22, 31). Despite nearly two decades of focused attention on IoC in both the educational literature and university strategic planning, translation of these ideals into best-practice guidelines for academics in the classroom is underdeveloped (5). It is widely accepted that authentic, meaningful IoC will be most effectively designed and implemented by academic staff embedded within the disciplines (5, 31).

A lack of engagement with IoC is particularly prominent among science disciplines [although there are some exceptions (3)]. Becher and Trowler (4) have demonstrated that professional identification within academic disciplines plays an important role in shaping attitudes toward curricular reform. In interviews with 30 academics from different disciplines, including physiology, Clifford (10) observed that academics in the “hard pure” disciplines (including natural sciences) reported significantly less engagement with IoC than their colleagues in “hard applied” (science-based professions such as pharmacy) or “soft” disciplines (e.g., social sciences). Consistent with this finding, a review of the literature on IoC and physiology education suggests sparse uptake of IoC within physiology education, which most commonly occurs within hard pure or hard applied degree programs. Even in the wide-reaching Google Scholar search engine, the terms “physiology education” and “internationalization” returned just 17 citations, of which only 3 citations related directly to physiology education (August 2013).

Clifford’s interviews suggest that academics in the hard sciences are generally convinced by the educational and professional benefits of IoC for students (10). Why, then, the apparent resistance to curriculum change? The belief that scientific content is intrinsically culturally neutral is widely held among scientists, so that IoC can be considered irrelevant or low priority (5, 7, 10, 24). This is particularly the case among pure scientists; those in obviously applied disciplines (e.g., health professions) are more likely to recognize that their students will require intercultural competence to engage with the community (10). Certainly, much of the content in an introductory physiology curriculum is well conserved, at a cellular and organ level, across the world’s human population (acknowledging the ethnic and individual differences revealed by a more thorough investigation). However, it could equally be argued that the pursuit of pure scientific knowledge will always occur in a particular cultural and societal context. Research laboratories are staffed by a more mobile, interna-
tionally and culturally diverse population than at any point in history, and expanding internet technologies mean that the professional environment extends far beyond physical or national boundaries. It therefore seems unlikely that the “universality” of biological processes negates our graduates’ need for skills to embed their learning in a culturally diverse global context.

Faculty members who ascribe to the benefits of IoC may also be deterred from implementing curricular change due to logistical challenges. Common faculty concerns about the implementation of IoC include a lack of expertise and workload (10). Many academics are discipline specialists who may lack the training or confidence to teach students about cultural competence (31). This could be addressed by a meaningful partnership with an educational developer well versed in IoC, but not all institutions or academics have access to this support, and it requires a particular motivation on the part of the time-poor academic to seek out this increased workload. Additionally, physiology academics are presumably motivated by a core interest in physiology, which may or may not be accompanied by a parallel concern with IoC.

Finally, there is the familiar question of “where will it fit?” While many disciplines have been transitioning to a reduced content, increased skill model, hard science units often retain very high content loads and large class sizes. Physiology academics may be conflicted about devoting staff and student time to a goal that is not widely accepted or lauded in the discipline, perhaps at the expense of delving more deeply into traditional unit content or developing specialist technical skills.

It seems unlikely that physiologists will be able to continue to resist IoC in a market-oriented tertiary education system, where students are increasingly savvy about the skills required to compete in an international employment market and institutions are increasingly required to demonstrate student attainment of internationalization-related graduate attributes (25). The present study aimed to work within the commonly experienced reality of a physiology unit: a content-laden course under the leadership of a physiology PhD with no formal training in educational theory. This project explored whether or not modest curricular change in this context would be enough to facilitate intercultural interactions and start students on a path toward developing greater global awareness.

MATERIALS AND METHODS

Educational Context

This research was conducted in semester 1 of 2012 at the School of Veterinary and Biomedical Sciences at Murdoch University (Perth, WA, Australia). Murdoch University is a small (~18,000 students), publically funded, research active university. Curricular change was implemented in a second-year Biomedical Physiology unit (BMS264) that covers the introductory cellular and systems physiology of nine topics (nervous system, endocrine, muscle, cardiovascular, respiratory, renal, gastrointestinal, and integrative physiology of sleep and exercise). Most content is delivered via lectures (42 h/semester) and laboratory classes (eight 4-h laboratories/semester) that combine computer simulations, human physiological recordings (e.g., electrocardiography and spirometry), and investigations of histological specimens. Nine optional tutorials (1 h each) are provided during the semester, each focused on providing an alternative presentation of difficult concepts and suggesting effective strategies for mastery of the material.

