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Student Acceptance of Evolution

Factors That Lead to Change

By Daniel G. Ferguson, Jamie L. Jensen, Adhieu Arok, Seth M. Bybee, and T. Heath Ogden

Acceptance of human evolution seems to be the majority position for the U.S. population; however, acceptance of evolution among conservative Christian groups is low, sometimes below 50%. There are many different reasons for this low acceptance, leading to a significant disconnect between scientific specialists and the general population. This study examined students in an introductory biology class at a large public university. Semistructured in-person interviews were conducted to better understand students' belief in evolution, or their lack thereof. At the beginning of the semester, 19 of the participants accepted evolution, a number that increased to 29 students by the end of the semester. In contrast, only eight students accepted human evolution at the beginning of the semester, but the number increased to 21 students by the semester's end. The interviews elucidated three essential factors that can change students' minds: teaching the evidence of evolution, providing the influence of a role model to reconcile religion and science, and assisting students with overcoming misconceptions about evolution.

Surveys have consistently found that less than 50% of U.S. adults accepted some form of human evolution (Brenan, 2019; Miller et al., 2006). Another study comparing levels of acceptance of human evolution in the United States to those in other nations worldwide reported that only 40% of U.S. adults agreed that humans evolved from earlier forms of life (Miller et al., 2006). However, over the past decade, the U.S. acceptance of human evolution has been increasing and has reached 57% according to one study (Brenan, 2019), 62% according to another survey (Pew Research Center, 2013), or 68% in a more recent poll (Masci, 2019). Based on how questions have been worded, acceptance has reached as high as 81% (Pew Research Center, 2019). Acceptance of human evolution seems to be the majority position for the U.S. population; however, there are still pockets in the population where acceptance is lower. Additionally, while 98% of scientists believe in human evolution, there is still a significant difference between specialists most informed on the subject and the general population (Pew Research Center, 2013).

With the amount of evidence that confirms evolutionary theory as the best explanation for the diversity of life, it is hard to understand why the theory is not more accepted. In the United States, several reasons may account for the nonacceptance of evolution, including religious beliefs (Coyne, 2012; Schilders et al., 2009), contradictory worldviews (Cobern, 1994; Dagher & BouJaoude, 1997), and misconceptions about evolution-

ary theory (Battisti et al., 2010).

Similarly, there are many reasons why college students struggle with evolution acceptance. Misunderstandings about evolutionary theory (Foster, 2012) and conflicts with religious beliefs (Stanger-Hall & Wenner, 2014) are two common factors. When evolutionary theory contradicts students' religious beliefs, students struggle with learning and accepting evolution (Cobern, 1994; Dagher & BouJaoude, 1997; Downie & Barron, 2000; Stanger-Hall & Wenner, 2014). This paradox leads students to maintain their own beliefs (Meadows et al., 2000) and shapes their learning about perceived controversial topics like evolution (Nadelson & Southerland, 2010). If beliefs guide the way one learns about science, it is essential to investigate further the relationship between religious beliefs and evolution (Deniz & Donnelly, 2011; Glaze et al., 2015; Nehm & Schonfeld, 2007; Nehm et al., 2009).

For the most part, studies on students' perceptions of evolution use surveys and other means of gathering quantitative data (Carter & Wiles, 2014; Ingram & Nelson, 2006; Manwaring et al., 2015). Another method of gathering insights into the acceptance of evolution is through interviews to acquire qualitative data (Patton, 2014). Interviews are beneficial for collecting information on a wide range of subjects and producing more in-depth quality responses and higher response rates (Nelson et al., 2003). Interviews have also proven useful for understanding students' views on evolution acceptance. For example, Schilders et al.'s (2009) interview data showed some students had difficulties coping with knowl-

Student Acceptance of Evolution

edge gained in the classroom because it contradicted their worldview. Semistructured interviews should provide important insights into the acceptance of evolution among university students to increase our understanding beyond survey research. In this research, the interviews followed a semistructured format.

