Dorner and Scott *Evo Edu Outreach (2016) 9:4*
DOI 10.1186/s12052-016-0055-x

Evolution: Education and Outreach

RESEARCH ARTICLE
Open Access

An exploration of instructor perceptions of community college students' attitudes towards evolution

Meredith A. Dorner[1*] and Eugenie C. Scott[2]

Abstract

Background: Faculty perception of student knowledge and acceptance of subject matter affects the choice of what to teach and how to teach it. Accurate assessment of student acceptance of evolution, then, is relevant to how the subject should be taught. To explore the accuracy of such assessment, we compared how community college instructors of life sciences courses perceive students' attitudes towards evolution with those students' actual attitudes towards evolution.

Results: The research had two components: (1) a survey of students of several biology classes at a community college about their acceptance of evolutionary theory and (2) interviews with the biology faculty teaching those classes about their perceptions of their students' attitudes towards evolution. Results of the study indicate relatively high levels of acceptance of evolution among community college students at this West Coast institution. We also found that community college instructors of life sciences courses varied in accuracy of their perceptions of their students' attitudes towards evolution–but not systematically. Although one professor assessed each class quite accurately, the other two professors frequently underestimated the acceptance of evolution among their students.

Conclusions: Errors in perception seemed independent of whether the class was composed of majors, nonmajors, or a combination. Clearly, in our sample there is much idiosyncrasy regarding community college instructor accuracy concerning student opinions about evolution.

Keywords: Higher education, Evolution acceptance, Teacher perception, Evolution, Creationism

Background

Evolution is a deeply unifying theme in biology, to the point that "nothing in biology makes sense except in the light of evolution" (Dobzhansky 1973). Both scientists and science educators affirm the importance of evolution in science education, particularly the understanding of evolution as central to education in biology (American Association for the Advancement of Science 1990; National Academy of Sciences 1999; Sager 2008; Wiles 2010). Despite the overwhelming agreement on and support for evolution among scientists (Alters and Alters 2001; Pew Research Center 2015; Wiles 2011), there is a disconnect between the views of scientists and those of the public regarding the scientific credibility of evolution (Campbell and Daughtrey 2006). In 2014, the Pew Foundation surveyed both scientists and the general public, asking whether "Humans and other living things have evolved over time" or "have existed in their present form since the beginning." Fully 98 % of scientists surveyed agreed that humans have evolved, while only 65 % of US adults agreed. Most surveys of the general public report that 45–50 % of American adults accept evolution; the recent Pew results are much higher than most studies (Miller et al. 2006; Gallup 2014). Nonetheless, the difference between the almost unanimous agreement among scientists as to the validity of evolution and the considerably lower public support is striking (Pew Research Center 2015).

*Correspondence: dorne101@mail.chapman.edu
[1] College of Educational Studies, Chapman University, One University Drive, Orange, CA 92866, USA
Full list of author information is available at the end of the article

Not only is there a sharp difference between scientists and the general public, but that difference is not fully appreciated by the public: 29 % of U.S. adults are unaware of the high level of acceptance of evolution in the scientific community, believing that scientists do not agree that humans evolved over time (Pew Research Center 2015). This further illustrates the disconnect between what scientists think and what the general public thinks. To begin to address this problem, it is important to understand how students (including community college students) view this issue.

Much research has been devoted to trying to understand why evolution acceptance is low in the United States. Several factors associated with evolution acceptance or rejection have been identified, including scientific knowledge and understanding, critical thinking skills, social and emotional factors, religious factors, and demographic variables (for a summary and discussion see Wiles and Alters 2011 and Wiles 2014). For example, acceptance of evolution can be positively correlated with level of education, years of education, and college degree attainment (Brumfiel 2005; Gallup 2014; Heddy and Nadelson 2012; Lord and Marino 1993; Pew Research Center 2013). In contrast, religiosity, the degree to which religion is important to people's lives (Pew Research Center 2008), tends to be negatively correlated with evolution acceptance (Alters and Alters 2001; Downie and Barron 2000; Heddy and Nadelson 2012, 2013; Miller 2008; Rissler et al. 2014; Woods and Scharmann 2001).

Previous studies have explored the views of the general public, high school students, four-year college students, high school teachers, or post-secondary instructors. Students at four-year colleges show a higher acceptance and/or knowledge of evolution compared to the general public (Carter and Wiles 2014; Hokayem and BouJaoude 2008; Wiles and Alters 2011; Winslow et al. 2011), and similarly, pre-college teachers also accept evolution at higher rates than the general public (Deniz and Donnelly 2011; Rutledge and Warden 1999). Based on our literature search, however, there are few studies published that have examined community college student attitudes towards evolution and creationism.

This gap in the literature is a significant omission both because of the large number of community college enrollees and the broad spectrum of the general population represented in these institutions. As of fall 2012, 12.8 million students were enrolled in the 1132 community colleges across the nation (American Association of Community Colleges 2014). The age of community college students stretches across a range from the traditional college starting age of 18 through late adulthood, with 57 % of students being between the ages of 22 and 39 (American Association of Community Colleges 2014).