Table 1. Student demographic characteristics by enrollment mode (international/domestic)

<table>
<thead>
<tr>
<th></th>
<th>International</th>
<th>Domestic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Percentage</td>
<td>Number</td>
<td>Percentage</td>
</tr>
<tr>
<td>Sex*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>56</td>
<td>22</td>
</tr>
<tr>
<td>Male</td>
<td>44</td>
<td>17</td>
</tr>
<tr>
<td>Age, yr*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>≤19</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>20</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>21</td>
<td>30</td>
<td>12</td>
</tr>
<tr>
<td>22</td>
<td>28</td>
<td>11</td>
</tr>
<tr>
<td>23</td>
<td>15</td>
<td>6</td>
</tr>
<tr>
<td>24+</td>
<td>28</td>
<td>11</td>
</tr>
<tr>
<td>Number of languages other than English spoken</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>1</td>
<td>31</td>
<td>8</td>
</tr>
<tr>
<td>2</td>
<td>46</td>
<td>12</td>
</tr>
<tr>
<td>3+</td>
<td>23</td>
<td>6</td>
</tr>
<tr>
<td>Region of primary residency†</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Australia</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Asia</td>
<td>61</td>
<td>14</td>
</tr>
<tr>
<td>Africa</td>
<td>17</td>
<td>4</td>
</tr>
<tr>
<td>Europe</td>
<td>17</td>
<td>4</td>
</tr>
<tr>
<td>Middle East</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Americas</td>
<td>4</td>
<td>1</td>
</tr>
<tr>
<td>Time enrolled at Murdoch University</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;3 mo</td>
<td>23</td>
<td>6</td>
</tr>
<tr>
<td>~1 yr</td>
<td>54</td>
<td>14</td>
</tr>
<tr>
<td>~2 yr</td>
<td>19</td>
<td>5</td>
</tr>
<tr>
<td>3+ yr</td>
<td>4</td>
<td>1</td>
</tr>
</tbody>
</table>

* Data derived from Murdoch University’s records system, including 26 students who did not complete the unit. † Region in which students had lived the majority of their lives.

Student Characteristics

The 2012 cohort consisted of 179 students, with an average age of 21.8 ± 0.2 yr (range: 18–42 yr). International students made up ~20% of the class (Table 1). The class was drawn from 13 different degree programs, with the largest cohorts from biomedical and chiropractic science. Consequently, there was significant variability in both the professional aspirations and academic preparedness of students, with entry requirements for the different degree programs ranging between the 65th and 80th percentiles of school leavers in 2011. Approximately 80% of students were required to complete the unit as part of the prescribed content of their degree program.

Data Collection

Twice during the semester (survey 1 at week 1 and survey 2 at week 13), students were asked to complete paper surveys combining ratings scale and open response questions. Survey questions included demographic information (sex, domestic/international status, primary country of residence, and languages other than English) as well as frequency and circumstances of within- and intercultural peer interactions and perspectives on global issues relating to biomedical science. All student responses were collected anonymously. The response rates for surveys 1 and 2 were 70% and 74%.

1 Data analysis revealed that the student’s status as a domestic student or an international student was an important factor determining their responses, although the significant cultural diversity within each of these groups is acknowledged.
Student experience in the unit was also assessed by centrally administered online surveys of teaching in lectures (n = 58, 32% response rate) and tutorials (n = 46, 26% response rate) conducted as part of Murdoch University’s standard monitoring of teaching quality.

Data Analysis

Compilation and $\chi^2$-analysis of survey findings were performed with Microsoft Excel (2011) software. All percentages were calculated based on the total number of respondents to a particular question. Students who responded “agree” or “strongly agree” were considered to have agreed with the statement in question. Figures were prepared with GraphPad Prism software (version 5.0).

This study was approved by the Human Ethics Committee of Murdoch University (permit no. 2011/175).

Interventions to Promote Intercultural Interactions and a Global Perspective

The unifying theme in interventions to the unit curriculum was to use student diversity as a resource for 1) enhancing intercultural awareness and 2) providing authentic global perspectives on course content.

While student diversity is an invaluable resource in IoC, this diversity in itself is not sufficient to promote global and intercultural awareness. These goals require meaningful interactions between students from diverse cultural and linguistic backgrounds. However, modern university students face numerous obstacles to informal interactions, including the tendency for individuals to self-select contact with peers of similar backgrounds, limited time spent on campus, and a lack of “common ground” to facilitate interactions (1, 15). These challenges foreground the importance of establishing educational structures that scaffold interactions between students from diverse backgrounds within class time (2).

The following three interventions were implemented within the unit to encourage interpersonal interactions, provide an opportunity for peer learning, and engage with subject knowledge:

- Embedding global awareness into the unit assessment
- Facilitating a conversation about a global perspective on biomedical science
- Providing increased opportunities for semistructured interactions during class time

**Intervention 1: Embedding a global perspective in the unit assessment.** Assessment is an important motivator of student performance (6); thus, including the development of intercultural competence and global insights in assessment items is important to optimize student engagement and learning (2). Consequently, changes were made to an existing group oral presentation project to embed the development of global perspectives and basic intercultural communication skills in the assessable activities of the unit.

The original assessment involved students working for 13 wk in groups of five students to research and prepare a 10-min oral presentation about a medical condition. For timetabling reasons, students self-nominated groups, although group selection was done after an intercultural icebreaker exercise (intervention 2) to encourage group heterogeneity. The major areas for assessment were 1) a description of core physiological and pathophysiological processes underlying the medical condition and 2) the development of a particular perspective on that medical condition, selected from five alternatives, depending on the group’s interest. For example, the biomedical science perspective required students to present the findings of a recent journal article relating to the medical condition, whereas the environmental science perspective required students to research environmental factors contributing to the development or progression of the disease.

