Active physiology learning in a diverse class: an analysis of medical student responses in terms of sex, home language, and self-reported test performance

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Higgins-Opitz SB, Tufts M. Active physiology learning in a diverse class: an analysis of medical student responses in terms of sex, home language, and self-reported test performance. Adv Physiol Educ 36: 116–124, 2012; doi:10.1152/advan.00132.2010.—The student body at the Nelson R. Mandela School of Medicine (NRMSM) is very diverse, representing many cultures, religions, and languages. Research has shown that weakness in English can impact student performance. Recent studies have also highlighted sex-based differences in students’ learning and listening styles. These factors pose both challenges and opportunities for teachers of physiology. Student presentations were incorporated for a number of years into the traditional didactic second-year medical physiology curriculum at the NRMSM. Feedback obtained about the perceived benefits of these presentations for the learning of gastrointestinal and endocrine physiology included demographic data pertaining to students’ sex, home language, and self-reported performance in tests. Analysis of the 50-item questionnaire responses, obtained over a 2-yr period, provided some interesting insights. Student responses to the items differed significantly in 27 of the 50 items in the questionnaire, based on sex alone (22%), sex and home language (7%), home language alone (37%), performance alone (26%), and performance and home language (7%). Our analyses of student perceptions support the findings of other studies and show that factors such as sex, home language, and student performance can play an important role in the way students are motivated to learn. In designing active learning strategies, academics need to take into account the potential influences that might affect student learning in diverse, multicultural, and multilingual classes.

Multicultural classes; multilingual students; physiology teaching; curriculum design

Physiology is not only a subject that is challenging to learn but also to teach (18–20). Over the past 2 decades, there has been an increasing recognition in the physiology education literature as to how innovative interventions can be used to address such issues ranging from case-stimulated and problem-based learning (27, 28), patient-centered learning (26), multiple format sessions (13), early clinical exposure (17), acting out concepts (10, 30), use of educational puzzles and card games (13, 15), and use of classical papers and animal models, both virtual and live (12, 23). In recent years, there has been an increasing focus on factors that influence learning, such as the effects of curricula design on student learning strategies (11), individual versus group learning preferences (4), learning style preferences (6, 14), and listening styles (3). This diversity is further compounded in situations where students come from differing cultural, economic, and linguistic backgrounds, as is the case in South Africa. Innovative ways are therefore required so that the teaching and learning of physiology can be adapted to meet the needs of students (24).

An increasing number of papers are now dealing with the effects of sex on the learning of physiology. In 2007, Slater et al. (22) reported using the VARK (where V is visual, A is auditory, R is reading/writing, and K is kinesthetic) learning preferences questionnaire developed by Fleming, that the majority of male and female first-year medical students preferred multiple types of teaching delivery. While they found no statistical differences in their study cohort in terms of sex, they did observe that female students preferred a greater diversity of teaching modes (22). This is in contrast to the findings of an earlier study conducted by Wehrwein et al. (29), in which male undergraduate Physiology major students were reported to prefer multiple learning modes, whereas female students preferred single-mode instruction. Similar sex-based differences were reported by Dobson (6) using a questionnaire that incorporated a section aimed at exploring students’ learning style preferences. However, in a more recent study (7) involving both undergraduate and postgraduate students and the use of Fleming’s VARK questionnaire, Dobson also found differences in male and female students in terms of their learning styles. However, these were only significant at the 90% confidence level and not at the usually accepted 95% level (P < 0.05). It is interesting to note that no sex-based differences were found in the performance of first-year medical (2) and third-year nursing (1) students, respectively. However, when learning styles and test performance were compared, a statistical difference was only reported for the study involving nursing students (1). Dobson (7) also explored the relationships among sex, learning styles, and course performance. Although he found a significant relationship between course performance and preferred sensory modality (6, 7), he did not find any statistically significant sex-based differences in student course scores (7). It is thus clearly evident that sex differences may exist in certain instances and that more research is needed in this field. Furthermore, if this is indeed the case for learning styles and sex as well as learning styles and student performance, it follows that student perceptions of active learning interventions may also differ based on sex and performance as well as other factors, such as home language.

We (10) recently reported on student perceptions of an exercise we conducted over 5 yr aimed at increasing student and staff interactions within a didactic medical curriculum. The exercise was based on using role play to encourage students to explore and gain an understanding of the physiological basis of signs and symptoms of selected endocrine and gastrointestinal...
diseases and conditions. Added benefits of the exercise were the enhancement of student computer and presentation skills, the promotion of independent research and group learning, and the encouragement of social interactions. In the last 2 yr of the exercise, we adapted the questionnaires given to students to ascertain information among others on sex, home language, and average performance in physiology tests thus far, to establish whether the exercise had been equally beneficial given the diversity of students in our classes, not only in terms of sex but also race, language, cultural, and socioeconomic background. This is not a phenomenon unique to South Africa, as globalization is changing the demographics of students at higher educational institutions. In the present study, we are thus reporting on student perceptions of the exercise in terms of these three parameters, namely, sex, language, and self-reported performance in class tests.