Community college students also vary greatly in scholastic preparation, and have a wide variety of goals for their post-secondary education, ranging from vocational education to preparation for additional education at the baccalaureate level. Because community colleges serve students pursuing continuing education as well those beginning higher education, community college students may enter with a different level of preparation than traditional 4-year college students. For example, of the 1.5 million students enrolled in community colleges in California in fall 2013, 10 % already possessed bachelor's degrees, 75.8 % were high school graduates, and 3.3 % were not high school graduates (Education Status Summary Report 2014). In addition, many of these students enrolled seeking certificates rather than degrees (Education Status Summary Report 2014).

There are only a few studies of community college student attitudes towards evolution. McKeachie et al. (2002) examined the effects of taking a biology course on community college student attitudes towards evolution. The researchers administered a pretest (a four question survey) to 60 students in an introductory biology course; 28 of those students completed the posttest survey. At the beginning of the semester, most students stated they did not know enough about evolution or the Bible to accept either. At the end of the course, students reported changes in the direction of acceptance of evolution; however, McKeachie et al. (2002) suggested this result was biased because a disproportionate number of the students who either failed to complete the posttest or dropped the class were those who did not accept evolution. In any case, the small sample size of this study limits the generalizability of the results.

Flower (2006) surveyed 342 students in both majors and nonmajors biology classes at a community college with regard to their attitudes towards evolution and creationism. Of the nonmajors students ($n = 242$), 58 % felt that evolution was scientific and well supported by evidence while 49 % acknowledged that species (including humans) evolved from earlier species. A large proportion of the majors' biology students (73 %, $n = 70$) agreed that evolution was well supported by evidence and 57 % agreed that all species evolved from earlier species. The results of this study (and other studies not reported here) suggest that students who are enrolled in majors biology courses have a higher rate of acceptance and/or understanding of evolution than those who are enrolled in nonmajors courses.

For many students, a 2-year college is the first (and sometimes the last) place that they will learn about evolution in a formal learning environment. The relative lack of research on community college students' attitudes towards evolution and their distinctiveness among post-secondary students suggest that it is important to attain a better understanding of their views. This led us to our first research question: what are community college students' attitudes towards evolution? Based on characteristics of the community college student universe, as well as the extant studies on community college student attitudes towards evolution, we hypothesized that community college student attitudes towards evolution will closely mirror that of the general public.

We also wanted to compare the perceptions of students' attitudes towards evolution held by community college instructors of life sciences courses with those students' actual attitudes towards evolution. How accurately do community college professors perceive/predict their students' attitudes towards evolution?

Research suggests distinct differences between how faculty and students perceive evolution. Paz-y-Miño's and Espinosa's (2011) comprehensive survey of both students and faculty at universities and colleges throughout New England predictably found that significantly more faculty accepted evolution than students. Those researchers also found that students typically have a poor understanding of the science behind evolution.

Are professors aware of differences between their acceptance of evolution and that of their students? This question does not seem to have been answered in the literature. The authors could find no studies specifically examining professor perceptions of students' acceptance of evolution or any other scientific concept. Yet it seems indisputable that education is more effective when professors and teachers (for the purposes of this study, we refer to instructors of K-12 students as 'teachers' and those at the college level as 'professors') have a clear and accurate understanding of students' knowledge and attitudes towards the subject. Larkin (2012) studied 14 preservice science teachers and found they all recognized the importance of student knowledge and attitudes (including misconceptions) in the learning process. An instructor might approach the learning process differently if they were aware of students holding a high level of antipathy towards a subject. In the case of evolution, in such a situation, a teacher or professor might consider spending more time on placing evolution within the context of biology as a whole, explaining easily observed examples (e.g., the evolution of antibiotic resistant bacteria), or focusing on evolution's power to explain diversity of nonhuman life on the planet before moving onto the more controversial topic of human evolution.

Lacking evidence of research on the matter of instructor perception of student knowledge and opinions on evolution, we broadened the scope of our review of the literature to include any studies we could find that looked at pre-college teacher or professor perception of any scientific concept in relation to student perception of said scientific concept or performance. More research has been conducted on teacher vs. student understandings than on professor vs. students, and most of the studies indicate a disconnect between the people in front of and behind the podium as to what is happening in the classroom.

For example, Slatter (2009) found that secondary school teachers perceived that they were implementing more critical thinking in their science classes than the students perceived. Another study found that teachers and their tenth grade students perceived their learning environments differently and suggested that understanding this disparity in perception is essential for creating optimal learning environments (Könings et al. 2014).

Student and teacher perceptions of scientific material do not always align well. For example, Şahin and Köksal (2010) examined ninth graders' and teachers' perceptions of the nature of science and found that many areas of misunderstanding were shared by both students and teachers. Additionally, students and teachers did not agree on the importance of understanding the nature of science; students ranked other types of science knowledge as more important than understanding the nature of science while teachers reported the opposite.

The differences between what teachers think and what students think is exemplified further by a study which explored student and teacher perceptions of the amount of emphasis of evolution in high school biology classes. Moore (2007) surveyed first-year college students and public high school biology teachers, and found that teachers and students had different perceptions of how much evolution was emphasized in high school: students remember much less emphasis on evolution and more emphasis on creationism than teachers reported. It is important to note, however, that in this study, the students surveyed were not the actual students of the teachers surveyed, merely a representative sample within the state of Minnesota.

In an additional study, Sadler et al. (2013) assessed eighth grade students' understandings of specific science standards and asked teachers to predict how well their students would perform. On the standard addressing the statement "Species diversity arises from evolution," teachers predicted that students would perform nearly twice as well as they actually did. These results suggest a disconnect between what teachers think their students know about evolution and what students actually know.