Changes implemented to the project to address aims relating to IoC were:

- A global perspective was included as a project option
- International newspaper articles were used to highlight global health issues during the topic selection
- The marking guide for spoken communication was amended to specify the need for effective communication with an international audience

**THE GLOBAL PERSPECTIVE AS A PROJECT OPTION.** Groups choosing the global perspective were asked to discuss “how the impact of this medical condition differs due to cultural and/or ethnic factors in two different groups within the global population.” This perspective made awareness of different cultural contexts core for completion of the assessment task and gave students an opportunity to develop a deeper understanding of the global issues relating to their course of study.

**INTERNATIONAL NEWSPAPER ARTICLES HIGHLIGHTING GLOBAL HEALTH ISSUES DURING TOPIC SELECTION.** Student groups were allowed to self-select a medical condition from a predetermined list to maximize their interest and engagement in the topic. Project selection was amended so that groups selected from a range of international newspaper articles, each relating to a particular medical condition, rather than from a list of medical conditions. Newspaper articles were selected to highlight the impact of medical conditions on geographically, ethnically, and culturally diverse populations. The articles filled the dual function of giving students an engaging, often illustrated, lay description of sometimes unfamiliar medical conditions and foregrounding the diverse prevalence and impact of medical conditions within different international contexts. Using publicly available newspaper articles increased global content without creating an additional workload for staff, other than collating the articles.

**AMENDMENT OF THE MARKING GUIDE FOR SPOKEN COMMUNICATION TO SPECIFY THE NEED FOR EFFECTIVE COMMUNICATION WITH AN INTERNATIONAL AUDIENCE.** In the original assessment, academic staff assessed spoken communication. In reviewing the assignment for this research project, staff recognized that the unpolished uniformity of academic staff characteristics (7 of 8 staff in 2012 were native English speakers with an Australian or English linguistic heritage) was a barrier to those staff in achieving their goal of an unbiased, equitable appraisal of oral communication among the linguistically diverse student body. Additionally, the academic staff, and Murdoch University, aim to produce graduates who are adept at oral communication within the diverse global workforce. This mechanism for assessing the oral presentation was therefore not adequately aligned with the desired graduate outcomes.

As staff availability and linguistic characteristics fluctuate from year to year, the project was amended to rely on a peer assessment of spoken communication rather than staff appraisal. This amendment harnessed the greater linguistic diversity in the large student cohort to provide more equitable and authentic assessment of students’ ability to communicate science to an international audience.

The peer assessment was carefully designed to minimize disadvantages to students from less common linguistic backgrounds. Assessment guidelines were amended to specify that all students would be assessed on their ability to communicate with an international English-speaking audience (Fig. 1). Peer assessors were randomly allocated on the day of the presentation, so that groups could not assume the linguistic background of the students assessing their communication (~5 student assessors/group).

Difficulties in spoken communication are commonly cited by staff and students as a barrier to intercultural interactions (1). Staff engaged directly with this perception in the project information session by 1) acknowledging that spoken communication in the global workplace, while essential, is challenging and 2) emphasizing that all parties in a communication share the responsibility for adjusting their spontane-
Groups prepared and endorsed a charter of group conduct and following specific supports were provided:

- Maximize the likelihood of effective, successful group processes. The opportunities, it was considered essential to provide adequate supports to diverse groups, which present unique challenges as well as opportunities to establish expectations about respecting and valuing diverse perspectives, important in shaping peer interactions (1), from the start of the course. The discussion was positioned alongside an outline of the group project, which included an optional global perspective, to highlight the value of diverse student perspectives for success in unit assessments.

Each class of ~100 students organized themselves into a line, based on how long they had spent living in Australia, necessitating initial interactions among class members. Staff then assigned students to groups of five students, to include members who had lived predominantly outside Australia and those who had lived entirely within Australia. This within-group diversity was designed to provide the range of personal experience and perspectives necessary to place the subsequent discussion in a global context. Groups were directed to discuss a series of questions about global issues influenced by, or impacting on, the conduct and application of biomedical science. The range of responses to each question was then briefly shared with the whole class before moving on. The exercise was supervised by a single instructor (physiology PhD without expertise in IoC), who facilitated the discussion and pointed out ethical or other issues raised by the discussion in the context of conduct of medical science.

Questions (see sample questions in Table 2) were designed to

1. mine students’ personal experiences to show the value of diverse perspectives and produce peer learning and 2) focus on issues of internationalization and globalization relating to the core physiological content of the unit. The emphasis on individual experience was important to prevent students being uncomfortably cast as representatives of a particular country or cultural group. Additional benefits of the exercise were that the focus on biomedical science emphasized an area of common ground for discussion and modeled an “ask, don’t assume” approach that represents good practice in effective intercultural communication and learning (28).

**Intervention 3: enhancing in-class interactions.** The final intervention was to introduce short interactive exercises to the start of some of the existing weekly tutorials on core course content (e.g., equilibrium and membrane potentials, acid-base balance, and Starling forces). The original tutorials involved peer interactions within self-selected small groups interspersed with whole class discussions. However, students tended to self-select group members with a similar cultural background (32); thus, self-selected groups do not necessarily provide much opportunity for developing intercultural competence. Consequently, short interactive exercises were included at the start of some classes, requiring students to engage, under the direction of staff, with a larger proportion of their classmates, selected from outside of usual friendship groups.