Our public postsecondary institution in the western United States is a unique place for researching the relationship between religious beliefs and the acceptance of evolution. The institution is located in a highly religious, conservative Christian demographic. Sixty-three percent of the state's citizens are members of The Church of Jesus Christ of Latter-Day Saints (CJC). Simultaneously, more than 80% of students enrolled in this public institution's nonmajors biology courses are also part of the CJC (Holt et al., 2018).

We were interested in understanding why students accept or do not accept evolution and why they do or do not change their minds. Given that 51% of the CJC population nationally does not accept evolution (Pew Research Center, 2014), we investigated how CJC student views changed or did not change after a student's participation in an introductory biology class. Some studies suggest that most students who reject evolutionary theory do so because they feel it contradicts their religious beliefs (Cobern, 1994; Dagher & BouJaoude, 1997; Barnes et al., 2017). This situation may be similar for CJC students as well. In a study by Manwaring et al. (2015) on CJC college students, 46% of the students had "low" to "very low" acceptance of evolution at the beginning of the semester. Manwaring et al. (2015) concluded that religiosity affected the acceptance of evolution among CJC students at the beginning of the semester. Still, religiosity did not hinder the students' ability to increase their acceptance of evolution by the end of the semester.

A literature review indicates that research on the acceptance of evolution mainly focuses on human evolution, especially the survey data (Pew Research Center, 2013; Brennan, 2019; Masci, 2019). Some studies indicate that there might be a difference in the levels of acceptance of human evolution versus general evolution, the notion that animals, plants, and other organisms (excluding humans) can evolve (Sinatra et al., 2003). We wanted to investigate this nuance concerning a difference in acceptance rates when including the issue of human evolution compared with evolution in general.

This study's main objective was to investigate students' perceived process of change concerning evolution acceptance through the experience of an introductory biology course and to determine factors that students perceived to be most influential as they made that change.

Methods

Approval from the Utah Valley University Institutional Review Board was obtained for this research before the interviews were conducted, and the data were collected in accordance with IRB policy (UVU IRB #01066).

Participants

We used semistructured interviews to investigate students' perceptions of how their opinions changed through an introductory biology course. Interviews with students were held at the end of their introductory biology class at a public university. This institution is a primarily undergraduate, open-enrollment public institution with a large population of CJC students (80% of the student population). The university's incoming first-year students' average high school grade point average was 3.31 and the average ACT score was 21.8.

Sampling

At the beginning of the semester, introductory biology class instructors were informed about the research and asked if they would contact their students about participating in the study. Recruiting began only after the evolution portion of the course was taught. We used emails, announcements in the learning management system, and sign-up sheets to recruit student participants. A signed informed-consent document was collected before the interview began. Thirty-one students out of approximately 600 volunteered to be interviewed. We did not offer any incentives to students for participation, but extra credit or other incentives could have been a way to increase student participation.

Interview process

Interviews were conducted by Daniel Ferguson in empty classrooms or quiet, secluded hallways. The semistructured interviewing process took between 7 and 10 minutes. We asked the participants a series of questions (see Online Appendix) to initiate a conversation, and the interviews were recorded. Occasionally, follow-up questions were asked if additional clarification was needed for the interviewer to understand students' responses better. The items were related to the participants' acceptance of evolution before and after their biology class's evolutionary lectures. Because the public university has a high percentage of CJC students, questions were also asked about their religious views.

Questions

The questions were designed to help the interviewer better understand the misconceptions, thoughts, and changes in students' perspectives throughout the class. There were six initial questions and additional follow-up questions that were used during the interview to create a discussion.

Analysis

When analyzing the interviews, we used a thematic analysis approach with emergent themes, referred to here as *binning* (Table 1). Students were placed into bins according to their responses to the questions asked during the interviews. When we analyzed the interviews, it was necessary to minimize ambiguity when placing students into bins. We used an inter-rater reliability process, in which two raters independently conducted the thematic analysis. Differences were discussed until 100% agreement was reached.

