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ABSTRACT

"Concepts in Science" is the title given to a group of 17 related miniseries produced for senior science students. This report presents the results of the summative evaluation of this series. The series explored important concepts in three areas of study: biology; physics; and chemistry. Each series consists of six 10-minute animated programs. The evaluation was based on three different sources of information, including a survey of teacher opinion, case studies of classroom use, and a survey of student opinion. The first chapter of this report provides background information on the series; the second chapter presents the results of a survey conducted among members of the Science Teachers' Association of Ontario. The third chapter reports case studies and examines the impact of the programs on students. The final chapter summarizes the main conclusions of the evaluation and discusses the implications for future science programming. Appendices include: (1) series titles; (2) videotape sales; (3) respondent characteristics; (4) objectionable elements; and (5) comments. (YP)

A SUMMATIVE EVALUATION

OF

CONCEPTS IN SCIENCE

BY

LYNETTE GILLIS, PH.D.

RESEARCH CONSULTANT

MAY 1989

REPORT NO. 2 — 1989-90

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Office of Project Research
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Abstract No. 2 — 1989-90

A SUMMATIVE EVALUATION OF *CONCEPTS IN SCIENCE*

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(TVOntario, Evaluation and Project Research Report No. 2 — 1989-90, 39 pp.)

This report presents the results of a summative evaluation of the series *Concepts in Science*, conducted by the TVOntario Office of Evaluation and Project Research. The purpose of the study was to examine the impact of *Concepts in Science* on the teaching and learning of senior science in Ontario schools. A second purpose was to expand our general knowledge of what constitutes useful science programming for education.

Concepts in Science is the title given to a group of 17 miniseries produced for senior science students. The series explore important concepts in three areas of study: biology, physics, and chemistry. Each series consists of six 10-minute animated programs. Since the release of the first series in 1983, the videotapes have sold well in Ontario. In all other market territories — Canada, the United States, and international — *Concepts in Science* is one of the bestselling series, exceeded only by *Nature Watch*.

For this evaluation of *Concepts in Science*, information was acquired from three different sources, including:

1. A survey of teacher opinion: Questionnaires were mailed to a random sample of 1,000 secondary teachers who were members of the Science Teachers' Association of Ontario (STAO). A total of 402 completed questionnaires were returned — an adequate sample of the population of secondary science teachers in Ontario.

2. Case studies of classroom use: Case studies were undertaken with three teachers in different parts of the province who use the series regularly in their teaching.

3. A survey of student opinion: A total of 118 students in grades 11 through 13 in three different schools completed questionnaires describing their perceptions of the series.

The major conclusions and recommendations were as follows:

IMPACT ON SCIENCE EDUCATION

1. Fulfilling a teaching need: The results gave strong indications that *Concepts in Science* fulfills a need in the senior science curriculum for good audiovisual resources. Three-quarters of the teachers who were aware of the programs used them in their teaching. They recommend that more be produced.

2. Reaching a broad audience: The programs are used by teachers in all the major science disciplines, both at the general and advanced levels, and in all grades 9 through 13. The programs appeared best suited, however, for senior students or students in advanced classes.

3. Teacher approval: The teachers in the study were generally satisfied with all major aspects of the series — their content, their structure, and the style of production. Although some suggested possible areas for improvement, the general reaction was overwhelmingly favorable.

4. Pedagogical effectiveness: Both teachers and students reported that the series play an important role in science education. Teachers use the series to contribute something to the teaching of science that they themselves cannot provide — succinct explanations, good reviews, humor, or complex visual models.

   Students claim the programs improve their general understanding of difficult concepts and sustain their attention with the humor and animation.

RECOMMENDATIONS FOR FUTURE PRODUCTIONS

1. Animation: Most teachers seemed satisfied with the way in which animation was used in the programs — though a few suggested that the graphics be complemented with live footage. It may be worthwhile in future science programming to consider using both techniques for instruction.

2. Cartooning: Although teachers generally approved of the graphics, a small contingent viewed the cartoon aspect of the programs as too juvenile, particularly for older students. In contrast, however, the students who were surveyed liked the cartoon characters and the humor, and claimed that they held their attention.

3. Review segments: A small number of teachers throughout the study commented that they disliked the review segment at the beginning of each program. This is mostly a problem when teachers show several programs during a single class period: the reviews are perceived as unnecessary and even tedious. Since teachers frequently show several programs at once, the necessity of review segments should be carefully considered in future productions of this length.

4. The ten-minute format: The results of this study also tended to support previous research indicating that ten-minute programs are easy for teachers to use and adapt to their own instruction. From the success of these programs, it is recommended that this short format be considered for future productions.