Given that there often is a disconnect between teachers' perception of classroom learning and actual learning, we would not be surprised to find that the community college professors we surveyed similarly had incorrect perceptions of student acceptance of evolution.

Post-secondary instructors spend less time with students than high school teachers and thus have less opportunity than high school teachers to develop personal relationships with students and the increased communication such relationships encourage. But the dearth of research on this topic suggests our contribution to this question at this point should be descriptive: how accurate *are* community college faculty perceptions of student acceptance of evolution? Our results could suggest more specific hypotheses for further research.

Methods

Because we required both quantitative as well as descriptive data, we employed a mixed methods approach for this study. This provided us a more comprehensive view of participant understanding than using only one method (Creswell 2009). Our approach was to combine quantitative surveys with qualitative interviews to provide a broader context, especially for our second question.

Following Institutional Review Board approval from a community college on the West Coast, we obtained permission from three college biology instructors to interview them and survey students in several of their classes. In order to ascertain student attitudes towards evolution we administered the Measure of Acceptance of the Theory of Evolution (MATE) instrument (Rutledge and Warden 1999). The MATE was chosen because its validity and reliability have been successfully measured several times (Donnelly et al. 2007; Rutledge and Sadler 2007; Rutledge and Warden 1999). The MATE contains questions that address students' knowledge and beliefs regarding evolution.

We surveyed 241 students in 11 courses taught by three instructors. Participation in the study was voluntary and students were required to provide informed consent before completing the survey. Completing the MATE took 15 min or less and students were only required to do so once, in the last full week of classes.

Courses surveyed ranged from introduction to biology (taken by both nonmajors and beginning biology major students), to specific courses for majors, including cell biology, organismal biology, and botany. We also surveyed one section of marine biology, a class taken almost exclusively by students not majoring in biology. Based on this information, for the purposes of analysis, we classified each course as being composed of majors, nonmajors, or mixed.

Data were transformed to account for negative scoring questions of the MATE. The data were then analyzed using SPSS to calculate standard central tendency measures (mean, standard deviations). We also calculated Cronbach's alpha to examine reliability of the MATE as applied to this sample of community college students. We also performed a one-way analysis of variance to examine differences between evolution acceptance among students in majors, nonmajors, and mixed courses.

In order to explore faculty perceptions of their students' attitudes towards evolution, one of the authors taped interviews of faculty separately in their offices. These interviews lasted fewer than 30 min. Interview data and notes taken during the interviews were analyzed and generalities emerged from the data.

Results

Of the 241 students sampled, we excluded from analysis 12 students because they did not fully complete the MATE instrument.

With regard to our first research question about community college students' attitudes towards evolution, across all 229 students, the average score on the MATE was a relatively high 81.4 (±14.3) out of a possible 100 points, as seen in Fig. 1. In addition, the distribution was skewed towards high acceptance: 69.4 % of students accepted evolution at a high or very high level (i.e., they scored a 77 or higher on the MATE). A one-way analysis of variance revealed that there were no significant differences between the acceptance levels in students enrolled in a non-majors course, majors course, or mixed course ($F = 2.237$, $DF = 228$, $p = 0.308$). In addition, there were no significant differences in acceptance of evolution between students of different instructors ($F = 2.384$, $DF = 228$, $p = 0.094$). The results of the 229 MATE scores support a Cronbach's alpha of 0.944, suggesting the MATE is reliable in this survey of community college students.

With regard to our second research question of how faculty perceive their students' acceptance of evolution, certain common themes emerged in the three faculty interviews. All professors indicated that they taught evolution in all of their courses, regardless of the specific content focus. More specifically, Professors Orville and Jones (pseudonyms) reported that in courses typically taken by both majors and nonmajors, they spent 2 weeks specifically covering evolution and evolutionary mechanisms. In his primarily nonmajors class, Professor Jones spends only 1 week specifically covering evolution, while in his majors classes, he initially spends 2 weeks on evolution, and another week on the subject later in the semester. Professor Orville reported spending approximately 4–5 weeks on evolution in her majors biology course (the same course that Professor Jones teaches). Professor Ronson (pseudonym) maintained that evolution was an ongoing theme in his courses.

All three professors stated that they do not teach any form of creationism (including intelligent design) in any of their biology classes. Furthermore, each professor

