

Measuring the acceptance of evolutionary theory in Texas 2-year colleges

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ABSTRACT

Evolutionary theory is the central unifying theory of the life sciences. However, acceptance and understanding of the theory have been found to be lacking in the general public, high school, and university populations. Prior research has linked low acceptance of the theory to a poor knowledge base in evolution, to the nature of science, and to conflicts with certain religious beliefs. The purpose of the present study was to measure the acceptance rate of the theory of evolution among students enrolled in science major biology courses in Texas community colleges. This research sought to begin to fill a gap in the knowledge base concerning acceptance of the theory of evolution among community colleges. To achieve the goal, the researcher gave students at five Northeast Texas community a combined survey consisting of; 20 Likert scale questions measuring acceptance of evolutionary theory, 10 multiple choice questions measuring basic knowledge of the theory, and a series of demographic questions assessing students' prior experience in high school with evolutionary theory and creationism. This article will focus on the findings from the MATE and KEE and their implications for science education at the K-12 and postsecondary levels. Data collected were statistically analyzed using SPSS version 22 to discover the relationships between the various independent variables and the dependent variable of the acceptance level of the theory of evolution.

Keywords: evolution, religiosity, creationism, intelligent design, acceptance

INTRODUCTION

Evolutionary theory by means of natural selection was developed in large part by Charles Robert Darwin between the 1830s and the 1850s (Reece & Campbell, 2011). The theory encompasses not just natural selection but sexual selection as well and explains the unity and diversity of life on this planet. The theory is considered the cornerstone of the life sciences (Futuyma, 2005; Reece & Campbell, 2011; Sadler, 2005) and is fully supported by observations and experiments in such fields as paleontology, molecular biology, cellular biology, and genetics. (Futuyma, 2005). Dobzhansky (1973) observed that “nothing in biology makes sense except in the light of evolution,” (p. 129), and many famed scientists such as., Carl Sagan, Richard Dawkins, and Douglas Futuyma, have endorsed his views and made it clear that evolution is a “fact” (Wiles, 2006). Further, the theory is endorsed by many scientific societies and agencies including; The American Association for the Advancement of Science (AAAS), The National Academy of Science (NAS), and The National Science Foundation (NSF).

Creationism or intelligent design (ID) is an idea that enters into the debate over the theory of evolution. It holds that a god/supreme being created the earth, the species on it, and the universe in its present/unchanging form between 5,000 and 10,000 years ago (Scott, 2004). Creationists differ in their concept of the designer and in how they adhere to the concepts of evolution and the age of the earth (Scott, 2004). Henry Morris, founder of The Institution for Creation Research (ICR), was the originator of creation science and spawned the creationist movement that believes in literal interpretations of the Bible (Scott, 2004). The ICR argues against the scientific age of the earth (Alters & Alters, 2001) and believes that teaching evolution is against their god (Alters & Alters, 2001). Other proponents of creationism and ID fully accept the tenets of evolution and the age of the earth but believe that some intelligent designer is behind the process, often giving examples of what they believe to be an irreducible complex system as evidence of that designer (Scott, 2004). Such examples include the bacterial flagellum or the blood clotting cascade in humans.

From the 1960s through 2005 there were 10 significant court cases concerning the teaching of evolution vs. creationism in high schools across this nation. All of these cases resulted in findings that creationism in any form is a religion, holding no scientific foundation and offering nothing to the field of science (Matsamura & Mead, 2007). In *Epperson v. Arkansas*, the United States Supreme Court (1968) made it unconstitutional for the state of Arkansas to stop the teaching of evolution in public schools (Matsamura & Mead, 2007). Similar cases with similar results have occurred involving Louisiana, Delaware, Texas, and California (Matsamura & Mead, 2007). Scott (2004) concluded that, despite the multiple court rulings against them, these non-scientific, religiously-based ideas will continue to be promoted to supplant the theory of evolution in the nation’s public schools.