5. Teacher guides: The problem of ensuring that the guides reach the teachers — or even that they know about the guides — is by no means new. This finding has emerged from previous studies as well. One possible way of making more teachers aware of the guides might be to advertise the availability of the guides on the videos themselves after the program credits.

6. Scheduling: Teachers frequently complained that when changes were made in the broadcast schedules, they were not informed of the alternative dates when the programs would be shown. They strongly recommended that these scheduling problems be resolved to facilitate their off-air taping.

TVOntario

Office of Project Research
Service de recherche et d'évaluation

Abrégé no 2–1989-90

A SUMMATIVE EVALUATION OF *CONCEPTS IN SCIENCE*

par Lynette Gillis, Ph.D.
Consultante en recherche

(TVOntario, Rapport de recherche et d'évaluation no 2–1989-90, 39 p.)

Le présent rapport expose les résultats d'une évaluation sommative de la série *Concepts in Science*, effectuée par le Service de recherche et d'évaluation de TVOntario. L'object de l'étude était premièrement d'examiner l'influence de *Concepts in Science* sur l'enseignement et l'apprentissage des sciences au cycle supérieur dans les écoles secondaires de l'Ontario et en deuxième lieu, d'élargir nos connaissances générales sur la réalisation d'émissions scientifiques pour les écoles.

Concepts in Science est le titre d'un ensemble de 17 mini-séries destinées aux élèves du cycle supérieur. Ces séries explorent les notions importantes de trois domaines d'études : la biologie, la physique et la chimie. Chaque série comporte six émissions d'animation d'une durée de 10 minutes. Depuis le lancement de la première série en 1983, les vidéocassettes se sont très bien vendues en Ontario. Dans tous les autres marchés – au Canada, aux États-Unis et outre-mer – *Concepts in Science* est la série la plus populaire, après *Nature Watch*.

Pour évaluer *Concepts in Science*, nous avons recueilli des renseignements des trois sources suivantes :

1) Sondage auprès des enseignants : Des questionnaires ont été expédiés au hasard à un échantillon de 1000 enseignants du secondaire appartenant à la *Science Teachers' Association of Ontario (STAO)*. Au total, 402 répondants ont rempli le questionnaire, ce qui représente un échantillon adéquat des professeurs de sciences du palier secondaire en Ontario.

2) Études de cas sur l'utilisation en salle de classe : Des études de cas ont été entreprises dans diverses parties de la province conjointement avec trois enseignants qui utilisent régulièrement les séries dans leur salle de classe.

3) Sondage auprès des élèves : Au total, 118 élèves de la 11e à la 13e année de trois écoles différentes ont rempli les questionnaires, décrivant leurs impressions sur les séries.

Principalement, il en est ressorti les conclusions et les recommandations suivantes :

CONSÉQUENCES SUR L'ENSEIGNEMENT DES SCIENCES

1) Réponse à un besoin pédagogique : Les résultats indiquent assez clairement que *Concepts in Science* répond à un besoin de matériel audiovisuel de qualité dans le programme de sciences du cycle supérieur du palier secondaire. Les trois quarts des enseignants qui connaissaient les émissions les utilisent dans leur salle de classe. Ceux-ci recommandent de réaliser davantage d'émissions de ce genre.

2) Accès auprès d'un vaste auditoire : Les émissions sont utilisées par les enseignants dans toutes les principales disciplines scientifiques, tant dans les cours de niveau général que de niveau avancé, ainsi que de la 9e à la 13e année. Les programmes semblent cependant mieux adaptés aux étudiants du cycle supérieur et à ceux des cours de niveau avancé.

3) Approbation des enseignants : Les enseignants étaient généralement satisfaits des principaux aspects des séries – contenu, structure et style de réalisation. Bien que quelques-uns d'entre eux aient indiqué certains points pouvant être améliorés, la réaction a été, dans l'ensemble, extrêmement favorable.

4) Efficacité pédagogique : Tant les professeurs que les étudiants ont affirmé que les émissions jouent un rôle important dans l'enseignement des sciences. Les enseignants utilisent les émissions pour compléter leur enseignement : explications succinctes, bonnes révisions, humour ou modèles visuels complexes.

Les étudiants soutiennent que les émissions les aident à comprendre les notions difficiles et qu'elles retiennent leur attention grâce à l'humour et à l'animation.

RECOMMANDATIONS POUR LES PROCHAINES RÉALISATIONS

1) Films d'animation : La plupart des enseignants semblaient satisfaits de la façon dont l'animation était utilisée dans les émissions – cependant, quelques-uns ont suggéré que les graphiques soient accompagnés de séquences cinématographiques. Il serait peut être pertinent d'utiliser les deux techniques au cours des prochaines émissions scientifiques.