MATERIALS AND METHODS

Context and student feedback. The 2000 and 2001 cohorts of second-year medical students at the Nelson R. Mandela School of Medicine (NRMSM) were asked to provide feedback on their perceptions of an innovative learning exercise that was included as part of their didactic physiology curriculum. It is important to note that responses were obtained from each year cohort separately on one occasion only. Consequently, no repeated information was gathered from each of the student respondents (n = 324). Feedback was obtained by means of a questionnaire (Supplemental Material, APPENDIX A)1 as previously detailed (10). For the purposes of the present study, students were asked to indicate not only their demographic information, such as sex and home language, but also their average performance in physiology tests that the students had completed up until the study. Other issues probed in the questionnaire (Supplemental Material, APPENDIX A) were the textbooks students used, students’ preferred format for tests and examinations, and the time students spent studying physiology compared with their other second-year subjects. However, we will not be reporting here on these other issues as they were included in the questionnaire for other purposes.

Student responses were categorized as either being positive (“yes”; “strongly agree” and “agree”) or negative (“no”; “strongly disagree” and “disagree”). Home language was categorized in terms of whether English was their first or second language. The data collected were entered into a spreadsheet (Microsoft Office Excel 2003) and analyzed quantitatively in terms of sex, home language, and academic performance in physiology tests as reported by the respondents. Results were expressed either as percentages of the numbers of positive respondents to each question or as means and SD. It should be noted, however, that actual numbers of respondents were used when the data was statistically analyzed.

Student responses were analyzed using $\chi^2$ statistics with the aid of EpiCalc 2000, in terms of sex, home language, and self-reported performance in tests. Comparisons yielding $P$ values of <0.05 were considered statistically significant. Responses were tested for differences not only within the year cohort but also by pooling the data obtained for the cohorts of both years. Before the latter being carried out, the two year groups were tested for variations in their respective responses using a $\chi^2$-test. If a variation between the years was found, then pooling of cohort responses could not be done. This study was granted ethical approval (HSS/0722/08) by the Human Sciences Ethics Committee of the University of KwaZulu-Natal. Security and confidentiality of student inputs were maintained throughout.

RESULTS

Table 1 shows response rates and characteristics of the second-year physiology class in 2000 and 2001. Response rates for 2000 and 2001 were 90% and 98%, respectively, with a combined response rate of 94%. As the characteristics of the classes in 2000 and 2001 were essentially similar, the results of the two classes were pooled. The overall sex profile of the respondents was 36% male and 49% female, and 15% did not provide any information in this regard. Similarly, in terms of language, 60% of the pooled respondents were English first language (EFL) and 36% were English second language (ESL) speakers, and in this case only 4% of the respondents did not specify their language. Finally, in terms of self-reported performance, the majority of the respondents ($n = 163, 50.3\%$)

<table>
<thead>
<tr>
<th></th>
<th>2000</th>
<th>2001</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total number of students in the class</td>
<td>172</td>
<td>173</td>
<td>345</td>
</tr>
<tr>
<td>Number of respondents</td>
<td>155</td>
<td>169</td>
<td>324</td>
</tr>
<tr>
<td>Response rate, %</td>
<td>90</td>
<td>98</td>
<td>98</td>
</tr>
<tr>
<td>Sex</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Male students, n</td>
<td>59</td>
<td>56</td>
<td>115</td>
</tr>
<tr>
<td>Female students, n</td>
<td>79</td>
<td>81</td>
<td>160</td>
</tr>
<tr>
<td>Unspecified, n</td>
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<td>32</td>
<td>49</td>
</tr>
<tr>
<td>Home language</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>EFL students, n</td>
<td>97</td>
<td>96</td>
<td>193</td>
</tr>
<tr>
<td>ESL students, n*</td>
<td>56</td>
<td>60</td>
<td>116</td>
</tr>
<tr>
<td>Unspecified, n</td>
<td>2</td>
<td>13</td>
<td>15</td>
</tr>
<tr>
<td>Ratio of EFL:ESL:unspecified students, %</td>
<td>63:36:1</td>
<td>57:36:7</td>
<td>60:36:4</td>
</tr>
<tr>
<td>Self-reported student performance</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;50%, n</td>
<td>43</td>
<td>50</td>
<td>93</td>
</tr>
<tr>
<td>50–70%, n</td>
<td>84</td>
<td>79</td>
<td>163</td>
</tr>
<tr>
<td>&gt;70%, n</td>
<td>22</td>
<td>21</td>
<td>43</td>
</tr>
<tr>
<td>Unspecified, n</td>
<td>6</td>
<td>19</td>
<td>25</td>
</tr>
<tr>
<td>Ratio of low (50%) to high (&gt;70%) performers, %</td>
<td>28:14</td>
<td>30:12</td>
<td>29:13</td>
</tr>
</tbody>
</table>

* The home language of these students included 9 of the 11 South African official languages and 1 language from a South African Development Corporation country.

