Carl Wieman Science Education Initiative
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DIFFERENCES IN STUDENT ATTITUDES TOWARDS BIOLOGY - FIRST YEAR VERSUS THIRD YEAR

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INTRODUCTION

A student's attitude toward a particular discipline may affect his or her motivation to excel (Osborne et al. 2003). In order to facilitate learning, it is therefore important that educators familiarize themselves with students' attitudes and associated behavior (e.g. effort, reasoning and problem solving skills) as well as the factors that may influence students' attitudes.

Student attitudes toward science have been investigated since the mid 1960s (Munby 1981; Ramsden 1998; Osborne et al. 2003; Reid 2006), when educators started seeing a decrease in enrollment in science courses and decreased interest in science and technology related disciplines among youth. As the association between attitudes and learning recently has become more clear new instruments and methods to measure the impact of courses on students' attitudes have been developed (Baldwin et al. 1999; Coll et al. 2002; Quinnell et al, 2005; Adams et al. 2006; Barbera et al. 2008).

In order to investigate the difference in attitude towards biology between students in first versus third year biology at the UBC we used a validated Biology Attitudinal Survey recently developed at UBC and University of Colorado. Our goal is to continue to study shifts in student attitudes within and among courses in biology as several courses are being redesigned and teaching techniques and classroom activities are being evaluated.

METHODS

The Survey

The survey consisted of 31 statements (seven categories determined by statistical factor analysis) that use a 5-point Likert scale (strongly agree to strongly disagree) and that was completed by students online (see the data collection section below for more information how the survey was administrated).

For a given statement, scoring was as follows: -1 if an expert or student chose strongly disagree or disagree; 0, if they chose neutral; and 1, if they chose agree or strongly agree. We then converted the responses to favorable or unfavorable (if a response was in agreement with the expert response it was denoted as favorable).

We compared two groups of students' responses (i.e., first year entering and third year exiting) to individual survey statements using unpaired Student's t-test analysis and p-values less than or equal to 0.05 were accepted as indicators for statistical significance. We compared % favourable (agreeing with the expert) for all statements (overall) and for each category. In order to compare student responses for each statement, we used a chi-square test.

METHODS (cont.)

Data Collection

The survey was administered in first (Biol 121) and third (Biol 304) year biology majors courses at UBC adhering to the Approved Board of Ethics protocol at UBC. Biol 121 is required for Life Science programs and is a survey course that covers introduction to genetics evolution and ecology. BIOL 304 is newly instituted course to be required of all Biology majors. It covers the fundamentals of ecology.

The number of students who completed the first year survey was 123 (i.e. ~50% of class) and third year survey was 283 (i.e. 72% of class).

The survey was administered in the first two and the last two weeks of Fall 2009 term online (Vista). Students were given 0.5-1.0% bonus marks for their participation.

