THE ACCEPTANCE AND UNDERSTANDING OF EVOLUTIONARY THEORY
AMONG OHIO SECONDARY LIFE SCIENCE TEACHERS

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THE ACCEPTANCE AND UNDERSTANDING OF EVOLUTIONARY THEORY
AMONG OHIO SECONDARY LIFE SCIENCE TEACHERS

BY

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The objective of this study was to determine the status of secondary life science teachers in the State of Ohio as it pertains to the theory of evolution. Data were collected through a survey sent to 300 Ohio secondary life science teachers in May, 2003. The primary focus of this study was on determining the acceptance level of these teachers for the theory of evolution. It was found that the majority accept evolutionary theory. Another component of this study focused on teachers’ knowledge level of evolutionary theory, and found that teachers have an adequate understanding. Finally, this study looked at some of the possible relationships that exist to a teacher’s acceptance of evolutionary theory and found a correlation between a teacher’s acceptance to his or her knowledge level. A teacher’s acceptance and knowledge levels of evolutionary theory are also correlated with the number of years the teacher has taught.
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Chapter 1

Introduction

In 1987, Michael Zimmerman found that 80.9% of Ohio public high school biology teachers surveyed believed that the theory of evolution was scientifically valid, yet 34.3% of public school teachers surveyed felt that creationism should be taught in public schools. In that same study, Zimmerman also found that the content of a teacher’s biology course was not independent of the teacher’s religious and personal feelings about the theory of evolution. Fourteen years later, the controversy over the teaching of the theory of evolution in Ohio’s science classrooms reemerged during the drafting of the new state science standards that dealt with the theory of evolution. The controversy received media attention in 2002 from major newspapers in the state such as the Columbus Dispatch, the Cleveland Plain Dealer, and the Cincinnati Enquirer. The debate even received national media coverage from the Washington Times, the Washington Post, and was covered extensively by the Associated Press.

The main movement that challenged the section of the Science Academic Content Standards (Ohio Department of Education [ODE], 2002) dealing with the theory of evolution was the Intelligent Design Movement. Supporters argued that since intelligent design never named the designer as God, intelligent design was not creationism, and therefore should not be considered to constitute religion in the classroom (Morozowski, 2002). Because of the resistance to the adoption of science standards dealing with the theory of evolution, there is a need to look again at Ohio’s secondary life science teachers’ attitudes in regards to evolutionary theory. A similar study was conducted among Indiana high school biology teachers by Rutledge and Warden (2000).
Specifically, the acceptance of the theory of evolution and the knowledge levels of secondary life science teachers needs to be examined. This examination may help determine the likelihood that the newly adopted state standards will be taught by teachers who accept the theory of evolution. It will further contribute to knowledge about the extent to which Ohio secondary life science teachers hold an adequate understanding of evolutionary theory. This knowledge of content is necessary in order to effectively teach students the concepts set forth in the Science Academic Content Standards adopted in 2002 by the ODE.

Statement of the Problem

The objective of this study was to assess the current level of acceptance of the theory of evolution among secondary life science teachers in the State of Ohio, and identify the current understanding secondary life science teachers have of the theory of evolution and some of the concepts associated with it. Each teacher’s knowledge level of evolutionary theory was compared to his or her acceptance level of evolution and other related factors. Though new Ohio science standards have been adopted, this may not necessarily indicate a change in teacher attitudes, especially in terms of their acceptance of the theory of evolution since many teachers may have strong religious beliefs against it.

Significance of the Study

The role that standards can play in the classroom is powerful. The debate over the new Ohio science standards may indicate that many citizens and teachers believe state standards are important to help ensure that children in Ohio public schools receive a strong science education. However, the fact that new Academic Content Science
Standards were adopted by the ODE does not mean that all teachers either fully embrace them or align their curriculum towards them. Skoog and Bilica (2001) state that “…responses to policy and curriculum decisions vary from teacher to teacher and, as a result, each classroom tends to be different” (p. 456). Because of this, biology and life science teachers may still choose to avoid the subject of evolution in their classrooms, and may also teach creationism and/or intelligent design. This is significant as studies have found that teachers can pass on pseudoscientific beliefs to their students (Eve & Dunn, 1988; 1990). Since evolution is often seen as a central organizing theme to the life sciences, its importance in a life science classroom could be pivotal to a student’s understanding of the nature of science and of the science subject matter itself (Dobzhansky, 1973; National Science Teachers Association [NSTA], 1997; National Association of Biology Teachers [NABT], 1997). A teacher’s knowledge of the theory of evolution may also impact the learning of the students since some concepts contained in the theory of evolution can be hard to grasp for students on many different levels of schooling, from junior high schools to medical schools (Brumby, 1984; Greene, 1990; Johnson, 1987; Lawson, 1988; Moore et al., 2002; Woods & Scharmann, 2001). The conclusions of this study may be useful to school districts in assessing the knowledge level that life science teachers carry into their classrooms. The study may further help school districts determine what resources these teachers may need to effectively teach the theory of evolution, especially at the secondary level.

Research Questions and Hypotheses

This study identified the current level of both acceptance and knowledge of evolutionary theory among secondary life science teachers across the state. To
accomplish this task, three research questions were asked about secondary life science
teachers in the State of Ohio. The primary research question was “What is the level of
acceptance of evolutionary theory among the secondary life science teachers in the State
of Ohio?” It was expected that the majority of Ohio secondary life science teachers
accepted the theory of evolution rather than rejecting the theory. Stated as a null
hypothesis;

Ho: Ohio secondary life science teachers neither showed acceptance nor rejection
of the theory of evolution.

Questions that support the primary research question were:

1) What is the current understanding of evolutionary theory held among
secondary life science teachers in the subject of biological evolution?
2) What are some of the possible factors relative to a teacher’s level of
acceptance to the theory of evolution?

It was also expected that the majority of teachers in Ohio have an adequate understanding
of the theory of evolution. To support this, the study should find that those teachers who
accept the theory of evolution have a higher knowledge level than those who reject the
theory of evolution. Stated as a null hypothesis;

Ho: There will be no difference in knowledge levels between those who accept
the theory of evolution and those who reject the theory of evolution in terms of
their understanding of evolutionary theory.

Another prediction was that there is a relationship between a teacher’s acceptance of the
theory of evolution and their knowledge level of evolution theory. A relationship should
exist between these two factors, and have relationships to other factors, such as the
number of college level classes they have taken on the theory of evolution. Stated as a null hypothesis;

Ho: There will be no relationships between a teacher’s acceptance of the theory of evolution or knowledge level of evolutionary theory and other factors.

**Delimitations**

1) The population chosen to research in this study was secondary life science teachers. Therefore teachers who did not teach grades 7 through 12 or did not have any life science aspect of the courses they teach were not included.

2) This study focused on teachers in the State of Ohio and may not be comparable to the situations in other states.

3) Only teachers in public schools were selected for this study, and no conclusions were drawn about private school teachers in the State of Ohio.

**Limitations**

The following may have been limiting factors to the study.

1) The survey length (3 pages, front and back) may have affected response rates and the quality of the responses.

2) Given the controversial subject matter, it was possible that some participants did not answer questions on the questionnaire honestly.

3) Since the questionnaire included 20 Likert scale items used to assess their personal beliefs about the theory of evolution, it was also possible for respondents to have inconsistencies in their responses of similar questions.

4) For the multiple-choice section of the survey that assessed the knowledge level of some of the concepts associated with the theory of evolution, it was possible
teachers may have looked up answers they did not know, therefore skewing results.

5) Those who returned the questionnaires may have been more likely to support the theory of evolution, and those who were not likely to support the theory of evolution might have been less likely to complete and return the questionnaire.

6) Participants were put into subjective groupings for analysis purposes.

Definition of Terms

Standard- A standard describes what all students should know and be able to do as a result of the Kindergarten through 12th grade (K-12) program. In life sciences specifically, the standard indicates that students are expected to “demonstrate an understanding of how living systems function and how they interact with the physical environment” (ODE, 2002).

Grade-level Indicators- Statements that define a specific concept students are to be able to grasp at particular grade levels. These indicators monitor a student’s progress toward being able to fulfill the standard. (ODE, 2002).

Theory of Evolution and Evolutionary Theory – These terms refer to biological evolution. Biological evolution is defined as the change of alleles or trait frequency in a population due to natural selection, mutation, gene flow, or genetic drift (Futuyma, 1998). The National Academy of Sciences [NAS] (1998) defines evolution as “Change in the hereditary characteristics of groups of organisms over the course of generations. (Darwin referred to this process as ‘descent with modification’)” (p. 13).
Natural selection- a key process of the theory of evolution, along with mutation, gene flow, and genetic drift in which organisms with heritable traits that are better suited to their environments have greater reproductive success, therefore increasing the frequency of favorable traits in a population (Futuyma, 1998; WGBH Educational Foundation, 2001).

Intelligent Design- An argument that the only explanation of the world, given the complexity of the earth and the life forms it contains, is an unnamed intelligent designer.

