To the Graduate Council:

I am submitting herewith a thesis written by Bärbel I. Brooks entitled "A Comparison of High School Science Education in Germany and East Tennessee." I have examined the final copy of this thesis for form and content and recommend that it be accepted in partial fulfillment of the requirements for the degree of Master of Science, with a major in Science Education.

A. Paul Wishart, Major Professor

We have read this thesis
and recommend its acceptance:

Patricia Davis Wiley

C Edward Koenke

Accepted for the Council:

The Graduate School

A COMPARISON OF HIGH SCHOOL SCIENCE EDUCATION IN GERMANY AND EAST TENNESSEE

A Thesis

Presented for the

Master of Science

Degree

The University of Tennessee, Knoxville

Barbel I. Brooks

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ABSTRACT

The purpose of this study was to identify, collect, and evaluate information for a comparative study of high school science education in a selected area of the United States, specifically East Tennessee, and West Germany (North German area). The structure of the school systems, curriculum design and control, teacher training, as well as student attitudes, were examined.

The review of related literature revealed that the vertical organization of schools as well as length of schooling were the most significant differences in the school systems.

The major conclusion of differences in curriculum design was that there is only one major institution, IPN in Kiel, West Germany, designing science curricula, whereas 42 institutions in the United States under the umbrella of the National Science Foundation are involved in curriculum study and design. Curriculum control in Germany was found to be centralized by the federal government, whereas the United States featured a decentralized system of curriculum governance, allowing the state to control curricula.

Teacher training, examined in both countries, appeared to be longer and more intense in Germany than in the United States.

Student attitudes were examined for this study with the help of a questionnaire containing 20 questions. Thirty questionnaires each were sent to an urban and to a rural school in North Germany as well as to an urban and to a rural school in East Tennessee.

German and East Tennessee schools had identical response rates of 83%. Evaluation of the responses indicated that biology was thought of in both countries as the most interesting as well as the easiest field of the sciences. Chemistry was identified as the most difficult field by German students whereas East Tennessee students rated physics as the most difficult field. Most Tennessee and German students agreed that homework assignments were done without parental help. Average homework time for science classes was given as 30 minutes for German students and 40 minutes for Tennessee students. Computer knowledge of students appeared to be slightly higher in East Tennessee than in Germany, where more than half the students reported not having any computer knowledge at all.

Years of science education were reported to be three times as great for German as for East Tennessee students; however, German students felt less certain about choosing a career in a science-related field. Disagreement also was evident in judging energy education and laboratory content of instruction. German students expressed a greater need than the Tennessee students for offering better energy education as well as desiring more laboratory content in their curriculum.

Basic agreement, though, was indicated by students from both countries that teachers make science instruction interesting and meaningful to them.

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CHAPTER I

INTRODUCTION

Scientific projects are increasingly taking on global characteristics. The international community of scientists lives in a seemingly harmonious state, striving persistently to create a network of science and technology, adding to the growing pool of knowledge. The first international organization of scientists was established in Paris more than 120 years ago. After years of international cooperation there are now over 300 international organizations in the world (Kerwin, 1981).

Global prospects, such as the International Geophysical Year, the Year of the Quiet Sun, and the Global Atmospheric Research Program have attracted much attention among scientists as well as laymen. Other programs such as the International Indian Ocean Expedition, lasting more than six years and involving scientists of some thirty nations of the world, have drawn less attention (Matthews, 1967).

Spectacular photographs of the Antarctic, published by Science Digest (1981) have most likely been used by educators to illustrate the interest of physicists, botanists, zoologists, geologists and paleontologists in this "Freeze-Dried Desert" as Charles Petit named the Antarctic. But educators in the sciences have shown an increased awareness towards the international aspect of science. This Antarctic exploration, involving more than a dozen nations, will hopefully have been a highlight emphasized in science classrooms.

Generally, advanced science research is associated with global research. However, science education does not start at universities. The foundations are laid in classrooms beginning at the elementary level and continued at the high school level. Therefore, if the importance of international cooperation in the world of sciences is recognized, science education and projects at all levels need to be taken into consideration. High school science educators need to look beyond their states, countries, and even beyond their continents to fulfill their responsibility of providing the most beneficial education for every student in the classroom. Only with this view beyond the local classroom wall can science educators contribute to the global aim of creating a network of science and technology.

D. Allan Bromley (1981), President of the American Association for the Advancement of Science, emphasized the importance of this international cooperation when he stated:

> Science remains perhaps, the most truly international of all man's activities, transcending national, political and ideological boundaries. Frequently, indeed, in times of international turmoil, scientific communication has been the only surviving channel linking large segments of the planet's population (p. 1063).

Problem

This study was undertaken to provide an insight into the structure of science education in a selected area of the United States and a selected area of Germany. The findings in German

settings were then compared to science education in the United States, with emphasis on two East Tennessee schools.

Statement of Purpose

The purpose of this study was to identify and to collect information for a comparative study of science education in Northern Germany and in East Tennessee. Comparative issues included the structure of the entire school system, curriculum governance, teacher training and orientation. Furthermore, focus was placed on students' attitudes toward science education.

Rationale

The worldwide cooperation in science and technology is well advanced and promoted on the scientific research level. Political, racial and linguistic difficulties have been overcome on joint explorations. Bromley stated in Science (1981), however, "disarray is increasingly a characteristic of Western educational systems, particularly in science and technology" (p. 1063). With this observation, he reminded science educators of the responsibilities placed on their shoulders. Education in the sciences needs to be as globally oriented as modern technology. Today, many teachers might then ask themselves: how can contributions be made to promote improvements in science education? If teachers recognized the link between science education in their own classroom and science classes in other countries students would be provided with a better foundation toward working in the international community of scientists.

Questions

The following questions were addressed with regard to school systems in both countries:

1. How is the school system structured?
2. Who controls the curriculum?
3. How are high school teachers trained?
4. What are students' attitudes toward science education?

Assumptions

This research was conducted based on the following assumptions:

1. Any translations of letters and questionnaires used in this study were undertaken without intended bias. The material was translated by the writer, a German National.
2. Access to educational materials of other countries was freely available for research and study.

Definitions of Terms

The study was undertaken based on the following interpretations:

1. Curriculum is defined in this study as "detailed system of teaching and learning elements the practicability and transferability of which has been empirically proved" (Schaefer and Kattmann, 1976).

2. Germany in terms of this study is defined as the Federal Republic of Germany.
3. Germany Rural in the tables of this study has been used as a term to refer to Nordsee Gymnasium Sankt Peter (North Germany).
4. Germany Urban in the tables of this study has been used as a term synonymous to the urban school in Germany, Gymnasium am Hillmannplatz, Bremen (North Germany).
5. IPN in this study is defined as the Institut fur die Padagogik der Naturwissenschaften/Institute for Science Education in Kiel, West Germany.
6. Sciences for the purposes of this study is defined as studies in biology, chemistry and physics.
7. Science Education is defined for the purpose of this study as instruction in biology, chemistry or physics.
8. U.S. Rural in the tables of this study refers to Rockwood High School, Rockwood, Tennessee.
9. U.S. Urban in the tables of this study is defined as Farragut High School, Farragut, Tennessee.

Limitations of the Study

1. Only literature published in the English language was reviewed. ERIC search did not reveal appropriate literature in other languages.
2. Only students enrolled in laboratory science classes were involved in the research soliciting opinions.

3. Only students in the last three high school years prior to graduation (as defined in Chapter III) were considered in the study; however, numbers of science classes taken in ninth grade were taken into consideration in the questionnaire.
4. No other criteria such as sex, race, religion or IQ were applied to student selection.
5. Organization and curriculum of schools was restricted to the post-World War II period.
6. The State Department of Education in Tennessee added a second year of science as a requirement for graduation from high school after the study was initiated.

Summary of Chapters

This study is organized into five chapters. Chapter I contains an introduction to the study, the problem, a statement of purpose, the rationale, questions, assumptions, definitions of terms and limitations. Chapter II reviews related literature. Chapter III contains criteria for selection of procedures, the methods of developing an evaluation instrument to obtain students' attitudes, criteria for selection of population and the methods to obtain information on students' attitudes. A presentation of the evaluation results is presented in Chapter IV. Summary, conclusions, implications and recommendations are located in Chapter V.

CHAPTER II

REVIEW OF RELATED LITERATURE

A study of the literature concerning science education in Germany revealed that relatively little has been published in the English language relating to this topic. Since the researcher's access to educational research materials was limited to material available in the United States, the writer limited the review of material to publications in the English language. The researched material, discussing science education in the United States, was then selected to correspond with available German material.

The studies discussed in this chapter have been grouped generally into the following four areas of investigation for presentation.

1. The Educational System.
2. Curriculum Governance.
3. Curriculum Design.
4. Teacher Training and Orientation.

Within each area of investigation the reviewed German literature precedes comparable United States studies. Studies relating to student attitudes were available for the United States. Iris Weiss (1977) examined students' attitudes thoroughly in her report (p. 158). However, corresponding literature for German students was not available. Therefore, a review of literature was omitted for this area.

The Educational System

In order to understand specific facets, such as science, in an educational system, the system in its entirety needs to be reviewed first. Howard Munson (1981) reported that a "description of the educational system in the Federal Republic of Germany may serve to modify some observations and place others in proper perspective" (p. 263). Munson outlined the system in the following way:

The four-year Grundschule, or foundation school, is attended by all children. Following attendance at this school, three different schools, namely: Hauptschule, Realschule and Gymnasium, respectively, cater to the needs of pupils according to their ability. Munson quoted attendance as: 50% for Hauptschule, 25% for Realschule, 25% for Gymnasium. He further summarized the basic characteristics of each school in the following pattern:

1. Hauptschule, a five-year school, places emphasis on "3 R's" where students learn one foreign language. Graduates then attend vocational school until age 18.
2. Realschule, a seven-year school with emphasis on two foreign languages, math, sciences and German. Graduates choose careers such as secretarial, nursing, practical engineering and sales.
3. Gymnasium, a nine-year school where the main objective is preparation for university.

A new experiment of the "Gesamtschule," or comprehensive school, was described by Annegret Korner (1981), who reported that in

1979/1980 a total of 178 comprehensive schools existed in Germany. In these schools, pupils of the same age were placed in different classes according to their ability. Most of these schools were observed to show a lower pupil/teacher ratio than conventional schools. Korner summarized that model comprehensive schools appeared to be very successful but recommended that more extensive and specific teacher training should be required for this type of school system.

The outlook for the future of comprehensive schools was viewed as promising along with a forecast of an increase in the number of schools.

In an analysis of the "Pupil Oriented Lesson in West Germany" La Pensée (1981) outlined the structure of the Gymnasium. The study pointed out that this structure can only be understood on the basis that there is no streaming within German schools. All Gymnasium students prepare for entrance to universities. Students in grades 11, 12 and 13 choose their own timetable. La Pensée emphasized, however, that science students must still prove abilities in the languages, mathematics, religion or social studies as well as sports. Final grades, given at the end of the 13th grade, reflect results of an exam as well as course work of the last two and a half years. During this period, four main areas of study are chosen by students who will have taken four 20 week courses with five classes per week for each of the four main subjects.

To sum up the entire school system in Germany, it was concluded by Miller (1981) that "the German public perceive the three

main secondary school types as a definite hierarchy: Gymnasium--Realschule--Hauptschule" (p. 42).

Organization of schools in the United States varies greatly. According to Robinson (1968, p. 45), "there is no single generally accepted plan of vertical school organization in the United States." Robinson explained the traditional plan where grades 1 through 8 were viewed as elementary grades whereas students in grades 9 through 12 were placed in high schools. However, a 6-3-3 organizational plan gained in popularity. Under this plan, students attend elementary school during the first six years of schooling, proceed to a junior high school and complete grades 10 to 12 in a high school. Further variations of this plan, a 6-3-3 as well as a 6-2-4 plan, were discussed by Robinson. A 6-6 plan was regarded by Robinson as particularly suitable for small communities. In yet another organizational structure, the 4-4-4 plan, grades 5 through 8 are placed in a middle school. On the extremes, Robinson commented, some school districts "include nursery schools as well as junior colleges" (p. 47) in their organizational structures. It was concluded that there is no standard vertical organizational plan in the United States. This finding was confirmed by Zais (1976) in his discussion of organizational structure in the American school (pp. 61-68). Furthermore, Trump and Miller (1979) gave an updated analysis of changes in the organizational structure of United States schools (p. 213).

Miller, Madden and Kincheloe (1972) reviewed the administration of the American school system. When discussing the complexity of this system it was remarked that it would be almost impossible to

describe "American schools to a visitor from a foreign country" (p. 4). American schools differ so much from each other that the visitor's question would be answered in terms of a but not about the schools of the United States. The authors of the text commented that:

> American public education is not a monolithic structure. We have no single system of schools such as is characteristic of many other countries. Our system is more of a conglomerate (p. 19).

However, it was observed by the authors that even though great differences exist between the schools, there is "a national character" about American schools (p. 20). This character, featuring scholastic as well as athletic activities, is so distinctive "that it may be referred to as an unofficial national system of schools" (p. 20).

Curriculum Governance

Miller (1981) explained the mechanism by which the curriculum control in Germany is governed. He stated that the Education Department in each "Land," or state, publishes the "Studentafel" (timetables) and "Lehrplane" (study programmes). Thus control of what is studied for and for how many periods lies with the state. However, Miller pointed out that the individual teacher has "the freedom of selecting teaching--style and approach" (p. 25).

A study by Bach (1975) revealed a more detailed description of curriculum control. He observed that only a small group of people influence and control educational policies. Generally, the appointed Minister of Culture in each of the 11 states belongs to the ruling political party.

The Culture Ministers of the states, in turn, are headed by the Federal Minister of Culture. Thus, ultimate responsibility lies with one person, the Federal Minister of Culture, who, in turn, is answerable to the public only through his political party at Federal elections.

The same findings were recorded by Munson (1976). However, his observations focused even more on the political nature of curriculum authority. Munson further explained that the Minister of Culture, ultimately responsible for school as well as university curriculum structure, only maintains the link to the general public through political elections to either the Christian Democratic Party (CDU) or Socialist Party (SPD).

In the United States, a decentralized educational system is found. Robinson (1968, p. 27) reported that each state controls education within its borders. However, Robinson pointed out that each state normally grants control to local districts. According to Robinson (p. 29), the state still requires that all courses of study be regulated by the state. The state superintendent, appointed by the state board of education, supervises the preparation of courses of study for classroom use. Improvements or changes in curriculum construction are made upon recommendation of the state superintendent, usually to the state board of education to be implemented by the department of education.

Miller, Madden and Kincheloe (1972) observed that one of the functions of the state education department was the development of a state course of study. Some states, according to the authors, give

"concern to curriculum through control over textbooks to be used in the schools of the state" (p. 47). It was further reported that state departments fund curriculum committees, thus stimulating curriculum developments in the state. Curriculum workshops, held by the state department, further enhance state control.

Reutter (1981, pp. 134-140) investigated the role of the state department of education. He concluded that the state board of education, a chief administrative officer, and a state department of education play an increasing role since the 1960's. Reutter, naming the state board of education the "policy making body for the public schools within a state" (p. 134), further explained that rules and regulations set by the state board of education are binding on the local school boards within the state.

A research report published by the Tennessee Education Association in 1982 stated:

> Constitutionally, education is the State's responsibility. The State is responsible for education at both the state and local level. Curricula improvements and the upgrading of standards are special responsibilities of the State Board of Education.

Curriculum Design

The Institute for Science Education in Germany organized a workshop in 1975 in cooperation with the Council of Europe. In a report on this workshop Dahnke, Hecht and Werner (1976) reported on the state of curriculum research and development in Germany. Their report (pp. 207-231) contained a comprehensive list of all seven institutions contributing towards curriculum research and

development. However, it was emphasized that IPN--Institut fur die Padagogik der Naturwissenschaften--or the Institute for Science Education--is the predominant institute to develop biology, chemistry and physics curriculum for the Gymnasium. It is stated that 50 scientific as well as the same number of non-scientific collaborators work in Kiel at the Institut on the curriculum development task.

An example of a newly developed IPN biology curriculum was discussed by Kattmann and Schaefer (1976). They recorded that new biology teaching concepts emphasize sub-disciplines such as genetics, ecology, theory of evolution and physiology. IPN syllabi generally are composed of small units not related to each other. Two basic approaches were identified and explained: the human centered curriculum and the cybernetic structuring approach. According to the authors of this article both curriculum forms have great social and interdisciplinary impact.

The same authors, Schaefer and Kattman (1976), gave a report on the IPN unit bank biology. They explained the concept of "unit bank" offering teaching units of from 10 to 15 lessons to biology teachers. Since the units are independent from each other, they can be used in any sequence. The units contain teaching objectives, methods, media as well as tests. The authors pointed out that the units may be used in their entirety or simply as stimulation of existing teaching. Units have been tested and revised continuously. Kattmann and Schaefer, after describing all existing units, concluded that the effects of the unit bank on biology teaching have

been significant. Furthermore, the authors of the article felt that the IPN unit bank could be seen as a sizeable contribution to the international curriculum movement.