The binned data analysis focused on determining the students' accep-

tance of general evolution and human evolution before and after the semester. Each area was broken down into three bins: (i) *accept*, meaning that students used language showing that they accepted evolution (either general or human); (ii) *not sure*, meaning students did not feel confident in making a stance either for or against evolution; and (iii) *did not accept*, meaning that students used language to indicate that they did not accept evolution.

To explain changes in acceptance of evolution over the semester, we identified main themes that emerged over the interviews. Again, an inter-reliability process was completed,

which showed three main factors (Table 2) that were identified as primary reasons that students changed their opinions: (i) evidence of evolution (the idea that knowledge of evolution helped them overcome non-acceptance); (ii) influence of a role model (the idea that someone [such as the instructor] served as an example of how to reconcile evolution with the student's worldview or religion; and (iii) knowledge (the idea that learning about evolution gave them a new perspective on evolution and possibly allowed them to overcome misconceptions). In a few cases, a participant described more than one factor as influencing their opinion on evolution. Most students highlighted the main three factors but sometimes highlighted other possible influences, such as past experiences (e.g., having a father who was a biologist; being raised in a scientific home) and church views (e.g., learning about a church's views on evolution).

Results

Of the 31 students interviewed, 25 were members of the CJC. The other six were either not religious or no longer considered themselves religious.

Acceptance of evolution before and after instruction

As shown in Figure 1, the 31 interviews showed that when students were asked about their acceptance of general evolution before instruction, 19 students were placed in the *accept* bin, seven were placed in the *not sure* bin, and five were placed in the *did not accept* bin. When asked about their acceptance of human evolution at the beginning of the semester, eight students were placed in the *accept* bin, 11 were placed in the *not sure* bin, and 12 were placed in the *did not accept* bin.

When students were asked about their acceptance of general evolution after instruction, 29 students were placed in the *accept* bin and two

TABLE 1

Students' quotes about evolution acceptance.

Bin	Examples of student quotes about evolution
Accept	"I have pretty much always accepted evolution ever since I was a kid." "I believe in evolution, but I maybe didn't understand it to the degree that I should have in college." "My stance on evolution before taking biology was ... I believe in God, and I believe that God is behind evolution."
Not sure	"I don't know. I never really understood enough about it to be for or against it." "That has always been a gray area for me. It was just kind of an 'I will figure that out one day.'"
Did not accept	"I didn't accept it." "I didn't like it; I guess that is your typical Utahan."

TABLE 2

Students' reasons for changing their views.

Bin	Primary reason for increasing acceptance
Evidence of evolution	"Scientific evidence is all there." "There's too much evidence."
Influence of role model	"I read that he was an evolutionist, and I had found out that he was LDS." "[The professor] specifically did help to broaden that horizon."
Knowledge	"I would say just because of my understanding." "I think now that I understand what I thought that human evolution was, was just a misconception."

Student Acceptance of Evolution

FIGURE 1

A comparison of views on general evolution and human evolution among introductory biology students before and after instruction.