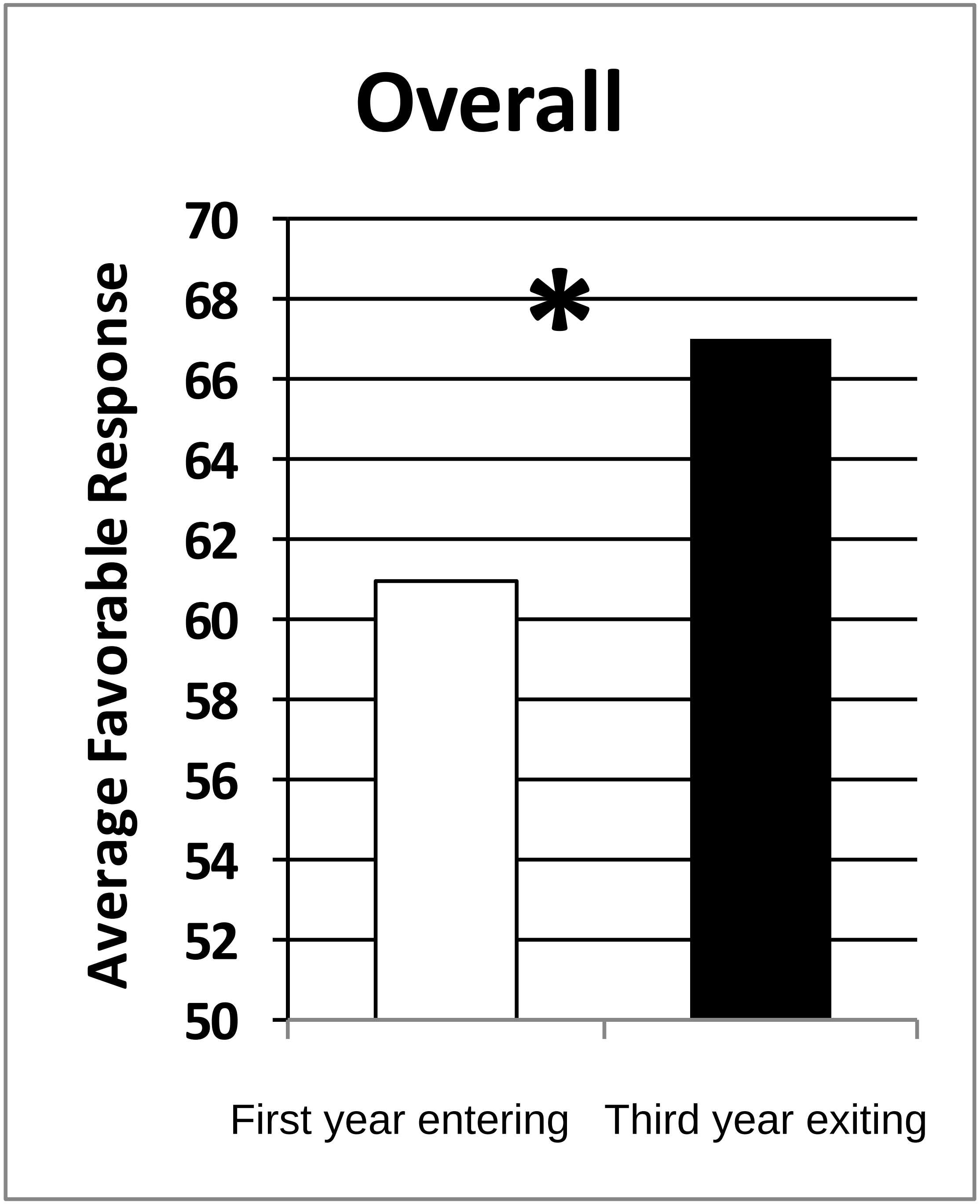

Figure 1: There was an overall statistically significant difference in student attitudes towards biology between first year entering and third year exiting students.