R. H. Miller (1981) reviewed the physics curriculum developed by IPN, the major science curriculum center in Kiel. He explained that a new attempt had been made to "treat physics within its social context" (p. 23). However, Miller also gave insight into IPN, the Institute for Science Education at the university in Kiel, founded in 1966, where curriculum material for biology, chemistry and physics are developed. The Institute, financially supported by the Foundation for Science Education, is supervised primarily by the Land (state) of Schleswig-Holstein; however, all German Lander (states) monitor the work. Miller, explaining that curriculum development in Germany is undertaken by university-based academics, criticized that too little teacher involvement might be a potential shortcoming. Nevertheless, the overall impression of IPN curriculum development was seen by Miller as

> having the over-riding aim of seeking to de-mystify science by the twin approaches of stressing everyday applications of the science learned, and attempting to show that scientific knowledge itself is something rather less than the sacred cow it is normally taken to be (p. 40).

Curriculum design in the United States was described in a publication of the National Science Foundation (1974). The major course and curriculum projects of school sciences were described in this publication (pp. 19-28). All project descriptions include major objectives, components of the projects, and materials available. The publication listed all 42 institutions (Appendix H) involved in

curriculum development. To emphasize the impact of some of the studies, it was pointed out that the CHEM study (Chemical Education Material Study) was translated into 14 languages.

A report by Marks (1979) assesses the need for federally supported curriculum development in education. Marks observed a decline of the momentum in curriculum planning of the 1960's. A new interest, according to Marks, should support a national improvement of existing National Science Foundation studies. Special focus was placed by Marks on BSCS since 30% of all science classes in 1979 used this curriculum design. Marks reported that BSCS students performed better on tests than conventionally trained students. The author of the publication concluded her report with the plea to review and revive some of the dwindling interest shown in science curriculum development and improvement in the 1960's.

Similar findings were recorded at the Exeter Conference on Secondary School Science Education in 1980. Brinkerhoff and Compton (1980) reported that a crisis in science education exists due to the fact that no major changes in curriculum development have occurred since the 1960's. However, the report stated that new material, not new courses, were needed to meet the demands of our changing social and ethnic structure of the student body. The conference report further stresses the need for a permanent Science Resource Center Network to aid teachers in finding suitable teaching materials.

Teacher Training and Orientation

Teacher training in West Germany was described as "extremely rigorous" by La Penseé (1981, p. 569). Prior to training in the classroom, the Gymnasium teacher will have studied, according to La Penseé, at least 10 semesters preparing two subjects for his state exam. Following the exam, three semesters will be spent at a teacher seminar. La Penseé presented a detailed outline of the "pupil oriented" lessons the referendar (trainee) has to prepare. Furthermore, the stressful situation of the referendars, facing up to eight observers in many examined lessons, was discussed.

Based on his own visit to several teacher education institutions in Germany, Munson (1976) quoted that "teachers for the Gymnasium are subject-matter specialists" (p. 266) trained in well-equipped facilities.

A training time of five to seven years was seen as the norm by Bach (1975). He further explained that Gymnasium teachers often show "feelings of superiority" (p. 270) toward their Grundschul/Hauptschul colleagues. Bach also discussed the new trend of teacher education in Padagogischen Hochschulen (teacher colleges associated with universities) which is not as lengthy. However, the class-bound German society did not view this educational route as desirable as a traditional education.

Bach's study further included a list of professional organizations in science teaching.

Certification of teachers was examined by Munson (1976). He noted that a teacher is certified for life in the German school system. According to Munson "no further education, up-dating, or new stimulation . . . is required or needed" (p. 266). Further observations by Munson included the lack of open communication among teachers. Ideas and problems, Munson found, were considered "private property and to share them is to give any one's secrets" (p. 266).

In-service training and career advancement were also examined by Bach (1975). He noted that certification for life (Beamter) invited very "little initiative or incentive to up-date specialized knowledge" (p. 273).

Teacher training in the United States was examined by Richardson, Williams and Stotler (1968). They stated that generally four years was seen as an accepted minimum time for preparation (p. 22). Generally, a fifth year is added. A survey quoted in this study indicated that the standard requirements are distributed in the following manner (p. 50): 46% Liberal arts education, 31% Science teaching field, 23% Professional education.

A review of teacher certification standards and requirements was included by the three authors. They pointed out that "the federal government has no responsibility for certification" (p. 103) since the states govern licensing policies. However, it was indicated that the federal government provides indirectly for the improvement of science teaching through in-service education and National Science

Foundation programs. A survey of 12 college and university science programs was reviewed by the authors (pp. 104-119). The in-service education of science teachers was also examined and seen as an essential part of science education since preparation for teaching was regarded as minimal. It was observed that academic as well as professional growth would be the result of in-service training (p. 95).

Robinson (1968, pp. 34-37) reported that certification of teachers is regulated by the state school superintendent. Since each state specifies its own criteria, certification standards vary from state to state. Robinson explained the procedure that certificates to teach are usually issued for a specific grade level or subject matter area. According to Robinson, a bachelor's degree is required in most states for teachers but "some states have increased certificate requirements above a bachelor's degree to include a master's degree" (p. 35).

Specific certification requirements for all 50 states were given and explained by Elizabeth Woellner (1982). Differences in length of certification were particularly emphasized. Duration of teaching certificates varies from three years in Oregon to ten years in Mississippi or Tennessee. Further conditions of renewal were discussed by the authors as well.

Summary

Based on the literature reviewed, it was found that the school systems in Germany and the United States differed in many aspects. The vertical organization of schools, as well as length of schooling,

appeared to be a major difference. Research on curriculum design and governance in science education revealed that two different approaches existed in the two areas compared. Germany featured an ultimate federal control over curriculum matters whereas the United States showed a completely decentralized system in which each state carried the responsibility for curriculum control. The literature review also showed that a difference in teacher training and orientation existed. Length of training and intensity of training were identified as the major differences in the two systems. The review of related literature further indicated that a study similar to this had not been done previously.

CHAPTER III

PROCEDURES

In order to compare science education in Germany with science education in America, the following five major aspects were identified:

1. Structure of the school system.
2. Teacher training and orientation.
3. Curriculum control.
4. Curriculum design.
5. Student attitudes.

To focus on these five areas the use of two different procedures was introduced. This chapter will explain criteria for selection of these two procedures, development of an evaluation instrument to obtain students' attitudes, criteria for selection of population and a description of the methods used.

Criteria for Selection of Procedures

Since this study involves a country more than 4,000 miles away, The World Almanac and Book of Facts, 1983 (1983, p. 165) quotes a distance of 4,181 miles from Washington, D.C. to Berlin, several research methods such as interviews or observations could not be utilized. To describe the first four focal points of this study, namely, structure of the school system, teacher training and orientation, curriculum control as well as curriculum design, the author

reviewed related literature separately for Germany and the United States to arrive at a comparative statement, extracted facts were then contrasted.

Since literature in the English language did not report on the attitudes of German students toward their science education, a questionnaire was chosen as the vehicle to solicit this information.

Development of an Evaluation Instrument to Obtain Students' Attitudes

To obtain information of students' attitudes, a questionnaire was designed. This questionnaire reflected viewpoints toward the importance of science education, homework, structure of class activities, self-evaluation and teacher evaluation, and was prepared in English as well as German. A precise and unbiased translation of the questionnaire was produced. The form (Appendix A, English version; Appendix B, German version) contained 20 questions relating to science education. To enhance interest and to encourage participation in the study, the questionnaires were printed on bright orange stationery.

Criteria for Selection of Population

A population of 120 students was chosen from four different high schools. The following four types of schools were selected:

1. Urban school in Germany.
2. Urban school in the United States.
3. Rural school in Germany.
4. Rural school in the United States.

Since the author attended an urban as well as a rural school during her years of high school education in Germany, these two schools were chosen to be representative of the German schools to be represented in this study. Two comparable American schools were chosen based on the writer's familiarity with the schools. The following four schools were then approached for their assistance:

1. Gymnasium at Hillmannplatz, Bremen.
2. Farragut High School, Farragut, Tennessee.
3. Nordsee Gymnasium Sankt Peter, St. Peter.
4. Rockwood High School, Rockwood, Tennessee.

Student participation was limited to criteria described below:

1. Students had to be in their last three years of high school education. This included grades 10, 11 and 12 in the United States. Since German students attend 13 years of school prior to high school graduation, grades 11, 12 and 13 were encompassed in this group of students in German schools.
2. Students had to be currently enrolled in a laboratory science class. Selected areas of science classes were designated as biology, chemistry and physics.

Methods to Obtain Information on Students' Attitudes

After the schools and their respective student populations were chosen according to the established criteria, a letter (Appendix C) was sent to the principal of each German school,

explaining the research study and informing the principal of regulations, intentions and involved procedures. Accompanying the letter to each principal was also a letter (Appendix D) to each science teacher assisting in the research. The letter to the involved science teacher contained a request to urge students to participate. Teachers were asked to inform students that participation in this study was voluntary and that all information would be kept confidential. To avoid mailing cost for both German schools, a mailing address in Germany was provided. Return postage to the German address was paid.

The author delivered the questionnaires personally to the principals of Farragut High School and Rockwood High School. Furthermore, the author met the involved science teachers in both schools.

Accompanying the questionnaires was a letter to the principal (Appendix E) explaining the research study and informing the principal of regulations, intentions and involved procedures. Further attachments were letters to involved science teachers (Appendix F) informing them of regulations that parental permission had to be obtained prior to students' participation. Letters to the parents (Appendix G) explaining the study were also personally given to the principals.

After return of the questionnaires, results were recorded in matrix form to identify patterns of responses. The patterns were

then entered on tables for summary purposes and a comparative statement was drawn between opinions of German students with those of American students.

CHAPTER IV

PRESENTATION OF RESULTS

To present a comparison of the differences in school systems, in curriculum governance and design as well as teacher training, the reviewed literature was utilized and interpreted. Contrasts between the structures in Germany and the United States will now be discussed in this chapter under Differences in School Systems, Differences in Curriculum Governance and Design as well as Differences in Teacher Training.

Evaluation of the responses to the questionnaire, sent to solicit students' opinions, is reported and analyzed in the second part of this chapter under Evaluation Results of Students' Attitudes.

Differences in School Systems

Length of schooling prior to high school graduation appeared to be the first difference found. German students were reported to have attended 13 years of school, whereas American students attended schools for only 12 years. The second distinguishing feature between the two systems was identified as streaming versus non-streaming of students. This procedure is sometimes also referred to as academic tracking. German students of the same age were placed in different schools, namely Hauptschule, Realschule and Gymnasium, according to students' ability. Introduction of the comprehensive school in Germany could be seen as a first effort towards streaming in Germany.

In the United States, on the contrary, all students of the same age were observed to attend the same schools, regardless of ability. However, in contrast to the German system, school organization of elementary school, middle school, junior high school and high school, varied not only from state to state but even within the states. It was therefore determined that length of schooling as well as vertical organization of education were two major differences in the two examined school systems.

Differences in Curriculum Governance and Design

Answers to the question, "Who controls and designs curriculum?" reflected again the different view in which education is perceived in Germany and the United States.

A centralized control, represented by the Federal Minister of Culture, was seen as the ultimate control in Germany. Reporting to the Federal Minister were the Ministers of Culture representing each of the 11 states. Political affiliations of the Ministers of Culture appeared to be an influencing factor in school and university curriculum controls.

In the United States, however, a decentralized system for curriculum control was found. Each state was given the responsibility in the Constitution to control education, thus to control the school curriculum. The state superintendent was described as the supervising authority for curriculum improvements or changes, whereas the state board of education appeared to be the policy-making body in the United States.

Examining curriculum design revealed, again, how the two countries choose different approaches. Germany's curricula were designed primarily by university-based academicians with very little teacher input. Seven institutions were involved in curriculum design; however, it was observed that the predominant institution is IPN--Institut fur die Padagogik der Naturwissenschaften--in Kiel. The concept of small units for curriculum appeared to be favored by IPN. These units, independent from each other, could be used in any desired sequence and could be utilized as a complete teaching unit or a supplementary material. Units for biology, chemistry and physics are available.

Curriculum design in the United States, however, appeared to be undertaken on a much larger scale. Forty-two institutions under the umbrella of the National Science Foundation (1974) were involved in curriculum design and development. While most activity in this field was observed in the 1960's, there appeared to be a renewed interest for national improvement of curricula in science education in 1980. A need for new material, based on the successful earlier studies, was reported. It was further emphasized that contrary to German curriculum development, American science curricula designs were developed and supported in cooperation with science teachers.

When contrasting time of curriculum developed it was observed that the United States produced a surge of new curriculum material throughout the 1960's and again on a smaller basis at the beginning of the 1980's. Germany, in contrast, only showed a first interest

in curriculum development in the late 1960's and published most new material at the beginning of the 1970's.

Thus, curriculum design and development not only differ in scope with 42 institutions in the United States and only one major institution in Germany, but also in time of development. It appeared that American curriculum designs were initiated approximately 10 years prior to IPN curriculum development in Kiel, West Germany.

Teacher Training and Orientation

When length of teacher training was compared it appeared that German teachers, with an average of five to seven years of training, spent more time in preparation for their teaching profession. In the United States, four to five years of preparation were seen as a norm.

However, it was observed that German teachers, certified for life, do not have to undergo any in-service training or further education. In the United States, where certification varies from state to state, in-service training was considered a requirement. Furthermore, it was observed that several states require further university education to renew teaching certificates.

When teacher orientation was compared, it appeared that German teachers preferred to work on their own and by themselves. They did not favor sharing ideas or problems. American teachers, however, as seen at the Exeter Conference on Secondary School Science Education, appeared very concerned about cooperation, improvements in their field of teaching and changes in the structure of the student body.

Evaluation Results of Student Attitudes

Responses to the questions of the questionnaire have been evaluated in the sequential order as they appear on the questionnaire. Answers have been analyzed in short descriptive form, supported by tables and figures to highlight the differences between both countries.

Response rate. Thirty questionnaires were delivered or sent to each of the four schools. A summary of the number of total responses returned may be found in Table I.

The total response rate of 83.6% was identical for German as well as for American schools. However, it appeared that both rural schools in Germany as well as in the United States, had a higher response rate than the urban schools involved. One hundred percent of the students in the rural East Tennessee school involved returned the questionnaire, whereas only 66.6% of the Farragut High School students, representing East Tennessee as an urban school, returned the questionnaires. Differences were not quite as drastic in German schools: 86.7% of rural students returned the questionnaire, while 80.0% of urban students sent their questionnaires back.

Importance of science education. Students were asked in Question 1 how important science education appeared to them compared with English or German as well as foreign language education. Table II summarizes the results of this question.

TABLE I

SUMMARY OF TOTAL RESPONSES OF STUDENTS ENROLLED IN LABORATORY SCIENCE COURSES IN GERMANY AND THE UNITED STATES

Name of School	No. Returned	% of Total Sent*
Germany		
Gymnasium an der Karlstrasse	24	80.0
Nordsee Gymnasium	26	86.7
Total	50	83.3
United States		
Farragut High School	20	66.6
Rockwood High School	30	100.0
Total	50	83.3

*Total number of forms per school = 30.

In response to Question 1, students in both countries stated that science education was more important to them than other subjects. East Tennessee students, however, rated science in first position (see Figure 1).

The graph suggests the overall tendency that the majority of students in both countries consider their education in the sciences as most important. However, it appeared that United States students feel stronger about this importance than German students.

Interest within the sciences. Students were asked in Question 2 to rate their interest within the sciences. Evaluation of this question, summarized in Table III, revealed that most interest in the United States as well as in Germany was shown in biology. This interest was, however, considerably greater for East Tennessee students than German students.

TABLE II

SUMMARY OF EVALUATIONS RATING IMPORTANCE OF SCIENCE EDUCATION WITH REGARD TO OTHER SUBJECTS*

Rank	Germany Urban		Germany Rural		U.S. Urban		U.S. Rural		Germany Total		U.S. Total	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Science 1st rank	10	41.7	13	52.0	13	65.0	20	66.7	23	46.9	33	66.0
Science 2nd rank	10	41.7	10	40.0	5	25.0	8	26.7	20	40.8	13	26.0
Science 3rd rank	4	16.6	2	8.0	2	10.0	2	10.0	6	12.3	4	8.0
Totals	24	100.0	25	100.0	20	100.0	30	100.0	49	100.0	50	100.0

*Question 1.