BACKGROUND LITERATURE

Despite the affirmations of various scientific and teacher organizations, the theory of evolution remains controversial in the general public with acceptance varying widely across the globe (Miller, Scott, & Okamoto, 2006). A mere 40% of Americans believe in evolution (Newport, 2009), and Berkman and Plutzer (2011) reported that only 28% of biology teachers advocated for teaching evolution. Research has shown low acceptance in the public, university, and high school population, but there is a big gap in the data for community colleges where 70%

of students begin their college education in Texas (Hamilton, 2013). This study will review the findings from the MATE and KEE and their implications for science education at the K-12 and postsecondary levels.

Research into the acceptance of evolutionary theory has found that even those who are responsible for teaching the theory at the secondary level, which builds the foundation for college entry, are skeptical of it. Berkman and Plutzer (2011) found that of the 926 biology teachers surveyed who were asked if they advocated for the teaching of evolution, only 28% said they did, a full 13% said they favored creationism, and 60% would not say which they favored. Of 939 high school biology teachers surveyed in 2007, 77% spent 5 hours or less teaching human evolution, 2% spent 20 hours or more, and 36% spent 5 hours or less teaching general concepts of evolution, with only 9% spending 20 hours or more on general concepts (Berkman, Pacheco, & Plutzer, 2008). Michael Zimmerman (1987) found a possible lack of understanding of the theory of evolution among high school biology teachers since just over half in his study thought the theory was actually testable by science even though scientific journals are inundated with tested research in evolutionary theory. In a survey of 654 Texas high school biology teachers it was found that 28% taught creationism to their students and 69% supported the inclusion of creationism into the classroom even though it is unconstitutional (Shankar & Scogg, 1993).

Public acceptance does not match scientific acceptance, and many in the public believe that there is a rift in the scientific community concerning the theory of evolution (Leshner, 2009). When asked if they agreed with the idea that humans and other living things had existed in their current form since the beginning of time, a full 31% of the public agreed while only 2% of scientists agreed (Leshner, 2009). When comparing polls, Leshner (2009) found that the younger one is, the higher his/her acceptance of evolution: evangelical Protestants have the lowest level of acceptance (9%) while the religiously unaffiliated have the highest levels (60%). Leshner (2009) also found that acceptance increases with a college education (45%) compared to those holding only a high school diploma (26%).

In a survey of 32 European countries and Japan it was found that only Turkey had a lower acceptance rate for the theory of evolution than the United States and that over a 20-year period (1985-2005), the acceptance of evolution had actually declined in America from 45% to 40%. This rate is compared to the 80% of adults in Iceland, Denmark, and France, and the 78% in Japan who accept the theory of evolution (Miller, Scott, & Okamoto, 2006).

A study of 74 freshman general studies majors and 51 general biology majors at the University of Alabama revealed that 90% of the students were at least open to the idea that the theory of evolution was valid (Blackwell, Powell, & Dukes, 2003). The two groups were very similar in their responses to the questions on the survey (Blackwell et al., 2003). When asked if evolution was the primary basis for the progression of life on earth, 34.4% of the general studies group agreed with the statement while 35.4% of the general biology majors group agreed (Blackwell et al., 2003). This study also revealed that students enter the university classroom with strong negative preconceptions about evolution that stem from prior religious teaching and from a lack of experience with the theory in high school (Blackwell et al., 2003).

A survey of 179 students enrolled in an introductory biology course at the Twin Cities campus of the University of Minnesota revealed that 22% had been taught both evolution and creationism in high school and 13% were taught neither (Moore, Brooks, & Cotner, 2011). The study also revealed that students enter with poor knowledge of evolution with the average score on the Knowledge of Evolution Exam (KEE) being 53% (Moore et al., 2011).

Moore and Cotner, (2009) surveyed 1,008 students enrolled in introductory biology courses for majors and nonmajors at the Twin Cities campus of the University of Minnesota. They found that 64% of the students had attended high school courses that taught evolution and creationism and that teaching creationism occurs in Minnesota even though it is in violation of Minnesota's state science standards and is considered unconstitutional

The combined effects of absence of evolution education, teaching of creationism, and conflicts with religious dogma are the leading factors in low acceptance and knowledge base of the theory of evolution in entering college students (Moore & Cotner, 2009). In her book *Evolution vs. Creationism*, Scott (2004) noted that it is religious factors and not disagreements in science that drive anti-evolution views. Creationism and intelligent design have been deemed religions by the courts. Nevertheless, they continue to be taught in public schools (Nehm et al., 2009; Moore & Cotner, 2009; Zimmerman, 1987). As a result, college students enter collegiate science courses carrying with them the baggage of the past having strongly held misconceptions about science and evolution that can disrupt their ability to understand the scientific explanations presented (Cunningham & Wescott, 2009).