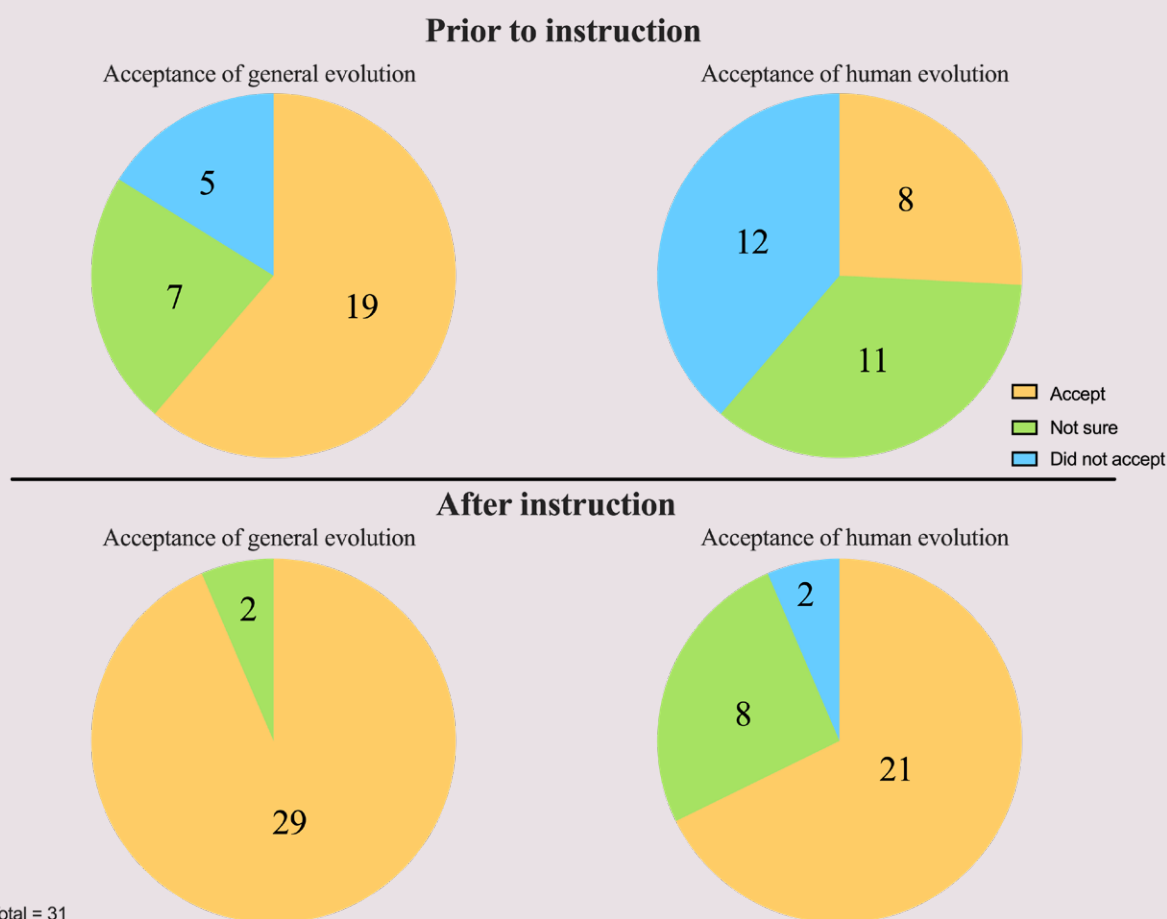
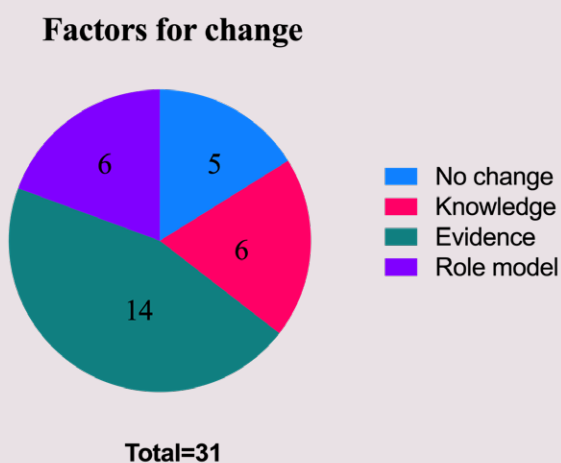


FIGURE 2

The leading factors that allowed students to change their minds about evolution theory.



were placed in the *not sure* bin; no students were placed in the *did not accept* bin (Figure 1). When students were asked about their acceptance of human evolution after the semester, 21 students were placed in the *accept* bin, eight were placed in the *not sure* bin, and two were placed in the *did not accept* bin.

Factors for change

The most prevalent factors that affected students' views were the influence of a role model, evidence for evolution, and knowledge (see Figure 2). Fourteen students said they changed their beliefs because of the evidence presented during evolutionary topics

instruction. Six students claimed their views changed because they saw the professor as a role model, and another six students indicated the importance of knowledge that helped them overcome misconceptions about evolution and their worldview (religious position). Five students had no change in their acceptance or nonacceptance of evolution over the course of the semester (e.g., they accepted the theory of evolution before and after the semester).