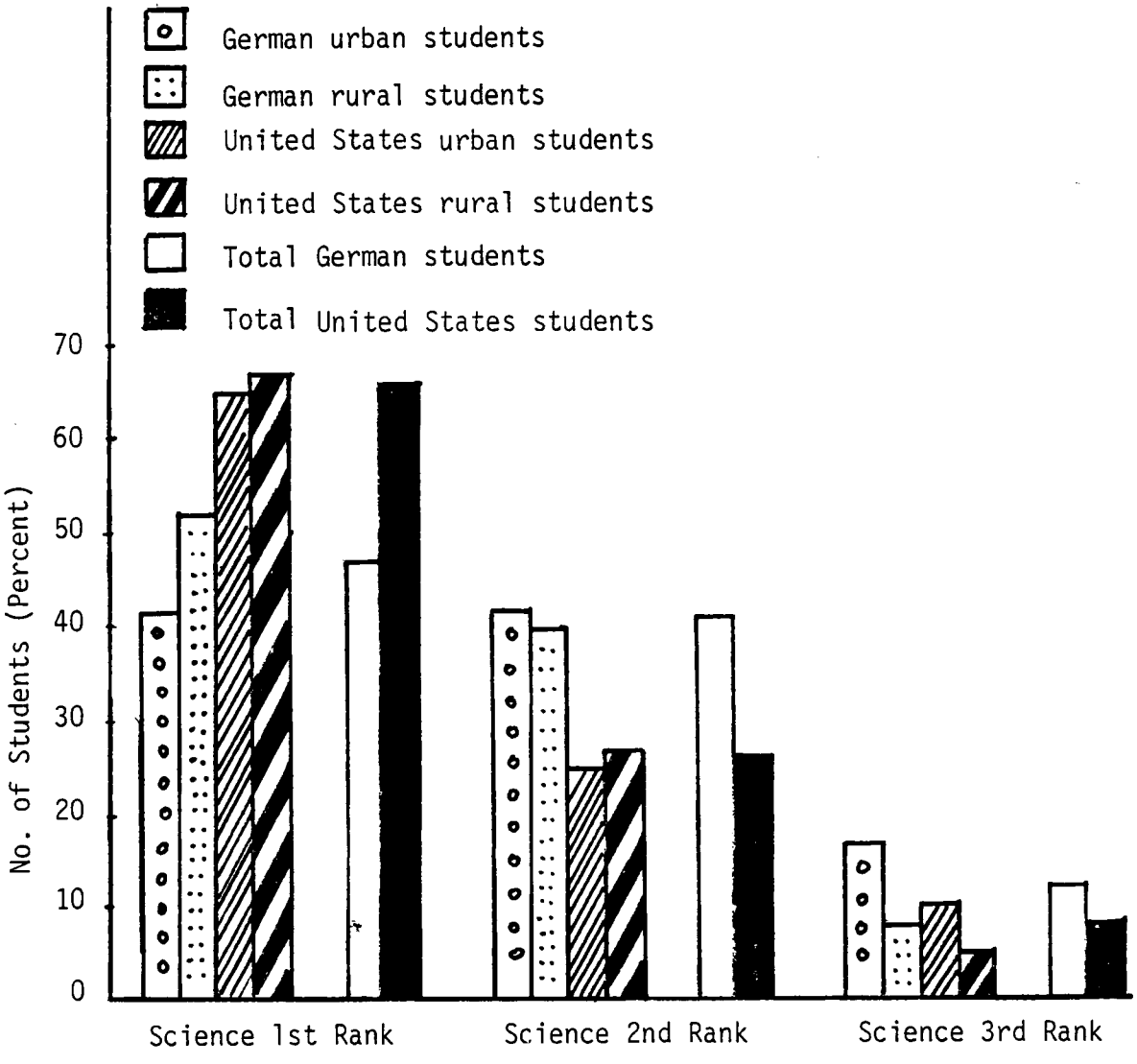

Figure 1. Rating importance of science education with regard to other subjects.

TABLE III

SUMMARY OF ANSWERS RATING SEQUENCE OF INTERESTS WITHIN THE SCIENCES*

Combinations of Interests and Their Rank	Germany Urban		Germany Rural		U.S. Urban		U.S. Rural		Germany Total		U.S. Total	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Biology-Chemistry-Physics	7	29.2	7	29.2	8	40.0	14	48.3	14	29.2	22	44.9
Biology-Physics-Chemistry	11	45.8	8	33.3	2	10.0	1	3.4	19	39.6	3	6.1
Chemistry-Biology-Physics	2	8.3	3	12.5	2	10.0	5	17.2	5	10.4	7	14.3
Chemistry-Physics-Biology	-	-	4	16.6	1	5.0	2	6.9	4	8.3	3	6.1
Physics-Biology-Chemistry	4	16.7	1	4.2	3	15.0	2	6.9	5	10.4	5	10.2
Physics-Chemistry-Biology	-	-	1	4.2	4	20.0	5	17.3	1	2.1	9	18.4
Totals	24	100.0	24	100.0	20	100.0	29	100.0	48	100.0	49	100.0

*Question 2.

It was further established that most American students with a preference for biology chose the following sequence of interest: biology-chemistry-physics. German students with a strong interest in biology, however, preferred primarily a biology-physics-chemistry sequence. Figure 2, showing the interests within the sciences, also highlights that interest in chemistry appeared slightly higher in the United States than in Germany.

Evaluating the interests in physics showed that more than twice as many students in the United States as in Germany regard physics as more interesting. Since no clear pattern between rural and urban schools could be established, Figure 2 is restricted to the comparison of total student numbers in Germany and the United States.

Difficulty of science fields. Question 3, relating to the rating of difficulty of the three science fields, was evaluated and indicated that biology was considered to be the least difficult field of science for German as well as United States students. Evaluations have been summarized in Table IV.

Even though German and United States students agreed on the easiest science field, they did not rate the same field as the most difficult one. German students found that chemistry was the most difficult science field for them, whereas United States students considered physics to be the most difficult science field. Almost half of the American students answered with the combination of physics-chemistry-biology in their difficulty rating, whereas almost

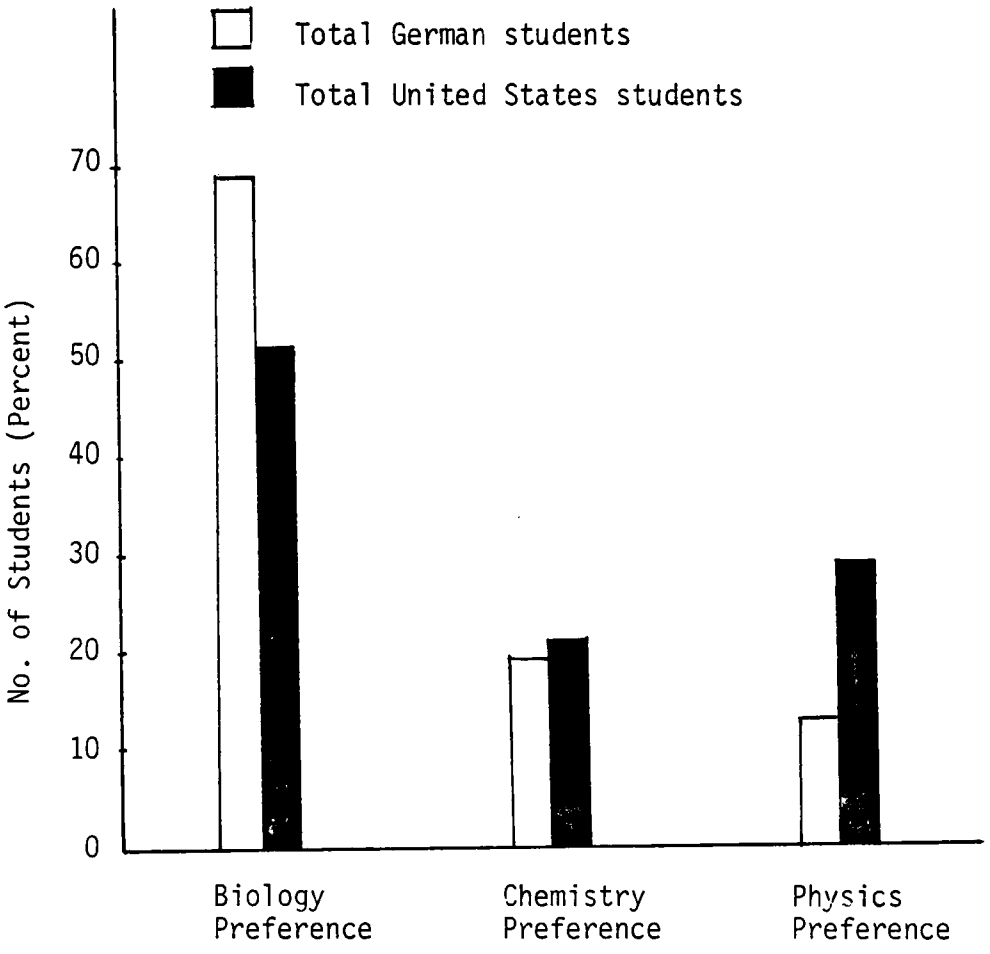

Figure 2. Interest within the sciences.

TABLE IV

SUMMARY OF RATING SEQUENCE OF DIFFICULTY OF SCIENCE FIELDS*

Combinations	Germany Urban		Germany Rural		U.S. Urban		U.S. Rural		Germany Total		U.S. Total	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Biology-Chemistry-Physics	-	-	3	12.5	-	-	2	6.9	3	6.2	2	4.1
Biology-Physics-Chemistry	-	-	-	-	1	5.0	-	-	-	-	1	2.0
Chemistry-Biology-Physics	2	8.3	6	25.0	4	20.0	6	20.7	8	16.7	10	20.4
Chemistry-Physics-Biology	15	62.5	7	29.2	1	5.0	7	24.1	22	45.8	8	16.3
Physics-Biology-Chemistry	1	4.2	2	8.3	6	30.0	-	-	3	6.3	6	12.3
Physics-Chemistry-Biology	6	25.0	6	25.0	8	40.0	14	48.3	12	25.0	22	44.9
Totals	24	100.0	24	100.0	20	100.0	29	100.0	48	100.0	49	100.0

*Question 3.

half of the German students considered the combination of Chemistry Physics-Biology as the most difficult one. Since a correlation between urban and rural students could not be clearly seen, Figure 3 presents a comparison between the opinions of German and United States students rating the difficulty of the three science fields.

Homework time for science classes. Question 4 gave insight into the homework time spent for science classes. Table V summarizes the responses of the students.

It was found that the majority of students in Germany as well as in the United States spent approximately 30 minutes per day on homework assignments for science classes. Figure 4 illustrates also that more urban students in Germany as well as the United States do not spend any time at all on science homework. However, the group of students not working on any homework assignments was greater in Germany than in the United States. Furthermore, the calculated mean for homework assignment time showed that American students, with a mean of 39 minutes, spent 10 minutes per day more than the German students with a mean of 29 minutes. A comparison of rural students with urban students showed that in the United States rural students spent approximately five minutes more per day on homework assignments than the urban student. A contrasting calculation was observed for German students, where urban students spent six minutes per day more than rural students. An illustration of the mean calculations is presented in Figure 5.

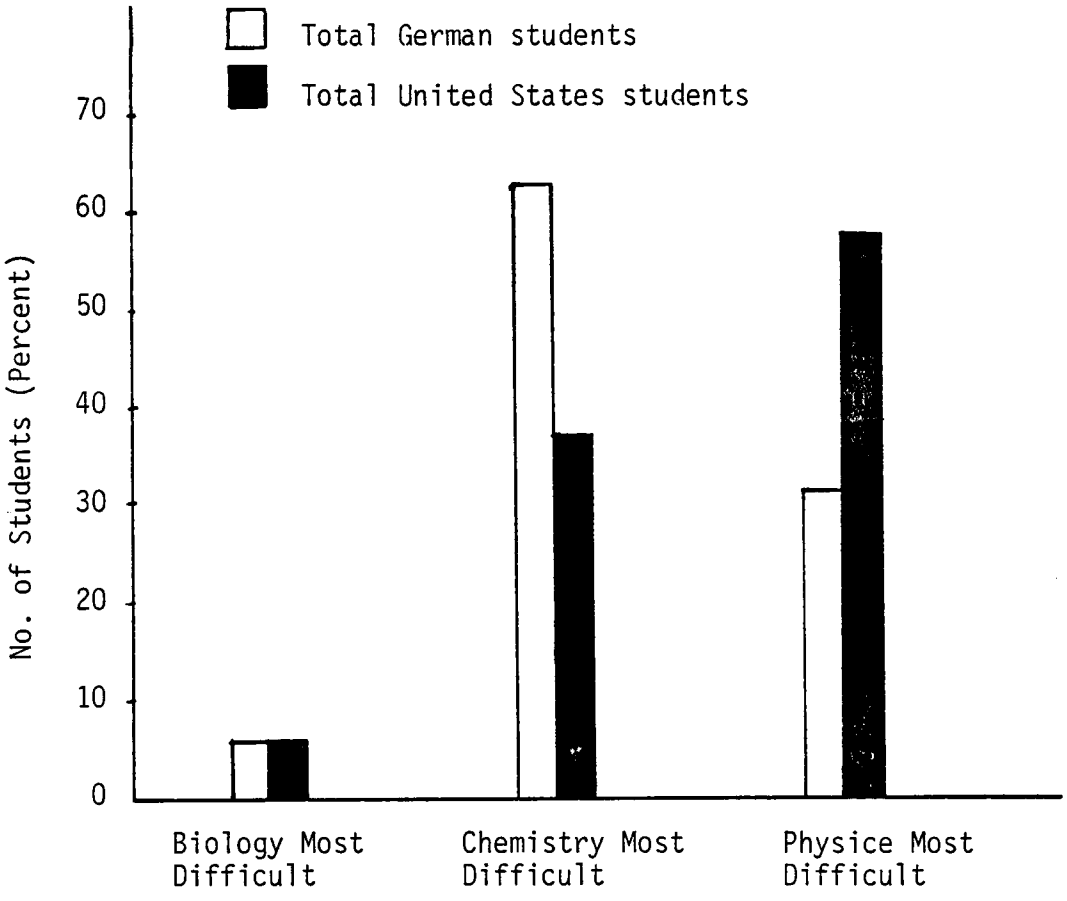

Figure 3. Rating difficulty of science fields.

TABLE V

SUMMARY OF RESPONSES INDICATING TIME SPENT ON HOMEWORK FOR SCIENCE CLASSES*

Time	Germany Urban		Germany Rural		U.S. Urban		U.S. Rural		Germany Total		U.S. Total	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
None	4	16.7	8	30.8	2	10.0	6	20.0	12	24.0	8	16.0
Thirty minutes a day	16	66.7	13	50.0	12	60.0	13	43.3	29	58.0	25	50.0
Sixty minutes a day	3	12.5	5	19.2	6	30.0	8	26.7	8	16.0	14	28.0
Two hours a day	1	4.1	-	-	-	-	3	10.0	1	2.0	3	6.0
More than two hours a day	-	-	-	-	-	-	-	-	-	-	-	-
Totals	24	100.0	26	100.0	20	100.0	30	100.0	50	100.0	50	100.0

*Question 4.

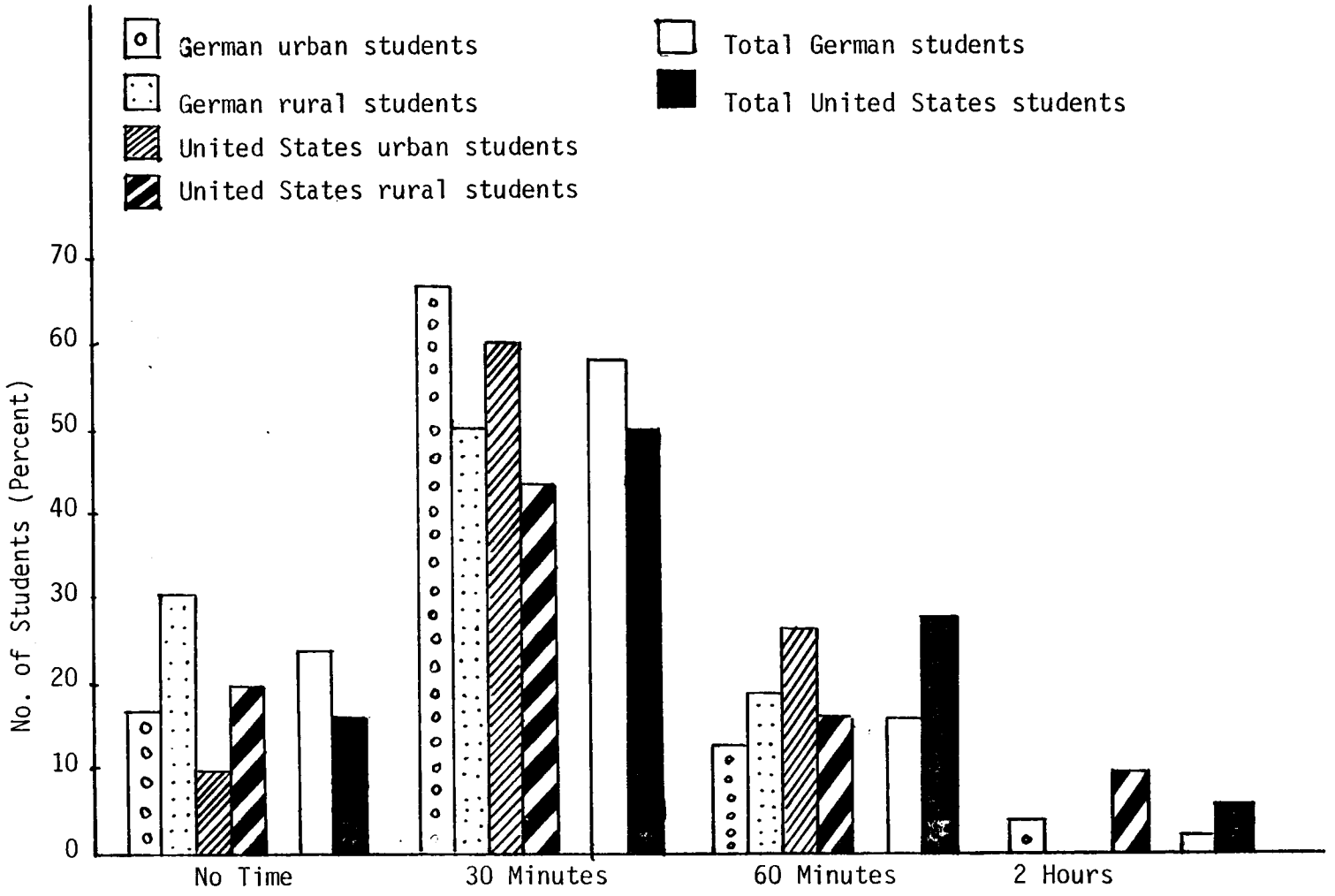

Figure 4. Homework time spent for science classes.