CONTEXT AND METHOD

Students enrolled in science majors' biology courses in five Texas community colleges located in the Northeast Texas region were surveyed. These institutions were selected for their location to cover the Northeast Texas area. Specifically, the study determined acceptance rates of the theory of evolution and entering knowledge base. Community college students at participating institutions were selected from sections of "biology for science majors" courses by the participating instructors as defined by the spring 2014 Lower-Division Academic Course Guide Manual, produced by the Texas Higher Education Coordinating Board (2014).

The research focused on measuring the acceptance of the theory of evolution using a 20-question Likert scale test, the Measure of Acceptance of the Theory of Evolution (MATE), which was developed by Michael L. Rutledge and Melissa A. Warren (Rutledge & Warren 1999). The MATE was designed to measure the overall acceptance of evolutionary theory by assessing perceptions of evolutionary theory's validity in science, acceptance in the scientific community, and its ability to explain phenomena (Rutledge & Warren 1999).

Participants also took the 10-question Knowledge of Evolution Exam (KEE). The KEE questions were developed and modified from an internal exam database and are on the level of a nonmajors' biology test experience (Cotner, Brooks, & Moore, 2009). The questions were designed by biology professors at the University of Minnesota to evaluate students' understanding of basic tenets of evolutionary theory only and require no in-depth knowledge (Moore et al., 2011). The questions were tested over a period of several years in introductory biology course exams given at the Twin Cities campus of the University of Minnesota and have been used as base knowledge gauge in several studies (Moore et al., 2011).

In addition, the researcher developed a short demographic survey using a multiple choice and Likert scale design. This survey gathered information about sex, age, size of high school attended, and previous experiences with coverage of evolutionary theory in high school, previous experience with creationism in high school, religious preference, and intrinsic religiosity.

This study was a nonexperimental quantitative design that used purposeful sampling to describe and explain the population being studied. Purposeful sampling of community college students enrolled in a biology for science majors course limited the research study to those students who planned on majoring in science. The participating instructors at each college gave

the MATE, KEE, and demographic questions as a single hard-copy packet during lab or class early in the Fall 2014 semester, prior to instruction on evolution. The researcher received an e-mail notification once the packets were completed and made individual arrangements with each participating instructor to retrieve the packets. The scores on the KEE, MATE, and collected demographic data from the participants were used to search for any correlations that might exist between the KEE scores, the gathered demographic data, and MATE scores as well as if any of the variables made predictions regarding MATE scores. Data from all student surveys were entered into a spreadsheet using the Statistical Package for the Social Sciences (SPSS) software, version 22. The research was descriptive, providing a picture of the status of acceptance rates, and explanatory, testing hypotheses to find relationships that explain a phenomenon and to see if predictors can be found (Johnson & Christensen, 2008).

A total of 411 surveys were returned, 13 were removed due to lack of a signature on the informed consent form leaving 398 usable surveys. Of the 398 remaining, 373 were used in the research, 25 surveys were removed due to conflicting answers.

RESULTS

Data were analyzed from five 2-year colleges located in the Northeast Texas region. A total of 460 surveys were delivered to the participating institutions and 398 were returned to the researcher. Of the 398, 373 were used in the research, with 25 surveys being eliminated due to conflicts in the surveys. Participants were 41% male ($n = 153$) and 59% female ($n = 219$). The ages varied but most, 95% ($n = 354$), ranged in age from 18-29. Racially the group was mostly white, 58% ($n = 216$), with 22% ($n = 83$) reported Hispanic, and 17% ($n = 62$) reported African American. Of the remaining 11 participants four reported being Native American, six Asian, and one Native Hawaiian.