Creationism- “A doctrine that or theory holding that matter, the various forms of life, and the world were created by God out of nothing, and usually in the way described in Genesis” (Merriam-Webster’s Collegiate Dictionary, 1993).

Creation Science- an attempt to legitimize creationism as a form of science by either trying to prove creationism and intelligent design, or by an attempt to disprove evolution (WGBH Educational Foundation, 2001).

Science- “A way of knowing about the natural world based on observations and experiments that can be confirmed or disproved by other scientists using scientifically accepted techniques” (WGBH Educational Foundation, 2001).

Theory- In vernacular English, the definition of a theory is often something that is unproven or assumed. However, in science, a theory is defined as “a well substantiated explanation of some aspect of the natural world that can incorporate facts, laws, inferences, and tested hypotheses” (NAS, 1998, p. 5).

Secondary- Grades 7 through 12.
Organization of the Study

Though standards play a critical role in what content is taught in science classrooms, it does not necessarily follow that the improvement of these standards in regards to the theory of evolution will necessarily ensure that all students across the state receive uniform educations. One reason for this inconsistency is that what is taught in the classroom is often a reflection of a teacher’s personal beliefs (Eve & Dunn, 1988; Meadows, Doster, & Jackson, 2000) and is dependent upon their level of understanding of the subject matter (Brumby, 1984; Hasweh, 1987; Carlsen, 1991).

After reviewing the literature in Chapter 2, this study reports in Chapter 3 the methodology including the research design, the population studied and the sample chosen, as well as the instrumentation used. Finally, the methodology section of this paper reports how the data were collected and analyzed. The results and implications of this study are reported in Chapter 4, focusing on the presentation the findings, discussion of the data, and the implications the findings may have on research and practice in the field of education.
Chapter 2

Literature Review

The controversy surrounding the drafting of the newly adopted Science Academic Content Standards (2002) in the State of Ohio suggests that it might be important to look at other factors that affect the teaching of evolution in secondary life science classrooms across the state. Therefore, this study examined the status of Ohio secondary life science teachers in terms of their knowledge base and level of acceptance of the theory of evolution, as of May, 2003. This literature review will first set the stage of this study by looking at why the teaching of evolutionary theory is important in secondary life science classrooms. Next, the literature that looks at some of the possible factors that could contribute to the teaching of evolutionary theory is reviewed, including the role that state standards play in curricular decisions. Then this review looks at research performed on the attitudes, public opinion, and acceptance of the theory of evolution and its teaching in public schools both nationally and in the State of Ohio. The last factor that affects the teaching of evolution in the classroom that is explored in this literature review is the knowledge level, or the understanding of, the theory of evolution held by different populations. Finally, this review summarizes why evolution education is important, as well as some of the factors that may affect the curricular decisions in regards to evolutionary theory.

*The Importance of Evolutionary Theory in Science Education*

The biologist Theodosius Dobzhansky wrote, “Nothing in biology makes sense except in the light of evolution” (1973, p. 125). Many scientists and educators see evolutionary theory as a unifying theme in biology, because evolutionary theory has the
ability to tie together many different subjects under the discipline of biology (NSTA, 1997; NABT, 1997). The implications of this could be immense in secondary science education, especially since studies have shown that some concepts associated with evolution, such as natural selection, can be difficult for students to grasp at many different levels of learning, from secondary education to medical school (Brumby, 1984; Demastes, Good, & Peebles, 1996; Greene, 1990; Lawson & Thompson, 1988). However, Osif (1997) found that only 67.7% of teachers agreed that the theory of evolution is vital in the study of biology.

The scientific content that is learned by studying evolutionary theory can be considered valuable in many different fields. Antolin and Herbers (2001) argue that knowledge of the concepts of macroevolution and microevolution are essential for three key fields: medicine, agriculture, and biotechnology. For example, in the field of medicine, doctors must be knowledgeable about microevolution to keep up with the resistance of bacteria and viruses to antimicrobial drugs. Furthermore, the principles of macroevolution are important in the testing of animals as models for humans, and in cross species transplantation of organs.

Though the concepts associated with evolutionary theory can be hard to grasp, several of the following studies have shown that teaching evolutionary theory can have merits above and beyond the acquisition of knowledge of some of these scientific concepts, like natural selection. For instance, the theory of evolution is said to be a good example in the science classroom in order to teach the nature of science (NAS, 1998; NSTA, 1998; see also Alles, 2001; Nickels, Nelson & Beard, 1996; Scharmann & Harris, 1992). An example of this in the classroom could be teaching the definition of
science and the definition of religion, and then comparing and contrasting the two. The nature of science can also be covered using evolutionary theory by teaching what makes theories different than facts in science. The newly adopted State of Ohio Science Academic Content Standards (2002) grade-level indicators for the 10th grade life sciences includes an indicator that would fit well with teaching evolutionary theory and the nature of science together. The indicator directs teachers to “Describe how scientists continue to investigate and critically analyze aspects of evolutionary theory. (The intent of this indicator does not mandate the teaching or testing of ‘intelligent design’.)” (p. 29).

However, in teaching evolutionary theory and possibly even the associated debates, researchers have found that teachers can help facilitate critical thinking skills in their students. (Mead & Scharmann, 1994; Nickels et al., 1996). However, there was some opposition to this grade-level indicator, as one scientist objected to the inference that the theory of evolution is the only concept in science that has controversies among the scientific community (Krauss, 2002). Overall, however, the research shows that teaching evolutionary theory is valuable to students not only for the learning of the key concepts of evolution and its processes, but also for reasons above and beyond the actual scientific content. The National Association of Biology Teachers (1997) concludes “teaching biology in an effective and scientifically honest manner requires classroom discussions and laboratory experiences on evolution” (p.1).

*The Role of Standards*

Standards have a very important role in what is taught in the classrooms. Moore (2002) states that strong standards in the theory of evolution give teachers who would like to teach the theory of evolution in their classrooms a strong framework within which
to do so. However, many states still do not have these strong standards with regard to the theory of evolution. In “Good Science, Bad Science: Teaching Evolution in the States”, Lawrence Lerner (2000) graded 49 of the 50 states, and the District of Columbia on their treatment of the theory of evolution. These grades were based on the wording and intent of each state’s science standards documents. Based on the standards available for him to study the summer of 2000, Lerner gave twelve states failing grades, including Ohio. A failing grade in this case was defined as “the treatment of evolution is useless or absent”. Among other reasons, Ohio received a failing grade because the standards at the time did not use the word “evolution” in the text. Overall, however, the Ohio science standards received a grade of “B”. Reviewing Lerner’s assessment of state standards relating to the theory of evolution and other pertinent literature on the subject, Moore (2002) concluded that many of the states that received failing grades had a large percentage of biology teachers that endorse or teach creationism.

In the time since Lerner’s analyses of the standards documents for each state were performed, Ohio has adopted new science standards that would likely receive a passing grade. However, it does not necessarily follow that standards for evolutionary theory will make their way into a teacher’s curriculum. Rutledge and Warden (2002) found that even though the State of Indiana has excellent standards for the theory of evolution, 43% of teachers avoid the subject or only mention it briefly. One reason this may be the case is that standards that adequately address evolution may not be enough to actually change instructional practices in the classroom, since classrooms vary from teacher to teacher (Skoog & Bilica, 2002). Olson (2001) states that, in fact, standards are making their way into the classroom, though they are not always well received by teachers.
Some research indicates that standards-based curriculum has the potential to have positive effects on students. Leonard, Speziale, and Penick (2001) concluded that students taught under a standards-based high school biology curriculum found the subject matter more interesting and outperformed students who were taught under traditional methods. However, more research needs to be performed as many teachers still have hesitations about the merits of standards based education. There also needs to be more research done on how standards dealing with the theory of evolution affect practice, given that teachers have a good deal of control over what is taught in their classrooms. Given the finding of Zimmerman (1987) that the content of a course was not independent of the teacher’s religious and personal feelings about the theory of evolution, teachers could possibly opt not to teach the standards to which they disagree.  

The Attitudes about and Acceptance of Evolutionary Theory  

Many studies have been conducted in different states testing the attitudes teachers hold about evolutionary theory. In Pennsylvania, it was found that 39% of teachers thought that creationism should be taught in public schools (Osif, 1997). Similar results were found in Louisiana, where Aguillard (1999) found that 29% of teachers thought that creationism should be taught in high school biology. Zimmerman (1987) found that 34.3% of Ohio public school biology teachers thought creationism should be taught in public schools. Even more extreme, Eve and Dunn (1990) found that 30% of secondary life science teachers would rather teach creationism than evolution if they had to choose between the two. On a national level, a survey performed by People for the American Way (2000) found that 13% of Americans wanted equal treatment of evolution and creationism in science classes, and that 16% of Americans believed only creationism
should be taught in public schools. This adds up to 29% of Americans supporting creationism being taught as science. However, this study also found that an additional 29% supported creationism being discussed in science class, but as a belief, not as a scientific concept, and that 17% of Americans felt that creationism could be taught in public schools, but should be kept out of science class. Fuerst (1984) concluded that anywhere from 74% to 86% of Americans want creationism to be taught in science classrooms of public schools, with 10% to 16% of that number wanting only creationism to be taught in science classrooms.