2) Dessins animés : Bien que les enseignants approuvaient généralement l'utilisation de graphiques, un petit groupe considérait le côté animation des émissions un peu trop juvénile, surtout pour les étudiants plus âgés. En contrepartie, les étudiants que nous avons interrogés aimaient les dessins animés et l'humour, affirmant que cela retenait leur attention.

3) Section révision : Un petit nombre d'enseignants au cours de l'étude ont fait remarquer qu'ils n'aimaient pas la section révision au début de chaque émission. Cette section présente un problème surtout lorsque les enseignants présentent plusieurs émissions pendant le même cours; les révisions sont jugées inutiles et même ennuyantes. Étant donné que les enseignants montrent souvent plusieurs émissions à la fois, il faudrait évaluer soigneusement la nécessité d'avoir une section révision dans les prochaines émissions de cette durée.

4) Émissions de dix minutes : Les résultats de l'étude semblent confirmer une recherche précédente qui indiquait qu'il était très facile pour les enseignants d'utiliser les émissions de dix minutes et de les adapter à leur propre enseignement. Étant donné le succès de telles émissions, on recommande que ce format de courte durée soit pris en considération pour les prochaines réalisations.

5) Guide du maître : S'assurer que les guides du maître parviennent aux enseignants – ou même que ces derniers soient au courant de leur existence – est un problème qui ne date pas d'hier, comme on a pu le constater dans des études antérieures. Une façon possible de mettre plus d'enseignants au courant de l'existence des guides du maître serait de les annoncer dans les vidéocassettes après le générique de l'émission.

6) Horaire : Les enseignants se plaignent souvent, lorsqu'il y a des changements à l'horaire, de ne pas être mis au courant des nouvelles dates de diffusion. Ils recommandent fortement de résoudre ces problèmes d'horaire afin de faciliter l'enregistrement des émissions à l'antenne.

Le rapport est disponible en anglais seulement.

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INTRODUCTION

This report presents the results of a summative evaluation of the series *Concepts in Science*, produced by the TVOntario department of Youth Programming. The evaluation was conducted by the Evaluation and Project Research Office of TVOntario, beginning in December 1988.

Concepts in Science is the title given to a group of 17 miniseries produced for senior science students. The series explore important concepts in three areas of study: biology, physics, and chemistry. Each series consists of six 10-minute animated programs. The first of these series was released in 1983, and the last of the series was released in spring 1989. (A complete list of the series titles appears in Appendix A.)

A summative evaluation is a study that is undertaken to assess the educational impact of a series after it has been in use for several years. This summative study examines the impact of the *Concepts* series on the teaching and learning of science in Ontario schools. Now that the programs have been available to teachers for more than five years, there is an opportunity to assess the instructional effectiveness of these programs, and in so doing, expand our general knowledge of what constitutes useful science programming for education.

This evaluation is based on three different sources of information, including: (1) a survey of teacher opinion, (2) case studies of classroom use, and (3) a survey of student opinion.

The first chapter of this report provides background information on the series; the second chapter presents the results of a survey conducted among members of the Science Teachers' Association of Ontario. The third chapter reports case studies and examines the impact of the programs on students. The final chapter summarizes the main conclusions of the evaluation and discusses the implications for future science programming.

CHAPTER ONE

THE *CONCEPTS IN SCIENCE* SERIES

1.0 Background

Concepts in Science was a major initiative in the Youth branch of TVOntario, representing 17 hours of senior science programming. As already noted, each of the 17 series consists of six 10-minute programs. Each program explores a discrete topic or concept selected from the core curriculum for senior science.

The programs are designed to capitalize on the ability of television to provide visual representations of complex ideas and models. They are entirely animated. The animation, however, is used to illustrate concepts as well as to introduce humor through the occasional use of cartoon characters and flourishes. The programs are intended to be entertaining as well as instructional.

The 10-minute format was used because previous formative evaluation had indicated that this length of program would be easier for teachers to integrate with their own instruction. The programs were intended to be used individually: that is, one program per class period.

1.1 Production and Sales

Each series of six programs was produced at an average cost of $115,000. A total of approximately 2.2 million dollars was spent on the production of all 17 English series. Since the release of the first series in 1983, the videotapes have sold well in Ontario, across Canada, and in the United States.

In Ontario, there have been approximately 775 orders for English versions of the various series and 106 orders for French versions. The sales for series in chemistry and physics have been greater than the sales of series in biology — though the difference is slight. As we would expect, those series that have been on the market longest have had the highest records of sales. Most sales have been to school boards or to individual schools; colleges and universities make up a small percentage of buyers.