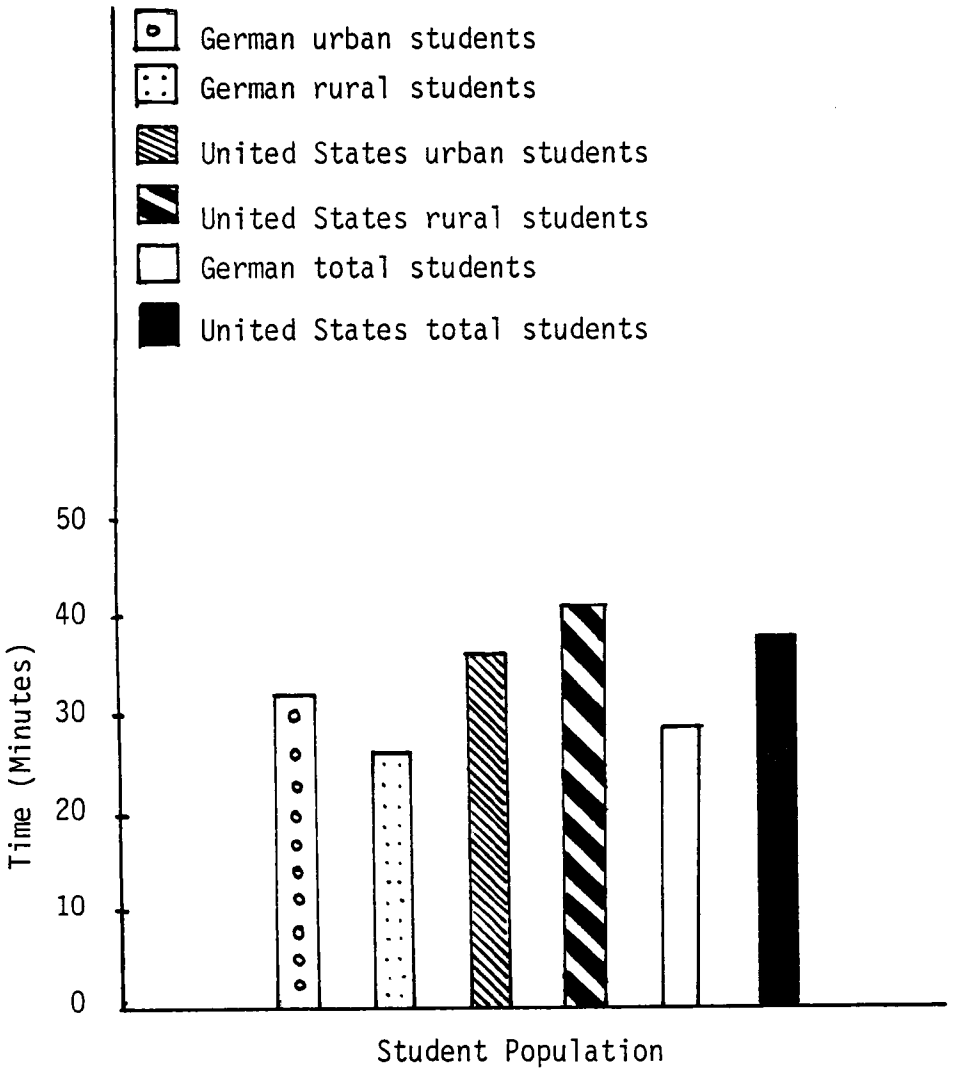

Figure 5. Calculated mean homework time spent for science classes.

Computer knowledge. Question 5, relating to students' attitude with regard to their own computer knowledge, showed that American students felt more confident about their computer knowledge than German students. A summary of responses is presented in Table VI.

More than half of all German students admitted to having no computer knowledge at all. This group was considerably smaller in the United States, where approximately one-third of all students admitted not having any computer knowledge. Figure 6 reviews the responses of American and German students.

An interpretation of this figure indicates that the majority of East Tennessee students (42%) are just beginning to learn computer usage, whereas the majority of German students (52%) have no computer knowledge.

Frequency of filling out questionnaires. Students were asked in Question 6 how many times they were presented with questionnaires during their school time. Responses, summarized in Table VII, indicated that similar involvement in this area was evident.

The majority of East Tennessee students (59%) reported to answer questionnaires one to three times a year, whereas 46% of German students indicated this frequency. The number of students stating that they never answer questionnaires was slightly higher in Germany (44%) compared to East Tennessee (35%).

Attitude toward science classes. The response to Question 7 gave an indication that most students in the United States as well as Germany had a positive attitude toward science classes. Table

TABLE VI

SUMMARY OF RESPONSES RELATING TO COMPUTER KNOWLEDGE*

Rating	Germany Urban		Germany Rural		U.S. Urban		U.S. Rural		Germany Total		U.S. Total	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Very competent and enjoy	2	8.3	1	3.8	2	10.0	1	3.3	3	6.0	3	6.0
Reasonably competent and enjoy	4	16.7	7	26.9	7	35.0	1	3.3	11	22.0	8	16.0
Just beginning to learn	4	16.7	6	23.1	5	25.0	16	53.4	10	20.0	21	42.0
No knowledge at all	14	58.3	12	46.2	6	30.0	12	40.0	26	52.0	18	36.0
Totals	24	100.0	26	100.0	20	100.0	30	100.0	50	100.0	50	100.0

*Question 5.

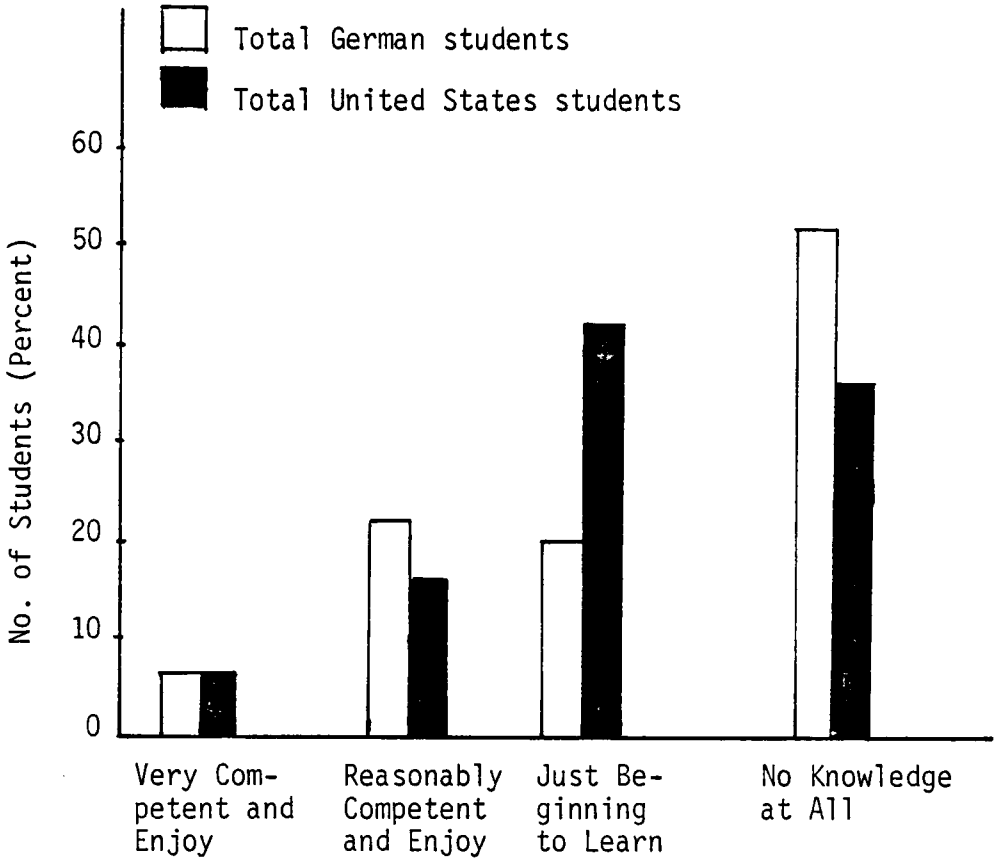

Figure 6. Students' attitude with regard to computer knowledge.

TABLE VII

SUMMARY OF RESPONSES SHOWING FREQUENCY OF FILLING OUT QUESTIONNAIRES*

Frequency	Germany Urban		Germany Rural		U.S. Urban		U.S. Rural		Germany Total		U.S. Total	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
None	7	29.2	15	57.7	9	45.0	8	27.6	22	44.0	17	34.7
1-3 per year	12	50.0	11	42.3	10	50.0	19	65.6	23	46.0	29	59.2
4-6 per year	3	12.5	-	-	-	-	1	3.4	3	60.0	1	2.0
One per month	-	-	-	-	1	5.0	1	3.4	-	-	2	4.1
One per week	2	8.3	-	-	-	-	-	-	2	4.0	-	-
Totals	24	100.0	26	100.0	20	100.0	29	100.0	50	100.0	49	100.0

*Question 6.

VIII presents the results of the answers, whereas Figure 7 summarizes the responses, giving a comparison between German and East Tennessee students. Evaluation of the graph on Figure 7 suggests that differences between students from both countries are small. German students rate themselves slightly higher with regard to their difficulties in sciences than East Tennessee students. However, even though they indicate a lower success rate, they still show a higher enjoyment rate than their fellow students in Tennessee. Dislike, expressed by 20% of all Tennessee students, was stated by only 16% of German students.

Foreign languages taken by students. From Table IX and Figure 8 it is evident that German students enrolled in science classes place much higher emphasis on foreign languages. Table IX, summarizing the responses, indicates that all German students take at least one foreign language, whereas approximately one-third of all East Tennessee students do not learn any foreign language at all. However, the percentage of students taking at least one language is far greater in urban East Tennessee than rural areas. The majority of students in East Tennessee (61.2%) take one foreign language in school, whereas 62% of German students reported to be taking two foreign languages. Thirty percent of the German students further indicated learning a third language. Figure 8 presents graphically the distribution of foreign language taken by students enrolled in science classes.

TABLE VIII

SUMMARY OF RESPONSES INDICATING ATTITUDES TOWARD SCIENCE CLASSES*

Type of Self-evaluation	Germany Urban		Germany Rural		U.S. Urban		U.S. Rural		Germany Total		U.S. Total	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Success and enjoyment	9	37.5	11	42.3	15	75.0	9	30.0	20	40.0	24	48.0
Difficulty but enjoyment	11	45.9	11	42.3	3	15.0	13	43.4	22	44.0	16	32.0
Success but dislike	2	8.3	3	11.5	2	10.0	4	13.3	5	10.0	6	12.0
Difficulty and dislike	2	8.3	1	3.9	-	-	4	13.3	3	6.0	4	8.0
Totals	24	100.0	26	100.0	20	100.0	30	100.0	50	100.0	50	100.0
Total success	11	45.8	14	53.8	17	85.0	13	43.3	25	50.0	30	60.0
Total difficulty	13	54.2	12	46.2	3	15.0	17	56.7	25	50.0	20	40.0
Totals	24	100.0	26	100.0	20	100.0	30	100.0	50	100.0	50	100.0
Total enjoyment	20	83.3	22	84.6	18	90.0	22	73.3	42	84.0	40	80.0
Total dislike	4	16.7	4	15.4	2	10.0	8	26.7	8	16.0	10	20.0
Totals	24	100.0	26	100.0	20	100.0	30	100.0	50	100.0	50	100.0

*Question 7.

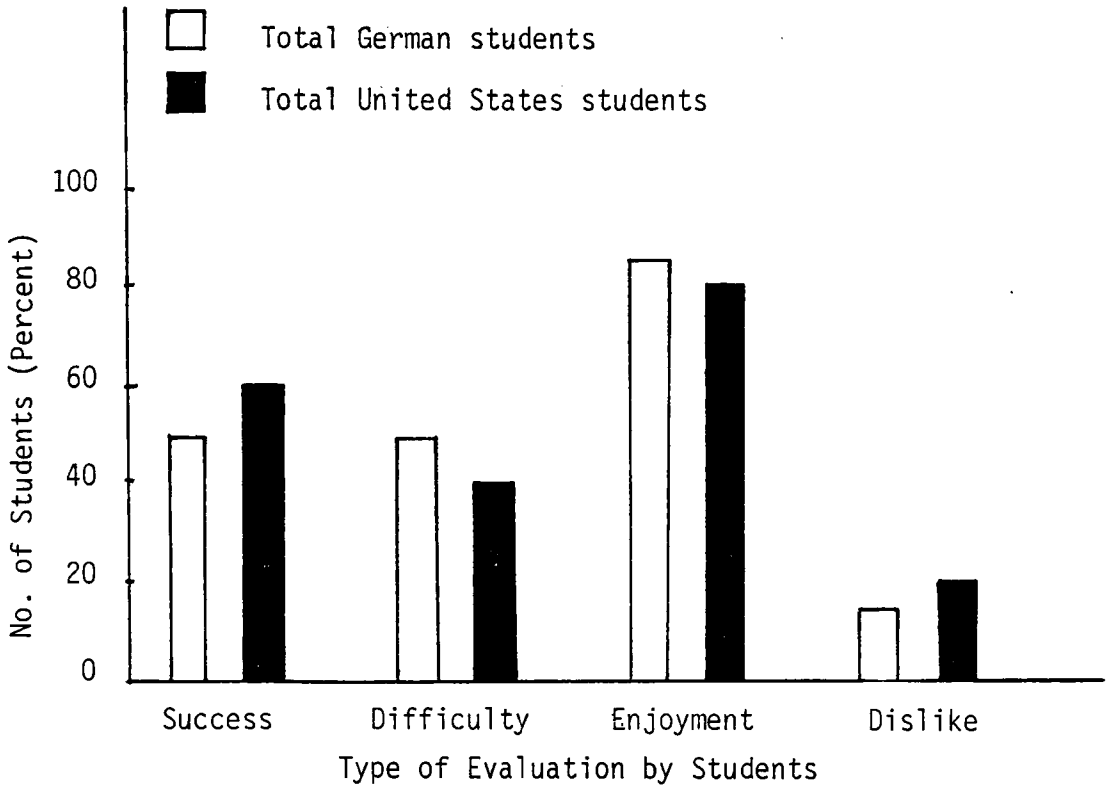

Figure 7. Students' attitudes toward science classes.

TABLE IX

SUMMARY LIST SHOWING FOREIGN LANGUAGES TAKEN BY STUDENTS*

Languages	Germany Urban		Germany Rural		U.S. Urban		U.S. Rural		Germany Total		U.S. Total	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
None	-	-	-	-	2	10.0	15	51.7	-	-	17	34.7
One foreign language	4	16.7	-	-	17	85.0	13	44.8	4	80.0	30	61.2
Two foreign languages	17	70.8	14	53.8	1	5.0	1	3.5	31	62.0	2	4.1
Three foreign languages	3	12.5	12	46.2	-	-	-	-	15	30.0	-	-
Totals	24	100.0	26	100.0	20	100.0	29	100.0	50	100.0	49	100.0

*Question 8.