Though these studies looked at the key factor of public opinion, which likely affects the decisions of teachers whether or not to teach the theory of evolution or alternate theories, there are other factors that may also impact teacher choice. Zimmerman (1991) tested the attitudes and beliefs of Ohio School Board Presidents since they are another key factor on the decisions that teachers make regarding whether to teach evolution or alternate theories such as creationism or intelligent design. He found that 49.7% of Ohio School Board Presidents accepted the theory of evolution, while 52.7% thought that “creation science” should be taught positively in public schools. College and university students in the State of Ohio have also been studied thoroughly regarding their attitudes towards evolution. However, the surveys were not always administered in classes solely for pre-professional science teachers, but were administered in mostly science classes. Studies at Ohio State University (OSU) (Fuerst, 1984) and Oberlin College (Zimmerman, 1986) using the same survey found that 63% and 89.2 %, respectively, of students believed in the theory of evolution, while 41% of OSU students and 13% of Oberlin College students believed that the theory of evolution
is not scientifically valid. These studies also found that 80% of OSU students and 56.3% of Oberlin College students felt that “other views” like creationism should be taught in public schools if evolution is taught.

One limitation of the preceding studies was that the researchers asked questions about whether or not the respondent believed the theory of evolution or if creationism should be taught in public schools, but did not measure the level of acceptance the respondents had to the theory of evolution. Rutledge and Warden (2000) assessed the levels of acceptance in high school biology teachers and found that Indiana teachers possessed a moderate level of acceptance of the theory of evolution. Another key limitation of these studies relative to this study and the debate over the drafting of the State of Ohio Science Academic Content Standards was that studies focused on creationism, and did not test the public opinions about intelligent design. A study sponsored by the Cleveland Plain Dealer and performed by Mason-Dixon Polling and Research in late May into early June of 2002, found that 45% of adult Ohioans were not at all familiar with the concept of Intelligent Design, while 20% of respondents said that they paid much attention to the debate between evolution and intelligent design (“Plain Dealer Ohio Poll”, 2002). This study also asked: “Currently, the Ohio Board of Education is debating new academic standards for public school science classes, including what to teach students about the development of life on Earth. Which position do you support?” However, given the unfamiliarity of Ohioans with intelligent design, the responses included…

1) Public schools should teach only evolution (8%)

2) Public schools should teach only intelligent design (8%).
3) Public schools should teach both intelligent design and evolution (59%).

4) Public schools should teach the evidence both for and against evolution, but not necessarily intelligent design (15%).

5) Public schools should teach nothing about human development (9%).

6) Not sure what public schools should teach (1%).

These responses show that the debate has no one answer for Ohioans, and that the percentage of Ohioans that believe that public schools should only teach evolution is very small.

Teacher’s acceptance of and their attitudes toward the theory of evolution can be related to a variety of factors. Studies have found a strong positive correlation between teachers’ acceptance of the theory of evolution and teachers’ understanding of evolutionary theory (Fahrenwald, 1999; Rutledge & Warden, 2000). Another strong factor that influences the acceptance of evolutionary theory is the amount of post secondary education in biological sciences, sometimes specifically classes focusing on evolution (Fuerst, 1984; “Plain Dealer Poll”, 2002; Zimmerman, 1986). However, Johnson (1985) found that completing a course in evolution did not significantly alter a student’s level of acceptance of the theory of evolution. However, the teaching of evolution by both secondary and collegiate instructors did increase the acceptance level of the student. Similarly, Johnson and Peebles (1987) found that college students’ level of acceptance of the theory of evolution related to their scientific understanding. It has also been shown that students in introductory level college biology courses who are Creationists are not likely to do as well as students who believe in evolution (McKeachie, Lin, & Strayer, 2002).
Teachers’ Knowledge Levels

Generally, the knowledge level of teachers about scientific concepts and principles will affect both what is taught in the classroom, as well as what students learn. The problem is confounded, however, by the issue of teaching evolutionary theory in science classrooms. One key reason this is the case is that many studies have shown that concepts associated with evolutionary theory can be difficult for many students to comprehend. In a study of 7th grade students, Lawson and Thompson (1988) found that the misconceptions students hold about natural selection are generally not eliminated based on the mental capacity of the student. On a collegiate level, the theory of evolution remains a difficult subject prone to misconceptions among students. The problem of misconceptions about the theory of evolution can even extend into medical school, given that Brumby (1984) found that only 10% of medical students had a reliable understanding of natural selection. Greene (1990) found that 3% of university education majors enrolled in an introductory science class held a true understanding of natural selection, while 43% held a functional understanding.

Since students on many different levels have been shown to hold misconceptions of evolutionary theory, it is important to examine what teachers actually know about the theory of evolution. Rutledge (1996) and Rutledge and Warden (2000) found that Indiana high school biology teachers had moderate levels of understanding of the theory of evolution. Other studies have found that secondary life science teachers have insufficient knowledge of the theory of evolution (Fahrenwald, 1999; Roelfs, 1987). Studies have found that teachers’ emphases on the theory of evolution in the classroom corresponds to the number of classes or credit hours they have taken that focused on
evolutionary theory (Aguillard, 1999; Roelfs, 1987). Roelfs (1987) also found that
teachers’ accuracy and emphasis in the teaching of evolutionary theory also relates to the
teacher’s academic background, and to what academic degree they have received.
Aguillard (1999) found that 50% of Louisiana public high school biology teachers who
stated that “they presented less information in their classroom instruction than was
presented in the textbook stated that their academic training was inadequate for teaching
evolution” (p. 186).

Just as a teacher’s acceptance or rejection of the theory of evolution has a
possibility of being passed on to students (Eve & Dunn, 1988, 1990), a teacher’s
misconceptions and knowledge of evolutionary theory could be passed on to students as
well. According to Hasweh (1987), a teacher’s subject matter knowledge can affect both
written curriculum for the classroom, as well as what is taught to the class. Therefore, if
a teacher holds prior misconceptions about the subject matter, it is likely that he or she
will teach that misconception in the classroom. Carlsen (1991) also found “teacher
knowledge influences decisions about instructional strategy” (p. 646). Though these
studies show that the knowledge level of biology generally affects teachers’ curricular
decisions, they do not specifically speak to the teaching of evolutionary theory.
Therefore, additional research can be done on this subject. Given the finding that only
3% of university education majors held a true understanding of natural selection (Greene,
1990), exactly how a teacher’s knowledge level of the theory of evolution affects
curricular decisions and student learning should be studied in greater depth to determine
the extent that teachers can pass down misconceptions about the theory of evolution and
its concepts such as natural selection.
Summary of the Literature

Due to its potential as a unifying theme in biology (Dobzhansky, 1973; NSTA, 1997; NABT, 1997), evolutionary theory can be a significant concept taught in secondary science classrooms. There are several factors that affect the teaching of the theory of evolution in science classrooms across the country. Standards can play a key role in what is taught in the classroom. Given that the State of Ohio adopted new Science Academic Content Standards, these standards may affect what is taught in Ohio secondary life science classrooms in the future. Research has shown that standards-based education can have positive effects in the science classroom (Leonard et al., 2001), though more research needs to be performed on the impact that standards have on the teaching of the theory of evolution in the classroom.

The research studying the attitudes of teachers regarding the theory of evolution is abundant. However, the issue has changed somewhat from the main opposition to the theory of evolution coming from Creationists to significant pressure coming from the Intelligent Design Movement, as was seen in the recent debate over the drafting of new State of Ohio Science Academic Content Standards. Because of this, some of the research regarding creationism and the theory of evolution may be outdated. However, the research shows that there are a significant proportion of science teachers in the United States that not only believes in creationism, but also would like to see it taught in public schools (Elgin, 1983; Osif, 1997; Zimmerman, 1987). Therefore, the literature reviewed can be regarded as important to the issues affecting the teaching of the theory of evolution in the science classrooms of today, and is a historical perspective on the attitudes of life science teachers across the country about the theory of evolution. These
previous studies on teacher attitudes help set the stage for the analysis of the primary research question presented in this study, which dealt with the acceptance level of the theory of evolution of Ohio secondary life science teachers. The reviewed literature also set the stage for the analysis of the supporting research question, which looked at the possible relationships that may exist between a teacher’s acceptance of the theory of evolution and other factors.