Appendix B provides tables showing sales of individual series and sales by regions of the province. These figures for videotape sales in Ontario, however, do not provide an accurate assessment of the popularity or use of the series in the province. Since many schools copy the programs off air or acquire copies from their board media centres, the actual number of schools or teachers using the programs in Ontario is considerably higher than the number of actual "orders" might suggest. Representatives of the videotape service at TVOntario describe the videotape sales in Ontario as "good and continuing to grow."

In all other market territories — Canada, the United States, and international — *Concepts in Science* is one of the best-selling series, exceeded only by *Nature Watch,* a series aimed at the general public. In the last fiscal year, sales for *Concepts* totalled $542,400 (Canadian), representing 44 percent of all sales in the Youth market. The marketing department of TVOntario describes this record of sales as "excellent," and in the near future, it plans to expand its promotion of the series internationally.

CHAPTER TWO

A SURVEY OF SCIENCE TEACHERS

2.0 Introduction

The principal source of information for this evaluation was a survey conducted with the members of the Science Teachers' Association of Ontario (STAO) in February 1989. The survey was conducted to:

1. investigate teachers' awareness and use of the programs
2. assess teachers' satisfaction with the content and production style of the programs
3. evaluate the contribution of this series to senior science education in Ontario

2.1 The Respondents

Questionnaires were mailed, with self-addressed return envelopes, to 1,000 secondary science teachers who were selected at random from the STAO membership. There is a total of 1,369 secondary-level science teachers in STAO; representing 58 percent of the total membership. According to STAO, approximately one of every four secondary science teachers in the province is a member of the organization. (In 1988, there were 5,278 secondary teachers in the province teaching one or more science courses.)

In this study, 402 teachers completed and returned their questionnaires. With a sample of this size, we can generalize the results of this study with a fair degree of confidence to the larger population of secondary science teachers in Ontario. We could predict that 95 out of 100 times, the exact figures will be within approximately five percentage points (greater or less) than the statistics quoted.

The majority of those who responded to the survey were teachers; a small percent (11 percent) identified themselves as heads of science departments. The group was fairly balanced in the number of teachers in biology, chemistry, and physics. Over half the sample, however, taught at least one general science course.

The sample included teachers from grades 9 through 13. Teachers of grade 13 (OAC) courses composed the largest single group (62 percent); whereas teachers of grade 12 courses composed the smallest group (38 percent). There were more teachers with courses at the "advanced" level than at the "general" level; relatively few teachers in the sample taught courses at the "basic" level.

It should be noted that although the Ontario curriculum includes basic-level courses in general science for grades 9 through 12, it is believed that, in actuality, there are few basic-level classes offered beyond the grade 10 level.

The sample also included educators from all regions of the province. The largest proportion of respondents (39 percent), however, were from the central region. (See Appendix C for tables of all demographic data.)

2.2 Awareness and Use

Awareness

Of the total sample, 345 teachers or 86 percent were aware of *Concepts in Science*; the remainder had never heard of the series or were unsure.

Use

Of the 345 teachers who were aware of the series, 76 percent claimed to use the programs in their teaching. (This number represents 68 percent of the total sample of respondents.)

When asked where they acquired the programs, approximately half the teachers reported that the programs were taped off air, either at the school or at the board media centre. The remainder claimed that they obtained the programs from their media centre, but did not know how the centre had acquired them.

The teachers who used the programs were asked to indicate which series they used. As we would expect, the series that have been used most widely tend to be those that have been on the market for the longest period of time.

Table 1 reports the proportion of the teachers who reported use of each of various series. Of all series, *The Mole Concept, Electron Arrangement and Bonding*, and *The Structure of the Atom* appear to be the most widely used.

Table 1. Proportion of respondents using each series

Series title	Proportion of respondents
Biology	
Homeostasis	26 %
Photosynthesis	25 %
Protein Synthesis	25 %
Energy Flow	24 %
Organic Evolution	17 %
Respiration	17 %
Chemistry	
The Mole Concept	39 %
Electron Arrangement and Bonding	38 %
Chemical Equilibrium	30 %
Electrochemistry	20 %
Organic Chemistry 1	14 %
Organic Chemistry 2	9 %
Physics	
Structure of the Atom	41 %
Wave-Particle Duality	24 %
Electricity	20 %
Nuclear Physics	19 %
Electromagnetism	17 %

Teachers claimed to show an average of two to three programs in a single class period.

Fifty-eight percent of users claimed they did not use the teacher guides, and many indicated by their comments that they were not even aware of the guides. Those who did use the guides claimed that they were useful.

Forty-two percent of users said they also used the guides that accompany the series and found the guides worthwhile.