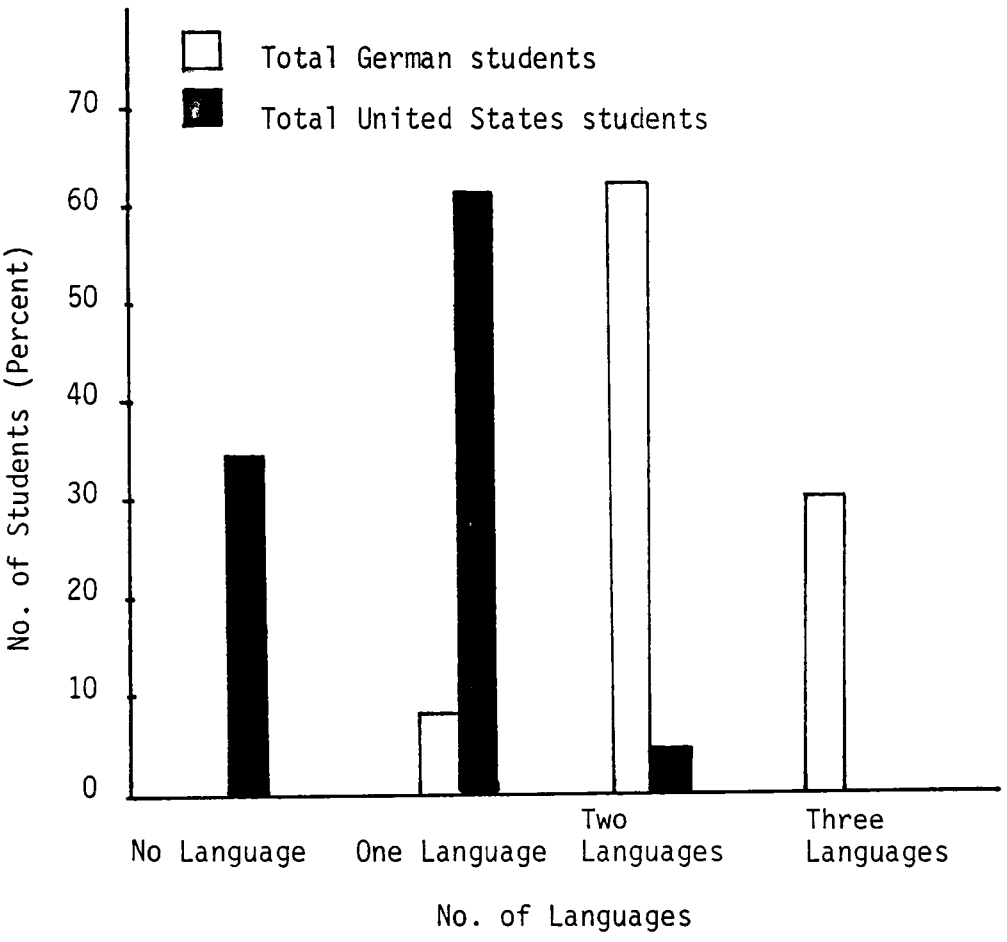

Figure 8. Number of foreign languages taken by students enrolled in science classes.

Science magazines. Answers to Question 9 gave an indication of the number of science magazines read by students. As Figure 9 indicates, German students appear to read more magazines than East Tennessee students. Calculations of the mean number of magazines read indicated that German students with a mean of .94 read twice as many magazines as United States students with a mean of .46. The most popular magazine in Germany was GEO, followed by PM. East Tennessee students read Science Digest most frequently, followed by Science World. It should furthermore be pointed out that students in urban areas seem to read more than in rural areas. This was observed in Germany as well as in East Tennessee. Calculated mean numbers of magazines were 1.2 for urban German students versus .73 for rural German students and .80 for urban Tennessee students versus .23 for rural students in Tennessee (see Table X).

Years of science courses taken. Responses to Question 10, reflecting the years of science courses taken in each field, have been summarized and evaluated in Table XI. It can be inferred from these answers that German students have a more extensive science background than East Tennessee students after leaving high school. For biological sciences, it was calculated that German students have a mean of 3.4 years of instruction whereas students in East Tennessee were represented with a mean of 1.5 years of biology instruction.

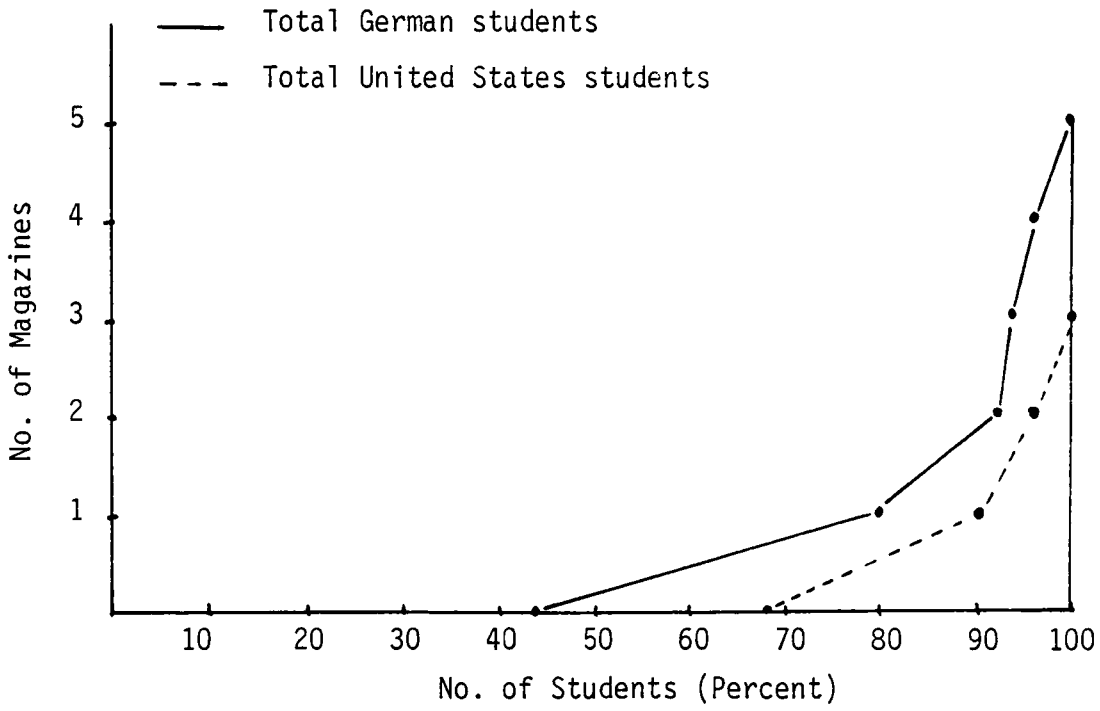

Figure 9. Number of science magazines read by students.

TABLE X

SUMMARY LIST INDICATING SCIENCE MAGAZINES READ BY STUDENTS*

No. of Magazines	Germany Urban		Germany Rural		U.S. Urban		U.S. Rural		Germany Total		U.S. Total	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
None	10	41.7	12	46.2	11	55.0	23	76.7	22	44.0	34	68.0
One	6	25.0	12	46.2	4	20.0	7	23.3	18	36.0	11	22.0
Two	5	20.7	1	3.8	3	15.0	-	-	6	12.0	3	6.0
Three	1	4.2	-	-	2	10.0	-	-	1	2.0	2	4.0
Four	1	4.2	-	-	-	-	-	-	1	2.0	-	-
Five	1	4.2	1	3.8	-	-	-	-	2	4.0	-	-
Totals	24	100.0	26	100.0	20	100.0	30	100.0	50	100.0	50	100.0

*Question 9.

TABLE XI

SUMMARY INDICATING YEARS OF SCIENCE COURSES TAKEN*

Variables	Germany Urban		Germany Rural		U.S. Urban		U.S. Rural		Germany Total		U.S. Total	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Biology												
None	-	-	-	-	-	-	1	3.4	-	-	1	2.0
1 year	-	-	1	3.9	19	95.0	5	17.3	1	2.0	24	49.0
2 years	-	-	3	11.5	1	5.0	23	79.3	3	6.0	24	49.0
3 years	15	62.5	13	50.0	-	-	-	-	28	56.0	-	-
4 years	6	25.0	6	23.1	-	-	-	-	12	24.0	-	-
5 years	3	12.5	3	11.5	-	-	-	-	6	12.0	-	-
Totals	24	100.0	26	100.0	20	100.0	29	100.0	50	100.0	49	100.0
Chemistry												
None	-	-	-	-	6	30.0	-	-	-	-	6	12.2
1 year	-	-	-	-	14	70.0	29	100.0	-	-	43	87.8
2 years	7	29.2	9	34.6	-	-	-	-	16	32.0	-	-
3 years	11	45.8	11	42.3	-	-	-	-	22	44.0	-	-
4 years	6	25.0	6	23.1	-	-	-	-	12	24.0	-	-
Totals	24	100.0	26	100.0	20	100.0	29	100.0	50	100.0	49	100.0
Physics												
None	-	-	-	-	14	70.0	15	51.7	-	-	29	59.2
1 year	1	4.2	-	-	6	30.0	14	48.3	1	2.0	20	40.8
2 years	10	41.7	10	38.5	-	-	-	-	20	40.0	-	-

TABLE XI (Continued)

Variables	Germany Urban No.	Germany Urban %	Germany Rural No.	Germany Rural %	U.S. Urban No.	U.S. Urban %	U.S. Rural No.	U.S. Rural %	Germany Total No.	Germany Total %	U.S. Total No.	U.S. Total %
Physics (cont.)												
3 years	4	16.6	10	38.5	-	-	-	-	14	28.0	-	-
4 years	3	12.5	4	15.4	-	-	-	-	7	14.0	-	-
5 years	6	25.0	2	7.6	-	-	-	-	8	16.0	-	-
Totals	24	100.0	26	100.0	20	100.0	29	100.0	50	100.0	49	100.0
Total years of science classes												
1 year	-	-	-	-	6	30.0	2	6.9	-	-	8	16.4
2 years	-	-	-	-	8	40.0	5	17.2	-	-	13	26.5
3 years	-	-	-	-	5	25.0	8	27.6	-	-	13	26.5
4 years	-	-	-	-	1	5.0	14	48.3	-	-	15	30.6
6 years	-	-	2	7.7	-	-	-	-	2	4.0	-	-
7 years	3	12.5	-	-	-	-	-	-	3	6.0	-	-
8 years	8	33.3	12	46.2	-	-	-	-	20	40.0	-	-
9 years	2	8.3	1	3.8	-	-	-	-	3	6.0	-	-
10 years	2	8.3	5	19.2	-	-	-	-	7	14.0	-	-
11 years	3	12.5	3	11.6	-	-	-	-	6	12.0	-	-
12 years	5	20.8	2	7.7	-	-	-	-	7	14.0	-	-
13 years	1	4.3	1	3.8	-	-	-	-	2	4.0	-	-
Totals	24	100.0	26	100.0	20	100.0	29	100.0	50	100.0	49	100.0

*Question 10.

The number of years in chemistry instruction differed greatly as well. German students showed a mean of 2.9 years, while students in East Tennessee had a mean of .9 years.

Physics instruction reflected the same tendency. German students indicated a mean instruction time of three years, whereas East Tennessee students had .4 years of instruction.

The total number of years in science instruction for students from both countries has been graphically illustrated in Figure 10.

When Figure 10 is interpreted, it is evident that the total amount of time spent on science education is approximately three times as great in Germany as in the represented United States schools.

Student attitudes toward science classes based on Questions 11 to 20. The responses to the last 10 questions are summarized in Table XII. The following analysis of each question is either discussed briefly in descriptive form or illustrated with a graph.

An over-view of all responses indicating a positive, negative or undecided opinion is illustrated in Figure 11.

Figure 11 implies that East Tennessee students appear to have a more positive attitude, are less undecided and show a lower rate of disagreement in their questions than German students.

Science related career. Responses to Question 11 suggest that German students were not as sure about a planned career in the sciences. While 16% of German students agreed completely and 8% partially to make a career selection involving the sciences,

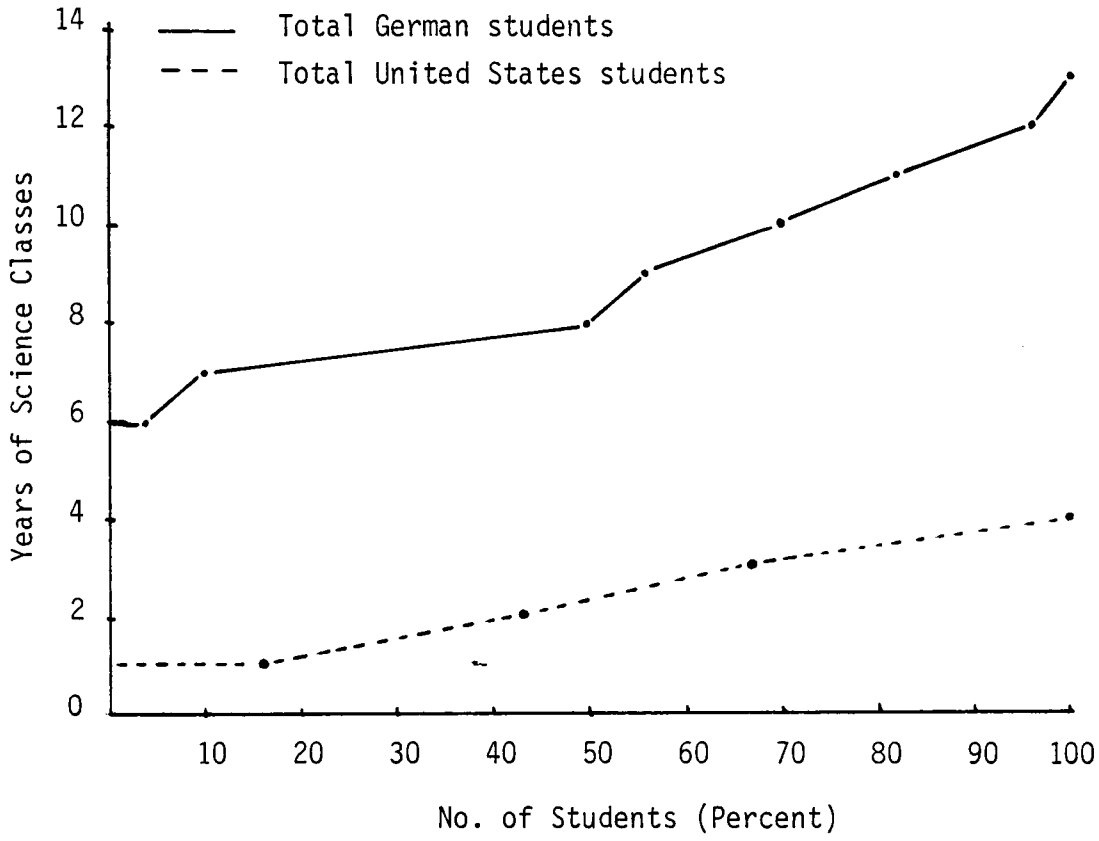

Figure 10. Total number of years in science education.