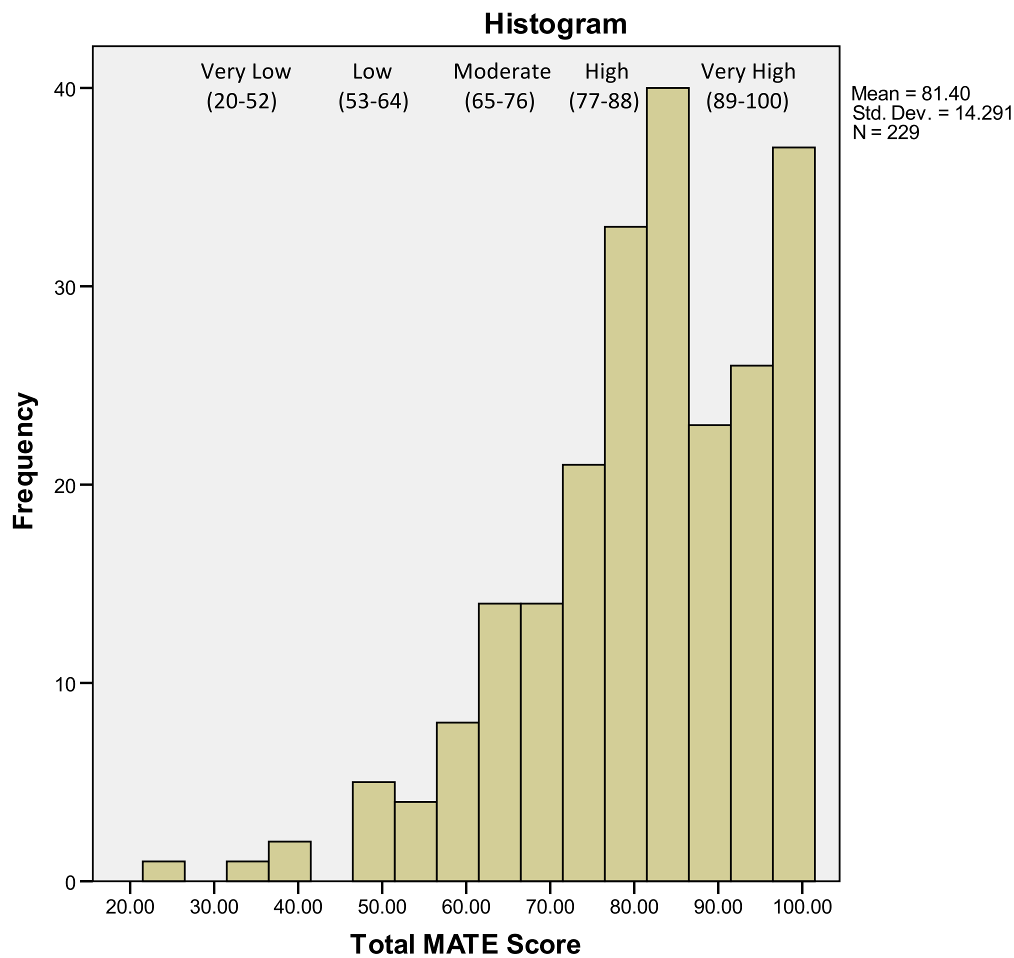

Fig. 1 The frequency distribution of all total MATE scores, across all course sections surveyed

asserted that in the past semester, none of their students have asked any questions about creationism in their classes. Professor Ronson attributed this lack of questions in part to the fact that his classes are taught with the underlying message that what he is presenting is based on evolution.

In every class, students asked questions about evolution, but the professors explained that those inquiries are usually about gaining greater understanding of how evolution works, clarification on details, how evolution relates to other subjects in the course, and exam preparation. Professors Ronson and Orville indicated having some students who asked some questions about the validity of evolution in their majors biology courses, but these few questions were typically asked before completing the evolution learning unit.

When asked about student attitudes towards creationism and evolution in his classes, Professor Jones reported that evolution does not seem to be a concern for most of his students. He believes that he has students who are creationists but that they are not overt about their views. He cited the fact that the number of creationist challenges and questions that come up in his classes have decreased significantly over the last 10 years. Professor Ronson also contended that he has creationist students but they do not voice their concerns. He hypothesized that his students are largely bimodally distributed, with many accepting evolution and many rejecting it, with only a small number who are unsure.

In Table 1, the individual course scores are broken down by instructor and course taught. These data are further grouped by degree of acceptance of evolution in Table 2. Rutledge (1996) divides scores on the MATE into five categories: Very low acceptance, low acceptance, moderate acceptance, high acceptance, and very high acceptance. high and very high acceptance can logically be indicators of acceptance of evolution, and Low and very low acceptance can be indicators of rejection of evolution, but the "moderate acceptance" category is problematic. Upon examination of Rutledge's (1996)

Table 1 Data across all sections surveyed

Professor	Course	Initial enrollment	Number enrolled	Number sampled	Mean	Standard deviation	Median	Mode	Range	Minimum score	Maximum score
Jones	*A*	63	58	31	79.8	16.0	83.0	84	61	39	100
	A+	40	29	10***	81.9	16.5	84.0	N/A	45	54	99
	B	25	23	16*	79.1	19.4	90.0	90	66	34	100
	<u>D</u>	26	24	17**	76.9	18.8	81.0	83	76	24	100
	F	51	33	21*	83	7.6	84.0	80	32	66	98
Orville	*A*+	44	34	22****	77.8	11.3	77.5	80	40	60	100
	C	26	22	18	84.5	11.9	84.5	84	42	58	100
	F	52	50	36*	78.8	13.7	80.0	98	51	47	98
Ronson	E	44	40	22	81.6	16.2	87.5	100	52	48	100
	G	45	36	30	86.3	12.8	87.5	100	52	48	100
	H	30	23	18	84.9	12.5	88.5	100	38	62	100

Initial enrollment was recorded at the time of the first census, approximately 3 weeks into the course while number enrolled and number sampled refer to the number of students in the class at the time of study

+, online course; *, each person sampled but excluded from analysis because he/she did not fully complete the survey; course letters in italics are those taken by both majors and nonmajors, underlined are those taken primarily by nonmajors

Table 2 The distribution of scores in each section, rated on the level of acceptance of evolution using Rutledge's (1996) guidelines