Future use

Those who had used *Concepts in Science* were asked if they intended to use the series again in their future teaching. In response to this question, 73 percent of this group said they would "definitely" use them again in the future; an additional 22 percent said they would "probably" use them.

Nonusers

Of the 345 teachers who were aware of the series, 24 percent claimed that they had never used any of the programs.

When asked why they had not used the programs, they cited a variety of reasons. As seen in Table 2 below, the largest proportion of nonusers (38 percent) claimed they "didn't know enough about the programs." The second most common reason was "difficulty accessing equipment" (24 percent). It is important to note that a relatively small proportion of teachers found the programs unsuited to either their courses or their students.

Table 2. Reasons cited for not using the series

Reason	Proportion of respondents	
I don't know enough about the programs.	38 %	
I have difficulty accessing equipment.	24 %	
The programs are not available to me.	17 %	
I don't use television in my teaching.	15 %	
I haven't had the time.	14 %	
The programs are not appropriate to my course.	10 %	
The programs are not suitable for my students.	7 %	
I have difficulty getting programs taped.	7 %	
I plan to use them in the near future.	7 %	
I am not teaching science this year.	7 %	
I find other programs more suitable.	6 %	N=72

Note: Teachers often cited more than one reason.

2.3 Pedagogical Value

Importance of teaching

All teachers who used the series (N=278) were asked to indicate how important the programs were to their science instruction. Their response to this question appears in Table 3. Approximately three-quarters of the users reported that programs were "very important" or "important" to their science instruction.

Table 3. Importance to science instruction

Scale	Percent of respondents	
very important	13 %	
important	65 %	
of little importance	17 %	
of no importance	2 %	
unsure	3 %	
	100 %	N=278

Effectiveness with students

Another question on the survey asked teachers how effective or ineffective the programs were in helping their students to understand science concepts. As seen in Table 4, the vast majority of these teachers (93 percent) perceived the programs as "very effective" or "effective" with their students.

Table 4. Effectiveness with students

Scale	Percent of respondents	
very effective	25 %	
effective	68 %	
ineffective	3 %	
very ineffective	—	
unsure	4 %	
	100 %	N=278

Usefulness of individual series

To assess the usefulness of each of the series, teachers rated them on a four-point-scale. A rating of 1 meant that the series was "of no use," and a rating of 4 meant that the series was "very useful."

The mean ratings assigned to each of the series appear in Table 5. For example, the biology series *Protein Synthesis* received a mean rating of 3.56 on the four-point scale, indicating that respondents perceived the series as very useful.

Overall, respondents perceived all the series as useful. As seen in the table, there is notably little variation between series in their mean ratings. The series perceived as most useful in each subject area were: *Protein Synthesis* (Biology), *Chemical Equilibrium* (Chemistry), and *Nuclear Physics* (Physics).

Table 5. Usefulness of individual series

Series title	Mean rating on four-point scale*	
Biology		
Protein Synthesis	3.56	N=84
Photosynthesis	3.53	N=80
Respiration	3.41	N=56
Homeostasis	3.37	N=86
Organic Evolution	3.26	N=54
Energy Flow	3.15	N=78
Chemistry		
Chemical Equilibrium	3.43	N=99
Electrochemistry	3.36	N=69
Organic Chemistry 2	3.36	N=28
Electron Arrangement and Bonding	3.35	N=127
Organic Chemistry 1	3.31	N=45
The Mole Concept	3.09	N=127
Physics		
Nuclear Physics	3.45	N=62
Structure of the Atom	3.42	N=133
Electricity	3.42	N=65
Wave-Particle Duality	3.39	N=75
Electromagnetism	3.30	N=56

Note: A rating of 1 meant the series was "of no use," and a rating of 4 meant the series was "very useful."

Comparisons with other series

The teachers were also questioned on how *Concepts in Science* compares with other television series or programs for senior science instruction. Their response to this question appears in Table 6. As seen in this table, about three-quarters of the respondents indicated that *Concepts in Science* is "a lot better" or "better" than other instructional science programs.

Table 6. Comparison of *Concepts in Science* with other science series

Scale	Percent of respondents	
a lot better	24 %	
better	51 %	
about the same	20 %	
not as good	4 %	
much worse	1 %	N=240

The five percent of teachers who indicated that the series were "not as good" or "much worse" were asked to list other science series they preferred. The most frequently mentioned programs included: *Nova, Eureka!, The Nature of Things,* the *Chemistry Study* films, *Introduction to Biology, Vista, The Mechanical Universe,* and *National Geographic.*

2.4 Content

The survey included several questions concerning the content of the series. The vast majority of the teachers (93 percent) claimed they were either "very satisfied" or "satisfied" with content.