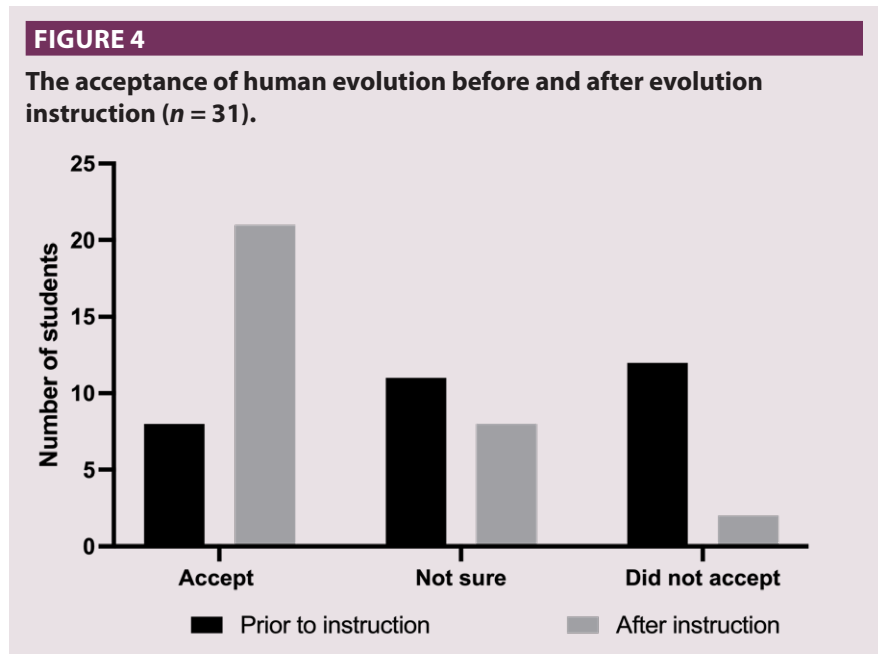
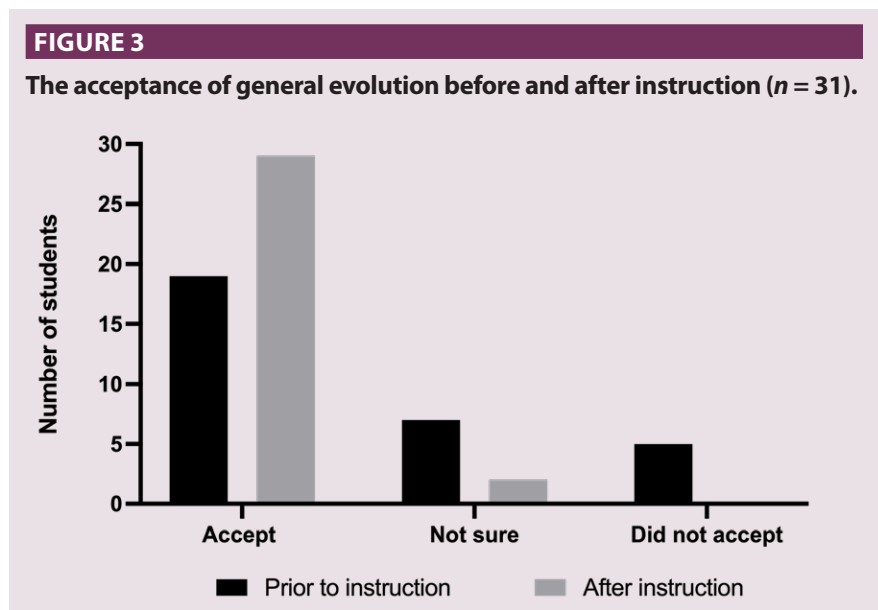
Discussion

Evolution in general

This study examined the potential change in students' positions on general evolution and human evolution in an introductory biology class. When students were asked before instruction about their acceptance of general evolution, 19 out of 31 students (61%; see Figure 3) said they accepted general evolution. Our data was similar to the 2013 Pew Research Center survey in which Americans' acceptance rate of evolution was 62%. Still, 12 students did not accept or were unsure about evolution. Quotes from their interviews offer insights into why they might have had a hard time accepting evolution before receiving any instruction on the topic.