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1 Supplemental Material for this article is available online at the Advances in Physiology Education website.
achieved between 50% and 70% on their tests thus far, whereas 29% and 13% of the respondents reported test performances of 50% and 70%, respectively. Eight percent of the respondents chose to withhold this information.

The total numbers of students in each cohort, as well as the range of number of respondents and response rates expressed as a percentage relevant to the questions covered, are shown in Tables S2–S10 in APPENDIX B in the Supplemental Material. As detailed above, a number of statistical comparisons were made. The results of the year cohort differences and the differences between the sexes, home language, and self-reported performance groups are also clearly indicated in the various tables shown both in the text (containing only statistically significant data) and in APPENDIX B in the Supplemental Material (showing all the student responses). In the few instances where statistically significant differences were obtained when the responses of students of the two year cohorts were pooled, these are highlighted in the DISCUSSION under the relevant themes.

The responses of female and male students to the different questions posed in the questionnaire are shown in Tables 2 and 3 and in the Supplemental Material (APPENDIX B, Tables S2–S4). They are presented in terms of the various themes, as previously described (10). Overall, there were few instances where sex-based differences were noted in the student responses. Where significant differences were observed, they tended to be sex-based differences either within one of the two year cohorts or due to variations in the student responses of the two year cohorts. There was only one instance (Table 3) where male respondents in 2001 were significantly more positive about being in control of their own learning than their female counterparts, and a difference was noted between the year groups.

| Table 2. Students' interest and perceived benefits of the gastrointestinal tract and endocrine presentations according to sex |
|---------------------------------|-----------------|-----------------|-----------------|
|                                | Female Students | Male Students   | Overall         |
|                                | 2000            | 2001            | 2000            | 2001            |
| Range as a percentage of the cohort | 78–96%          | 75–99%          | 78–100%         | 64–100%         | 72–88%| 70–96% |
| Number of students             | 79              | 81              | 59              | 56              | 172   | 173   |

**Student perceptions of this learning experience**

Question: topics were relevant
- Female Students: 87
- Male Students: 88
- Overall: 87

Question: presentations as part of the second-year curriculum
- Female Students: 55
- Male Students: 59
- Overall: 57

Question: difficulty in following and understanding the presentations
- Female Students: 47
- Male Students: 42
- Overall: 45

Question: exercise was a waste of time
- Female Students: 28*
- Male Students: 35
- Overall: 34

**Improve understanding of the physiological basis of diseases**

Question: helped to integrate material covered in the physiology course†
- Female Students: 65
- Male Students: 72
- Overall: 69

Question: topics helped me to understand normal functioning of the:
  - Gastrointestinal system†
    - Female Students: 64
    - Male Students: 80
    - Overall: 66
  - Endocrine system
    - Female Students: 59
    - Male Students: 56
    - Overall: 56

Overall data included students who did not specify their sex. *Statistically significant differences were found in the responses of female and male students within the year group (*P < 0.05); †combined female and male student responses differed statistically between the year groups (*P < 0.05).

| Table 3. Students' opinions on active- and group-based learning according to sex |
|---------------------------------|-----------------|-----------------|-----------------|
|                                | Female Students | Male Students   | Overall         |
|                                | 2000            | 2001            | 2000            | 2001            |
| Number of respondents, range   | 65–76           | 64–80           | 48–58           | 42–56           | 124–151| 121–166 |
| Range as a percentage of the cohort | 82–96%          | 79–99%          | 81–98%          | 75–100%         | 72–88%| 70–96% |
| Number of students             | 79              | 81              | 59              | 56              | 172   | 173   |

**Promote independent research**

Question: felt good being in control of own learning†
- Female Students: 56
- Male Students: 63
- Overall: 61

Question: presentation encouraged me to read more about:
  - The gastrointestinal system†
    - Female Students: 39
    - Male Students: 36
    - Overall: 40
  - The endocrine system†
    - Female Students: 50
    - Male Students: 42
    - Overall: 49

Question: have read about topics other than that presented by my group†
- Female Students: 41
- Male Students: 43
- Overall: 42

Question: internet information found to be at more superficial level than that required for second-year studies†
- Female Students: 61
- Male Students: 45
- Overall: 63

**Encourage social interactions**

Question: physiology staff members approached were helpful
- Female Students: 77
- Male Students: 77
- Overall: 79

Question: presentations enhanced class “camaraderie”
- Female Students: 77
- Male Students: 79
- Overall: 76

**Promote group-based learning**

Question: group work was beneficial to my learning
- Female Students: 64
- Male Students: 58*
- Overall: 59

Overall data included students who did not specify their sex. *Significant differences (P < 0.05) were found between female and male student responses; †student responses statistically significantly differed (P < 0.05) according to the year of study.
Interestingly, although not statistically significant, a similar trend was seen between the female and male respondents in 2000.