The literature also indicates that there are many other factors that may influence whether the theory of evolution is taught in science classrooms, is ignored, or whether alternative theories are taught instead. Another key factor is the knowledge level of science teachers about the theory of evolution. The research shows that knowledge level plays a large role in curricular decisions (Carlsen, 1991; Hasweh, 1987). The research also shows that the knowledge level of public school teachers about the theory of evolution is relatively low compared to the rest of the scientific community (Fahrenwald, 1999; Roelfs, 1987; Rutledge, 1996; Rutledge and Warden, 2000). This existing research sets the stage for this study’s analysis of the current understanding and knowledge level of evolutionary theory posed in the supporting research question involving the knowledge level of teachers.
Chapter 3

Methodology

Research Design

This study was research based on a survey of Ohio secondary life science teachers. This study’s objective was to identify the status of the teaching of evolution in secondary life science classrooms following the December, 2002 adoption of Science Academic Content Standards that included the theory of evolution. To assess the status of evolution education, as it pertains to Ohio secondary life science teachers, the focus of this study was on teacher’s level of acceptance of the theory of evolution as well as the teacher’s knowledge base of evolutionary theory. This study also examined some possible factors that may relate to whether or not a teacher accepts or rejects the theory of evolution, as well as what a teacher actually knows about some of the key concepts in evolution.

The questionnaire was composed of two established instruments, and a component that was developed to obtain key demographic data. Twenty Likert Scale items tested the levels of acceptance of the theory of evolution. The 21 multiple-choice questions of the second instrument were used to determine teachers’ levels of understanding about key concepts in the theory of evolution. These two instruments were chosen since they had been validity and reliability tested, and were shown to be an effective measure of the acceptance of the theory of evolution as well as an effective measure of the knowledge level of the theory of evolution for life science teachers (Rutledge & Warden, 1999; 2000). Finally, key demographic data were obtained through six questions in the form of yes/no and fill-in-the-blank. These questions pertained to the
teacher’s history in teaching, information on the school district, and the teacher’s background in evolution.

The questionnaires were mailed to 300 secondary schools in the State of Ohio that were chosen at random. The labels were addressed to the life science teacher of each school. Each envelope contained a questionnaire, a cover letter explaining the study, and a self-addressed stamped return envelope. Returned questionnaires were numbered to protect anonymity of respondents and entered into a database.

Population and Sample

The population targeted for this study was Ohio secondary school life science teachers. To be included in the study, respondents had to indicate that they taught any grade from seventh through twelfth, and that at least some component of their course included life sciences. The sample was selected from a list of all Ohio public secondary schools obtained through the Ohio Department of Education (ODE) website, using the Ohio Educational Directory System (OEDS). The data were then loaded into Microsoft Excel. All schools without the 7th, 8th, or 10th grades were eliminated since most of the life science standards for evolutionary theory are listed under these grades. Therefore many alternative schools and freshman academies were eliminated from the list. Of the 815 remaining schools, 300 schools were randomly selected using the random selection program of the SPSS statistical package. Of the 300 questionnaires mailed, 87 usable questionnaires were returned, at a 30.3% response rate. Four returned questionnaires were not included in the study because the respondents were not life science teachers. Of the respondents, 14.9% were 7th or 8th grade life science teachers, while the majority
(85.1%) of the respondents were high school teachers, grade 9 through grade 12. See Table 1 for more demographic data of the respondents.

**Instrumentation**

The questionnaire included twenty Likert scale items designed by Rutledge and Warden (1999). The instrument, the Measure of Acceptance of the Theory of Evolution (MATE), was designed to test the attitudes and level of acceptance of the theory of evolution of life science teachers. In validity testing, Rutledge and Warden (1999) concluded that the MATE showed construct validity in that the factor analysis indicated that one particular trait was being measured by the MATE, as was shown by an eigenvalue being greater than 1.0. Rutledge and Warden (1999) also performed reliability tests, and found that the reliability was 0.98 using the Cronbach alpha method.

The second instrument used in the questionnaire included 21 multiple-choice questions that assessed teachers’ level of understanding of the theory of evolution. This instrument was modified by Rutledge and Warden (2000) from an existing instrument (Johnson, 1985). Many aspects of evolutionary theory were included in this instrument, such as intermediate forms, speciation, reproductive success, etc. Rutledge and Warden (2000) determined this instrument to be valid using item analysis performed by a jury of professional biologists and educators. The reliability coefficient, as determined by using measures of internal consistency, was found to be 0.78.

The final section of the questionnaire was developed to elicit key demographic data. This section comprised six questions. Questions sought information regarding the grades and subjects taught by the teachers, the number of years the teacher taught life science, and whether or not the teacher was certified or licensed to teach life science in
Table 1

Demographic data including grade levels taught, licensure, location of schools, and years of teaching experience for participants in the study.

<table>
<thead>
<tr>
<th>N</th>
<th>%</th>
</tr>
</thead>
</table>

**Grade Levels Taught**

- High School: 74 (85.1)
- Junior High: 13 (14.9)

**Licensed for Secondary Life Science***

- Yes: 83 (95.4)
- No: 3 (3.4)

**Location of School**

- Urban: 16 (18.4)
- Suburban: 26 (29.9)
- Rural: 38 (43.7)
- Suburban/Urban: 1 (1.1)
- Suburban/Rural: 3 (3.4)

**Years Teaching Experience**

- Max: 35
- Min: 1
- Average: 14.4

* Those not certified held elementary certificates, and were teaching 7th and/or 8th grades.

** One or more respondents did not reply to this question
the State of Ohio. Teachers were further asked to classify their school district as urban, suburban, or rural. Two questions regarding the treatment of evolution were asked. The first question was a yes/no question that asked if the teacher actively taught the theory of evolution in his or her life science classes. If not, teachers were asked to indicate from a checklist of possible factors, which influenced their decisions not to teach evolution. The final question asked how many college level classes the teacher had taken that focused on evolution. The questionnaire used in this survey can be found in Appendix A.

Data Collection

Each survey was mailed in May, 2003 and included a questionnaire (Appendix A), a cover letter (Appendix B), and a self-addressed stamped return envelope after the study received approval from the Institutional Review Board of Ohio University (Appendix C). The cover letter was addressed to life science teachers, and asked the participants to complete the questionnaire and to return it for analysis using the self-addressed stamped envelope. The cover letter also ensured participants’ anonymity, and stated that sending back the survey implied consent to participate in the survey. Some respondents added notes with their name and address requesting the findings of the study. In these cases, the notes were immediately separated from the returned questionnaire and filed separately to ensure the anonymity of each respondent.

Data Analysis

To facilitate data analysis, a score was given for each question of the MATE component of the survey (questions 1 through 20). The Likert scale used gave the score of 5 for strongly agree, 4 for agree, 3 for undecided, 2 for disagree, and 1 for strongly disagree. Answers with the highest level of acceptance of the theory of evolution
received a score of 5 on a five point scale (see summary of data in Appendix D), and decreased to the score of 1 which indicated a low acceptance of the theory of evolution. Questions numbered 2, 4, 6, 7, 9, 10, 14, 15, 17, and 19 were stated negatively. To be scored, the responses of these questions were converted. For example, a mark of 5, which indicated a response of strongly agree for a negatively stated item received a score of 1, which indicated a low acceptance level for the theory of evolution. Scores were then tabulated for each respondent by taking the sum of all items included on the MATE. An individual respondent’s score for the MATE items of the questionnaire could not exceed the sum of 100, nor be less than 20. Based on these scores, respondents were placed into two categories. The first group was labeled as accepting of the theory of evolution (Acceptance Group), while the other group was labeled as not accepting of the theory of evolution (Rejection Group). The criterion for the grouping was any score below 70 was put into the Rejection Group. To determine the cut off point of the score of 70, each questionnaire near a score of seventy was scrutinized. These groupings were applied to all comparisons of the responses of the Acceptance Group versus the Rejection Group. These two groupings were then sometimes compared against the entire group of respondents as a whole for analysis purposes.

The scores for the MATE portion of the questionnaire were also used to find the levels of acceptance of the theory for each group. To do this, the mean scores per item and the standard deviation were calculated for the entire group of respondents, the Acceptance Group, and the Rejection Group. The scaled response items of the MATE were also ranked by average score of the Acceptance Group and of the Rejection Group to determine the items that scored the highest and those that scored the lowest for each
group. Finally, to determine if the difference in average scores between the groups was significant, median ranks were tested using a nonparametric Mann-Whitney test.

Each respondent was also given a score for the multiple-choice portion of the questionnaire dealing with his or her knowledge levels of the theory of evolution. These scores were calculated by computing a percentage formed by dividing the number of questions correct by the total number of questions. Though there were 21 multiple-choice questions on the questionnaire, question 34 was deemed to be unsuitable for analysis, therefore leaving the total number of questions to 20. Question number 34 was deleted because the majority of respondents (72.9%) answered it incorrectly, and because its difficult content matter was deemed too advanced for the majority of secondary life science teachers. Averages were analyzed to determine if there were significant differences in the scores between the groups. A Levene’s test for equality of variances was used to compare variances of the Acceptance and Rejection Groups. The variances were unequal; therefore an independent sample \( t \)-test was used with unequal variances. The other comparisons showed homogeneity of variances, so an independent sample \( t \)-test was used with equal variances.