---

**Peer Assessment of Spoken Communication Marking Sheet**

<table>
<thead>
<tr>
<th>What proportion of the group met the following criteria?</th>
<th>None of the group members</th>
<th>Only one group member</th>
<th>Roughly half the group members</th>
<th>Almost all the group members</th>
<th>All of the group members</th>
</tr>
</thead>
<tbody>
<tr>
<td>Speed of speech made it easy for an international audience to understand</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Volume of speech made it easy for an international audience to understand</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Clarity of speech made it easy for an international audience to understand</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Style of speech was engaging and maintained the audience’s attention</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* Assume (1) audience members come from a wide range of linguistic backgrounds and (2) all audience members have achieved Murdoch University English language proficiency requirements.

NOTE: Everybody speaks, everybody assesses the speech; everybody will need help from other students to tailor his or her speech to an international audience.
Table 2. Representative, summarized student responses during directed discussion about global perspectives in biomedical science

<table>
<thead>
<tr>
<th>Sample Responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>In which country have you spent the most time? What medical condition do you think has the biggest impact on the people living in that country?</td>
</tr>
<tr>
<td>Colon cancer in Singapore.</td>
</tr>
<tr>
<td>Obesity in Australia.</td>
</tr>
<tr>
<td>Malaria in Africa (sic).</td>
</tr>
<tr>
<td>Depression in England.</td>
</tr>
<tr>
<td>From your experience, can you think of any cultural factors that impact on the treatment and/or experience of that medical condition?</td>
</tr>
<tr>
<td>Availability of fast food in Australia makes treating heart disease difficult, can you do the research but it won’t work if people keep eating unhealthy foods.</td>
</tr>
<tr>
<td>Male circumcision is an important rite of passage in some cultural groups in Africa, if instruments aren’t sterilised this contributes to the spread of AIDS.</td>
</tr>
<tr>
<td>If, on average, 50% of the people in a country die from a particular disease, what percentage of the government’s health budget should be spent on that disease (assuming there is a government and a health budget in this country)?</td>
</tr>
<tr>
<td>50%, government funding should be assigned based on the proportion of the population affected.</td>
</tr>
<tr>
<td>15%, the amount spent doesn’t necessarily equal the effectiveness, a good preventative campaign could have a big effect but not require all of the health budget.</td>
</tr>
<tr>
<td>5%, the major health priority in my country is infrastructure, we need clean water and accessible medical clinics rather than focusing on particular diseases.</td>
</tr>
<tr>
<td>That depends, is it being spent on health care or research?</td>
</tr>
<tr>
<td>You are approached by a mother of a child with progeria. Will your government fund research into this this extremely rare (~1/6 million live births) premature aging disease?</td>
</tr>
<tr>
<td>I think my government should fund research into progeria, understanding the mechanisms of premature aging could help the entire global population.</td>
</tr>
<tr>
<td>My government shouldn’t fund progeria research, we need to focus on more common causes of infant mortality.</td>
</tr>
<tr>
<td>Is your disease largely preventable by an individual’s lifestyle choices? No, many people in my country are born with AIDS and therefore the disease isn’t preventable for them.</td>
</tr>
<tr>
<td>Partly, diet choices can reduce the risk of colon cancer, but some people in Singapore have a higher genetic risk.</td>
</tr>
<tr>
<td>Yes, most skin cancer can be avoided by reducing sun exposure. Yes, overeating and smoking are lifestyle choices that dramatically increase a person’s risk of heart disease.</td>
</tr>
</tbody>
</table>

AIDS, acquired immunodeficiency syndrome.

Interactive exercises incorporated into tutorial classes included the following:

- The addition of a 5-min icebreaker exercise in the first class
- The inclusion of a dynamic group simulation of the cardiac cycle
- The development of an interactive autonomic nervous system card game

ADDITION OF A 5-MIN ICEBREAKER EXERCISE IN THE FIRST CLASS. Students commonly cite a lack of common ground as a barrier to interactions across cultural boundaries (15). To address this issue and establish an expectation of peer interactions during tutorial classes, students were assigned to a group of three at the start of the first tutorial and raced other groups to identify something that they all had in common. As some sources of common interest may not stretch across cultural boundaries (e.g., sports or television shows), students were provided with suggestions of less culturally weighted sources of commonality, e.g., birth order within a family.

Inclusion of a dynamic group simulation of the cardiac cycle. An abridged version of the exercise developed by Carvalho (9) was included, where class members act as erythrocytes or heart chambers and work together to integrate the electrical and mechanical events of the cardiac cycle to move student “erythrocytes” through the heart.