Question No.	Question Topic	Germany Total Scale* (1) No.	%	Total	%	(1) No.	%	(2) No.	%	(3) No.	%	(4) No.	%	(5) No.	%	Total No.	%	U.S. Total Scale* (1) No.	%	(2) No.	%	(3) No.	%	(4) No.	%	(5) No.	%	Total No.	%
11	Science related career	2	8.3		100.0	8	16.0	4	8.0	18	36.0	5	10.0	15	30.0	50	100.0	21	42.9	15	30.6	7	14.3	1	2.0	5	10.2	49	100.0
12	More mandatory science classes	-	-	1	100.0	-	-	14	28.0	9	18.0	12	24.0	15	30.0	50	100.0	18	36.7	19	38.8	7	14.3	2	4.1	3	6.1	49	100.0
13	Fair testing practice	6	25.0	1	100.0	7	14.0	17	34.0	16	32.0	7	14.0	3	6.0	50	100.0	13	27.1	22	45.8	5	10.4	7	14.6	1	2.1	48	100.0
14	Enough energy education	-	-		100.0	4	8.0	13	26.0	5	10.0	22	44.0	6	12.0	50	100.0	7	14.3	21	42.9	8	16.3	8	16.3	5	10.2	49	100.0
15	Parental help with homework	1	4.2		100.0	1	2.0	4	8.0	1	2.0	8	16.0	36	72.0	50	100.0	12	24.5	3	6.1	2	4.1	6	12.2	26	53.1	49	100.0
16	Enough laboratory work	1	4.2		100.0	1	2.0	12	24.0	2	4.0	20	40.0	15	30.0	50	100.0	12	24.5	13	26.5	4	8.2	14	28.6	6	12.2	49	100.0
17	Fair amount of homework	5	20.8		100.0	7	14.0	14	28.0	14	28.0	11	22.0	4	8.0	50	100.0	19	39.6	13	27.1	4	8.3	8	16.7	4	8.3	48	100.0
18	Enough laboratory equipment	-	-		100.0	2	4.0	8	16.0	7	14.0	16	32.0	17	34.0	50	100.0	15	30.6	9	18.4	3	6.1	5	10.2	17	34.7	49	100.0
19	Fair amount of memorizing	3	12.5	1	100.0	5	10.0	24	48.0	11	22.0	5	12.0	4	8.0	50	100.0	26	53.1	16	32.6	3	6.1	2	4.1	2	4.1	49	100.0
20	Positive teacher evaluation	1	4.2	1	100.0	3	6.0	26	52.0	6	12.0	11	22.0	4	8.0	50	100.0	21	43.7	15	31.2	2	4.2	8	16.7	2	4.2	48	100.0
						38	7.6	136	27.2	89	17.8	118	23.0	119	23.8	500	100.0	164	33.7	146	30.0	45	9.2	61	12.5	71	14.6	487	487

*Scale: (1) Agree completely
(2) Agree partially
(3) Undecided
(4) Disagree partially
(5) Disagree completely

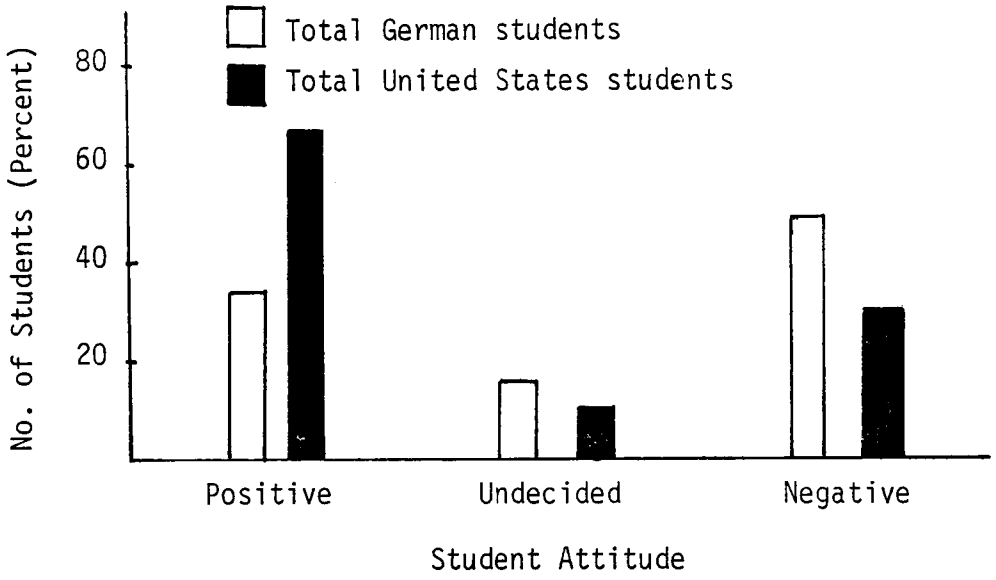

Figure 11. Student attitude toward science classes based on Questions 11-20.

approximately three times as many students in East Tennessee (43% completely, 31% partially), agreed to plan a career in a science-related field. Disagreement was far stronger with this issue in Germany than in the United States.

Mandatory science classes. The majority of Tennessee students (75%) stated the opinion that more science classes should be mandatory. Only 28% of the German students shared this opinion, and more than half of the German students (54%) felt that enough science classes were offered in their high school curriculum.

Fair testing. Figure 12 illustrates that German as well as United States students agree mainly with their testing policies.

The responses to Question 13, relating to the testing issue, are presented in Figure 12.

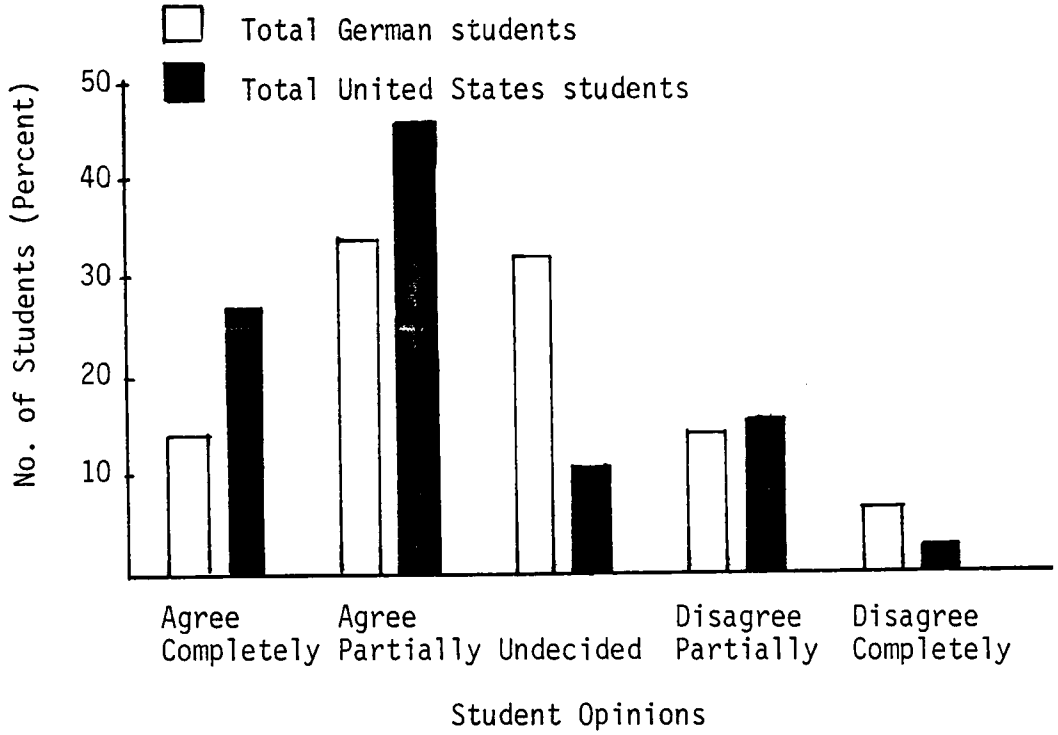

Figure 12. Student opinions reflecting fair testing policies.

Energy education. Question 14, reflecting students' opinions about energy education, showed that German students feel very differently about this topic. Fifty-six percent of the German students stated that not enough energy related topics were taught in their classes. Only half as many East Tennessee students (27%) expressed a lack of energy related instructions. Figure 13 illustrates responses to Question 14.

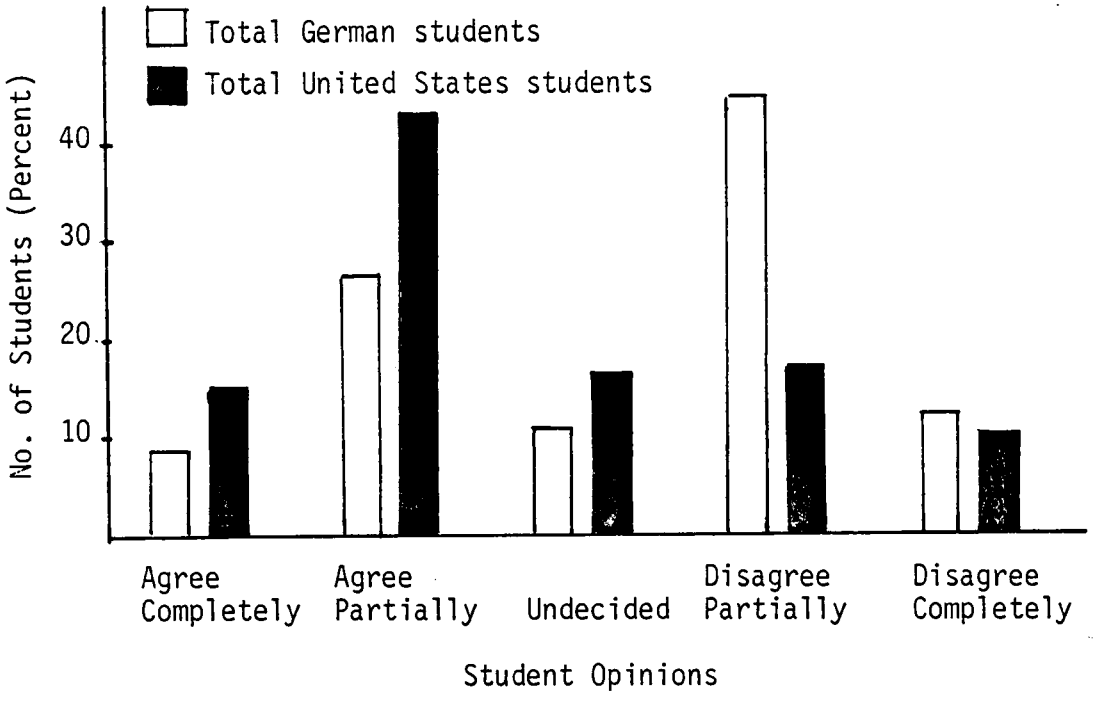

Figure 13. Student responses to the statement that enough energy education is provided.

Parental help with homework. Question 14 solicited slightly similar responses from students in both countries. The majority of students, 88% in Germany, 65% in the United States, stated that they do not receive parental help with their homework. However, the number of students receiving help from their parents was three times as great in the United States than in Germany. Thirty-one percent of East Tennessee students do homework with parental help, whereas only 10% of German students shared their homework with parents. Figure 14 presents a summary of responses relating to this issue.

Laboratory work. Question 16, indicating that enough laboratory work is included in the high school curriculum, was

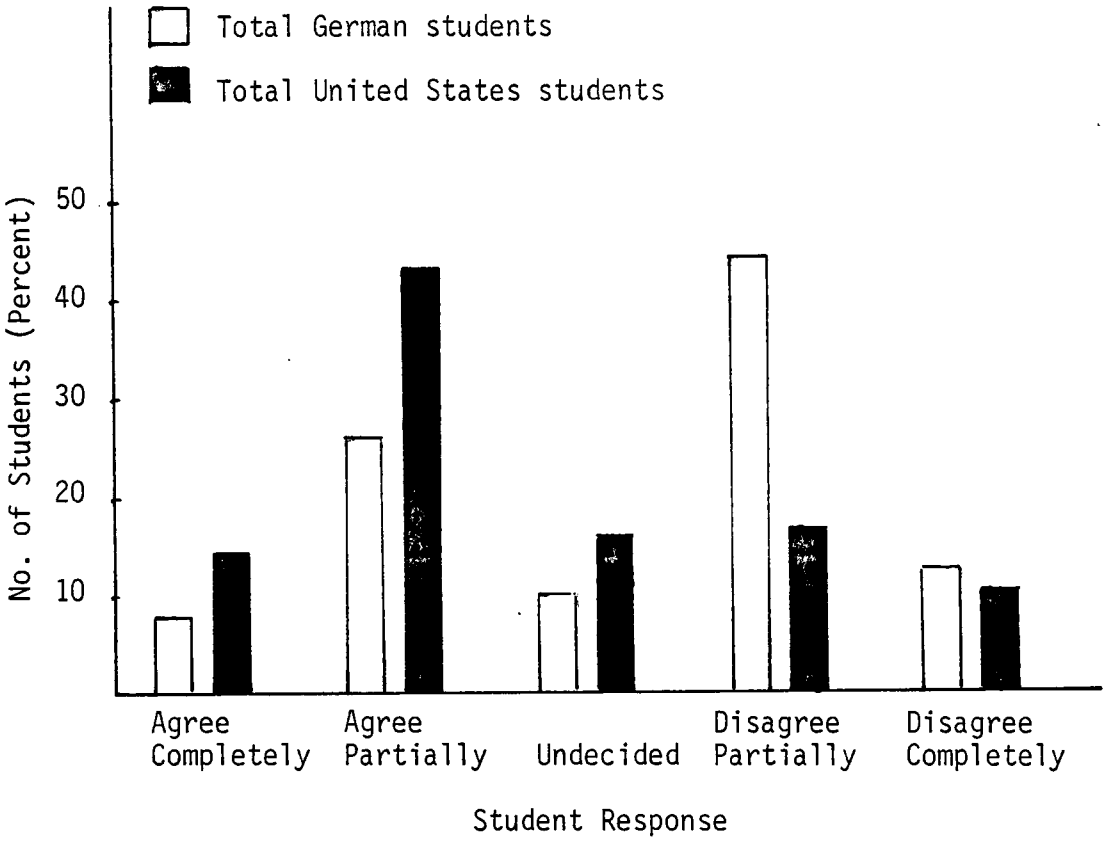

Figure 14. Student responses to the statement indicating parental help with homework.

responded to in slightly different ways by the two groups of students. As Figure 15 indicates, students reacted differently on complete agreement as well as complete disagreement, whereas partial agreement and partial disagreement received approximately similar responses. Students in East Tennessee appeared to be more satisfied with the laboratory content of their classes than the students in Germany.

Homework load. Student responses to the statement in Question 17, indicating that the amount of homework was considered to be fair, varied to a great extent. As Figure 16 suggests, East

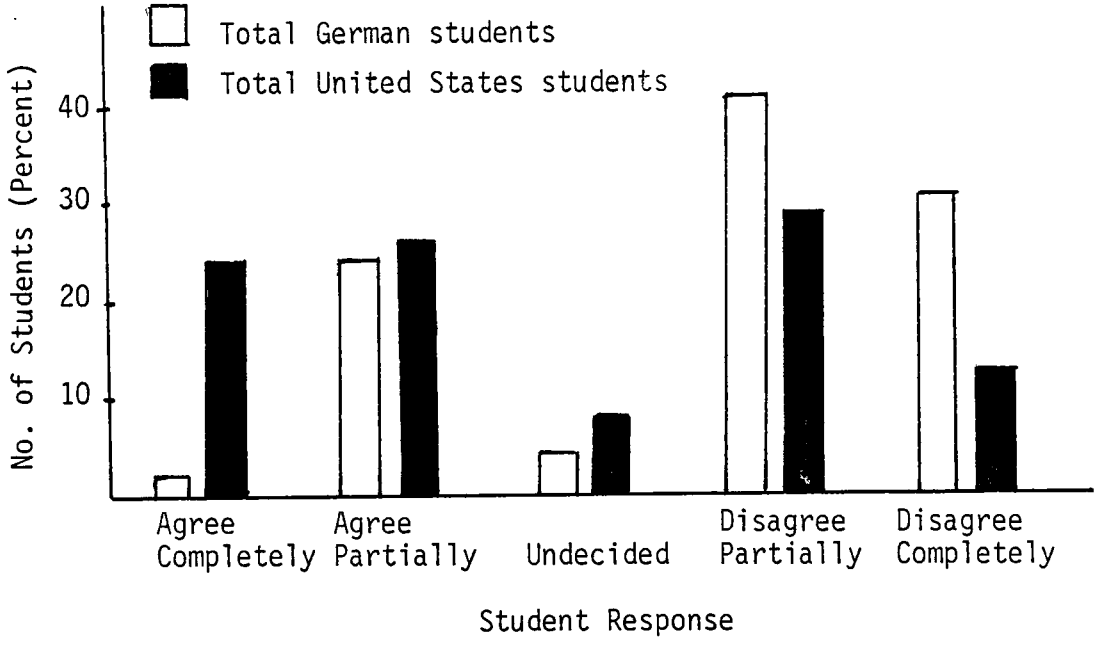

Figure 15. Student responses to the statement that enough laboratory work is included in their instruction.

Tennessee students seem to agree much stronger with their homework assignments than German students. The rate of partial agreement as well as the rate of strong disagreement, however, appear to be almost identical.

Laboratory equipment. Question 18, asking students to respond to the statement that enough laboratory equipment was available to them, showed that more students in East Tennessee believed they were better supplied with equipment than German students. Figure 17 summarizes these results.