The questions that averaged the lowest correct response rates per group were then ranked to determine the evolutionary theory content knowledge lacking in each group. The population number used for the multiple-choice analysis was 76, as one respondent put in the Rejection Group answered the first multiple-choice question and did not mark any more responses. This respondent’s data were still used for other portions of this study, but have been omitted from analysis in the knowledge level of evolution portion of the study. Otherwise, skipped questions were marked as incorrect.
Finally, correlation analysis was applied to determine the relationship between the acceptance of the theory of evolution, the knowledge base of evolutionary theory, and other factors. A nonparametric Spearman’s Ranked Correlation Analysis was used to determine these correlations. The primary possible correlation that was tested was the correlation between teachers’ acceptance of the theory of evolution (score on the MATE portion of the questionnaire) and their knowledge level of the theory of evolution (score on the multiple-choice portion of the questionnaire). The correlation between a teacher’s acceptance of the theory of evolution, their knowledge of the theory of evolution, and the following factors was determined: the number of years a teacher has taught life science; whether the school district is considered urban, suburban, or rural; and the number of college level courses the teacher has taken that have focused on the theory of evolution. For all statistical tests, the confidence level was set at 95% ($\alpha = 0.05$).
Chapter 4

Results, Conclusions, and Implications of the Study

In this chapter, the results are reported and analyzed as related to the acceptance and to the knowledge level of the theory of evolution. First, the findings of the study are presented for each research question. Also, the findings are discussed in light of how they relate to the current available literature, and conclusions are drawn for each of the three research questions. Finally, an analysis of how the findings of this study may affect current practice and future research are explored.

Presentation of the Findings

Of the 300 questionnaires mailed to Ohio secondary life science teachers, 87 usable questionnaires were returned, a 30.3% response rate. Four returned questionnaires were not included in the study because the respondents were not life science teachers. Of the respondents, 14.9% were 7th or 8th grade life science teachers, while the majority (85.1%) of the respondents were high school teachers, grades 9 through grade 12. Of the 87 respondents used in the study, 77 were placed in the Acceptance Group, while 10 respondents were placed in the Rejection Group.

Primary Research Question: Acceptance of the Theory of Evolution.

The first research question in this study asked what is the current level of acceptance of the theory of evolution in Ohio secondary life science teachers. The data indicate that for the MATE portion of the survey, the average total score of the respondents was 87.47 out of 100 points (N = 87, SD = ±17.24). This is an average score of 4.37 for each individual item on the MATE, which falls in between agree and strongly agree with the statements supporting the theory of evolution (see Table 2 for group means). Broken down by
Table 2

The mean score and standard deviation per question of the MATE responses for the entire group of respondents, the Acceptance Group, and the Rejection Group.

<table>
<thead>
<tr>
<th>Item #</th>
<th>Entire Group of Respondents (N = 87)</th>
<th>Acceptance Group (N = 77)</th>
<th>Rejection Group (N = 10)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>SD</td>
<td>Mean</td>
</tr>
<tr>
<td>1</td>
<td>4.44</td>
<td>1.15</td>
<td>4.77</td>
</tr>
<tr>
<td>2</td>
<td>4.09</td>
<td>1.23</td>
<td>4.38</td>
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<tr>
<td>3</td>
<td>4.33</td>
<td>1.15</td>
<td>4.69</td>
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<tr>
<td>4</td>
<td>4.44</td>
<td>1.08</td>
<td>4.75</td>
</tr>
<tr>
<td>5</td>
<td>4.41</td>
<td>0.71</td>
<td>4.53</td>
</tr>
<tr>
<td>6</td>
<td>4.25</td>
<td>1.07</td>
<td>4.52</td>
</tr>
<tr>
<td>7</td>
<td>4.67</td>
<td>0.87</td>
<td>4.88</td>
</tr>
<tr>
<td>8</td>
<td>4.46</td>
<td>0.83</td>
<td>4.68</td>
</tr>
<tr>
<td>9</td>
<td>4.52</td>
<td>0.96</td>
<td>4.74</td>
</tr>
<tr>
<td>10</td>
<td>4.51</td>
<td>0.96</td>
<td>4.74</td>
</tr>
<tr>
<td>11</td>
<td>4.40</td>
<td>0.92</td>
<td>4.61</td>
</tr>
<tr>
<td>12</td>
<td>4.25</td>
<td>1.13</td>
<td>4.55</td>
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<td>13</td>
<td>4.13</td>
<td>1.32</td>
<td>4.37</td>
</tr>
<tr>
<td>14</td>
<td>4.59</td>
<td>0.76</td>
<td>4.75</td>
</tr>
<tr>
<td>15</td>
<td>4.31</td>
<td>1.11</td>
<td>4.59</td>
</tr>
<tr>
<td>16</td>
<td>4.29</td>
<td>1.12</td>
<td>4.61</td>
</tr>
<tr>
<td>17</td>
<td>4.38</td>
<td>0.87</td>
<td>4.55</td>
</tr>
<tr>
<td>18</td>
<td>4.37</td>
<td>1.08</td>
<td>4.68</td>
</tr>
<tr>
<td>19</td>
<td>4.33</td>
<td>1.28</td>
<td>4.61</td>
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<tr>
<td>20</td>
<td>4.30</td>
<td>1.11</td>
<td>4.61</td>
</tr>
<tr>
<td>Average</td>
<td>4.37</td>
<td>0.14</td>
<td>4.63</td>
</tr>
</tbody>
</table>
group, the data indicate that the average total score for the Acceptance Group was 92.60 (N = 77, SD = ±8.91) which averages to a score of 4.63 per item. This group’s average leans more to the score of 5 (strongly agree) than does the average of 4.37 for the entire group of respondents. The Rejection Group scored an average of 48.00 (N = 10, SD = ±14.70), which averages to a score of 2.40 per item. This falls in between undecided and disagree, leaning more towards disagreeing with the items that are positive for theory of evolution.

The questions that received the lowest level of acceptance from the respondent population as a whole were question 6 (M = 4.25, SD = ±1.07) that pertained to the ambiguity of data supporting evolution, question 12 (M = 4.25, SD = ±1.13) that pertained to the soundness of current evolutionary research, question 13 (M = 4.13, SD = ±1.32) that pertained to the testability of evolutionary theory, and question 2 (M = 4.09, SD = ±1.23) that dealt with whether evolution is scientifically testable (see appendix A for the complete instrument). The questions that received the lowest scores for the Acceptance Group were question 6 (M = 4.52, SD = ±0.7), question 20 (M = 4.38, SD = ±0.7) that dealt with the scientific validity of evolutionary theory, and question 13 (M = 4.37, SD = ±1.1). All three of the lowest scoring items still fell in between agree and strongly agree with items positive towards the theory of evolution. The lowest scoring items of the MATE in the Rejection Group were question 20 (M = 1.90, SD = ±0.9), question 16 (M = 1.80, SD = ±1.0) that pertained to the data that support evolutionary theory, and question 3 (M = 1.60, SD = ±0.7) that pertained to the evolution of humans. These scores fell in between the categories of disagreeing and strongly disagreeing with the theory of evolution.
The data indicated that there were significant differences between the average scores of the entire group of respondents and the Acceptance Group (U = 34.0, p < 0.001), between the entire group of respondents and the Rejection Group (W = 210.0, p < 0.001), and between the Acceptance Group and the Rejection Group (W = 210.0, p < 0.001).

**Supporting Research Question One: Knowledge Level of the Theory of Evolution.**

The data showed that overall; Ohio secondary life science teachers scored an 83.2% on the study’s 20 multiple-choice questions that tested teacher knowledge of evolution. The scores for the entire population of respondents ranged from a 30% correct score to eleven 100% correct scores. By group, the Acceptance Group scored almost 18 percentage points higher than the Rejection Group with an average of 85.1% of questions answered correctly. The Rejection Group, however, correctly answered an average of 67.2% of the multiple-choice questions. The data indicated that the differences between the mean scores on the multiple-choice questions in the survey for the Acceptance Group and the Rejection Group were significantly different (\(t = 2.40, df = 8.70, p = 0.041\)). It was also found that the Rejection Group’s mean multiple-choice scores were significantly different from the scores of the group of respondents as a whole (\(t = 2.88, df = 93, p = 0.005\)). However, the Acceptance Group did not show mean scores that were significantly different than those of the entire group of respondents (\(t = -0.83, df = 161, p = 0.406\)).

Of the 20 questions, question number 26 dealing with the definition of mutation was answered correctly by the entire respondent population (Table 3). The Rejection Group also answered question 27 that pertained to niche habitats, and question 35 that
Table 3

The ranks of multiple-choice questions testing evolutionary knowledge for the entire group of respondents, the Acceptance Group, and the Rejection Group.