Development of an interactive autonomic nervous system card game. Staff recognized that students often had difficulty learning the transmitters and receptors involved in autonomic nervous system function, which is essential learning for mastering most physiological topics. In part this was perceived to be because students passively read and heard, but did not say or engage with, the names of neurotransmitters and therefore failed to identify linguistic links that reflect functional relationships (e.g., acetylcholine and cholinergic receptors). To encourage students to grasp these functional relationships in a non-threatening, interactive way, decks of playing cards were printed, depicting nervous system components including neurotransmitters, receptors, and structures (e.g., preganglionic parasympathetic neurons and metabotropic receptors). In small groups, students raced to discard their hand of cards, by stating aloud a functional link between one of their cards and the card on the top of the deck (Fig. 2). The card game format was used to highlight the reasonably simple rules describing which autonomic nervous system structures release which transmitters.

RESULTS AND DISCUSSION

Outcomes from Interventions

Outcomes from intervention 1: embedding a global perspective in the unit assessment. Around 5% of groups chose the global perspective. This relatively low uptake rate was expected as some cohorts of students (e.g., chiropractic) feel a strong affiliation with their course and thus almost exclusively select the perspective relating to their discipline. Despite the low uptake, staff observed that the global perspective became a unifying option for student groups with members derived from diverse degree programs. One student explained his group’s decision to do a global perspective as it was “something we could all be interested in and contribute to.” In this sense, the global perspective was genuinely providing an area of common ground for student interactions. Across the unit, ~60% of students saw one or two 15-min presentations that included a global perspective. Embedding a global angle in this form of assessment therefore made a significant contribution to international content in the unit, with minimal staff involvement.
As one core objective of the assessment was to promote spoken intercultural communication, students’ English confidence was assessed at the beginning and end of the project. There was a marked increase in the English confidence of international students, particularly the proportion of students who rated their ability to converse with their classmates as excellent, over the course of the project (from 15% to 43% of respondents), consistent with previous work documenting improved English language confidence of international students as a benefit of IoC (1).

Outcomes from intervention 2: starting the conversation about global perspectives. The diversity of the student body meant that the discussions in both groups of students covered perspectives from a range of developing and developed countries and highlighted student experiences of different national and individual choices relating to biomedical science (Table 2). At the end of the directed discussion, students were asked the following question: “Can you think of any ways that cultural beliefs could impact the study of biomedical physiology or its application to the treatment of medical conditions in the community?” Approximately 50% of students identified specific ways that cultural beliefs would impact on the study of biomedical physiology or its application to community health problems. In the subsequent year, the same survey was administered to students before, rather than after, the directed discussion on global perspective, to obtain a measure of baseline student knowledge, and only 30% of student respondents identified a specific interaction between cultural beliefs and biomedical science. These findings suggest that this short, informal, semistructured discussion on course-related global issues was sufficient to markedly increase the proportion of students who could, or chose to, articulate a global perspective on their course content (for a further discussion of development of this learning over time, see Overall Findings).

Interactions between culture and biomedical science identified by students tended to mirror the different professional aspirations represented in the cohort (scientific vs. clinical focus), suggestive of students engaging in reflection on what these cultural considerations might mean in their own professional life. The following are some student responses:

As virtually all students here will be trained in Western medicine/thought, understanding differences in approach will enable practitioners to be more aware in their clinical settings.

Cultural beliefs would [affect] what people feel is an appropriate application of treatment. e.g., Religion and stem cell research.

Approaching things with a different mindset can provide completely different solutions … cultural beliefs can provide different methods to approach a biomedical problem.

Whether or not they believe in the same disease model (e.g., Can be caused by viruses, bacteria etc.)

Xenotransplantation using pigs hearts is unacceptable to Muslims, this could hinder/help advancement in xenotransplantation.

Outcomes from intervention 3: enhancing in-class interactions.

One hundred percent of respondents (n = 44) to a survey on unit tutorials administered as part of Murdoch University’s standard surveys of teaching process agreed that teaching in tutorials “encourage[d] collaboration with others,” suggesting that tutorials contributed effectively to the goal of facilitating peer interactions.

Importantly, given that the primary educational function of the tutorials is to promote mastery of physiological content, 100% of respondents also agreed that “useful strategies for tackling work were demonstrated”; 97.7% of respondents agreed that teaching in tutorials “maintains a classroom atmosphere conducive to learning.” These results suggest that the incorporation of short interactive exercises into the 45-min tutorials was not detrimental to their core pedagogical function.

Comments relating to tutorials were overwhelmingly positive, with students commonly highlighting the importance of tutorials in their mastery of course content, although a small minority of students found the interactive approach to tutorials too confronting and would have preferred a more instructor-centered approach:

The [tutorials] are so helpful its [sic] unbelievable, they should be mandatory!

[Tutorials] are so useful as they help clarify everything I don’t understand in the lecture and just make learning a lot easier.

[Tutorials] are too confronting…suggest more of a tutorial based thing…where students are expected to attempt questions beforehand and then ask for your help.

I think the hands on approach (such as the activities where we got up and moved around the classroom) was extremely useful and helped further the understanding of the lecture material.

Staff commented that the interactive activities tended to engage a wider and at times distinct subset of students from the more traditional worksheet-based activities. For example, a student who was generally quiet and reluctant to contribute to class discussions was seen leaping out of his chair with arms raised in victory having won a round of the autonomic card game. The incorporation of these exercises therefore appeared to have the additional benefit of supporting a more diverse range of student learning styles (8).