Participants reported high school sizes ranging from 199 and below to 2090 or more. The distribution was more even for the size of high school attended. Of the 370 participants, 29% ($n = 109$) attended a school with 1005-2089 students, 22% ($n = 80$) attended schools with 450-1004 students, 21% ($n = 78$) attended schools of 200-449 students, 19% ($n = 69$) attended schools of 2090+ students, and 9% ($n = 34$) reported attending schools with 199 or fewer students.

A total of 372 participants reported on their previous college biology course work. The majority, 74%, ($n = 277$), reported that they had no previous college-level biology, before the course they were enrolled in when completing the survey. This group had mean scores of 45.09 on the KEE and 66.63 on the MATE. Just over 17% ($n = 65$) had taken one previous college-level biology course: this group had a mean of 50.46 on the KEE and 71.56 on the MATE. Only 6% ($n = 21$) reported having had two college level biology courses previously, this group had a mean of 44.76 on the KEE and 62.76 for the MATE. Very few participants, 3% ($n = 9$) reported having had more than two previous college-level biology courses. This group averaged 44.44 on the KEE and 68.67 on the MATE.

A total of 373 participants reported on parents' level of education. A group of 42% ($n = 158$) reported that neither parent had graduated from college; 21% ($n = 77$) reported having at least one parent with a 2-year associate's degree; 23% ($n = 84$) reported at least one parent with a bachelor's degree; and 14% ($n = 54$) reported at least one parent with a graduate degree.

The mean of the measure of acceptance of evolutionary theory (MATE) was 67.32 ($n = 371$) with possible scores ranging from 20 to 100. This mean for the MATE is considered to be a moderate level of acceptance, scores from 65-76 (Rutledge & Sadler 2007). The mean for the

knowledge of evolution exam (KEE) was 45.95 ($n = 373$) with possible scores ranging from 0 to 100.

Research Question 1 asked “How do students enrolled in a freshman-level science major biology course in Texas community colleges describe their prior education regarding evolution?” The majority of survey participants (61.5%) indicated that 1-5 hours of class time was spent on evolution, while 23.2% (see Table 1) indicated that evolution was not taught in their high school biology class. If added together, 84.7% of participants had 5 hours or less of class time with the theory of evolution. A total of 2.2% of participants reported that evolution was a key theme throughout their high school course.

When reporting on their perception of the quality of instruction in the theory of evolution, 34.2% indicated that they received a moderate explanation of evolution, another 34% indicated that they received very little explanation about evolution, and 11.6% reported having no explanation at all, bringing the total to 45.6% who indicate receiving very little to no explanation of the theory of evolution. The remainder of participants perceived their explanation of the theory as “*explained well*” (16.7%) or “*explained very well*” (3.5%)

Over half (52.4%) of the participants reported having no class time spent on the topic of creationism. The remaining 47.6% reported having some class time spent on creationism, with most of those (36.8%) spending between 1-5 hours on creationism and 2.7% reporting it to be a key theme throughout their high school course. In a separate question concerning quality of explanation almost half (46.8%) of respondents received no explanation on creationism, with another 26.5% indicating they received very little explanation on the topic, and 1.9% reporting that creationism was explained well.

Table 1
Survey Participants’ Perceptions of High School Class Time Spent on Evolution and Creationism

Time	Evolution (N = 371)		Creationism (N = 370)	
	Number	Percent	Number	Percent
0 Hours (Did not teach it)	86	23.2	194	52.4
1-5 hours	228	61.5	136	36.8
6-10 hours	43	11.6	27	7.3
11-20 hours	6	1.6	3	0.8
Core theme (most all classes)	8	2.2	10	2.7

Table 2
Survey Participants’ Perceptions of Quality of High School Explanation of Evolution and Creationism

Quality of explanation	Evolution (N = 371)		Creationism (N = 370)	
	Number	Percent	Number	Percent
No explanation	43	11.6%	173	46.8%
Very little explanation	126	34%	98	26.5%

Moderate explanation	127	34.2%	68	18.4%
Explained well	62	16.7%	24	6.5%
Explained very well	13	3.5%	7	1.9%