<table>
<thead>
<tr>
<th>Entire Group Of Respondents</th>
<th>Acceptance Group</th>
<th>Rejection Group</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rank</td>
<td>Item #</td>
<td>% Correct</td>
</tr>
<tr>
<td>-----</td>
<td>-------</td>
<td>--------</td>
</tr>
<tr>
<td>1</td>
<td>26</td>
<td>100</td>
</tr>
<tr>
<td>2</td>
<td>28</td>
<td>94.2</td>
</tr>
<tr>
<td>3</td>
<td>29</td>
<td>92.9</td>
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<tr>
<td>4</td>
<td>39</td>
<td>92.8</td>
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<td>5</td>
<td>31</td>
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<td>6</td>
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<td>87.1</td>
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<td>10</td>
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<td>79.1</td>
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<td>13</td>
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<td>78.6</td>
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<td>14</td>
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<td>78.2</td>
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<td>24</td>
<td>72.3</td>
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<td>17</td>
<td>36</td>
<td>69.9</td>
</tr>
<tr>
<td>18</td>
<td>41</td>
<td>63.9</td>
</tr>
</tbody>
</table>
pertained to meiosis at 100% correct (N = 9). The three other best answered questions for the Acceptance Group were question 28, at 96.1% correct, and questions 29 and 39 with 94.7% correct. Question 28 dealt with characteristics of first land animals, question 29 pertained to reproductive isolation, and question 39 dealt with Lamarckian evolution. Both groups also had the lowest percentage of correct responses for question 41 that dealt with life history strategies, at 50% correct for the Rejection Group and 65% correct for the Acceptance Group. The Rejection Group also scored 50% correct response for question 23 that dealt with radioactive dating techniques, question 32 that dealt with the evidence for macroevolution, question 36 that pertained to intermediate forms, and question 40 that dealt with Darwin’s theory of natural selection. The Acceptance Group’s other poorest scoring questions were question 33 (73.7%) that dealt with Darwin’s theory of natural selection, question 24 (74.3%) that dealt with the processes of evolution, and question 38 (78.9%) that dealt with radiometric dating techniques.

**Supporting Question Two: Relationships between Acceptance and Other Factors.**

The primary relationship tested was the correlation between the understanding secondary life science teachers have of some of the key concepts in the theory of evolution and their personal acceptance of the theory. The data indicated that the percentage of correct responses on the multiple-choice portion of the questionnaire positively correlated with the score on the MATE portion of the questionnaire ($r_s = 0.575$, $p < 0.001$) (Figure 1). Therefore a teachers’ knowledge level of the theory of evolution correlated to his or her personal acceptance of the theory of evolution. Another notable positive correlation that was found was between the number of years the teacher has
Figure 1

A comparison of Ohio secondary life science teacher’s score on Multiple-Choice plotted against score on MATE for the Acceptance and Rejection Groups.
taught life science and their score on the multiple-choice questions \( (r_s = 0.220, p = 0.041) \). There was also a positive correlation between the number of years the teacher has taught life science and the teacher’s score on the MATE portion of the questionnaire \( (r_s = 0.361, p = 0.001) \).

The scores of the respondents on the MATE and on the multiple-choice portions of the questionnaire did not correlate to the geographic location of the school, meaning whether the school district was located in an urban, suburban, or rural setting \( (r_s = -0.157, p = 0.151) \). Also, scores on the MATE portions of the questionnaire did not correlate to the number of college level courses the teacher has taken that have focused on the theory of evolution \( (r_s = 0.165, p = 0.126) \). Also, a teacher’s score on the multiple-choice questions was not correlated with the number of college level courses they had taken that had focused on evolution \( (r_s = 0.133, p = 0.219) \).

Discussion

**Primary Research Question: Acceptance of the Theory of Evolution.**

The null hypothesis that was tested for the primary research question stated that Ohio life science teachers will neither show acceptance or rejection of the theory of evolution. The null hypothesis was rejected, since the entire group of respondents received an average MATE score of 87.47. This shows that, in fact, the majority of Ohio secondary life science teachers in this sample do accept the theory of evolution, therefore supporting the alternative hypothesis that the majority of teachers accept the theory of evolution. Of those teachers who rejected the theory of evolution, the average score on the MATE was only 48.00. The difference between the scores on the MATE for all groups was found to be significant. This shows that the grouping of participants into the
Figure 2

A comparison of Ohio secondary life science teacher’s score on multiple-choice plotted against score on MATE for the different locations of teacher schools.
Acceptance Group and the Rejection Group was justified, in that the scores on the MATE portion of the survey were markedly different.  

Since this study was adapted from a study performed by Rutledge and Warden (2000), comparisons between the two studies can be made. On average, Ohio life science teachers scored 9.88 points higher on the MATE than Indiana public high school biology teachers. The reason for this difference could be because Indiana and Ohio could have studied significantly different populations. This study surveyed secondary life science teachers, rather than only high school biology teachers, as in Rutledge and Warden (2000). Rutledge and Warden (2000) also found that the items with the lowest scores, or the concepts that were least accepted in Indiana, were questions 2 and 13, dealing with the testability of evolutionary theory, and questions 4 and 18, dealing with the evolution of humans. The data in this study agree with the findings of Rutledge and Warden (2000) with regard to the testability of evolutionary theory, as Ohio life science teachers also showed the lowest levels of acceptance for questions 2 and 13. Other lower scores were for questions that dealt with the ambiguity of the data supporting evolutionary theory (question 6), and the quality of research and methodology used to study evolutionary theory (question 12). However, these scores still fell in the acceptance range of evolutionary theory even though they were lower than the scores on all other questions.  

These questions that received the lowest scores show a significant trend in that they all deal with evolution as it pertains to the nature of science. It is possible that if a respondent did not agree that evolution is a scientifically valid theory, they may be unknowledgeable about what science includes or the definition of a theory within science, rather than morally opposed to evolutionary theory. These low scores on items
that discuss the data, research, and methodology related to the testing of evolutionary theory may also indicate that there is a significant lack in the knowledge of the nature of science.

This study also finds that Ohio life science teachers differ slightly in respect to the acceptance of the items pertaining to the evolution of humans, as this concept received more acceptance than items pertaining to how evolutionary theory related to the nature of science in its testability and its validity, and in the evidence supporting the theory of evolution. However, the Rejection Group scored the question about humans being the result of evolutionary processes (question 3) as the lowest of all questions.

Supporting Research Question One: Knowledge Level of the Theory of Evolution.

The hypothesis that the majority of life science teachers have an adequate knowledge of evolutionary theory is accepted; given that average score on the multiple-choice portion of the instrument was 83.2%. For the supporting hypothesis to this research question, the null hypothesis is rejected. This hypothesis stated that there is no difference in the understanding of evolutionary theory between those who accept the theory of evolution and those who reject the theory of evolution. Instead, this study supports the alternative hypothesis that teachers who accept the theory of evolution have a higher knowledge level that those who reject the theory of evolution. The supporting evidence for accepting this hypothesis includes

1) The Acceptance Group’s average score on the multiple-choice section of the survey testing knowledge of concepts associated with evolutionary was 17.9 points higher than the Rejection Group.

2) The analysis of the data showed that these differences were significant.
This acceptance of the hypothesis that Ohio secondary life science teachers who accept the theory of evolution have a higher knowledge level than those who reject the theory of evolution helps determine the result of the supporting research question asking “What is the current understanding of secondary life science teachers hold in the subject of biological evolution?” Given that the differences between the two groups were significant, and that the average for the entire respondent population for the multiple-choice questions was 83.2%, the average knowledge level is adequate. However, the data show that since the scores ranged from 30% to 100% correct, the knowledge level of Ohio secondary life science teachers can range from at worst dismal, and at best excellent.

Ohio secondary life science teachers on average scored 12.2 percentage points higher than Indiana high school biology teachers on the questions testing their knowledge of some concepts associated with the theory of evolution. However, this figure drops to 10.3 percentage points when question 34 is included into the analysis of this study, though it was omitted. Therefore, a difference of 10.3 percentage points is more representative of the actual difference, since Rutledge and Warden’s (2000) analysis of the knowledge level of Indiana high school biology teachers included question 34. Rutledge and Warden (2000) found that six questions averaged a correct response of 60% or less. Of these questions, the current study found that Ohio secondary life science teachers also scored low on three of these questions. Of these three questions, number 34 was left out of analysis, and the remaining two questions that also proved difficult for Ohio teachers were questions 24 and 41. Question 24 dealt with the definition of the process of evolution, and question 41 dealt with successful life history strategies. These
two questions did not receive less than 60% correct as in Indiana; rather question 24 was the third to hardest question for teachers and received an average of 72.3% correct responses, and question 41 received the lowest average score of all questions for Ohio teachers with an average of 63.9% correct responses. Question 36, which was the second hardest for Ohio teachers, was answered correctly 69.9% of the time. This shows that many Ohio life science teachers are unable to identify the correct definition of intermediate forms. These areas of insufficiency in teacher knowledge could have drastic effects on the learning of evolutionary theory by their students, given that Hasweh (1987) and Carlsen (1991) have found that the knowledge level of teachers can affect curricular decisions and what content is taught in the classroom. This problem could be exacerbated by the fact that evolution and its associated concepts can be difficult to grasp in the first place (Brumby, 1984; Greene, 1990; Johnson, 1987; Lawson, 1988; Moore et al., 2002; Woods & Scharmann, 2001).