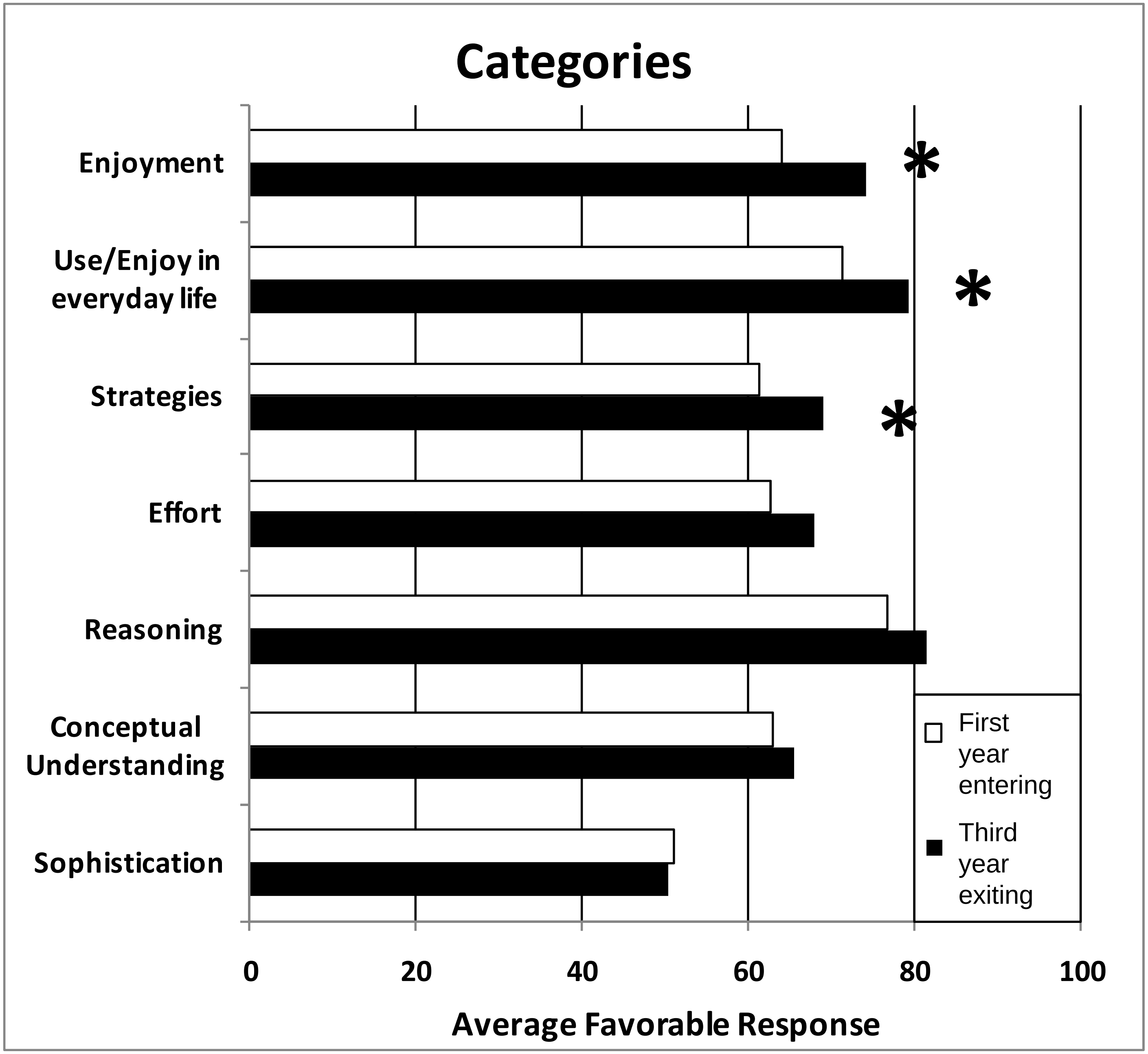

Figure 2: Three categories (enjoyment, use/enjoy in everyday life, and strategies) out of seven showed significant differences between first year entering and third year exiting students.

Table 1: Attitudinal Survey Results

Survey Statements	Category	Expert response	First year pre (% favourable)	Third year post (% favourable)	Difference (%)	p-value
To learn biology, I only need to memorize facts and definitions	Conceptual Understanding/Memorization	D	78	69	-9	<0.05
For me, biology is primarily about learning known facts as opposed to investigating the unknown	Conceptual Understanding/Memorization	D	46	59	14	<0.05
There is usually only one correct approach to solving a biology problem	Conceptual Understanding/Memorization	D	64	65	1	NS
Biological principles are just to be memorized.	Conceptual Understanding/Memorization	D	75	70	-5	NS
I want to study biology because I want to make a contribution to society.	Enjoyment	A	59	68	9	NS
If I had plenty of time, I would take a biology class outside of my major requirements just for fun	Enjoyment	A	72	72	0	NS
My curiosity about the living world led me to study biology	Enjoyment	A	67	82	15	<0.05
I enjoy explaining biological ideas that I learn about to my friends	Enjoyment/ PS - effort (combo of strategies plus enjoyment)	A	52	71	19	<0.05
If I get stuck on answering a biology question on my first try, I usually try to figure out a different way to answer it	PS - effort (combo of strategies plus enjoyment)/ Conceptual Undrsatnding/Memorization/ PS-strategies/ Reasoning	A	66	72	7	NS
There are times I think about or solve a biology question in more than one way to help my understanding.	PS - effort (combo of strategies plus enjoyment)/ PS-strategies	A	50	55	6	NS
When I am not pressed for time, I will continue to work on a biology problem until I understand why something works the way it does	PS - effort (combo of strategies plus enjoyment)/ Reasoning	A	82	76	-6	NS
When studying biology, I relate the important information to what I already know rather than just memorizing it the way it is presented	PS - effort (combo of strategies plus enjoyment)/PS- Strategies	A	69	75	6	NS
After I study a topic in biology and feel that I understand it, I have difficulty applying that information to answer questions on the same topic.	PS - sophistication (difficulty)	D	51	36	-15	<0.05
When I am answering a biology question, I find it difficult to put what I know into my own words	PS - sophistication (difficulty)	D	34	37	3	NS
If I don't remember a particular approach needed for a question on an exam, there's nothing much I can do (legally!) to come up with it.	PS - sophistication (difficulty)	D	50	51	1	NS