Staff also reported the establishment of more cohesive peer networks within the class than in previous years, which, in some cases, extended to working together outside of class. Students who choose to attend tutorials are often high needs in terms of staff input, either because they have particularly high performance aspirations or because they are struggling to master the course content. The formation of stronger peer networks therefore had the added benefit of reducing students’ dependence on staff to support their learning.

Overall Findings

The end-of-semester survey (survey 2) explored the following two main questions about the overall student experience of internationalization of the unit curriculum:

1. Did the unit provide opportunities for and develop skills in intercultural interactions in a professional context?
2. Did students gain insights into the global context for their learning about physiology?

Opportunity for and learning about intercultural interactions in professional groups. Ninety-four percent of students surveyed at the end of semester said that the unit activities had “encouraged or helped [them] to build relationships with their BMS264 classmates” (n = 138 responses). When students were asked to nominate one class activity that had been most important in building those relationships, students most commonly nominated the group project (70% and 57% of domestic
and international student respondents, respectively), with tutorials as the second most common response, both activities where IoC interventions were implemented. Class activities therefore succeeded promoting peer interactions for the large majority of students, which is a necessary first step in developing intercultural competence.

The more central question, given the overall goal of the project, was whether or not these in-class interactions had contributed to the development of intercultural competence among the student body. Overall, 40% of domestic and 60% of international students surveyed identified something specific that they had “learned about interaction in cross-cultural groups from [their] class activities in BMS264.” Commonly articulated themes in student learning were the logistics of working in intercultural groups, insights into other perspectives or cultures, and finding common ground with people from different backgrounds (Fig. 3). This represents a significant proportion of the student body being able to articulate specific learning in this area, particularly given the relatively modest amount of time and teaching resources devoted to promoting a more global perspective on unit content. Certainly there was also a sizeable proportion of students who did not report any learning about intercultural interactions within the unit (Fig. 3), and, therefore, there was ample scope to expand or refine interventions to the unit to try and promote learning in a larger proportion of the class. However, this result emphasizes the potential of a unit with a core physiological focus to promote the development of important graduate attributes around IoC.

International students were more likely to report intercultural learning than domestic students (Fig. 3), which most likely reflects the more intense intercultural experience associated with immersion in a nonhome culture (Ref. 27, although see also Ref. 30). A similar trend was apparent in the directed class discussion (intervention 2), where students who had lived predominantly in Australia were less likely to engage in the discussion and tended to identify interactions between biomedical science and “other” cultures rather than recognizing equivalent interactions within their own cultural context. This appears to reflect a greater difficulty in recognizing one’s own culture and its implications for worldview among the domestic students. An important focus for future developments of the course content will therefore be adjusting the content and/or moderation of the directed discussion at the start of semester to better address the challenge of supporting home students to recognize and reflect on their own culture (27), a key transformation in developing intercultural competence. Given the relatively small proportion of international students in the class (Table 1), greater emphasis on the cultural variation among the domestic student population may also enhance learning among home students.

Importantly, 60% of students surveyed indicated that “interacting with students from other cultures [had] helped them develop a deeper or more informed understanding of biomedical physiology.” Thus, the majority of students identified intercultural interactions as a positive contributor to their grasp of core course content as well as the more obvious benefits for training graduates prepared for a global workforce.

Insights into the global context of course physiology content. Having made various interventions to highlight the global context of core physiological content, the surveys explored

![Image](http://advanphysiology.org/)

**Fig. 3. Learning about working in professional intercultural groups by enrollment mode (domestic/international).** Shown are percentages of students who identified learning about intercultural groups attributed to physiology class activities and student quotes reflecting the three main themes in responses: intercultural similarities, insights into other cultures, and the logistics of working in intercultural teams.
whether or not students were able to independently identify and articulate a global perspective on their learning. The question “Can you think of any ways that cultural beliefs could impact the study of biomedical physiology or its application to the treatment of medical conditions in the community?” was asked in surveys at both the beginning and end of the semester to investigate any changes in this learning over the course of the unit (Fig. 4; see further discussion and representative student responses in intervention 2 above).

There was a slight decrease in the percentage of domestic students who identified a culture/physiology interaction over the course of the semester. This is likely because the first survey was performed immediately after the directed discussion on global biomedical issues, which may have prompted student reflection in this area. A more notable change was observed over the course of the semester in the responses of international students ($\chi^2$-test, $\chi^2 = 5.92$, degrees of freedom: $= 2$, $P = 0.052$), who were initially unable or reluctant to identify interactions between physiology and culture. Pleasingly, over the semester, the proportion of international students articulating these interactions increased to a similar level as seen among domestic students.

By the end of the semester, more than 45% of the student respondents described an interaction between physiology and cultural factors and physiological understanding over the semester in the responses of international students, which is likely because the first survey was performed immediately after the directed discussion on global biomedical issues, which may have prompted student reflection in this area. A more notable change was observed over the course of the semester in the responses of international students ($\chi^2$-test, $\chi^2 = 5.92$, degrees of freedom: $= 2$, $P = 0.052$), who were initially unable or reluctant to identify interactions between physiology and culture. Pleasingly, over the semester, the proportion of international students articulating these interactions increased to a similar level as seen among domestic students.