Amount of memorizing. The majority of students in Germany as well as in the United States responded to Question 19 that the amount of memorizing in science classes was considered to be fair. It

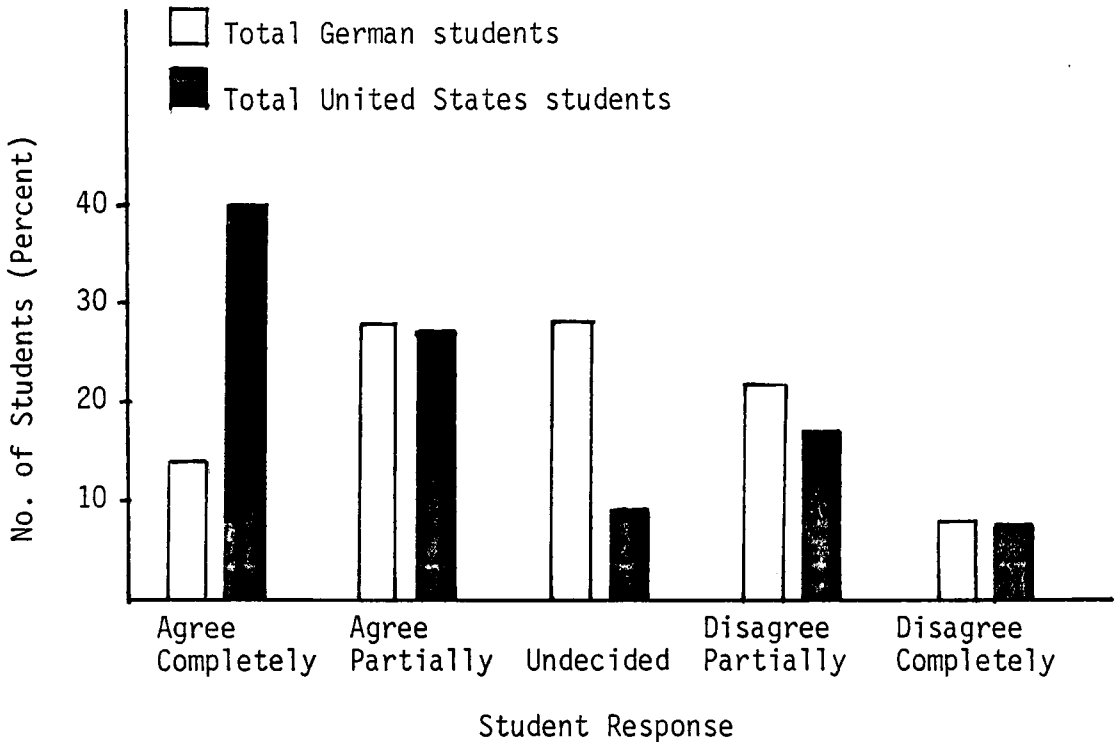

Figure 16. Student responses to the statement that the amount of homework is kept to a fair amount.

appeared, however, that United States students felt stronger about this issue than German students. The rate of disagreement seemed similar in both countries. Figure 18 summarizes the responses.

Teacher evaluation. Responses to Question 20 indicated that most students in both countries evaluated their teachers positively. Figure 19 illustrates, however, that more East Tennessee students agreed completely, while more German students agreed only partially. The overall tendency to rate their teachers negatively was more than twice as great in Germany as in the United States.

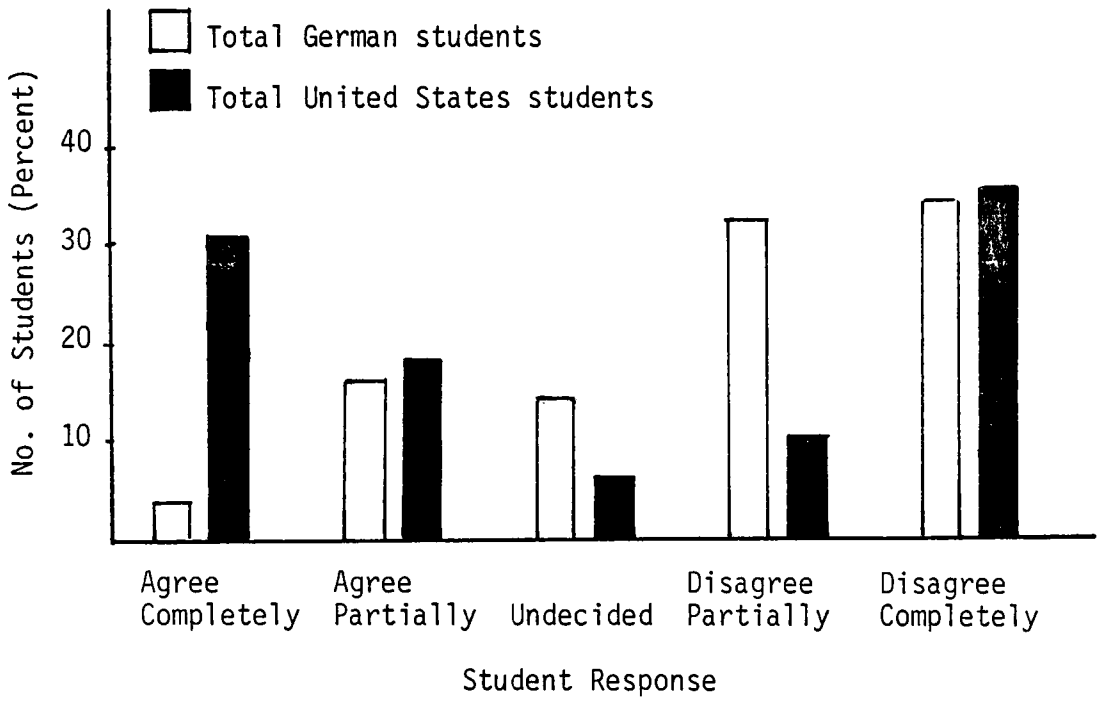

Figure 17. Student responses to the statement that enough laboratory equipment is available.

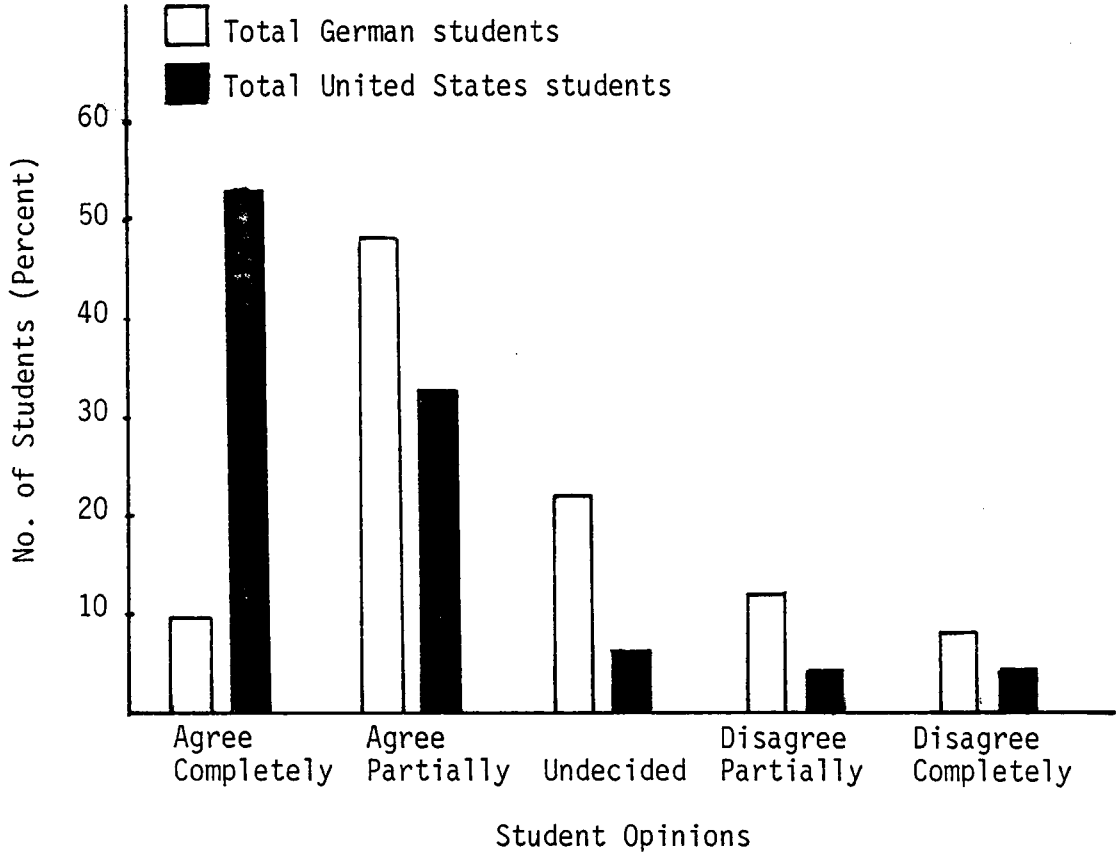

Figure 18. Student responses to the statement that the amount of memorizing is considered to be fair.

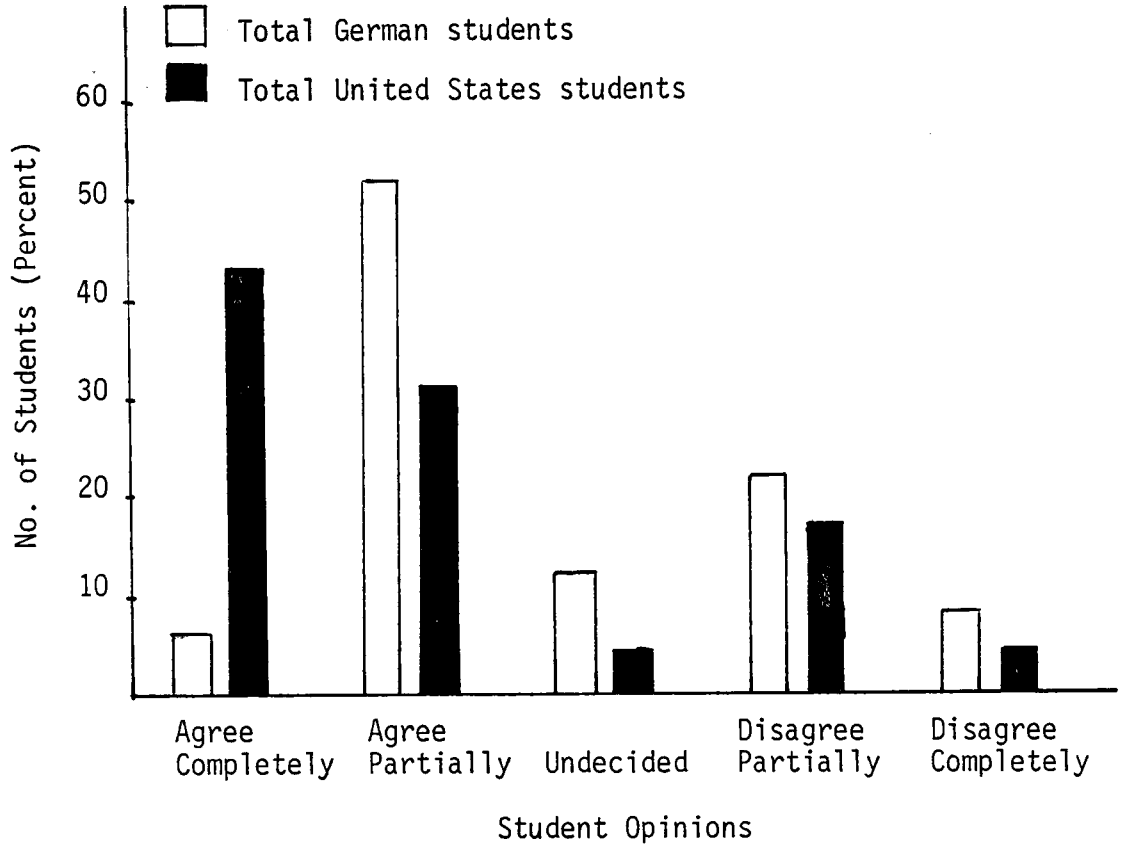

Figure 19. Student responses to the statement that science teachers make science classes interesting and meaningful to students.

CHAPTER V

SUMMARY, CONCLUSIONS, IMPLICATIONS AND RECOMMENDATIONS

Summary

This study was undertaken in order to identify and collect information for a comparative study of science education in North Germany and East Tennessee. Four questions were deemed important to this study: How is the school system structured? Who designs and controls curriculum? How are high school teachers trained? What are students' attitudes toward science education?

The review of selected literature revealed that school systems in Germany and the United States differed in many respects. The vertical organization of schools as well as length of schooling were facets of considerable contrasting importance.

In examining curriculum design the literature disclosed that, in Germany, only one major institution, IPN in Kiel, is involved in designing curriculum units, whereas in the United States 42 institutions develop and design science curricula. The findings in the literature relating to curriculum control suggested that Germany featured an ultimate federal control, whereas the United States featured a decentralized control which allowed each state the responsibility for curriculum control.

The reported findings in the review of literature relating to teacher training emphasize that length of training and intensity of training were more extreme in Germany.

In accordance with the intent of this study to collect and evaluate students' attitudes, a questionnaire featuring 20 questions was designed. A rural as well as an urban school was then selected in North Germany as well as East Tennessee. Thirty copies of the questionnaire were sent to each school.

Evaluation of student responses indicated that differences of attitudes and opinions between students in both countries exist. Of the 120 copies of the questionnaire sent, 100 copies (83.3%) were returned. Rural schools in both countries showed a higher return rate than urban schools. The combined rural and urban schools reflected the identical return rate for Germany as well as for East Tennessee.

The results of the questionnaires' evaluation showed that students in both countries consider science education to be the most important subject in school. Biology was thought of in both countries as the most interesting field of sciences; at the same time, it was also rated in both countries as the easiest field of sciences. After homework time for science classes was examined, it was evident that East Tennessee students spend approximately 10 minutes more on their assignments than German students, who spend 30 minutes per day on their science homework. Students' computer knowledge, after being assessed, proved to be more extensive in East Tennessee than in Germany, where more than half the students do not have any computer knowledge at all. After attitudes were investigated with regard to science classes, it was observed that students in Germany as well as East Tennessee showed a high enjoyment

and success rate. Foreign languages taken by students enrolled in science classes were more numerous in Germany where the majority of students were enrolled in two foreign language classes. Most East Tennessee students, however, were only learning one foreign language. As the years of science courses taken in high school were examined, it was observed that German students spent three times as many years in science education as the East Tennessee students.

It could furthermore be inferred from student responses that the East Tennessee students were more certain about a career in sciences than the German students. Most Tennessee students stated the opinion that more science courses should be mandatory for high school graduation. German students did not share this view. There was agreement, however, that testing policies in science classes were fair. The amount of energy education was considered to be too minimal by German students, whereas East Tennessee students appeared more content with their energy instruction.

Homework without parental help was observed to be the general trend in Germany as well as the United States. However, the percentage of students receiving help was considerably larger in East Tennessee than in Germany. Laboratory content of science classes was rated as too little by German students, whereas East Tennessee students showed more satisfaction with this issue.

As homework load for students was examined, German students indicated discontent with their homework load, while East Tennessee students seemed to view their homework load as reasonable.

The amount of memorizing for science classes was considered to be fair by students from both countries. Basic agreement among the majority of students was also reached in a positive teacher evaluation. Most students in both countries considered their teachers to be interesting instructors.

Conclusions

The general purpose of this study was to identify and evaluate differences in science education in North Germany and East Tennessee. Four questions were judged to be important for this study. Each is based on the results of collecting and evaluating literature and student responses.

Question 1. How do the school systems in Germany and the United States differ from each other? It was concluded that length of schooling and vertical structure were the most important differences between the two countries.

Question 2. Who designs and controls curriculum? It was determined that curriculum design was undertaken by only one major institution in West Germany, whereas many institutions are involved in the United States under the umbrella of the National Science Foundation. Control of the curriculum appeared to be centralized by the Federal Minister of Culture in Germany, whereas a decentralized system was observed in the United States where each state has the power to control the curriculum.

Question 3. How does the teacher training differ in Germany from the United States? It was concluded that teacher training in

Germany was longer and more intense than in the United States. However, continued teacher education, as observed in the United States, is non-existent in Germany.

Question 4. What are students' attitudes toward science education? The questionnaire, chosen as the vehicle to solicit students' attitudes and opinions, revealed that students in both countries considered science as the most important subject in their curriculum. However, a slightly more positive viewpoint was exhibited by students in Tennessee than by German students. East Tennessee students, spending more time on science homework, considered their homework load as being more manageable than German students. Agreement was observed in selecting biology as the easiest field of science. While German students considered chemistry to be the most difficult field, East Tennessee students classified physics as the most challenging field of science. An examination of testing policies suggested that most students in both countries considered testing to be fair. Opinions relating to energy education showed that German students were less satisfied with the content of energy instruction than East Tennessee students.

Lastly, the majority of students in both countries considered their teachers to be fair instructors, providing students with interesting lectures.

Recommendations

For secondary science classroom teachers to provide successfully the most beneficial education for every student in the

classroom, the following recommendations based on the responses to the questionnaire are made:

1. Science education in the high school classroom should be viewed as a starting element to prepare students for the international community of scientists, contributing to global research. With this goal in mind, teachers should show an interest in science education in other countries.
2. Differences in international science education curricula should be pointed out to students enrolled in science classes.
3. Students should be motivated by science teachers to investigate science education and instruction in other countries.
4. Pupil awareness of differences between their American science education and that of students in other countries should be particularly fostered for those students having a command of or a familiarity with the language of the respective foreign countries.
5. Based on Question 8 of the questionnaire, further research should be undertaken to investigate foreign language study and science content expertise.
6. Science education in other countries should be studied and compared to science education in the United States. Findings should promote better multinational understanding in the community of scientists.

To provide educators as well as students with further research findings, comparative studies involving science education in other countries should be encouraged and promoted.

Implications

Since students in high school science classes receive the foundation for possible later participation among the international community of scientists, an international orientation of the science teacher is all-important.

In order that students learn to extend their views of the sciences beyond that of their own school, city, county or state, students must be prompted to look at students in other countries. An observation will then be followed by a comparison. Such comparison should be introduced and supported by the science teacher. Students should be encouraged to share their findings in class.