The responses of EFL versus ESL students are shown in Tables 4–6 (Supplemental Material, Appendix B, Tables S5–S7). Compared with sex, there were more instances where the responses of the two language cohorts differed statistically significantly ($P < 0.05$) from one another. ESL student responses were generally more positive in terms of their perceptions of the learning exercise, the improvement in their understanding of physiology, and the promotion of independent research (Tables 4 and 5). It is worthwhile noting that the two language groups gave similar responses regarding social interactions and group-based learning (Supplemental Material, Appendix B, Table S6). In terms of presentation and peer review skills (Table 6), there was only one instance where a difference was noted in the student responses.

Tables 7 and 8 (Supplemental Material, Appendix B, Tables S8–S10) shows a comparison of the responses of students according to their self-reported performance in tests. There were a number of instances where significant differences ($P < 0.05$) were found in the responses of low and high performers (representing 29% and 13% of the total number of respondents, respectively). To make the outcome of these comparisons more meaningful, the responses of each of cohort were also compared with responses of the larger group of students (50% of the respondents).

Table 9 shows an attempt to elucidate what is obviously a complex relationship between home language, sex, and student performance in tests using a stratified approach. When the self-reported performance in all categories was compared according to sex, no statistical differences were found between male and female students. In contrast, a highly significant difference was found in the performance of EFL and ESL students. When the performances of students were compared taking sex and home language combined into account, significant differences were only found in those groups in which home language differed. It is noteworthy that the percentage of

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### Table 4. Students' interest and perceived benefits of the gastrointestinal tract and endocrine presentations according to home language

<table>
<thead>
<tr>
<th></th>
<th>EFL Students</th>
<th>ESL Students</th>
<th>Overall</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2000</td>
<td>2001</td>
<td>2000</td>
</tr>
<tr>
<td>Number of respondents, range</td>
<td>80–95</td>
<td>69–95</td>
<td>37–52</td>
</tr>
<tr>
<td>Range as a percentage of the cohort</td>
<td>82–98%</td>
<td>72–99%</td>
<td>66–93%</td>
</tr>
<tr>
<td>Number of students</td>
<td>97</td>
<td>96</td>
<td>56</td>
</tr>
</tbody>
</table>

**Student perceptions of this learning experience**

- **Question: presentations as part of the second-year curriculum**
  - EFL: 49*, 58
  - ESL: 75*, 73
  - Overall: 57, 64

- **Question: became more enthusiastic toward my studies†**
  - EFL: 36*, 55*
  - ESL: 62*, 80*
  - Overall: 44, 65

- **Question: presentations extended to other sections‡**
  - EFL: 31*, 47*
  - ESL: 59*, 70*
  - Overall: 40, 53

- **Question: more exercises like this later in studies**
  - N/A, 54*
  - N/A, 72*
  - Overall: N/A, 60

**Improve understanding of the physiological basis of diseases**

- **Question: helped to integrate material covered in the physiology course**
  - EFL: 65
  - ESL: 68*
  - Overall: 76, 85*
  - Combined: 69, 75

- **Question: topics helped me to understand normal functioning of the: Gastrointestinal system†**
  - EFL: 58*
  - ESL: 80
  - Overall: 81*, 79
  - Combined: 66, 80

- **Endocrine system**

Overall data included students who did not specify their home language. *Statistically significant differences were found in the responses of EFL and ESL students within the year group ($P < 0.05$); †combined EFL and ESL student responses differed statistically between the year groups ($P < 0.05$).

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### Table 5. Students' opinions on active- and group-based learning according to home language

<table>
<thead>
<tr>
<th></th>
<th>EFL Students</th>
<th>ESL Students</th>
<th>Overall</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2000</td>
<td>2001</td>
<td>2000</td>
</tr>
<tr>
<td>Number of respondents, range</td>
<td>84–95</td>
<td>79–95</td>
<td>39–53</td>
</tr>
<tr>
<td>Range as a percentage of the cohort</td>
<td>87–99%</td>
<td>82–99%</td>
<td>70–95%</td>
</tr>
<tr>
<td>Number of students</td>
<td>97</td>
<td>96</td>
<td>56</td>
</tr>
</tbody>
</table>

**Promote independent research**

- **Question: felt good being in control of my own learning**
  - EFL: 56
  - ESL: 60*
  - Overall: 69, 82*
  - Combined: 61, 70