Professor	Course	% very low acceptance	% low acceptance	% moderate acceptance	% high acceptance	% very high acceptance
Jones	*A*	9.7	6.	12.9	38.7	32.3
	A+	0.0	14.3	14.3	28.6	42.9
	B	6.7	26.7	0.0	13.3	53.3
	<u>D</u>	6.7	13.3	13.3	46.7	20.0
	F	0.0	0.0	15.0	65.0	20.0
Orville	*A*+	0.0	16.7	27.8	33.3	22.2
	C	0.0	5.6	16.7	38.9	38.9
	F	5.7	11.4	22.9	34.3	25.7
Ronson	E	4.6	9.1	18.2	27.3	40.9
	G	3.3	0.0	23.3	23.3	50.0
	H	0.0	5.6	22.2	22.2	50.0

Rutledge (1996) established categories of acceptance of evolution based on specific MATE scores: very low (20–52), low (53–64), moderate (65–76), high (77–88), very high (89–100). Courses with the same letter represent the same course, (e.g., A is is "mixed nonmajors/majors", the same course regardless of who teaches it)

+, online course; italic course letter are those taken by both majors and nonmajors, underlined are those taken primarily by nonmajors

dissertation, we could find no justification for the values assigned to each scoring category. Because our results are skewed towards the higher acceptance of evolution—the average across all classes (as shown in Fig. 1) is 81.4, falling into the "high" category—and because this part of our analysis is largely descriptive, we report the data with and without the "moderate" category in Table 3. In the discussion of the accuracy of a professor's prediction of student acceptance of evolution, we include students who scored in the moderate acceptance range as accepting evolution.

Instructors' accuracy at predicting the level of acceptance of evolution in their classes varied as seen in Table 3. We considered professors to be accurate if they were able to predict the degree of acceptance of evolution among their students within 10 % of the actual acceptance. Professor Ronson underestimated the acceptance of evolution in all of his classes while Professor Orville's predictions were very accurate. Professor Jones's accuracy varied by class. When asked about the basis for their predictions, each professor offered different reasons. Professor Ronson explained that he expected the students in his E (introduction to biology for majors) class to have the lowest levels of acceptance because the class may represent the first time they have been exposed to evolution in detail. He predicted that 40–50 % of students in the E class would accept evolution—but 86 % did. He believed

Table 3 The professors' predictions of levels of acceptance in each course and the actual level of acceptance based on the summation of percentages of high and very high levels or moderate, high, and very high levels of acceptance

Professor	Course	Predicted acceptance (%)	Actual acceptance (very high, high and moderate) (%)	Actual acceptance (very high and high) (%)
Jones	*A*	80	83.9	71
	A+	80	85.7	71.4
	B	75–80	66.7	66.7
	<u>D</u>	75–80	80	66.7
	F	66	100	85
Orville	*A+*	80–85	83.3	55.6
	C	90–95	94.5	77.8
	F	85–90	82.9	60
Ronson	E	40–50	86.4	68.2
	G	60–70	96.7	73.3
	H	60–70	94.4	72.2

+, online course; italic course letter are those taken by both majors and nonmajors, underlined are those taken primarily by nonmajors

that his other classes should have higher rates of acceptance because they will have taken more science classes and would be likely to take the idea more seriously. The G and H classes, which are taken after E, do exhibit higher levels of acceptance than E—about 90 %. However a t test revealed that the difference between the more advanced classes and the introductory E class is not statistically significant ($p = 0.246$). All three classes exhibited a relatively high level of acceptance.

Professor Orville's estimates were accurate for all classes. She also provided a more specific breakdown of predictions about evolution acceptance for her students. She predicted that in her majors classes (C and F), 50 % of her students fully accepted evolution while 40 % had some conflicting ideas and 5–10 % seriously objected to evolution. Her nonmajors class predictions were similar, but she predicted more uncertainty and rejection of evolution. Comparing these predictions to the results in Table 2, most students in her classes do accept evolution, and indeed, there is a difference in the number of students who accept it at a very high, high, or moderate level, as she predicted. In addition, there are very few (0–5.7 %) who accept evolution at a very low level and few who exhibit low acceptance (5.6–16.1 %). Professor Orville's predictions were primarily based on her belief that in her C and F classes for majors, students have already taken biology and been introduced to evolution. She inferred that those students would be more likely to understand the nature of science and evolutionary biology. She did, however, predict that her F class might show a lower level of evolution acceptance because it is a very culturally diverse class and the students appear to have strong religious and cultural ties, some to traditions hostile to evolution. This class did in fact exhibit the lowest level of evolution acceptance as seen in Tables 2 and 3, and was the only Orville class to have students score in the lowest category of evolution acceptance.

Finally, as shown in Table 3, while Professor Jones accurately predicted the acceptance level in three of his five classes, he inaccurately predicted that his nonmajors (D) and mixed majors/nonmajors courses' (A and B) students would exhibit more acceptance of evolution than students in his majors classes (F). Professor Jones contended that those students in his mixed and nonmajors courses had plenty of opportunity to ask questions about evolution's validity and yet they did not make inquiries. He inferred that their acceptance levels must be high. Additionally, he predicted that the students in his majors course (F) would be less likely to accept evolution because they asked more questions about evolution in class. Furthermore, like Professor Orville, he suggested that the culturally diverse nature of class F might indicate more conservative religious values and that those students might be less inclined to speak out against evolution. Professor Jones asserted that as biology majors, they would be less likely to ask questions that they would perceive might put their grades in danger as they would consider themselves to be "serious" students. In contrast, results indicate that the vast majority of his students in his majors' course accept evolution and in fact none wholly reject it (Table 2).