By the end of the semester, more than 45% of the student respondents described an interaction between physiology and cultural factors and physiological understanding over the semester in the responses of international students, which is likely because the first survey was performed immediately after the directed discussion on global biomedical issues, which may have prompted student reflection in this area. A more notable change was observed over the course of the semester in the responses of international students ($\chi^2$-test, $\chi^2 = 5.92$, degrees of freedom: $= 2$, $P = 0.052$), who were initially unable or reluctant to identify interactions between physiology and culture. Pleasingly, over the semester, the proportion of international students articulating these interactions increased to a similar level as seen among domestic students.

By the end of the semester, more than 45% of the student respondents described an interaction between physiology and cultural factors and physiological understanding over the semester in the responses of international students, which is likely because the first survey was performed immediately after the directed discussion on global biomedical issues, which may have prompted student reflection in this area. A more notable change was observed over the course of the semester in the responses of international students ($\chi^2$-test, $\chi^2 = 5.92$, degrees of freedom: $= 2$, $P = 0.052$), who were initially unable or reluctant to identify interactions between physiology and culture. Pleasingly, over the semester, the proportion of international students articulating these interactions increased to a similar level as seen among domestic students.

By the end of the semester, more than 45% of the student respondents described an interaction between physiology and cultural factors and physiological understanding over the semester in the responses of international students, which is likely because the first survey was performed immediately after the directed discussion on global biomedical issues, which may have prompted student reflection in this area. A more notable change was observed over the course of the semester in the responses of international students ($\chi^2$-test, $\chi^2 = 5.92$, degrees of freedom: $= 2$, $P = 0.052$), who were initially unable or reluctant to identify interactions between physiology and culture. Pleasingly, over the semester, the proportion of international students articulating these interactions increased to a similar level as seen among domestic students.

By the end of the semester, more than 45% of the student respondents described an interaction between physiology and cultural factors and physiological understanding over the semester in the responses of international students, which is likely because the first survey was performed immediately after the directed discussion on global biomedical issues, which may have prompted student reflection in this area. A more notable change was observed over the course of the semester in the responses of international students ($\chi^2$-test, $\chi^2 = 5.92$, degrees of freedom: $= 2$, $P = 0.052$), who were initially unable or reluctant to identify interactions between physiology and culture. Pleasingly, over the semester, the proportion of international students articulating these interactions increased to a similar level as seen among domestic students.

By the end of the semester, more than 45% of the student respondents described an interaction between physiology and cultural factors and physiological understanding over the semester in the responses of international students, which is likely because the first survey was performed immediately after the directed discussion on global biomedical issues, which may have prompted student reflection in this area. A more notable change was observed over the course of the semester in the responses of international students ($\chi^2$-test, $\chi^2 = 5.92$, degrees of freedom: $= 2$, $P = 0.052$), who were initially unable or reluctant to identify interactions between physiology and culture. Pleasingly, over the semester, the proportion of international students articulating these interactions increased to a similar level as seen among domestic students.

By the end of the semester, more than 45% of the student respondents described an interaction between physiology and cultural factors and physiological understanding over the semester in the responses of international students, which is likely because the first survey was performed immediately after the directed discussion on global biomedical issues, which may have prompted student reflection in this area. A more notable change was observed over the course of the semester in the responses of international students ($\chi^2$-test, $\chi^2 = 5.92$, degrees of freedom: $= 2$, $P = 0.052$), who were initially unable or reluctant to identify interactions between physiology and culture. Pleasingly, over the semester, the proportion of international students articulating these interactions increased to a similar level as seen among domestic students.

By the end of the semester, more than 45% of the student respondents described an interaction between physiology and cultural factors and physiological understanding over the semester in the responses of international students, which is likely because the first survey was performed immediately after the directed discussion on global biomedical issues, which may have prompted student reflection in this area. A more notable change was observed over the course of the semester in the responses of international students ($\chi^2$-test, $\chi^2 = 5.92$, degrees of freedom: $= 2$, $P = 0.052$), who were initially unable or reluctant to identify interactions between physiology and culture. Pleasingly, over the semester, the proportion of international students articulating these interactions increased to a similar level as seen among domestic students.

By the end of the semester, more than 45% of the student respondents described an interaction between physiology and cultural factors and physiological understanding over the semester in the responses of international students, which is likely because the first survey was performed immediately after the directed discussion on global biomedical issues, which may have prompted student reflection in this area. A more notable change was observed over the course of the semester in the responses of international students ($\chi^2$-test, $\chi^2 = 5.92$, degrees of freedom: $= 2$, $P = 0.052$), who were initially unable or reluctant to identify interactions between physiology and culture. Pleasingly, over the semester, the proportion of international students articulating these interactions increased to a similar level as seen among domestic students.

Concluding Remarks

Together, the results of this study suggest that relatively minor interventions to the design of a single content-heavy physiology course are enough to encourage cross-cultural interactions and start students on the path to understanding the global context of their studies.