- **Question: presentation encouraged me to read more about the: Gastrointestinal system†**
  - EFL: 32*
  - ESL: 49*
  - Overall: 51*, 77*
  - Combined: 40, 59

- **Endocrine system**
  - EFL: 43
  - ESL: 51*
  - Overall: 57, 70*
  - Combined: 49, 59

- **Question: have read about topics other than that presented by my group‡**
  - EFL: 38
  - ESL: 54
  - Overall: 51, 66
  - Combined: 42, 57

- **Question: resources used: Peers/students from other years**
  - EFL: 48
  - ESL: 38*
  - Overall: 59, 64*
  - Combined: 51, 50

- **Journals‡**
  - EFL: 39
  - ESL: 27
  - Overall: 35, 23
  - Combined: 37, 25

- **Question: internet information found to be at more superficial level than that required for second-year studies‡**
  - EFL: 63
  - ESL: 44
  - Overall: 61, 57
  - Combined: 63, 50

Overall data included students who did not specify their home language. *Significant differences ($P < 0.05$) were found between EFL and ESL student responses; †combined EFL and ESL student responses differed statistically between the year groups ($P < 0.05$).
self-reported performance in the 50–70% range was not affected by either sex or language. However, this does not seem to be the case for the low- and high-performing students, respectively, where sex does not appear to be a factor, whereas language distinctly does seemingly exert an influence on the outcomes.

**DISCUSSION**

In diverse classes, it is important as educators to know how sex and language influence the perceptions of students to innovative active learning strategies that are adopted to improve their learning. Students studying medicine at the NRMSM reflect, to a large extent, the diversity of the general population in South Africa. In terms of sex (Table 1), the student year cohorts mirrored the statistics found during the 2001 census for both South Africa as a whole and that of the KwaZulu-Natal region (25, 25a). Religious beliefs and language are both features of cultural diversity (5, 16). Although religious beliefs were not included in the biographical data collected, from our experience of interacting with students, the three dominant religions among our student body are Christianity, Hinduism, and Islam. As shown in Table 1, students whose home language was English comprised ~60% of the respondents for each year. This is considerably higher than both the national (8%) and regional (14%) figures for 2001 (25, 25a). It is interesting to note as well that although the majority of the ESL groups of students were isiZulu speaking (38%), the remainder represented 9 of the 11 official languages in South Africa, confirming the multicultural nature of the second-year medical student classes.

Table 1 also shows the spread of academic performance in tests as reported by the two student year cohorts. The majority of the students reported scores of between 50% and 70%. Comparisons were made of the responses of the weaker students (i.e., those whose test performance was reported to be 50%) with those of the stronger students (scores 70%) for the following reasons. First, in our opinion, it is unlikely that a student who is performing adequately will self-report their score as poor. In view of this, we are confident that those students who reported scores below 50% did in fact reflect the opinions of the weaker students. Similarly, in view of the low numbers (Table 1), it is unlikely that students would have overreported on their academic achievements. Finally, the number of students whose self-reported test scores were above 70% compared favorably with the actual number of the high achieving students in the classes over the two years.

For the purposes of a meaningful comparison, only those responses that showed a statistically significant difference

<table>
<thead>
<tr>
<th>Table 6. Students' development and use of skills according to home language</th>
</tr>
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<tbody>
<tr>
<td></td>
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<tr>
<td>----------------</td>
</tr>
<tr>
<td><strong>Number of respondents, range</strong></td>
</tr>
<tr>
<td><strong>Range as a percentage of the cohort</strong></td>
</tr>
<tr>
<td><strong>Number of students</strong></td>
</tr>
</tbody>
</table>

**Develop presentation and peer review skills**

Table 7. Students' interest and perceived benefits of the gastrointestinal tract and endocrine presentations according to their self-reported performance in tests

<table>
<thead>
<tr>
<th></th>
<th>Self-Reported Test Performance of &lt;50%</th>
<th>Self-Reported Test Performance of &gt;70%</th>
<th>Self-Reported Test Performance of &gt;50% to &lt;70%</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Number of respondents, range</strong></td>
<td>32–42</td>
<td>40–49</td>
<td>19–22</td>
</tr>
<tr>
<td><strong>Range as a percentage of the cohort</strong></td>
<td>74–98%</td>
<td>80–98%</td>
<td>86–100%</td>
</tr>
<tr>
<td></td>
<td>43</td>
<td>50</td>
<td>22</td>
</tr>
</tbody>
</table>

**Student perceptions of this learning experience**

- Question: topics were interesting
  - 83
  - 82*
  - 76
  - 100*
  - 86

- Question: would have put more effort if marks were awarded
  - 54
  - 75*
  - 58
  - 29*
  - 66

- Question: became more enthusiastic toward my studies†
  - 50
  - 55
  - 36
  - 76