Discussion

Our first hypothesis, that community college students will be similar in evolution acceptance to the United States general public, was not supported by our data. We found these community college students' acceptance of evolution exceeded that of the general public. In every class, at least 20 % of the students exhibited very high acceptance of evolution and in all classes, over 55 % of the students reported either high or very high acceptance, and the average MATE score (81.40) falls within the level of high acceptance. This is a considerably higher level of acceptance of evolution than the general public reports (Gallup 2014); it is comparable to acceptance rates seen at 4 year colleges. Carter and Wiles (2014) reported 60 % of college students surveyed scored at a high or very high level of acceptance on the MATE, whereas ours ranged from 55 to 85 %.

As discussed, community college students generally are more representative of the public as a whole, having a broader range of ages, socioeconomic levels, ethnicities, and other demographic characteristics. Students attending this community college, however, may have a somewhat different profile than most community colleges. The majority of students at the college surveyed come from a high income area with high levels of education. Specifically, as of 2013, in the city in which the community college is located, and from which many of students come, 96.3 % of the adult population over age 25 graduated from high school, while 64.9 % graduated from college (USA Census 2015). Additionally, the median annual household income was over $90,000. In comparison, the national rate of high school graduation is 86 % and the median household income is just over $53,000 (USA Census 2015). This increased level of education and income suggests that the student population surveyed may not be a representative sample of other areas of the country. Since education level is usually positively correlated with evolution acceptance (Brumfiel 2005; Lord and Marino 1993), these students may represent a skewed sample. For example, of the 1668 students enrolled in Life Sciences class at this community college in the semester in question, 5.6 % already possessed bachelor's degrees, 1.5 % had already earned an associate's degree and only 1.6 % had not earned a high school diploma or equivalent (InForm 2014).

The timing of the administration of the survey (the last week of classes), also may have influenced the results. Several studies have demonstrated a positive correlation between instruction in evolution and nature of science with an increase in the acceptance of evolution (Carter and Wiles 2014; Wiles and Alters 2011). Each of the students in this study had already experienced a significant amount of instruction in evolution (as claimed by the three professors) before taking this survey. Future research should consider administering the survey before explicit instruction in evolution takes place, in order to gain a sense of students' attitudes upon entering the class.

Additionally, because the sampling occurred so late in the semester, some students who already dropped the class may have done so in part because of their attitudes towards evolution. We also only surveyed students who were present on the day of the survey and as is apparent in Table 1, some students were not present on that date. There were varying degrees of attrition between the classes' initial enrollment and the number enrolled at the time of sampling. It is possible that the views of the students who were absent might have affected the results had they been included.

When examining the difference between students with and without a biology major, Paz-y-Miño and Espinosa (2009) found statistically significant differences in evolution acceptance between biology majors and nonmajors students, which we did not find in this study. Additionally, in contrast to Flower's (2006) earlier work, we found no significant difference in the level of acceptance of evolution between students enrolled in biology majors and nonmajors courses. It is important to note that we were able to survey only one small nonmajors class which limits the generalizability of our results. We did however, find the largest range of scores on the MATE in the mixed and nonmajors courses suggesting there may be more variation in the acceptance of evolution in those courses. However, because this group was also the largest group surveyed, the increase in variation may be an artifact of the increase in sample size. This presents an opportunity for further research, with larger samples sizes, conducted earlier in the semester to examine this trend more fully.

Regarding our second research question, our results suggest that there is much individual variation in how accurately faculty infer the acceptance of evolution among their biology students. Two of three professors interviewed were not consistently able to accurately predict the degree of evolution acceptance among their community college life sciences students. Furthermore, the observed errors were not systematic (i.e., in overestimating or underestimating acceptance, accuracy with respect to course type [majors or nonmajors], size of class, or other variables we could identify). Professors Orville and Jones were the most accurate at estimating the acceptance of evolution among their students while Professor Ronson underestimated the amount of acceptance among his students. Interestingly, if we classify those students who scored in the "moderate acceptance" range as not accepting evolution, Professors Orville and Jones overestimate their students' level of acceptance, and Ronson is even more inaccurate.

Our results are compatible with other studies finding a discrepancy between student and teacher perception. The disconnect between what professors believe and what students actually think is relevant to learning and instruction; research suggests teacher perceptions influence both teaching practices and student performance. Pas and Bradshaw (2014) determined that elementary teachers who rated their teaching environment positively were more likely to view various classroom experiences more favorably.

With regard to subject matter, Khan and Din (2014) examined the relationship between teacher perceptions and knowledge, and student learning and performance in tenth grade physics students. They found that in classes where teachers viewed their students as more active in asking questions, those students performed better on assessments. In addition, physics teachers who had a better understanding of physics believed their students performed better on assessments. These results suggest that both teachers' content knowledge and perceptions of students may affect student success.

Furthermore, Akar and Yildirim (2011) surveyed high school biology teachers and found similar connections between their beliefs and perceptions about their students and the use of teaching methods and instructional tools. Teachers who perceived their students as actively participating in class were more likely to use discussion techniques. Also, teachers who perceived their students as more interested in the material were more likely to use demonstrations in class. Thus, teacher perceptions of student interest and knowledge can affect the way teachers teach. In the current study, it is clear that teacher perceptions do not necessarily reflect student attitudes towards evolution. Future research could delve into whether the perceptions held by community college instructors affect their teaching.