Table 1: Attitudinal Survey Results

Survey Statements	Category	Expert response	First year pre (% favourable)	Third year post (% favourable)	Difference (%)	p-value
If I get stuck on a biology question, there is no chance I'll figure it out on my own	PS - sophistication (difficulty)	D	66	63	-3	NS
If I want to apply a method or idea used for understanding one biological problem to another problem, the problems must involve very similar situations	PS - sophistication (difficulty)/ Conceptual Understanding/Memorization	D	32	33	1	NS
I do not expect the rules of biological principles to help my understanding of the ideas	PS - sophistication (difficulty)/ Conceptual	D	65	74	9	<0.05
I do not spend more than a few minutes stuck on a biology question before giving up or seeking help from someone else	PS - sophistication (difficulty)/ PS - effort (combo of strategies plus enjoyment)	D	59	57	-2	NS
To understand biology, I sometimes think about my personal experiences and relate them to the topic being analyzed	PS -strategies, including using real world/own language	A	62	73	12	<0.05
Learning biology that is not directly relevant to or applicable to human health is not worth my time	Use/enjoy biology in everyday life	D	79	76	-3	NS
It is a valuable use of my time to study the fundamental experiments behind biological ideas.	Use/enjoy biology in everyday life	A	49	70	22	<0.05
I enjoy figuring out answers to biology questions	Use/enjoy biology in everyday life / Enjoyment/ PS - effort (combo of	A	62	69	6	NS
The subject of biology has little relation to what I experience in the real world.	Use/enjoy biology in everyday life/ Conceptual Understanding/Memorization	D	78	81	3	NS
I think about the biology I experience in everyday life	Use/enjoy biology in everyday life/ Enjoyment	A	70	82	12	<0.05
Learning biology changes my ideas about how the natural world works	Use/enjoy biology in everyday life/ Reasoning	A	84	89	5	NS
Reasoning skills used to understand biology can be helpful to my everyday life	Use/enjoy biology in everyday life/ Reasoning	A	76	88	12	<0.05
Mathematical skills are important for understanding biology	NO CATEGORY	A	19	52	32	<0.05
The general public misunderstands many biological ideas.	NO CATEGORY	A	46	72	25	<0.05
Knowledge in biology consists of many disconnected topics	NO CATEGORY	D	71	67	-4	NS
It is important for the government to approve new scientific ideas before they can be widely accepted.	NO CATEGORY	D	27	29	2	NS

RESULTS

• There was an overall significant positive difference between the two student groups (students in third year demonstrating more expert-like thinking) (**Figure 1**), i.e. when all questions were included, a significantly larger number of students agreed with expert responses at the end of the third year course than in the beginning of the first year course.

• When questions were divided into categories, only three (enjoyment, use/enjoy in everyday life, and strategies) out of seven categories showed significant difference in the positive direction (towards expert-like thinking), no categories showed significant difference in the negative direction (away from expert-like thinking) (**Figure 2**).

• When questions were considered on their own, there was a significant difference for 12 out of 31 questions (**Table 1**).

DISCUSSION

While it is encouraging to see a significant difference in the positive direction for the following categories: enjoyment, use/enjoy in everyday life, and strategies, it is discouraging not to see a significant difference in other categories (i.e., effort, reasoning, conceptual understanding and sophistication).

We are not aware of other studies that have investigated differences in students' attitudes from lower level to upper level biology. However, our results agree to a certain degree with similar studies on attitudinal shifts (within a course) in physics where students make negative shifts (shifts towards novices) for questions in categories such as conceptual understanding, problem solving and effort (Adams et al. 2006) and in chemistry (Berg 2005). A number of recent studies (Adesoji 2008; Otero and Gray 2008; Redish and Hammer 2009; Brewe et al. 2009; Erdemir 2009), however, found positive shifts in categories such as problem solving, conceptual connections, sophistication and applied conceptual understanding.

Many authors hypothesize that a change in teaching methods to include interactive classroom activities will improve students' attitudes toward science, i.e. that an increase in student engagement during class will result in a larger number of students having favourable attitudes.

DISCUSSION (cont.)

For example, Brewe et al. (2009) used inquiry laboratories and class activities that focused on conceptual reasoning and problem solving, Erdemir (2009) and Adesoji (2008) implemented activities that focused on problem solving techniques, Ewing et al. (1987) implemented small group discussions and associated short readings outside the textbook , Redish and Hammer (2009) redesigned an entire course in order to focus classroom activities on conceptual change, and Otero and Gray (2008) implemented inquiry-based learning activities and activities where students were asked to reflect on their own learning.

It is however important to note that significant changes in attitudes often do not happen within the short term of a semester. Instead, programs that succeed to improve students' attitudes toward a discipline may experience small changes within courses, while significant changes occur over the course of the program. We therefore emphasize the benefit of assessing student attitudes in as many courses as possible in order to track changes.

We predict that the number of students in UBC's Life Science programs who adopt "expert-like" attitudes towards biology will increase when courses promote these attitudes throughout the program.

IMPLICATIONS FOR TEACHING AND LEARNING

• Assessment of changes in student attitudes facilitates the evaluation of course material and classroom activities.

• The benefit of assessing student attitudes is maximized if changes for each student can be tracked throughout a program, i.e. attitudinal surveys should be given in as many courses as possible.

• Students who adopt “expert-like” attitudes towards biology is expected to increase if:

1) Clear learning goals are set up for each course
2) Classroom activities that provide students with ample opportunities to learn and practice problem solving are designed and implemented for each learning goal, and
3) Assessments (i.e. quizzes and exams) are designed to measure the impact of such activities.

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