Table 7. Satisfaction with the content

Scale	Percent of respondents	
very satisfied	48 %	
satisfied	45 %	
neutral	5 %	
dissatisfied	1 %	
very dissatisfied	1 %	N=248

Another question concerned the difficulty level of the programs. Teachers were asked if the programs were "too elementary" or "difficult" for any of their courses. In general, the response to this question suggested that most teachers were satisfied with the programs' level of sophistication.

Teachers said that, of necessity, some series were more difficult than others, and that the programs in each series varied as well. However, they perceived the variation in difficulty as a function of the subject matter — not a result of the presentation. Most claimed to match the difficulty level of the program topics to the grade and level of their students. Also, depending upon the particular group of students, they used some programs for introduction and others only for review.

A small proportion of the sample (less than 15 percent) perceived the series as too elementary for OAC students. About one-third of the sample claimed that the programs were too difficult for general students or students in grades 9 and 10.

2.5 Production

Style and structure

As a final part of the survey, teachers were asked several questions concerning the production quality of the programs.

Overall, the vast majority of teachers indicated that they were "very satisfied" or "satisfied" with the style and structure of the series (see Table 8 below).

Table 8. Satisfaction with the style and structure of the production.

Scale	Percent of respondents	
very satisfied	38 %	
satisfied	48 %	
neutral	6 %	
dissatisfied	7 %	
very dissatisfied	1 %	N=280

Animation

The teachers were asked how effective or ineffective they thought the animation was in helping their students to understand the concepts being taught.

Their response to the question appears in Table 9. Ninety-three percent of the teachers perceived the animation as "effective" or "very effective."

Table 9. Effectiveness of animation

Scale	Percent of respondents	
very effective	46 %	
effective	47 %	
ineffective	4 %	
very ineffective	— %	
not sure	3 %	N=279

Objectionable content

When questioned about objectionable content in the programs, 93 percent of the teachers indicated that they had not perceived anything objectionable. The comments of those who perceived offensive or objectionable elements in the programs are reported in Table 17, Appendix D.

2.6 Final Comments

The last question on the survey asked teachers if there were any other final comments they wished to make. Approximately half of those who had used the programs (140 teachers) offered comments. Roughly two-thirds of the comments were favorable and concerned either the effectiveness of the series or the need for more. The remaining one-third of the comments offered suggestions for improving either the programs or the broadcast services to the schools.

The need for more programs

One of the most frequent comments offered by respondents was that they would like to see more programs produced. They expressed the strongest need for programs in two areas:

1. for grade 9 and 10 science courses
2. for the courses and topics that have been recently added to the curriculum under the new science guidelines

In addition to the current subjects, they suggested that programs be produced for earth science, astronomy, society and industry, and the environment. Table 18 in Appendix E provides a list of representative comments.

The effectiveness of the series

The other favorable comments offered by teachers concerned the overall effectiveness of the programs, or expressed their appreciation of TVOntario's efforts. Several of these teachers described the importance of the programs to their science instruction:

> "This has been an enormous help in teaching concepts not easily visualized or not done experimentally. I can't imagine teaching wave-particle duality without the video series."
>
> "Even while I have taught grade 13 biology for 21 years, I've found that I have appreciated the odd 'new twist' or nuance which I have picked up from various TVO programs."

Teachers also commented on how well the series corresponded to the science curriculum, or they complimented various aspects of the production — such as the animation, the length, and commentary.

> "The quality is good, but the unique feature that makes them so useful is their suitability for *our* curriculum. Programs made in the U.S. or U.K. must be adapted while yours already fit right in."

> "The use of computer-enhanced animation really captures the interest of the students. Quantum theory was actually enjoyed by my OAC chemistry class."

(For a more complete list of representative comments, the interested reader is referred to Table 19 of Appendix E).

Areas for improvement

As mentioned, about one-third of the final comments suggested areas for improvement. These comments centred largely on four issues.

The first issue concerned not the programs themselves, but the difficulties associated with using or acquiring them. For example, some commented that they lived in parts of the province where they could not receive the broadcast and urged TVOntario to extend its service. Others expressed confusion regarding the copyright laws on video programs, and as a result, declined to use the videos. Several were disturbed that broadcast times seemed to be changed without notice of alternative dates. As one remarked:

> "Many new programs are *not* run when advertised. We are *never* told an alternate date. Sometimes the series is not run on time, and if taped, one only gets put off the series. Also, recently in *Electricity* series showed some programs twice and others not at all. This whole area *needs* improving *a lot.*"

A second issue of concern to several respondents was the absence of "real events" in the programs — such as video clips of organs, organisms, scientific phenomena, or actual experiments. These respondents commented that, although the animation was useful for explaining various abstract or hard-to-visualize concepts, they would prefer "an approach blending the animation with the real-world situation."