Limitations

Some of the limitations of this study have already been discussed (e.g., time of sampling in the semester and atypical demographic characteristics of the sample). We should also note that sample size is a limitation in this study: we were limited to interviewing three professors. A similar study with a larger sample of professors could clarify the connection between professor perceptions and student attitudes towards evolution. This is especially important as we obtained results suggesting that idiosyncrasies among professors may affect how accurately they perceive their students' attitudes towards evolution. A larger sample of professors and an examination of individual characteristics of those professors might provide more conclusive results that would be more generalizable. In addition, collecting data from multiple community colleges, with a larger group of students across a variety of regions would be valuable for further ascertaining community college student attitudes towards evolution. Finally, professors self-reported the amount of evolution coverage in each of their classes. Given that self reporting can be flawed, future research should include other means of measuring how much evolution is taught in class (e.g., comparing student and instructor reports, analyzing syllabi and course materials, measuring student understanding of evolution based on instruction).

Conclusion

The results of this study suggest that acceptance of evolution among some community college students may be higher than among the general public and more in alignment with acceptance levels found at 4 year colleges and universities. In addition, professors may idiosyncratically underestimate or overestimate the acceptance of evolution in their life sciences courses, which research suggests can affect teaching methods and content. We suggest that more research is necessary to determine community college students' attitudes towards evolution and the accuracy of instructors' perceptions of those attitudes.

Authors' contributions

MAD collected data, conducted data analysis, and wrote the first draft of the manuscript. ECS provided editorial and research design guidance as well contributed text to the final manuscript. Both authors read and approved the final manuscript.

Author details

[1] College of Educational Studies, Chapman University, One University Drive, Orange, CA 92866, USA. [2] National Center for Science Education, 420 40th Street Suite 2, Oakland, CA 94609-2688, USA.

Competing interests

The authors declare that they have no competing interests.

Received: 20 October 2015 Accepted: 14 April 2016
Published online: 27 April 2016

References

Akar EO, Yildirim A. Influence of teacher perception of students on teaching high school biology. Eurasian J Educ Res. 2011;44:19–32.

Alters BJ, Alters SM. Defending evolution in the classroom: A guide to the creation/evolution controversy. Boston: Jones and Bartlett Publishers; 2001.

American Association for the Advancement of Science. Science for all Americans. In: Science for all Americans Chapter 1: the nature of science. New York: Oxford University Press. http://www.project2061.org/publications/sfaa/online/chap1.htm (1990). Accessed 20 July 2014.

American Association of Community Colleges. 2014 Fast fact sheet. http://www.aacc.nche.edu/AboutCC/Pages/fastfactsfactsheet.aspx (2014). Accessed 10 Oct 2014.

Brumfiel G. Intelligent design: who has designs on your students' minds? Nature. 2005;434:1062–5.

Campbell JA, Daughtrey T. Teaching the contexts: why evolution should be taught as an argument and how it might be done. Relig Educ. 2006;33(3):14–39.

Carter BE, Wiles JR. Scientific consensus and social controversy: exploring relationships between students' conception of the nature of science, biological evolution, and global climate change. Evol Educ Outreach. 2014;7(6). http://www.evolution-outreach.com/content/7/1/4.

Creswell JW. Research design: qualitative, quantitative, and mixed methods approaches. Thousand Oaks: Sage Publications; 2009.

Deniz H, Donnelly LA. Preservice secondary science teachers' acceptance of evolutionary theory and factors related to acceptance. Rep Natl Cent Sci Educ. 2011;31(4). http://reports.ncse.com/index.php/rncse/article/viewFile/50/43.

Dobzhansky T. Nothing in biology makes sense except in the light of evolution. Am Biol Teach. 1973;35(3):125–9.

Donnelly LA, Kazempour M, Amirshokoohi A. Student perceptions of evolution instruction: Understanding, acceptance and learning experiences. Proceedings of the 2007 annual conference of the national association for research in science teaching. New Orleans: National Association for Research in Science Teaching; 2007.

Downie JR, Barron NJ. Evolution and religion: attitudes of Scottish first year biology and medical students to the teaching of evolutionary biology. J Biol Educ. 2000;34:139–46.

Education status summary report. Retrieved from California Community Colleges Chancellor's Office—Data Mart on October 7, 2014. http://datamart.cccco.edu/Students/Education_Status_Summary.aspx.

Flower P. Knowledge of and attitudes toward evolution in a population of community college students. Forum on public policy. 2006. www.forumonpublicpolicy.com/archive06/flower.pdf. Retrieved 5 Oct 2014.

