Head, Shoulders, Knees and Toes:
What concepts should your anatomy students know?
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Concept Survey Development: What to ask?

- **What topics to cover?** Focused on topics of known factual and conceptual misinformation of students entering course, known student difficulties during course, and known areas of poor retention across curriculum.

- **How did we “know” these troublesome topics?** Based on interviews with both anatomy faculty and upper-division faculty and information from physiology student focus groups.

- **How did we create questions?** Interviewed students on broad open-ended essay questions. Created more specific multiple choice (MC) questions and distracters based on interview responses. Interviewed students/experts on MC questions; gave surveys in class requiring students to explain responses. Based on responses revised survey (rev).

| TIMELINE |
|------------------|-----------|-----------|-----------|-----------|-----------|
| Spr07 | F07 | F08 | F09 | Spr09 | REV. | First Survey |

Descriptive Statistics of Human Anatomy Concept Survey

**Figure 1. HACS Item Difficulty Index (P) grouped by Learning Goal**
The item difficulty index reports the percent of correct answers for each question. Blue bars represent the P values on the pretest; Blue/Purple bars represent the P values on the posttest. (Purple alone represents the gain on that item.) LG=learning goal

**Figure 2. HACS Item Discrimination Index (D) grouped by Learning Goal**
The item discrimination index reports the difference in the percent correct between the top and bottom third of overall scores. Items with higher D scores are better able to distinguish between students whose scores identify them as generally strong or weak.

**Basic Survey Statistics**
- Average PRE-test Score: 6.2 (27%)
- Average POST-test Score: 11.7 (51%)
- Ave. Learning Gain per student: 32%
- Ave. Learning Gain per question: 34%
- Ave. Exam Score Correlations: PRE: r²=0.05 POST: r²=0.18 Learning Gain: r²=0.12

Survey Validation

- **Interviews**
  - 39 Students Interviewed on essay survey (“think aloud”): Responses were scored by two reviewers for common answers and misconceptions and used to create survey questions and answer choices.
  - 38 Students Interviewed on MC survey (“think aloud”): Prior to the final survey, questions that received responses (correct or incorrect) with reasoning that did not match the answer choice were revised. This led to 4 dropped questions and 8 with minor and 4 with major revisions. For the questions on the final survey, each question had at least 5 students choose the correct answer for correct reasoning (with the exception of Q23, a particularly difficult question that only received 4 correct responses during interviews). Among distracters receiving more than 15% on the pretest, we collected an average of 5 interview responses (with at least 2) that accurately matched reasoning to the answer choice.
  - 6 Expert Reviews (online survey): Experts answered the survey questions and commented on question accuracy, clarity, and alignment to goal. Of the questions on the final survey, 95% of expert responses were correct. Any questions with issues raised in the comments were either revised (5 Qs) or dropped (6 Qs).

- **Reliability**
  - Test-Retest (Correlation of percent correct between Spr10 & Fall09): ALL: r = 0.89 Excluding Q4,14,16 (due to distracter differences): r = 0.92
    - Commercially available tests typically range between 0.8 and 0.9.
  - Distracter Distribution: There were no significant differences among the answer choice distributions between Spr10 & F09. (Chi-square tests; p values range 0.27-0.45; no comparison available for Q4,14,16)

Examples of HACS Utility

**EVALUATING INSTRUCTIONAL TECHNIQUES**
The HACS has demonstrated how specific homework questions targeting misconceptions can lead to student learning gains on the assessment. E.g., a single homework question appears to increase student learning gain on Q2 (assessing students’ mental models of the overall organization of neuronal connections in the body).

**Q2 Gains**
- PRE Homework Q: 19%, 19%      POST Homework Q: 32%, 32%, 29%

**Comparing factual knowledge & deep understanding**
Commonly, students possess factual knowledge about biology without having a deep understanding of the underlying principles or ability to apply those principles. We have embedded several pairs of questions on the HACS that illuminate these issues. Here we present data from one of those pairs:

**Smooth Muscle Layering (LG3):** In Human Anatomy students learn about the arrangement of smooth muscle layers in the intestine. The reason why multiple layers are needed is that muscle cells can only contract in one direction. Thus if the muscle needs to contract in different directions, multiple layers with different cell orientations are required.

**While students are very good at memorizing the number of muscle layers in the intestine and even reasoning on the pretest that multiple layers would need to exist (Q14, top), most fail to learn the connection with how muscle cells work (Q17, bottom).**

<table>
<thead>
<tr>
<th>Q14</th>
<th>L.Gain: 75%</th>
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</thead>
<tbody>
<tr>
<td>P_pre=0.40</td>
<td>P_post=0.05</td>
</tr>
<tr>
<td>D_pre=0.26</td>
<td>D_post=0.34</td>
</tr>
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**Future Directions & Acknowledgments**

- **General use in Human Anatomy to examine effectiveness of course changes.**
- **Sharing results with other faculty.** For example, sharing results with the faculty teaching upper level courses: Physiology I/II, Neurophysiology, Biomechanics, etc.
- **Use selected questions on senior exit survey.**

Thank you to all the students who interviewed and/or took the survey in class and to the experts who gave feedback on the HACS.

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