Respondents also questioned the need for the review at the beginning of the programs or perceived the programs as "too repetitive." This review or repetition of content was seen to be more of a problem when teachers showed several programs in a single class period:

> "The programs in a series tend to be a little too repetitive in the beginning. I don't need this repetition since I usually show two or three in the series at one time."

Some of the respondents claimed that the repetition slowed the pace of the programs:

> "The programs are very slow-paced and draggy. The repetition of fact — although sometimes a good strategy for learning — often bores the viewer, making the programs less effective than they would be if they were more to the point and presented at a quicker pace."

Although the respondents praised most of the *Concepts* series, several claimed that they disliked *The Mole Concept*.

They remarked that it was "more confusing than useful" and that it "didn't get its point across very well."

The few remaining comments recommended changes in a variety of different areas. (For a more complete list of representative comments, the interested reader is referred to Table 20 of Appendix E.)

2.7 Summary

This chapter reported the results of a mail survey conducted among the members of the Science Teachers' Association of Ontario. The 402 teachers who responded to the survey included teachers from all regions of the province and from each of the major science disciplines in grades 9 through 13. The major findings were as follows:

Use

The first important finding of the survey is that approximately three-quarters of the teachers who are aware of *Concepts in Science* use the programs. This is a very encouraging finding. It clearly suggests that the series fulfill a need for audiovisual resources in secondary science education.

Furthermore, the teachers who have not used the programs cite reasons that have little to do with the programs themselves. On the contrary, nonusers claim they haven't used the programs because they don't know enough about them or they have difficulty accessing equipment. Very few teachers found the programs unsatisfactory or inappropriate to their courses or students.

It is also encouraging to find that teachers' use of *Concepts in Science* is not confined to just a few series. Many of the teachers reported that they had used at least five different series in their teaching — a few even claimed to have used programs from all of the series.

There was also indication that teachers' use of the series will continue, if not grow, over the next few years. Teachers expressed a strong commitment to using the programs in their future teaching.

The findings of this survey were also instructive as revealing more about how teachers obtain the series and use them with their classes. Two findings are of particular interest. First of all, as many have suspected, a large proportion of users obtain the programs from off-air taping. At least 50 percent of the teachers in this sample acquired the programs in this way. Second, when using the programs, teachers show as many as two or three programs in one class period.

Also, as found in previous studies, there is still a problem with teacher guides' not reaching the teachers. A fairly large proportion of teachers in this survey (58 percent) claimed that they did not use the guides that accompany the series — many claimed they were not even aware of the guides.

Content

A major strength of this series is that it seems to have succeeded in reaching a fairly wide audience of learners. Teachers perceive the programs as suitable for numerous courses and several different grades and levels of study. There was consensus that the programs are probably best suited to students in grades 11 through 13 (the primary target group for the series) and advanced-level students.

In spite of major changes in the science curriculum over the past few years, the series also seem to have succeeded in maintaining their relevance to current science instruction.

Teachers frequently suggested that more programs be produced, particularly for grade 9/10 or general-level audiences. They also recommended that programs be produced for the new courses and topics that have recently been added to the curriculum guidelines.

Pedagogical value

The findings of this survey give strong indication that programs are pedagogically effective and useful to the senior science curriculum. According to the teachers, *Concepts in Science* plays an important part in their science instruction. They perceive the programs as effective in helping their students to understand difficult scientific concepts.

Compared with other science series, they describe *Concepts in Science* as better or a lot better. The only other programs they make significant use of tend to be broadcast series such as *Nova, National Geographic,* or *The Nature of Things* — none of which are curriculum-based or specifically intended for in-school audiences.

Production quality

The findings on the style and structure of the production were similarly favorable — the vast majority of teachers said they were satisfied with the quality of the programs. Teachers also endorsed the use of animation in the programs; 93 percent perceived the animation as effective in helping their students to understand the concepts. There were some teachers (roughly 8-10 percent), however, who maintained that the animation should be complemented with video footage of actual experiments, real organisms, or real events.

One issue that may necessitate discussion, however, is the use of review and repetition in 10-minute programs. When teachers use two or three programs in one class period — as many seem to do — the review is seen by some as unnecessary or even counterproductive.

In their final comments, teachers expressed their appreciation of the series, recommended that more programs be produced, and urged TVOntario to "keep up the good work."

CHAPTER 3

CASE STUDIES OF CLASSROOM USE

3.0 Introduction

This chapter presents three case studies of teachers who use *Concepts in Science* as an integral part of their science instruction. These studies were conducted to supplement the statistical findings of the teacher survey with information of a more qualitative nature. They describe how teachers acquire and use the programs and how the programs are perceived by their students.