Gallup. In U.S., 42 % believe creationist view of human origins. 2014. http://www.gallup.com/poll/170822/believe-creationist-view-human-origins.aspx. Retrieved 7 Oct 2014.
Heddy BC, Nadelson LS. A global perspective of the variables associated with acceptance of evolution. Evol Educ Outreach. 2012;5:412–8.
Heddy BC, Nadelson LS. The variables related to public acceptance of evolution in the United States. Evolution: Education and Outreach. 2013;6(3). http://www.evolution-outreach.com/content/6/1/3.
Hokayem H, BouJaoude S. College students' perceptions of the theory of evolution. J Res Sci Teach. 2008;45(4):395–419.
InForm data warehouse. Life sciences and technologies profile report. 2014. https://sharepoint.socccd.edu/. Retrieved 18 Dec 2014.
Khan M, Din MN. Students' conceptual thinking and teachers' perceptions about their classroom performance in physics. J Res Reflect Educ. 2014;8(1):65–74.
Könings KD, Seidel T, Brand-Growel S, van Merriënboer JJG. Differences between students' and teachers' perceptions of education: profiles to describe congruence and friction. Instr Sci. 2014;42:11–30.
Larkin D. Misconceptions about "misconceptions": preservice secondary science teachers' views on the value and role of student ideas. Sci Educ. 2012;96(5):927–59.
Lord T, Marino S. How university students view the theory of evolution. J Coll Sci Teach. 1993;22:353–7.
McKeachie WJ, Lin Y, Strayer J. Creationist versus evolutionary beliefs: effects on learning biology. Am Biol Teach. 2002;64(3):189–92.
Miller KR. Only a theory. evolution and the battle for America's soul. New York: Penguin Group; 2008.
Miller JD, Scott EC, Okamoto S. Public acceptance of evolution. Science. 2006;313:765–6. doi:10.1126/science.1126746.
Moore R. The differing perceptions of teachers & students regarding teachers' emphasis on evolution in high school biology classrooms. Am Biol Teach. 2007;69(5):268–71.
National Academy of Sciences. Science and creationism: a view from the national academy of sciences. Washington: National Academy Press; 1999.
Pas ET, Bradshaw CP. What affects teacher ratings of student behaviors? The potential influences on teachers' perceptions of the school environment and experiences. Prev Sci. 2014;15:940–50.
Paz-y-Miño GC, Espinoza A. Acceptance of evolution increases with student academic level: a comparison between a secular and a religious college. Evol Educ Outreach. 2009;2:655–75.
Paz-y-Miño GC, Espinoza A. New England faculty and college students differ in their views about evolution, creationism, intelligent design, and religiosity. Evol Educ Outreach. 2011;4:323–42.
Pew Research Center. Pew Global Attitudes Report. 2008. 17 Sep 2008. http://www.pewglobal.org/files/2008/09/Pew-2008-Pew-Global-Attitudes-Report-3-September-17-2pm.pdf.
Pew Research Center. Public's views on human evolution. 2013. 30 Dec 2013. http://www.pewinternet.org/2013/12/30/public-views-on-human-evolution.
Pew Research Center. Public and scientists' views on science and society. 2015. 29 Jan 2015. http://www.pewinternet.org/2015/01/29/public-and-scientists-views-on-science-and-society/.
Rissler LJ, Duncan SI, Caruso NM. The relative importance of religion and education on university students' views of evolution in the Deep South and state science standards across the United States. Evol Educ Outreach. 2014;7(24):1–17.
Rutledge ML. Indiana high school biology teachers and evolutionary theory: acceptance and understanding. Doctoral dissertation, Ball State University. 1996.
Rutledge ML, Sadler KC. Reliability of the measure of acceptance of the theory of evolution (MATE) instrument with university students. Am Biol Teach. 2007;69(6):332–5.
Rutledge ML, Warden MA. The development and validation of the measure of acceptance of the theory of evolution instrument. School Sci Math. 1999;99:13–8.
Sadler PM, Coyle H, Cook Smith N, Miller J, Mintzes J, Tanner K, Murray J. Assessing the life science knowledge of students and teachers represented by the K-8 national science standards. CBE-Life Sci. 2013;12(3):533–75.
Sager C, editor. Voices for evolution. 3rd ed. Berkeley: National Center for Science Education; 2008.
Şahin CT, Köksal MS. How are the perceptions of high school students and teachers on NOS as a knowledge type presented in schools in terms of "importance" and "interest". Int J Environ Sci Educ. 2010;5(1):105–26.
Slatter CJ. Teacher and student perceptions of critical and creative thinking within a science programme for high ability females in Singapore: implications for classroom practice and staff development. 2009. Online submission Accessed 19 Feb 2015. http://www.eric.ed.gov/contentdelivery/servlet/ERICServlet?accno=ED537604.
USA Census. USA quick facts. http://quickfacts.census.gov/qfd/states/00000.html, http://quickfacts.census.gov/qfd/states/06/0636770.html. Accessed 20 Feb 2015.
Wiles JR. Overwhelming scientific confidence in evolution and its centrality in science education—and the public disconnect. Sci Educ Rev. 2010;9(1):18–27.
Wiles JR. Challenges to teaching evolution: what's ahead? Futures. 2011;43:787–96.
Wiles JR. Gifted students' perceptions of their acceptance of evolution, changes in acceptance, and factors involved therein. Evol Educ Outreach. 2014;. doi:10.1186/s12052-014-004-5.
Wiles JR, Alters B. Effects of an educational experience incorporating an inventory of factors potentially influencing student acceptance of biological evolution. Int J Sci Educ. 2011;33(18):2559–85.
Winslow MW, Staver JR, Scharmann LC. Evolution and personal religious belief: christian university biology-related majors' search for reconciliation. J Res Sci Teach. 2011;48(9):1026–49.
Woods CS, Scharmann LC. High school students' perceptions of evolutionary theory. Electron J Sci Educ. 2001;6(2). http://ejse.southwestern.edu/article/view/7676.