Research Question 2

Research Question 2 asked “Does the entering knowledge base of the theory of evolution predict the acceptance rate of the theory of evolution?” The data revealed that there was a positive relationship (see Figure 1) between an increased knowledge base of evolution and acceptance of evolutionary theory. The regression showed that scores on the Knowledge of Evolution Exam (KEE; Cotner, Brooks, & Moore, 2009) were a strong predictor of scores $F(1,369) = 92.082, p < .001$ on the Measure of Acceptance of the Theory of Evolution (MATE; Rutledge, 1999). The unstandardized beta coefficient (.353) was significant ($p < .001$), making the KEE a strong predictor of acceptance of evolutionary theory, as measured by the MATE. The adjusted R^2 of .198 indicated that of the total variability that existed in acceptance of the theory of evolution, 19.8% is associated with variability in knowledge of evolution. Because the measure of the entering knowledge base was a statistically significant predictor of the acceptance rate of the theory of evolution, the null hypothesis failed to be accepted.

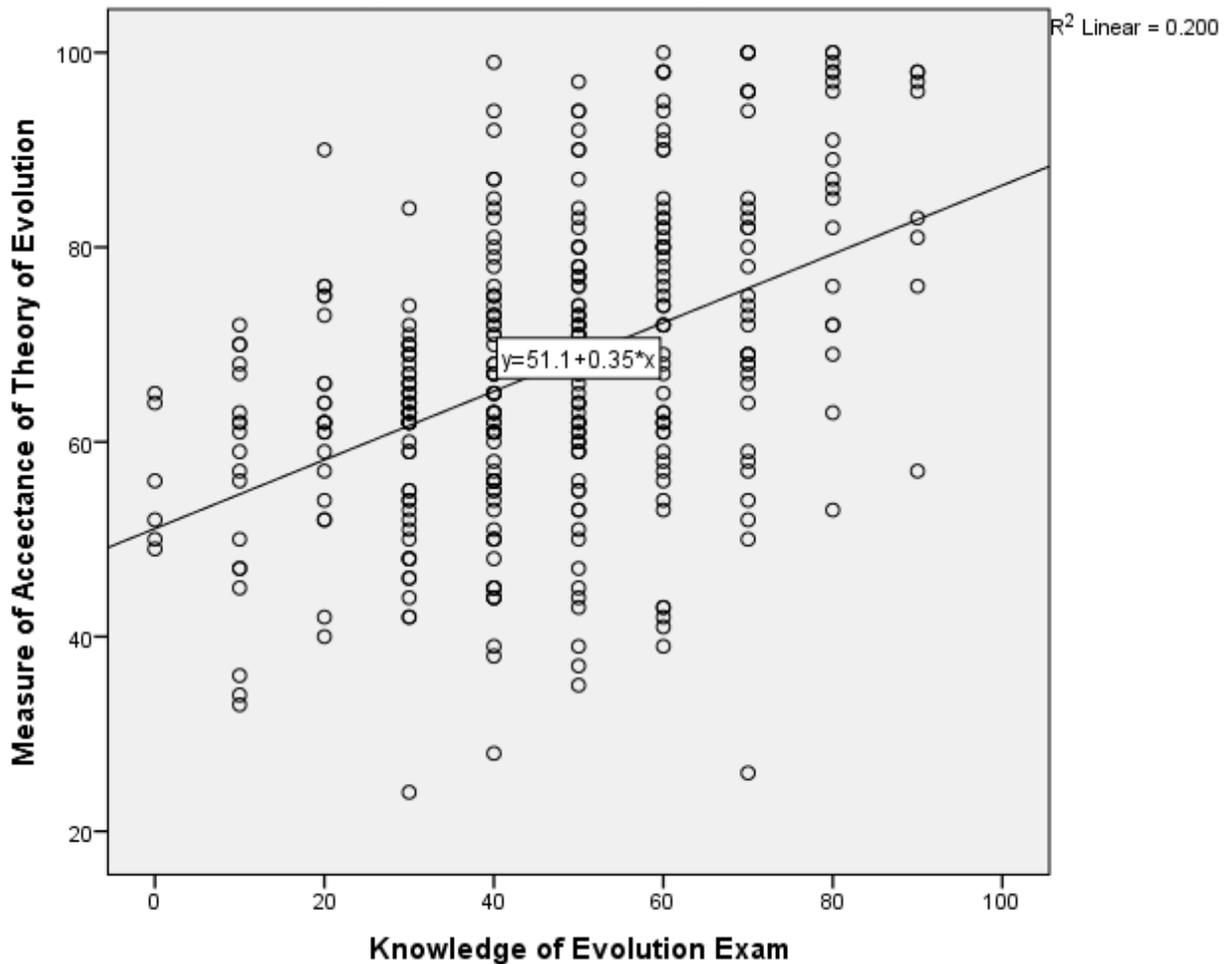


Figure 1. Relationship between acceptance of evolution and knowledge of evolution