We found that conflicting religious beliefs are a significant factor for the nonacceptance of evolution in our population, which is consistent with what other studies have found concerning religious beliefs (Cobern, 1994; Dagher & BouJaoude, 1997; Schilders et al., 2009; Coyne 2012) and conflicts with religious beliefs (Stanger-Hall & Wenner, 2014) as reasons for non-acceptance of evolution.

When students were asked about their acceptance of general evolution after instruction, 29 students accepted general evolution, an increase of 32% (see Figure 3). This idea of students possibly being able to change their minds goes along with Sinatra et al. (2008) proposing that student engage-



ment (e.g., discussion, debate, experiments) in topics such as evolution can lead to a high likelihood of change.

Human evolution

There was an increase in the number of students who accepted the idea of general evolution. But when participants were explicitly asked about human evolution, they had a more difficult time accepting this idea before instruction, with only eight of the 31 accepting human evolution (Figure 4). Again, it is not surprising that this

population of students might have difficulty accepting human evolution, as 81% of students (25 out of 31) self-reported as members of CJC.

Interestingly, similar to acceptance of general evolution, there was also an increase in the number of students who accepted the idea of human evolution after instruction, from eight students to 21 (a 42% increase). This value is the same as was found in a Pew Research Center survey (Masci, 2019), in which 68% of Americans accepted human evolution if the

Student Acceptance of Evolution

FIGURE 5

The acceptance of general evolution (before and after instruction) among students who are members of the CJC ($n = 25$).

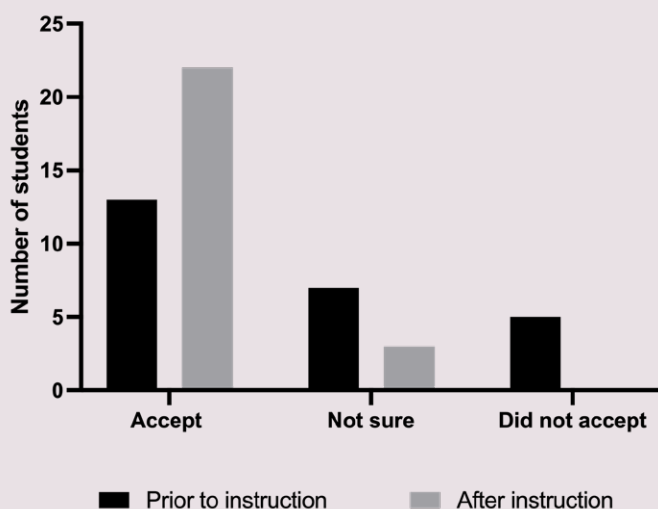
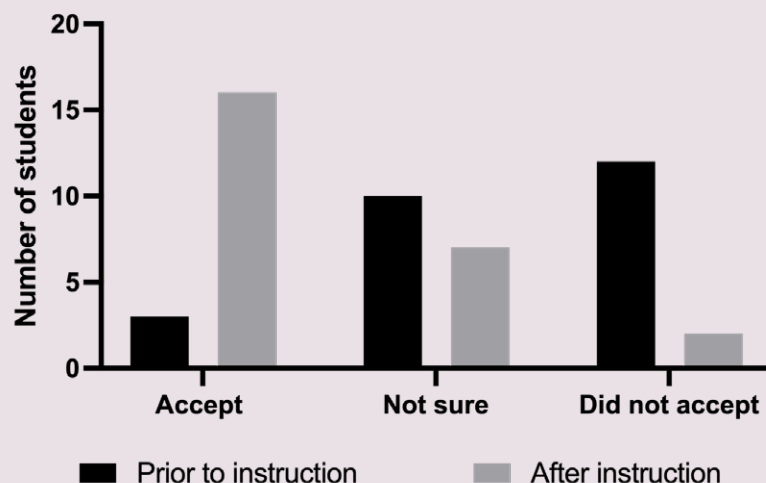