Publications in professional magazines and textbooks should encourage teachers to direct their thinking toward comparative studies. Comparisons of science education in other countries might show students advantages as well as possible deficiencies in their own science education.

This study indicated that attitudes appeared to be an important element in science education. Further research in this area might benefit students as well as educators.

A replication of this study, involving other states, districts or continents might reveal interesting and beneficial findings in the field of science education.

An internationally oriented science teacher will not only attempt to give students the best science background but further strive to provide an education that enriches the social and personal pool of students' knowledge.

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APPENDIXES

APPENDIX A

STUDENT ATTITUDES TOWARD SCIENCE EDUCATION
(Biology, Chemistry and Physics)

Instructions: Please rank questions 1, 2 and 3 on a scale of 1 - 3.
1 = 1st rank (strongest)
2 = 2nd rank
3 = 3rd rank

1. Which area of education is most important to you?
___ Sciences
___ Foreign languages
___ English

2. Which field of science are you most interested in?
___ Biology
___ Chemistry
___ Physics

3. Which field of science is most difficult to you?
___ Biology
___ Chemistry
___ Physics

Instructions: Please circle the most appropriate answer for questions 4-7.

4. How much time do you spent on homework assignments for science classes?
(a) none at all
(b) 30 minutes a day
(c) 60 minutes a day
(d) 2 hours a day
(e) more than 2 hours a day

5. How do you rate yourself with regard to operating a computer?
(a) very competent and enjoy
(b) reasonably competent and partially enjoy
(c) just beginning to learn
(d) no knowledge at all

6. Indicate the frequency of filling out questionnaires during your school hours, other than this questionnaire.
(a) none
(b) 1-3 per year

(c) 4-6 per year
(d) 1 per month
(e) 1 per week

7. How do you rate yourself with regard to your science classes.

(a) success and enjoyment
(b) difficulty but enjoyment
(c) success but dislike
(d) difficulty and dislike

Instructions: Please list appropriate answers for questions 8-10.

8. List foreign languages taken in school.

(a)_____
(b)_____
(c)_____
(d)_____
(e)_____

9. List science magazine/s you read regularly.

(a)_____
(b)_____
(c)_____
(d)_____
(e)_____

10. List for each of the sciences named below the years of courses taken since 9th grade (including the 9th grade).

___ Biology
___ Chemistry
___ Physics

Instructions: Circle appropriate answers for questions 11-20 according to the following scale:
(1) Agree completely
(2) Agree partially
(3) Undecided
(4) Disagree partially
(5) Disagree completely

SCALE

1 2 3 4 5 11. I plan a career in a science related field.

1 2 3 4 5 12. More science classes should be mandatory for high school graduates.

1 2 3 4 5 13. Testing practices in science classes are fair and reflect my knowledge in science.

1 2 3 4 5 14. I learned enough about energy, energy sources, their applications and dangers in my science classes.

1 2 3 4 5 15. My parents help me with my homework and preparations for exams.

1 2 3 4 5 16. Enough emphasis is placed on practical laboratory work in my science classes.

1 2 3 4 5 17. Homework assignments are kept to fair and manageable levels.

1 2 3 4 5 18. There is enough laboratory equipment available for science classes.

1 2 3 4 5 19. Science classes contain a fair amount of memorizing.

1 2 3 4 5 20. My science teachers make classes interesting and meaningful to me.

THANK YOU FOR YOUR COOPERATION !!!!

APPENDIX B

SCHÜLERMEINUNGEN ÜBER NATURWISSENSCHAFTLICHEN UNTERRICHT
(Biologie, Chemie und Physik)

Anweisungen: Fragen 1 - 3 bitte geben Reihenfolge von 1 - 3 an, wobei
1 = 1. Platz
2 = 2. Platz
3 = 3. Platz

1. Welches Unterrichtsfach halten Sie für das Wichtigste?
___ Naturwissenschaften
___ Fremdsprachen
___ Deutsch

2. An welchem Geguet der Naturwissenschaften sind Sie am meisten interessiert?
___ Biologie
___ Chemie
___ Physik

3. Welches Gebiet der Naturwissenschafter erscheint Ihnen am schwierigsten?
___ Biologie
___ Chemie
___ Physik

Anweisungen: Fragen 4 - 7, bitte Kreuzen Sie die passende Antwort an!

4. Wieviel Zeit nehmen Ihre Hausaufgaben für naturwissenschaftliche Klassen in Anspruch?
(a) keine
(b) 30 Minuten pro Tag
(c) 60 Minuten pro Tag
(d) 2 Stunden pro Tag
(e) meht als 2 Stunden pro Tag

5. Wie schätzen Sie sich selbst mit Hinsicht auf Computerbedienung ein?
(a) sehr fachkundig und begeistert
(b) beschränkt fachkundig und teilweise begeistert
(c) fange gerade an zu lernen
(d) keine Erfahrung

6. Bitte geben Sie an, wie oft Sie Fragebogen während Ihrer Schulzeit ausfüllen, (dieser Fragebogen ist davon ausgeschlossen).

(a) nie
(b) 1 - 3 Mal pro Jahr
(c) 4 - 6 Mal pro Jahr
(d) 1 Mal pro Monat
(e) 1 Mal pro Woche

7. Wie schätzen Sie sich selbst ein in Bezug auf naturwissenschaftliche Klassen?

(a) Erfolg und begeistert
(b) Schwierigkeiten aber begeistert
(c) Erfolg aber unbeliebt
(d) Schwierigkeiten und unbeliebt

Anweisungen: Bitte beantworten Sie Fragen 8 - 10 in den angegebenen Spalten

8. Bitte führen Sie Fremdsprachen an die Sie in der Schule lernen.

(a)_____
(b)_____
(c)_____
(d)_____
(e)_____

9. Bitte führen Sie naturwissenschaftliche Zeitungen an, die Sie regelmässig lesen.

(a)_____
(b)_____
(c)_____
(d)_____
(e)_____

10. Bitte geben Sie für jedes aufgefuhrte naturwissenschaftliche Fach an, wieviele Jahre Sie seit der 9. Klasse absolviert haben. (9. Klasse eingeschlossen)

___ Biologie
___ Chemie
___ Physik

Anweisungen: fur Fragen 11-20 kreuzen Sie bitte passende Antworten nach folgendem Masstab an:

(1) stimme vollkommen überein
(2) stimme teilweise überein
(3) unentschlossen
(4) teilweise unzutreffend
(5) vollkommen unzutreffend

1 2 3 4 5 11. Ich plane eine berufliche Karriere in Naturwissenschaften.

1 2 3 4 5 12. Mehr naturwissenschaftliche Fächer sollten Pflicht sein um das Abitur zu bestehen.

1 2 3 4 5 13. Examen in naturwissenschaftlichen Fächern sind fair und reflektieren meine Kenntnisse.

1 2 3 4 5 14. Iche lerne genug über Energie, Energiequellen, Anwendungen und damit verbundene Gefahren.

1 2 2 3 4 15. Meine Eltern helfen bei Hausarbeiten und Examenvorbereitungen.

1 2 2 3 4 16. In unserem naturwissenschaftlichem Unterricht is genug praktische Laborarbeit enthalten.

1 2 3 4 5 17. Hausaufgaben sind fair und gut zu bewältigen.

1 2 3 4 5 18. Die Laboraustüstung ist ausreichend in unseren naturwissenschaftlichen Klassen.

1 2 3 4 5 19. Die 'enge des Auswendiglernens ist fair für naturwissenschaftliche Klassen.

1 2 3 4 5 20. Die Lehrer in naturwissenschaftlichen Klassen machen den Unterricht interessant und bedeutungsvoll für mich.

Vielen Dank für Ihre Mitarbeit.

APPENDIX C

2. Mai 1983

Oberstudiendirektor
Nordsee Gymnasium Sankt Peter
St. Peter

Als Student der Universitat Tennessee in Knoxville arbeite ich zur Zeit an einer These für den Magister der Pädogogik der Narurwissenschaften ("Master of Science in Science Education.") Da das Thema der These ein Vergleich zwischen naturwissenschaftlichem Unterricht in Deutschland und den Vereinigten Staaten ist, habe ich einen Fragebogen entworfen, der Ansichten und Meinungen deutscher Schuler reflektiert.

Es würde mir sehr helfen in meiner Forschungsarbeit, wenn Schüler in naturwissenschaftlichen Klassen 11-13 den Fragebogen ausfüllen würden. Anliegend finden Sie Fragebogen sowie mehrere Briefe für Lehrer, die Fragebogen an die Schüler austeilen. Um gesetztliche Richtlinien einzuhalten, werden die Lehren gebeten, den Schulen mitzuteilen, dass die Teilnahme an der Forschungsarbeit freiwillig ist und alle Informationen vertraulich behandelt werden. Um Ihnen aussergewöhnliche Portokosten zu ersparen, habe ich eine Postadresse in Deutschland arrangiert. Sie wurden mir sehr entgegenkommen, wenn Sie die beigelegten Fragebogen bis zum 23, Mai an folgende Adresse zurucksenden wurden:

B. Brooks
c/o Barrakling
Grossbeerenstrasse 33
28 Bremen

Sollten Sie am Ausgang meiner Forschungsarbeit interessiert sein, teile ich Ihnen gern meine Resultate mit.

Als ehemalige Schülerin des Nordsee Gymnasiums St. Peter (1961-1964) hoffe ich, dass Sie mir in meiner Forschungsarbeit helfen!

Mit verbindlichem Dank,

Bärbel Brooks
703 Crestview Drive
Rockwood, TN 37854
USA

APPENDIX D

Ich möchte Ihnen recht herzlich für Ihre Mitarbeit in meiner Forschungsarbeit danken! Bevor Sie die Fragebogen austeilen, lesen Sie den Schülern bitte laut folgende Anweisung vor:

"Das Thema dieser Forschungsarbeit is ein Vergleich zwischen naturwissenschaftlichem Unterricht in Deutschland und den Vereinigten Staaten. Ihre Teilnahme an dieser Arbeit ist freiwillig. Sollten Sie sich entschliessen, nicht teilzunehmen, so entsehen keine Nachteile für Sie. Ihre Informationen wird vertraulich behandelt werden. Vielen Dank für Ihre Teilnahme!"

Bitte geben Sie den Schülern eine Maximalzeit von 5 Minuten, um die Fragebogen auszufüllen. Sollten Sie Fragen in Betreff auf diese Forschungsarbeit haben, stehe ich Ihren gern zur Verfügung.

Vielen Dank für Ihre Hilfe!

Bärbel Brooks, Graduate Student
Department of Science Education
University of Tennessee
Knoxville, TN 37996
USA

APPENDIX E

May 2, 1983

The Principal
Rockwood High School
Rockwood, TN 37854

Dear Sir:

As a graduate student of science education at the University in Knoxville, I am currently working on a thesis comparing secondary science education in West Germany to science education in East Tennessee. The study is under the direction of Dr. Paul A. Wishart in the College of Education. The enclosed questionnaire is designed to solicit students' opinions to their own high school science education.

I would greatly appreciate it if you would allow your 10th to 12th grade students enrolled in laboratory science classes such as Biology, Chemistry or Physics to complete this form. A maximum time limit of five minutes should be set to fill out the questionnaire. To fulfill existing regulations, I enclose letters to the parents as well as letters to the teachers handing out questionnaires. Regulations require parental permission prior to students' participation in research studies. Teachers will inform students that participation is voluntary and that all information is kept confidential. If at all possible, I would like to pick up the completed questionnaires by May 13, 1983.

I realize that this time of the year prior to graduation and completion of the current school year is extremely busy for you; however, I would greatly appreciate your cooperation.

If you are interested in the study I will gladly make a summary of the results available to you.

Thank you for your assistance!

Sincerely,

Barbel Brooks
703 Crestview Drive
Rockwood, TN 37854

APPENDIX F

Dear Science Teacher:

I greatly appreciate your assistance in this study! regulations require that the enclosed letter with the permission slip has to be sent home with each student prior to participation. Please encourage the full participation of all students as this is necessary for the success of the study. A maximum time of five minutes should be set to fill out the questionnaires. Before you hand out the questionnaires, please read the following instructions to the students:

"This research activity involves a study comparing science education in Germany to science education in East Tennessee. Your participation in this study is voluntary. Refusal to participate will involve no penalty or loss of benefits to you. All of the information from you will be kept confidential. Thank you for your cooperation!"

If you have any questions regarding this research you may contact the researcher named below at any time.

Barbel Brooks, Graduate Student
Department of Science Education
University of Tennessee
Knoxville, TN 37996
Phone: 354-9319 (home)

THANK YOU FOR YOUR COOPERATION!

APPENDIX G

May 2, 1983

Dear Parent:

A research project involving science education in Germany and the U. S. is being conducted by Barbel Brooks, a graduate student at The University of Tennessee. The study is under the direction of Professor A. Paul Wishart in the College of Education. The study will involve asking your son/daughter to fill out a questionnaire relating to science classes. It is hoped that the results from this and similar studies can be used to improve science instruction in high school.

There are no anticipated risks or discomforts to the students who agree to participate in the study, and all of the information that is obtained from the student will be kept confidential. Students will not be required to sign their names to the questionnaire. Refusal to participate will not involve a penalty to any student.

If you will allow your son/daughter to participate in the study, please sign this letter and return it to school. If you have any questions regarding this research, you may contact the researcher or Project Director by calling the numbers listed below. Thank you very much for your cooperation.

Barbel Brooks
Department of Curriculum and Instruction
The University of Tennessee
Knoxville, TN 37996
974-2433 (Dr. Paul Wishart)
354-9319 (Barbel Brooks)

I, _____, agree to allow my son/daughter
(please print)

_____, to participate in the research
(student's name)

project described above.

_____
(parents signature)

APPENDIX H

CURRICULUM PROJECTS SUPPORTED BY THE NATIONAL SCIENCE FOUNDATION

ACMP	Anthropology Case Materials Project
ACSP	Patterns in Human History: Anthropology Curriculum Study Project
BICP	Biomedical interdisciplinary Curriculum Project
BSCS	Biological Science Curriculum Study
CBA	Chemical Bond Approach
CCSM	Cambridge Conference on School Mathematics
CHEM study	Chemical Education Material Study
COPES	Conceptually Oriented Program in Elementary Science
CSE	Commission on Science Education
ECCP	Engineering Concepts Curriculum Project
EEP	Environmental Experiments Program
EHN	Exploring Human Nature
ES	Environmental Studies for Urban Youth
ESCP	Investigating the Earth: Earth Science Curriculum Project
ESS	Elementary Science Study
ESSP	Elementary School Science Project
FUSE	FUSE Center for Unified Science Education
HSGP	Geography in an Urban Age: High School Geography Project
HSP	Human Sciences Program
HUNTINGTON II	Development of Computer Simulation Materials
IPS	Introductory Physical Science
ISCS	Probing the Natural Word: Intermediate Science Curriculum Study
ISIS	Individualized Science Instructional System
MACOS	Man: A Course of Study: Social Studies Curriculum Program
MAD-M	Madison Mathematics Project
MINNEMAST	Minnesota School Mathematics and Science Teaching Project
OBIS	Outdoor Biology Instructional Strategies
PMT	The Adaptation of Programmed Tutoring to Mathematics (Programmed Math Tutorial)
PPC	Project Physics Course
PS II	Physical Science II
PSSC	Physical Science Study Committee
SAPA	Science--A Process Approach: Commission on Science Education
SCIS	Science Curriculum Improvement Study
SMSG	School Mathematics Study Group

SRSS	Sociological Resources for the Social Studies
SSEC	Social Science Education Consortium
SSMCIS	Unified Modern Mathematics: Secondary School Mathematics Curriculum Improvement Study
TMMW	The Man-Made World: Engineering Concepts Curriculum Project (ECCP)
TSM	Time, Space and Matter: Secondary School Science Project (SSSP)
UICSM	University of Illinois Committee on School Mathematics
USMES	Unified Science and Mathematics for Elementary Schools

VITA

Barbel Ilse Brooks (nee Barrakling) was born in Bremen, West Germany, on August 11, 1946. She attended elementary school and the Gymnasium in Bremen and Sankt Peter. After successfully completing a three-year training program as a travel agent, the writer worked as a travel agent in Bremen until July 1967. She then accepted a position as airline representative with Lufthansa German Airlines in Cape Town, South Africa. While working in Cape Town she was married to Albert D. Brooks, a native of North Carolina. The author was employed by Lufthansa until January 1969.

She then placed her emphasis on raising her two daughters, Anja and Jeni. In March 1977, the writer moved to Tennessee. She attended Roane State Community College in Harriman, Tennessee from 1979 to 1981 and received the degree of Associate of Science with High Honors. After transferring to The University of Tennessee in Knoxville in 1981, the writer was graduated with Highest Honors, receiving a Bachelor of Science degree in Science Education in March 1983. Ms. Brooks received the Master of Science degree in Science Education in August 1983.