- Question: more exercises like this later in studies N/A 66* N/A 29* 59

**Improve Understanding of Physiological basis of diseases**

- Question: better understanding when symptoms role played†
  - 73*
  - 89
  - 43*
  - 72
  - 79

- Question: topics helped me to understand normal functioning of the: Gastrointestinal system†
  - 62
  - 78
  - 43
  - 81

- Endocrine system
  - 60
  - 67*
  - 60
  - 90*
  - 71

*Significant differences (P < 0.05) were found between the responses of low performers (<50%) and high performers (>70%); †combined responses of low- and high-performing students differed statistically between the year groups (P < 0.05).
either in terms of sex, language, or student performance will be discussed. Moreover, these will be presented and considered in terms of the themes of the questionnaire (10). As the overall response rate for the study was good, with >90% participation being recorded in most instances, it makes us confident of the reliability of the responses and comparisons made.

The learning experience. There were 14 questionnaire items that probed the students’ overall perceptions of the learning exercise. There were only four instances where students’ perceptions differed significantly according to sex, three of which involved the 2001 cohort (Table 2). There did not appear to be any trend in the responses given by either male or female students that could be attributed to sex per se even though male students appeared to be more likely to have difficulty in understanding the presentations and to consider the exercise a waste of time. However, this observation was not consistent over the two years. It should be remembered (Table 1) that the findings could not have been influenced by the responses of those students who did not specify their sex, since these were omitted from the analysis and are not shown in Tables 2 and 3 (Supplemental Material, APPENDIX B, Tables S2–S4).

In those instances where significant differences were found in the responses of EFL and ESL students (Table 4), the ESL students consistently responded more positively. ESL students indicated that they had become more enthusiastic about their studies and that exercises such as this should be included not only as part of the second-year curriculum but also later on in their studies. This was a consistent finding across both years. Consequently, it would appear that active learning strategies, such as the one we developed (10), do not necessarily impact negatively on the perceptions of ESL students, despite an earlier study (9) that reported that student difficulties in basic medical subjects were correlated with their proficiency in English.

In terms of performance, significant differences were recorded in only three instances when the responses of weaker students were compared with those of high-achieving students (Table 5). It is noteworthy that this was only the case in the 2001 cohort of students. While both groups of students responded positively to the topics covered, >60% of the under-achieving students felt that they would have put more effort into the exercise if marks had been awarded and indicated that that active learning exercises such as this should take place again at a later stage of their studies. This contrasts noticeably with the responses given by those students who reportedly had scored >70% in their tests.

Understanding the physiological basis of diseases. No differences in the responses of male and female students were found. In contrast, it is pleasing to note that ESL students thought that the assignment was beneficial to their learning and assisted their abilities to integrate the physiology they had learned in the course thus far as well as to understand the normal functioning of the gastrointestinal tract when their responses were compared with those of EFL students (Table 4). Role play was seen by students irrespective of sex and home language to be beneficial to their understanding of diseases (Supplemental Material, APPENDIX B, Tables S2 and S5). With respect to performance, however, the use of role play was consistently perceived to be more beneficial by the weaker students (Table 7). One anomaly, which we cannot explain, was the response of high achievers in the year 2000, who seemingly did not find the role play to be useful to their understanding and thus learning of disease processes. This is made even more apparent when the percent positive responses of those students who reported test scores between 50% and 70% were calculated (Table 7).

Independent research. There are a number of important issues that emerged from the analysis of the students’ responses in terms of sex, home language, and performance that may assist physiology educators to get a better understanding of how students are engaging in independent research. Of the 14 items included in this theme, statistical differences were noted in 9 of these either in terms of sex (1 item; Table 3), home language (5 items; Table 5), and performance (3 items; Table 8). Male students in both year cohorts were generally more positive about being in control of their own learning, although this sex-based difference was statistically significant for the 2001 cohort only, although the sample size was not great enough to definitively infer a relationship. When the perceptions were analysed in terms of home language, there were more variations in student responses (Table 5). EFL speakers were more positive about being in control of their own learning, whereas ESL students reported that the presentations encouraged them to read up on topics relating to both...
GIT and endocrine physiology. However, in terms of sample size, only the 2001 cohort for GIT physiology was found to be large enough.

In terms of resources used during their preparation of the presentations, the only difference noted was that ESL students tended to consult their peers and students from other years more than EFL speakers. This is most likely due to the fact that campus residences at our institution predominantly house ESL students, thus providing an environment where interactions between students can more readily take place. When student opinions were analyzed according to their self-reported performance (Table 8), an interesting finding was the fact that while high-performing students of the 2001 cohort seemed to be relying predominantly on textbooks and the internet, the weaker students of both year cohorts, when pooled ($P=0.006$), reported using peers and students of other years as one of their important resources. We noted too that there were nine instances involving six questionnaire items in which statistically significant year differences (i.e., between 2000 and 2001 students) were noted when comparisons were made within the various subgroups (Tables 3, 5, and 8). These may be attributed to the fact that, as previously reported (10), the 2000 cohort of students as a whole, for unknown reasons, differed in their perceptions of the exercise compared with the other year cohorts, namely, students from 1997 to 1999 and 2001. It is important to note, however, that these year differences did not impact on the specific differences seen in terms of sex, home language, and self-reported test performance. The only disadvantage was that we were unable to pool the data from each year, and, as a result, the sample size used for analysis was smaller.