Though the multiple-choice questions included in the survey can all loosely relate to the grade-level indicators dealing with evolutionary theory for the 7th, 8th, 10th, and 11th grades included in the Science Academic Content Standards, some specific questions could directly relate to the grade-level indicators. The most easily comparable are questions 33 and 40 that deal with Darwin’s theory of natural selection. Natural selection is encompassed in the 8th grade indicator that requires students to be able to explain how variations in organisms can allow them to have increased survival and reproduction (evolutionary theory indicator number 3). Similarly, but at an increased complexity, the 10th grade indicators call on students to be able to explain how natural selection is a mechanism for evolution (evolutionary theory indicator number 21) and be able to
analyze the past and present consequences of natural selection and other mechanisms of evolution (evolutionary theory indicator number 24). If teachers do not have an adequate knowledge of natural selection, which is apparent in questions 33 and 40 being two of the lowest scoring questions, they may be unable to adequately teach these 8th and 10th grade-level indicators.

*Supporting Question Two: Relationships between Acceptance and Other Factors.*

The hypothesis that there is a relationship between a teacher’s acceptance of evolutionary theory and their knowledge level of that subject as well as relationships between these two measures and other factors, such as the number of college level classes they have taken on the theory of evolution is accepted. Therefore, the null hypothesis that there are no relationships between a teacher’s acceptance of the theory of evolution and other factors is rejected. Significant relationships were found between a teacher’s level of acceptance of the theory of evolution and a teacher’s knowledge level of evolutionary theory (see figure 1). This finding agrees with the findings of previous research (Fahrenwald, 1999; Rutledge & Warden, 2000). These findings show that the more a teacher accepts the theory of evolution, the more likely he or she is to be more knowledgeable about evolutionary theory, and vice versa.

This study also found a significant relationship between the number of years a teacher has taught life science and his or her acceptance of the theory of evolutionary. There was also a positive relationship between the number of years a teacher has taught life science and his or her understanding of evolutionary theory. These findings indicate that content knowledge comes with experience, and may depend on the attitude the teacher holds towards the material. These findings may also indicate that teachers with
experience may be keeping up on the latest in the field of life science through personal education, college level classes, district in-services, etc. Another possibility for this correlation is that those who do not accept the theory of evolution may be getting out of teaching the life sciences and moving into other disciplines. This study found that there are no relationships between a teacher’s acceptance and knowledge level relative to the geographic location of the school (i.e. urban, suburban, or rural). This suggests that teachers with different acceptance and knowledge levels may be equally dispersed across the State of Ohio (see Figure 2).

There are no relationships between a teacher’s acceptance or knowledge level of the theory of evolution and the number of college level courses they had taken that focused on evolution. This finding is somewhat contradictory to similar research that has found that a teacher’s emphasis on evolution in the classroom correlates to his or her knowledge level of evolutionary theory (Aguillard, 1999; Roelfs, 1987).

Conclusions

This study attempted to provide an assessment of the current status of the theory of evolution as it pertains to the acceptance and knowledge level of Ohio secondary life science teachers. The primary research question looked to elicit the current level of acceptance of the theory of evolution, and found that the majority of Ohio secondary life science teachers do accept the theory of evolution. A supporting research question looked to provide conclusions relative to the current level of understanding of evolutionary theory in Ohio secondary life science teachers. This study concludes that, in general, teachers have an adequate level of understanding, but given that the score of the lowest respondent was 30% correct, there is still room for improvement. The most
important conclusion in terms of this study relates to the supporting research question that looked at the relationships between teachers’ acceptance of the theory of evolution and their knowledge level. This study concludes that there are important relationships to teachers’ acceptance of the theory of evolution. Of these, the most important relationship found is the one between teachers’ acceptance of the theory of evolution and their knowledge level of evolutionary theory.

Recommendations for Further Study and Practice

Since the State of Ohio adopted the new Science Academic Content Standards in December of 2002, and this study was performed in May of 2003, it would be valuable to repeat the study again once the standards have had time to be implemented in the classrooms across the state. Also, the study could be changed in several ways to possibly improve it. First, the instrument could be modified to include questions about intelligent design and creationism. This may help alleviate some of the bias in the return of the survey, as those who do not accept the theory of evolution may then be more comfortable with the survey. Also, the study may be improved by adding questions regarding teacher’s knowledge level of the nature of science. Since the many of the low scoring items on the MATE indicated that many teachers may have low knowledge levels of the nature of science, further study may be beneficial in order to determine if teachers in fact do not accept the theory of evolution, or rather have an inadequate understanding of the nature of science. Finally, the study could be improved by analyzing whether or not Ohio life science teachers are currently or plan to start teaching evolution, and how this factor influences the acceptance and knowledge levels of the theory of evolution.
Given that this study finds that about one in eight Ohio secondary life science teachers does not accept the theory of evolution, and that a teacher’s knowledge level of evolution has been found to be correlated with their acceptance of evolutionary theory, the Ohio Department of Education and Ohio school districts need to assess how the personal and religious beliefs of teachers could negatively impact the teaching of evolutionary theory in the classroom at both the school and district level. This assessment is of utmost importance as students may soon be tested on evolutionary theory now that it has been added to the Science Academic Content Standards in the State of Ohio. No conclusions were drawn as to whether teachers who reject evolutionary theory are able to put aside their personal beliefs to effectively teach it, this study recommends that administrators and science department heads set expectations for the teaching of evolution in the classroom to insure that the theory of evolution is being taught.

Given the finding that knowledge level increases as the teacher’s years of experience increase, it is recommended that teachers make use of outside resources such as books, journals, and websites intended to increase their own personal knowledge of the theory of evolution. Continuing education classes at universities and community colleges can also be a resource for increasing a teacher’s knowledge of the theory of evolution. However, it is also recommended that teacher training programs in the state of Ohio ensure that the courses required for life science education majors have satisfactory coverage of the theory of evolution, as this may help alleviate the problem of inadequate knowledge before teachers enter the classroom. Ohio school districts may want to invest into providing in-service and professional education experiences for teachers who need to
increase their personal knowledge level of the theory of evolution and the nature of science. This is important as insufficient knowledge could lead to poor curricular planning (Carlsen, 1991; Hasweh, 1987). Therefore, teacher training is the next logical step if Ohio truly intends to implement the teaching of evolutionary theory as part of its science curriculum. Teachers, school districts, and the ODE also need to take a closer look at the national and state standards to ensure that the nature of science has received the proper emphasis in the standards.
References


Appendix A

Questionnaire
For the following items, please indicate your agreement/disagreement with the given statements using the following scale.

Strongly Disagree
Strongly Agree
1 2 3 4 5
Disagree
Undecided
Agree

1) Organisms existing today are the result of evolutionary processes that have occurred over millions of years. 1 2 3 4 5
2) The theory of evolution is incapable of being scientifically tested. 1 2 3 4 5
3) Modern humans are the product of evolutionary processes which have occurred over millions of years. 1 2 3 4 5
4) The theory of evolution is based on speculation and not valid scientific observation and testing. 1 2 3 4 5
5) Most scientists accept evolutionary theory to be a scientific valid theory. 1 2 3 4 5
6) The available data are ambiguous as to whether evolution actually occurs. 1 2 3 4 5
7) The age of the earth is less than 20,000 years. 1 2 3 4 5
8) There is a scientific body of data which supports evolutionary theory. 1 2 3 4 5
9) Organisms exist today essentially the same form in which they always have. 1 2 3 4 5
10) Evolution is not a scientifically valid theory 1 2 3 4 5
11) The age of the earth is at least 4 billion years old. 1 2 3 4 5
12) Current evolutionary theory is the result of sound scientific research and methodology. 1 2 3 4 5
13) Evolutionary theory generates testable predictions with respect to characteristics of life. 1 2 3 4 5
14) The theory of evolution cannot be correct since it disagrees with the Biblical account of creation.

15) Humans exist today in essentially the same form in which they always have.

16) Evolutionary theory is supported by factual, historical, and laboratory data.

17) Much of the scientific community doubts if evolution occurs.

18) The theory of evolution brings meaning to the diverse characteristics and behaviors observed in living forms.

19) With few exceptions, organisms on earth came into existence at about the same time.

20) Evolution is a scientifically valid theory.
For the following items, please circle the letter that corresponds to the BEST answer.

21) The evolutionary theory proposed by Charles Darwin was:
   a. Change in populations through time as a result of mutations
   b. The spontaneous generation of new organisms
   c. The passing on of genes from one generation to the next
   d. Change in populations through time as a response to environmental change*
   e. The development of characteristics by organisms in response to need.