While defining and measuring the development of intercultural competence remain elusive targets, even among IoC experts (13, 14), the results of the present study suggest that many students have made positive steps along the path toward this understanding. In particular, skills in intercultural communication are recognized as core to enabling a sophisticated intercultural understanding (32), and student reports suggest that interventions in the present study provided both increased opportunity for intercultural communication and improved student confidence about such communication, particularly among international students.

Interestingly, the skills considered central to competence in intercultural communication—asking, rather than making assumptions, and being open to learning from the understanding of others (14)—have strong parallels with those essential for the rigorous application of the scientific method. Thus, the promotion of an inquisitive approach in the context of internationalization should be complementary to the development of the core scientific approach likely to be implicitly or explicitly demanded by a physiology curriculum.

Relationship building among classmates was one of the most commonly and positively documented outcomes of the interventions in the present study, which is likely to contribute to increased disciplinary as well as intercultural understanding among students. Interactions with international students are associated with quantifiable increases in intercultural competence (20), consistent with the qualitative observations in the present study. Additionally, strong peer relationships are known to promote optimal learning outcomes at university (21, 29) by enabling students to build on each other’s strengths and educational experiences; thus, it seems that the interventions here to promote intercultural interactions, with their indirect consequence of promoting peer interactions generally, have the potential to enhance discipline-related student learning. Furthermore, peer relationships are integral to a strong sense of institutional belonging and loyalty and therefore support student retention (1, 18). For science students in particular, having a friend or relative in the sciences is positively correlated with their intention to continue studying science (11). Peer relationships also contribute to the development of a discipline identity among science students, encouraging them to start to identify as contributors to a wider scientific community (16). In the hard sciences, where discipline content is often considered difficult by students and where attracting and retaining undergraduate students remains a challenge for many institutions, interventions such as those demonstrated here that promote the development of peer networks to strengthen learning and connectedness among students seem a particularly warranted use of class time, with benefits for both the discipline as well as the academic achievement of individual students.

Ultimately, intercultural competence is a nebulous understanding that requires ongoing development and adjustment in response to the ever-changing intercultural experiences of the individual. In this context of lifelong learning, openness to intercultural experience on the part of the individual is considered core to the development of effective intercultural interactions (14). The overwhelmingly positive student responses to the interventions presented in the present study are therefore
notable, suggesting that the supports for these interventions were adequate and that the framing and magnitude of the changes were appropriate to be accepted by the students and provide them with a challenging, but typically rewarding, intercultural experience. As such, it seems that even the relatively minor interventions implemented in the present study are likely to support openness to intercultural interactions and the future development of intercultural competencies among students.

Implementing such small changes consistently across a program of study may provide an achievable means for developing global perspective in a range of content-driven courses. It seems likely that a greater depth of understanding would emerge if students were routinely asked to consider their learning in a global context, enabling the scaffolding of higher-level learning over the course of a degree program. Such an approach may also have other benefits in the context of IoC being implemented by discipline specialists. Cultural beliefs are central to an individual’s sense of self, and, therefore, activities highlighting links between course content and cultural values have the risk of unmasking conflicts within students’ world views (e.g., between traditional beliefs and evolutionary theory). By their nature, small changes implemented by multiple discipline specialists in various units within a program study have the added benefit of minimizing and spacing out any risks to students’ self-concepts arising from the implementation of IoC by nonexperts in this area.

The work here reports on, by necessity and by design, the innovations of a discipline specialist rather than an academic developer with expertise in IoC. The reality is that a degree of intercultural competence is, or should be, a requirement of all teachers, so that all of us are required to have some awareness of the cultural norms that enable or challenge our students, our selves, and our discipline in particular contexts. Reflecting on and recognizing our awareness in this area may enable us as a discipline to approach IoC more confidently. Cliftord (10) has suggested that academics in the hard disciplines, like physiology, are engaging in IoC without identifying it as such, to themselves or to their colleagues. This suggests that there may be an existing, underused pool of resources around IoC within the physiology academy. It is hoped that this work will contribute to a growing conversation about what internationalization of the physiology curriculum is, about what we are currently doing, and about what improvements can feasibly be made to physiology curricula to provide physiology students with greater skills for engaging with the global scientific community and enhance the depth of understanding of core physiological content.

ACKNOWLEDGMENTS

The author acknowledges the valuable feedback and support of Murdoch University staff Dr. Craig Whitsed (Centre for University Teaching and Learning) and Assoc. Prof. John Bolton (School of Veterinary and Life Sciences) during the implementation of the project.

GRANTS

This work was supported by a Citation for Outstanding Contributions to Student Learning 2012 (to S. Etherington), by the Australian Government Office for Learning and Teaching.

DISCLAIMER

The views in this article do not necessarily reflect the views of the Australian Government Office for Learning and Teaching.

DISCLOSURES

No conflicts of interest, financial or otherwise, are declared by the author(s).

AUTHOR CONTRIBUTIONS

Author contributions: S.J.E. conception and design of research; S.J.E. performed experiments; S.J.E. analyzed data; S.J.E. interpreted results of experiments; S.J.E. prepared figures; S.J.E. drafted manuscript; S.J.E. edited and revised manuscript; S.J.E. approved final version of manuscript.

REFERENCES