FIGURE 6

The acceptance of human evolution (before and after instruction) among students who are members of the CJC ($n = 25$).



choice was given to allow a deity to be involved somehow. This rate is much lower than it is for acceptance of general evolution, but it is still beneficial to see considerable gains in human evolution acceptance. A similar phenomenon might be happening with this population of religious students, where they are able to accommodate the idea of a deity somehow being involved in humans' evolutionary process—a type of theistic evolution.

However, we did not specifically investigate this question.

The Latter-Day Saint factor

As described above, a large majority of 25 out of the 31 students interviewed were members of the CJC. The lack of understanding that Latter-day Saints have about their church's position on evolution and man's origin is well documented (Evenson & Jeffery, 2005; Stephens

& Meldrum, 2001). CJC has no official position for or against the theory of evolution. Official doctrinal statements addressing this issue are rare and lack any concrete details (Manwaring et al., 2015). The most authoritative statements are found in the Brigham Young University evolution packet (Brigham Young University, 2009) and in a CJC magazine article (The Church of Jesus Christ of Latter-Day Saints, 2016). These statements primarily rely on CJC authorities' perspectives from the early 1900s. The Church is neutral on how the diversity of life was created, including the origin of the physical body of man or *homo sapiens*. Thus, the Church neither confirms nor denies that an evolutionary process could be possible and has left it open to scientific interpretation (Manwaring et al., 2015) or even a personal understanding of how the Earth was created. Even though the Church has officially had a neutral stance on the theory of evolution, most members still do not accept evolution (Pew Research Center, 2014).

Before instruction, 13 of the CJC students (25 students overall) accepted general evolution, whereas seven were not sure, and five did not accept it. After instruction, 22 CJC students accepted evolution, and three were still not sure (Figure 5). No CJC students rejected general evolution at the end of the semester. When asked about human evolution before instruction, three CJC students accepted the theory, while 10 students were not sure and 12 students did not accept human evolution. Again, the number of students who accepted human evolution increased after instruction to 16 CJC students; seven students were not sure and two did not accept human evolution, both of which were decreases from before instruction (Figure 6). Research conducted at Brigham Young University (Bradshaw et al., 2018) claimed that many students saw the importance of learning that the CJC has no official position on evolutionary theory as a

factor in increasing their acceptance. In the current study, when CJC students were asked about their knowledge of the Church's official position (doctrine) on human origins, only about half (12 out of the 25) of these students correctly knew the "official" position of the Church, as stated in the BYU evolution packet (Brigham Young University, 2009). Interestingly, all 12 of those students accepted evolution. Thus, students who understand their religion's official position on evolution (assuming the doctrine is flexible) may be more likely to accept evolution, though more research specifically in this area will be beneficial.

Conclusion

When students are confronted with topics such as evolution, issues with acceptance and understanding may arise. In our study, students who brought up a perceived contradiction between their religious views and evolutionary theory during interviews had difficulty accepting evolution before instruction. After instruction, most of the students were able to increase their acceptance of evolution. The evidence of evolution, the influence of a role model, and knowledge about evolution were identified as essential factors that led students to increase their acceptance of evolution. We propose that students keep an open mind to subjects like evolution that might conflict with their religious beliefs instead of immediately discounting ideas. It is also important that teachers keep an open mind with students and their worldviews and look for ways to help them reach acceptance. Students who understand their religion's official position on evolution may be more likely to accept evolution as the best explanation for the diversity of life. This was especially important for CJC students. With this in mind, encouraging religious students to investigate their own faith tradition's doctrines may be a pathway to increased acceptance.

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