Social interactions. All groups, irrespective of sex, home language, and academic performance, were positive regarding the benefits of the exercise in terms of promoting class cama-

### Table 9. Relationship of sex, home language, and self-reported student performance

<table>
<thead>
<tr>
<th>Gender</th>
<th>Self-Reported Test Performance of &lt;30%</th>
<th>Self-Reported Test Performance of 50–70%</th>
<th>Self-Reported Test Performance of &gt;70%</th>
<th>Not Known</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Percentage of the total number of students</td>
<td>Number of students in each category</td>
<td>Percentage of the total number of students</td>
<td>Number of students in each category</td>
<td>Percentage of the total number of students</td>
</tr>
<tr>
<td>Female students</td>
<td>25</td>
<td>20</td>
<td>56</td>
<td>44</td>
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<tr>
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<td>30</td>
<td>24</td>
<td>49</td>
<td>40</td>
<td>11</td>
</tr>
<tr>
<td>2001</td>
<td>27.5</td>
<td>11</td>
<td>52.5</td>
<td>84</td>
<td>13.1</td>
</tr>
<tr>
<td>Male students</td>
<td>31</td>
<td>18</td>
<td>54</td>
<td>32</td>
<td>12</td>
</tr>
<tr>
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<td>17</td>
<td>49</td>
<td>27</td>
<td>11</td>
</tr>
<tr>
<td>2001</td>
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<td>35</td>
<td>51.5</td>
<td>59</td>
<td>11.5</td>
</tr>
<tr>
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<td>21</td>
<td>20</td>
<td>55</td>
<td>53</td>
<td>16</td>
</tr>
<tr>
<td>2001</td>
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<td>54</td>
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<td>5</td>
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<td>3</td>
</tr>
<tr>
<td>2000 + 2001</td>
<td>40.5</td>
<td>47</td>
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<td>4.0</td>
</tr>
<tr>
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<td>12</td>
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<tr>
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<td>20.9</td>
<td>24</td>
<td>54.8</td>
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<tr>
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<tr>
<td>2001</td>
<td>25</td>
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</tr>
<tr>
<td>2000 + 2001†</td>
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<td>53.0</td>
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<td>17.0</td>
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<tr>
<td>Male ESL students</td>
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<td>8</td>
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</tr>
<tr>
<td>2001</td>
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<td>9</td>
<td>43</td>
<td>10</td>
<td>4</td>
</tr>
<tr>
<td>2000 + 2001†</td>
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<td>17</td>
<td>50.0</td>
<td>22</td>
<td>2.3</td>
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</tbody>
</table>

Data that were not known were omitted when statistical comparisons were made. *The performance of EFL and ESL students differed significantly ($P = 0.0001$); an analysis of power revealed that a sample size of 286 achieved 98% power to detect an effect size of 0.2600 using a two degrees of freedom $\chi^2$-test with a significance level of 0.0500. †The performance of female EFL and ESL students was found to differ significantly ($P = 0.005$), as was that of male EFL and ESL students ($P = 0.03$).
raderie and staff-student interactions. However, it is noteworthy that the responses of female students (Table 3), irrespective of home language and performance, were statistically found to be more positive than their male counterparts in 2001 and for both years when the data for each year were pooled ($P = 0.04$ and $P = 0.02$, respectively). These findings might reflect inherent sex-based preferences and styles of motivation. It is interesting in this regard to note that Ferguson et al. (8), in their systematic review of factors associated with success in medical schools, cited that qualities such as “helping others” are more closely associated with predicting the performance of female students, whereas qualities such as “intellectual growth” may more closely predict male performance. Clearly this is an avenue that requires further research.

Group-based learning. In only two of the six items probing group-based learning did we observe any sex-, language-, or performance-based differences in student perceptions. With regard to group cooperation, there was a statistical difference in 2001 between the responses of the high- and low-achieving students (Table 8) as well as when responses of the two student year cohorts were pooled ($P = 0.008$). One can only speculate as to the reasons for this particular finding, especially since students self-selected their group members and worked independently of a facilitator (10). Despite this, it is encouraging to note that both EFL and ESL students reported good group cooperation and found the group-based learning exercise to be beneficial to their learning (Table 5). This is in keeping with the findings of Singaram et al. (21), who also observed no statistical differences in the perceptions of medical students at the NRMSM in terms of home language regarding group dynamics and effectiveness in a problem-based curriculum. With regard to sex, male students in 2001 found the exercise to be more beneficial to their learning than their female counterparts (Table 3), although this difference was not found to be statistically significant when the data from the two year cohorts were pooled.