22) The wing of the bat and the fore-limb of the dog are said to be homologous structures. This indicates that:
   a. They have the same function
   b. Bats evolved from a lineage of dog
   c. They are structures which are similar due to common ancestry*
   d. The limb bones of each are anatomically identical
   e. They have a different ancestry but a common function

23) Using radioactive dating techniques, the first life seems to have appeared on the earth about
   a. 10 thousand years ago
   b. 270 million years ago
   c. 3.3 billion years ago*
   d. 4.5 million years ago
   e. 10 billion years ago

24) Which of the following phrases best describes the process of evolution?
   a. The development of man from monkey-life ancestors
   b. The change of simple to complex organisms
   c. The development of characteristics in response to need
   d. Change of populations through time*
   e. The change of populations solely in response to natural selection

25) Marine mammals have many structural characteristics in common with fishes. The explanation that evolutionary theory would give for this similarity is:
   a. Fish and mammals are closely related
   b. Fish evolved structures similar to those already existing in mammals
   c. Marine mammals evolved directly from the fishes
   d. Marine mammals never developed use of limbs
   e. Marine mammals adapted to an environment similar to that of the fishes*

26) An alternation in the arrangement of nucleotides in a chromosome, possibly resulting in either a structural or physiological change in the organism, is called:
   a. Genetic drift
   b. Gene flow
   c. A mutation*
   d. Natural selection
   e. A recessive gene

27) It is thought that there was a rapid evolutionary rate once animal life invaded land from the oceans. The explanation given for this rapid evolution is:
   a. There were many potential habitats for new forms to fill*
b. The land was a perfect haven for life  
c. There were many climatic changes occurring at that time  
d. Radiation from the sun caused many mutations  
e. The ocean was too stable and limited to allow for evolution to occur

28) The first animals to settle on land probably had which one of the following characteristics?  
   a. They were quite mobile to escape from predators  
   b. They were partially dependent upon water for survival*  
   c. They were capable of completely adapting to the terrestrial environment in their life span  
   d. They had wings for flight from one habitat to another  
   e. They were quite adept at feeding on specific terrestrial plants

29) Two islands are found in the middle of the Pacific Ocean, isolated from any other land mass. These two islands were at one time connected by a land bridge and are of recent origin. They have identical plant and animal life and are separated by 50 miles of ocean. Assuming different selection pressures, which of these island populations would be most likely to be reproductively isolated, possibly allowing for species divergence?  
   a. Dandelions, with airborne seeds  
   b. Coconuts with floating seeds  
   c. Birds  
   d. Butterflies  
   e. Mice*

30) The population of Florida panthers has been drastically reduced by the actions of man. Which of the following most likely threatens their ability to continue to evolve in response to the pressures of their environment:  
   a. There is no longer the prospect of over-reproduction  
   b. There is no longer the prospect of a struggle for limited resources  
   c. There is a lack of genetic variation for selection to act upon*  
   d. There is no longer the prospect of a trait conferring a reproductive advantage  
   e. There is no longer the prospect of genetic drift occurring

31) A sudden major climatic change would most likely initially result in:  
   a. A rapid increase in adaptive radiation  
   b. A rapid increase in extinction rates*  
   c. A sharp increase in numbers of species  
   d. An increase in mutation rates  
   e. Plants and animals developing new characteristics in order to cope with environmental changes

32) The most compelling evidence for large-scale evolutionary change or macroevolution is:  
   a. Kettlewell’s release-recapture experiment with peppered moths  
   b. The fossil record*  
   c. The occurrence of mass extinctions  
   d. Domestication of plants and animals  
   e. The observed increase of mutation rates across all species
33) When first proposed, Darwin’s theory of natural selection did not fully explain how evolution could occur. This was due to:
   a. Darwin’s failure to recognize the tendency of organisms to over-reproduce
   b. Darwin’s initial overemphasis of the significance of genetic drift
   c. The fact that accurate mechanisms explaining genetic inheritance were not widely known*
   d. The absence of accurate descriptions of the embryological development of most plants and animals
   e. The absence of biochemical techniques to determine the genetic similarities between species

34) The presence of tropical rain forest fossil forms in Canada can best be explained by:
   a. A shifting of environmental requirements by these types of species
   b. A major climatic shift on the earth*
   c. A drifting of continents in a northward direction
   d. An uplifting of lowland areas
   e. A long term constancy of climate

35) Individuals within a species tend to be genetically different. The primary mechanism generating this individual variability is:
   a. Meiosis*
   b. Mitosis
   c. Polyploidy
   d. Duplications
   e. Asexual reproduction

36) The extinct species *Archaeopteryx* had characteristics of both birds and reptiles. This is an example of a(n):
   a. convergent species
   b. trace fossil
   c. archetype
   d. intermediate form*
   e. polymorphic species

37) The earliest fossils found in the geologic record are:
   a. Fungi
   b. Bacteria*
   c. Small photosynthesizing plants
   d. Seed plants
   e. Protozoa

38) Radiometric dating techniques rely on the fact that:
   a. The bony portions of organisms decompose at a known rate
   b. Organisms which lived earlier in time will tend to be found in sediments below organisms which lived more recently
   c. The magnetic field of the earth has reversed its polarity at known time intervals in geological time
d. The earth contains elements which change into other elements at a constant known rate*

e. During the decomposition process organic matter is converted into radioactive elements at a known rate

39) Which of the following best represents Lamarck’s ideas on the evolutionary process?
   a. Survival of the fittest
   b. Inheritance of acquired characteristics*
   c. Neutral drift
   d. Punctuated equilibrium
   e. Assortive mating

40) Which of the following is not a part of Darwin’s theory of natural selection?
   a. Individuals of a population vary
   b. Organisms tend to over-reproduce themselves
   c. There are limited resources for which individuals compete
   d. Modifications an organism acquires during its lifetime can be passed to its offspring*
   e. Variations possessed by individuals of a population are heritable

41) The life histories of five birds of the same species are listed below. The most evolutionally successful bird is the one that:
   a. Lives 5 years, lays 12 eggs in a lifetime, 4 hatch
   b. Lives 2 years, lays 8 eggs in a lifetime, 5 hatch
   c. Lives 6 years, lays 2 eggs in a lifetime, 2 hatch
   d. Lives 4 years, lays 7 eggs in a lifetime, 6 hatch*
   e. Lives 5 years, lays 4 eggs in a lifetime, 3 hatch
Please fill in your responses or circle yes or no to the following questions.

42) What biology/life science courses and grade levels do you teach? __________________
__________________________________________________________________________
__________________________________________________________________________.

43) How many years have you taught biology/life sciences? ________________

44) Are you currently licensed or certified to teach Life Science in the State of Ohio? Yes No

45) Is your school district considered Urban, Suburban, or Rural? ______________

46) Do you currently teach evolution in your biology/life science classroom? Yes No
If so, do you teach it as a unit or overarching theme? ______________
If you do not actively teach evolution, what factors are most influential in this decision?

___ Students
___ School Board
___ Parents
___ Principal
___ Department Chair
___ Personal Beliefs
___ Other

47) Have you taken any college level classes that have focused on evolution? Yes No
If yes, how many? ______________

Thank You for completing and sending this survey!
Appendix B

Cover Letter
Dear Ohio Life Science teachers,

My name is Sarah Korte and I am a Masters student at Ohio University in Athens, Ohio. My program is Masters of Teaching with Licensure in secondary education, life sciences. In partial fulfillment of this degree, I am working on completing a graduate thesis on the status of evolution education in the State of Ohio. I request your participation by filling out this questionnaire. All responses will be anonymous, no responses will ever be linked to names in any reports, and responses will be grouped in the data. Please answer all questions completely and honestly.

The results of this study may have future benefits to science teachers and educators in the State of Ohio. The results may benefit science educators in providing a better understanding of the role of science teachers in teaching evolution in the State of Ohio. There is no immediate personal benefit for your participation, and you will not be compensated for your participation. However, the results may also allow school districts to assess the needs of science teachers in curriculum development as well as determining need for in-service topics related to the theory of evolution. Results of this study will be sent to each school district with participating teachers, though not directly to all participants. This will help protect each participant’s anonymity, as no identifying information will be sent that could identify participants.

There is no consent form to sign for this study in order to protect your anonymity. Therefore, sending back your completed questionnaire implies your consent to participate in this study. Please use the envelope provided.

If you have any questions regarding this study, feel free to contact …

Sarah Korte       Colleen Sexton, Ph.D.
Graduate student researcher    Faculty advisor
(740)797-0077     (740)593-0848
sk261595@ohio.edu       sextonc@ohio.edu

If you have any questions regarding your rights as a participant in this research, please contact…
Jo Ellen Sherow
Director of Research Compliance
Ohio University
(740)593-0664

Sincerely,

Sarah E. Korte
Appendix C

Research Compliance Approval
A determination has been made that the following research study is exempt from IRB review because it involves:

Category 2 research involving the use of educational tests, survey procedures, interview procedures or observation of public behavior.

Project Title: The Attitude of Ohio High School Biology Teachers Regarding the Theory of Evolution and the New State of Ohio Science Standards.

Project Director: Sarah Korte

Department: Teacher Education

Advisor: Colleen Sexton

Rebecca Cale, Associate Director, Research Compliance
Institutional Review Board

3-24-03
Date
Appendix D

Summary of Raw Data
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