CONCLUSIONS

This study indicated that evolution education is lacking in both time and quality in Northeast Texas high schools. The mean score on the KEE was 45.95% ($n = 373$) for this study. Scores on the KEE are absent in the literature for community colleges so comparison here is not possible but data from research done on introductory biology courses at the University of Minnesota indicated mean scores of 54% and 53% in separate studies (Moore, Cotner & Bates, 2009). However, a mean of 45.95% on the KEE, which measures base level knowledge of evolution, indicates that students do indeed enter Northeast Texas community colleges knowing very little about evolution. For participants who had no previous biology course work the mean KEE score was 45.09. The mean increased to 50.46 for those who had one previous biology course ($n = 65$).

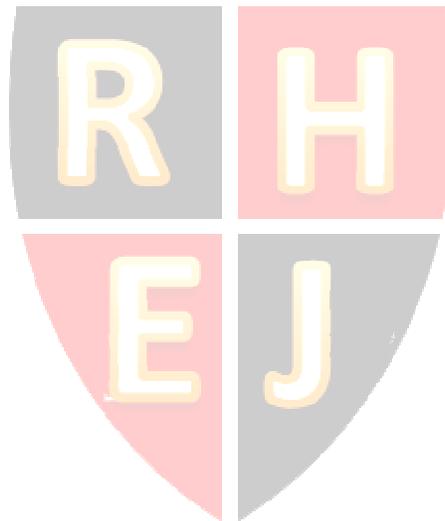
The mean score on the MATE ($n = 371$) for this study was 67.32, indicating moderate acceptance. When assessing the reliability of the MATE using 61 students enrolled in a nonmajors' biology course at Middle Tennessee State University the mean score on the MATE was found to be 55.87, indicating low acceptance (Rutledge & Sadler, 2007). Of 552 returned surveys from Indiana public high school biology teachers the mean score on the MATE was found to be 77.59, indicating high acceptance (Rutledge & Warden, 2000). For participants who had no previous biology course work the mean MATE score was 66.63. It increased to 71.56 for those who had one previous biology course ($n = 65$). Once again data from community colleges is absent. This study will provide serve as a data source in future research involving community college students.

A total of 84.7% of participants reported that 5 hours or less was spent on evolution in their high school biology course and 79.8% thought that the quality of explanation of evolution was moderate or below. According to 47.6% of respondents, at least some time was spent teaching creationism in their high school biology courses. It is noted that the survey relied on the accuracy of the participants and that some of the participants may have attended private schools where creationism was taught legally. However, the lack of adequate instruction in evolution implies that high school graduates in the region are ill equipped to enter most scientific professions, including the health sciences where job opportunities abound. Health science fields require a thorough understanding of evolution by means of natural selection in order to comprehend and better communicate the growing problem of the evolution of drug resistant strains of microorganisms.

The research indicated that the quality of instruction in high school biology courses is perhaps more important/significant for improving students' knowledge and acceptance of evolution than is the amount of time spent teaching the theory. When knowledge of evolution is improved, then acceptance may improve as well.

Respondents reported creationism is taught to many students in high school, and little time is devoted to understanding the theory of evolution. Improving the scientific literacy of students majoring in science will require that changes be implemented throughout the educational system. For 2-year college instructors, one immediate suggestion is to increase the amount of time devoted to teaching evolution and include it in all biology courses. Further changes to the university curriculum would be desirable to increase the knowledge base of evolution for future educators in Texas who wish to teach science. A course designed to cover the evidences, law, state learning outcomes, and potential controversies a new teacher could face in the classroom would be beneficial. Beginning evolution education sooner, elementary level,

will need to be considered for effectiveness and viability in improving the scientific literacy of the population.



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