Presentation and peer review skills. In 2001, a significantly greater proportion of ESL students indicated that they had played an active role in the presentation of their group’s work to the rest of the class compared with EFL students (Table 6). This may reflect the beneficial aspects of the exercise for ESL speakers as well as aspects of their cultural background. The finding also highlights, once again, the fact that ESL students were seemingly not prejudiced by the exercise. In this regard, it is also gratifying to note from student responses that neither sex nor performance negatively affected students’ perceptions of their development and use of presentation skills (Supplemental Material, APPENDIX B, Tables S4 and S10).

Limitations and conclusions. This study was observational and conducted retrospectively using data obtained on student perceptions regarding the introduction of a novel teaching and learning method into a didactic second-year physiology curriculum. The study was not designed to be an intervention study. As a result, there were no treatment and control groups to identify and limit confounding factors. Consequently, there are a number of limitations to the study. The sample size was dictated by the class sizes of the 2 yr under consideration. In most instances, no multiple comparisons were performed, and where these were deemed to have been carried out, no multiple comparison adjustments were done, as this was an observational study.

Performance had to be based on self-reported scores and not actual test scores for a variety of reasons. Although we had access to students’ results, we could not use them as they could not be linked to individual student responses to the questionnaire items. Furthermore, had we asked the students to identify themselves, we may have had a much lower response rate and the students may not necessarily have been as forthcoming in giving their views. Similarly, had we been able to identify the students, we would have been able to establish the degree of students’ English competency from their school leaving English examination results. It is for this reason that we could only divide students on the basis of English being their first or second language based on their home language. In retrospect, the biographical data collected could have included questions on the students’ financial status (i.e., whether they were dependent on financial aid or in receipt of a bursary) and details of the high school they had attended. This would have allowed us to gain insights into the students’ degree of preparedness for university studies and their socioeconomic background. Finally, another possible limitation of the study was the fact that because we wanted to retain the anonymity of students, we were unable to verify students’ responses through interviews and focus group discussions.

Despite the above-mentioned limitations, there are some important findings and observations that are not only applicable to our specific context but also more widely. As already been reported in the literature, Nageswari and colleagues (24) have highlighted the importance of varying teaching methods and the need for these to be matched to the learning preferences of at least 30% of students in any given class. Similarly, Hofgaard Lycke et al., in their study (11), reaffirmed that students’ learning strategies are affected by the way that educational programs are constructed. The findings of the present study in terms of sex are in keeping with the studies of others on teaching and learning modes (22, 29), learning style preferences (6), and performance (1, 2, 7) in that no clear pattern in terms of sex-based differences in student perceptions could be identified.

In many universities world wide, knowledge of and good communication in English is essential as it still serves as the medium of instruction for many students. Furthermore, the majority of textbooks and other resources available to students are in English. It was thus gratifying to discover through our analyses that ESL students indicated that they benefited from the innovative exercise that we had introduced into the second-year curriculum. It was also encouraging to note from their responses that they were apparently not disadvantaged even though ESL students appeared to form the bulk of the weaker students in terms of test performance (Table 9). The data shown in Table 9 also clearly demonstrate that, in our context and given our sample size, language significantly contributed to test performance in all three self-reported performance categories. Based on the findings of our study, physiology educators should therefore not be discouraged from introducing novel teaching and learning methodologies to ESL students in diverse classes. However, neither should teachers lose sight of the fact that language can present a barrier to students’ performance, as our results shown in Table 9 suggest.

Clearly there is a lot more research work that can be carried out regarding the influence of such factors as sex, language, socioeconomic status, and diversity on how students perceive...
the benefits and effectiveness of different active and innovative teaching and learning activities. This could entail systematic reviews of the available literature and a meta-analysis of the available data on some of these factors. Intervention studies with the inclusion of experimental and control groups, thus limiting confounding variables, could also be designed to test the relative impact of these types of factors on teaching and learning methodologies. It is worth recalling the remarks that Ann Sefton (18) made in the conclusion of her 1998 paper:

We are standing at an unprecedented time of change and challenge for the teaching of our discipline. New methods and ideas abound, both in traditional educational settings and in the use of the newer technologies. The opportunities are many but will be enhanced with greater national and international sharing of ideas and active cooperation. In those ways we can enhance the professionalism of physiology teachers, whatever their local settings.

We hope that by sharing the findings of the present study we have made a small contribution to this ideal.

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DISCLOSURES

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

AUTHOR CONTRIBUTIONS


REFERENCES