

A Homeostasis Concept Inventory for Undergraduate Physiology

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Overview

The homeostasis concept inventory (HCI) is intended primarily to be used as a tool to evaluate instruction of undergraduate-level physiology and anatomy & physiology courses in life science departments. The HCI consists of 20 multiple-choice questions that focus on important critical components and constituent ideas from a validated homeostasis conceptual framework. The HCI has been rigorously validated in multiple contexts, and we present these contexts here. The questions have been validated using student interviews, faculty surveys and testing in physiology courses at a variety of institutions. The data presented here are from 670 students at 12 institutions in 8 states: 4 community colleges (199), 4 liberal arts institutions (123), 2 comprehensive regional universities (144) and 2 research universities (204).

Question Development

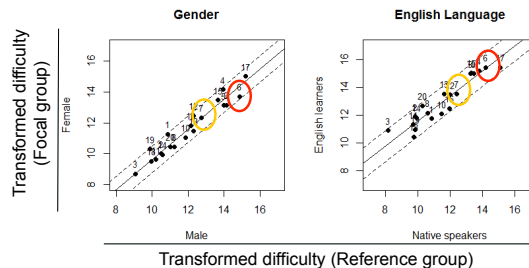
The HCI was developed with

- feedback from ~ 60 physiology faculty at conference presentations and workshops.
- assessment by 23 physiology faculty from a broad range of colleges, universities & medical schools through online surveys.
- student interviews (in WA, CA, WI, NY) for interpretation, language and content.
- student testing in undergraduate courses.

The instrument is readable by undergraduate students and has minimal jargon.

No English Language or Gender Bias

Figure 1. None of the 20 questions show any bias against gender or English language status. Each graph shows a scatter plot of transformed item difficulties for two groups (i.e. Delta plot). A point close to the diagonal means that given item operates similarly for the two groups given the knowledge level of individual student.



Difficulty and Discrimination

A range in difficulty (%correct) and discrimination (consistency between an item's performance and its relationship to a student's overall performance on the test) allows the HCI to be used as an assessment of a broad spectrum of undergraduate physiology students.

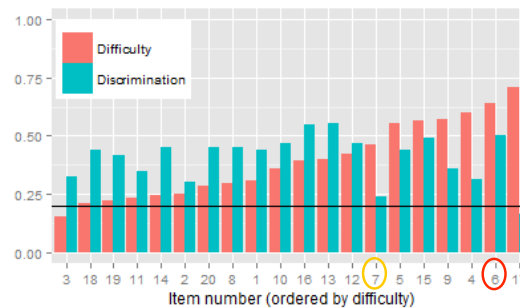


Figure 2. Difficulty and discrimination for the 20 questions in the HCI homeostasis concept inventory, ordered from least difficult item (question 3) on the left to the most difficult item (question 17) on the right. Bold line represents discrimination cut-off 0.2 usually assumed for items to perform well. The range in difficulty enables the HCI to assess a broad spectrum of undergraduate physiology students.

Question 6 is an example of an item with high discrimination and difficulty:

- ⑥ Normal body temperature of a healthy adult is about 37 degrees C. A fever occurs when the temperature set-point is elevated. Jasmine feels cold as she develops a fever because her body temperature at that time is
- A. less than 37 degrees C.
 - B. increasing above 37 degrees C.
 - C. less than the new set point temperature.

Question 7 has low discrimination, but was not omitted because it addresses a persistent misconception:

- ⑦ A homeostatic mechanism in the human body has a control center, also called an integrator, that is part of which organ system or systems?
- A. the endocrine system
 - B. the nervous system
 - C. the endocrine system, the nervous system, or both

Performance of Biology Majors and Nonmajors at Diverse Institutions

Figure 3. Probability density curves of total score (0-20) for 670 students. Curves describe relative likelihood of a given total score for each group.

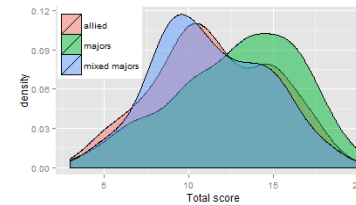


Figure 3A. Students taking physiology in courses for science majors scored higher than those in courses for allied health students and non-majors.

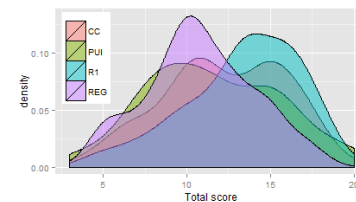


Figure 3B. The HCI can assess homeostasis understanding in students from a wide range of institutions: community colleges, primarily undergraduate institutions, research intensive and regional universities.

Conclusions

The HCI is valid and reliable. It can be used

- at a wide range of institutions.
- in courses for biology majors and non-majors.
- to assess students' conceptual understanding (formative assessment).
- to reveal and address misconceptions.
- to evaluate the effectiveness of teaching and learning structures.

References

- Adams, W.K. and Wieman, C.E. 2011. Development and validation of instruments to measure learning of expert-like thinking. *International Journal of Science Education* 33:1289-1312.
- Libarkin, J. 2008. Concept inventories in higher education science. Paper presented at the National Research Council Promising Practices in Undergraduate STEM Education Workshop 2, held 13-14 October 2008, in Washington, DC.