To conduct the case studies, the evaluator contacted science coordinators in three different regions of the province. The coordinators were asked to identify science teachers in their boards who were currently using the series. On their recommendation, the evaluator recruited one teacher in each board who planned to use the programs in the time frame of the study and who would also be willing to participate in the research. An effort was made to select one teacher from each of the three science disciplines: biology, chemistry, and physics. To conduct the case studies, the evaluator visited the three sites, interviewed the teachers, observed their classes, and surveyed the students.

3.1 Case 1: A Northern School

The first case study was conducted with a senior chemistry teacher in a northern Ontario community. The teacher had used series from *Concepts in Science* with his grade 11-12 chemistry classes for the past year.

At this particular school, teaching resources were scarce. There were no textbooks for the senior chemistry courses. According to the chemistry teacher, the old texts were outdated, and they would not be able to purchase new texts for another year or two. He claimed that he and colleagues had "to scramble" for resources, and they were very pleased to have discovered *Concepts in Science*.

The school also lacked adequate audiovisual equipment. Until this year, the school had only one videotape player, and unfortunately, science teachers had little access to it. To obtain a player for their department's use, the science teachers raised funds to purchase their own. Once they obtained a videotape player, however, they had further problems finding appropriate programming. The audiovisual catalogue, prepared by their board, provided an alphabetical listing of videotapes and films, but did not classify the resources by division, grade level, source, or subject. Finding programming was a long and arduous task. They were not aware of the TVOntario catalogues.

When the teachers finally discovered *Concepts in Science*, they were pleased to find that many of the programs were suited to their courses. The chemistry teacher reviewed many of the programs himself. He found some of the programs more advanced in content than recommended by the new Ministry of Education guidelines, but still useful.

According to this teacher, *Concepts in Science* and the TVOntario series *Eureka!* are the best available series for science instruction. Although he sometimes shows programs from *The Nature of Things* and *National Geographic* for general interest, he describes *Concepts* as his "bread and butter" programs. He finds them especially useful for chemistry, where he claims good programming is scarce. He uses the *Concepts* series to enhance his students' understanding of complex concepts and to make "very dry" topics more interesting.

He uses the programs to introduce or summarize topics, sometimes showing them twice to a single class. Typically, he shows one or two programs during a class period and occasionally three. He stops between programs to elaborate and discuss critical points.

This teacher was not aware of the guides that accompany the series. After hearing about them, however, he said that he would like to obtain them — particularly for more detailed descriptions of the programs.

Although he was very satisfied with the range of program topics, he said that he would like to see more series produced, particularly on "solutions," "kinetic electrical theory," and "ph." He would also like a more extensive program on the periodic table, more in-depth information on enzymes, and more programs on the social implications of various concepts for industry and society.

He was also satisfied with the production style and the structure of the programs. He especially likes the 10-minute format. He claims that short modular programs like *Concepts* and *Eureka!* are easier for teachers to use and integrate with their own instruction. His only concern about the production style was that sometimes his students perceive the humor as "infantile."

This teacher sees the animation in the programs as "absolutely essential" — "the real value of the programs." He claimed that he could not conceive of the concepts' being taught as effectively without it.

On the day the evaluator visited the school, the teacher showed two programs from the *Structure of the Atom* series. He said that the programs provided a better explanation of the concepts than he could himself.

On the day before the visit, his students viewed the first program in the series that discussed the history of atomic structure. He claimed that it would have taken him many hours of work to "dig up all this historical information" and even then, "the presentation would not have been as interesting."

When using the programs, the teacher integrated his own instruction with the ideas presented in the videos. He summarized and elaborated the content of the programs and often made reference to the examples used in them. During this particular class period, he used the programs to demonstrate an apparatus called a spectroscope. The spectroscope demonstration is recommended by the curriculum guidelines for the advanced chemistry course. This apparatus, however, takes a long time to set up, and the high voltage required by the equipment presents a safety hazard for both teachers and students. When showing the apparatus, the teacher must darken the room completely and then conduct the demonstration with only one or two students at a time, leaving the rest of the class sitting in total darkness for most of the class period. Rather than conduct this very awkward and time-consuming "live" demonstration, the teacher prefers to use a program from the *Structure of the Atom* series that discusses the spectroscope. The video is more convenient, and he claims his students benefit as much from the program as from a live demonstration — and possibly more.

3.2 Case 2: A Metropolitan Toronto High School

The second case study was conducted with a senior biology teacher in a metropolitan Toronto high school. The teacher at this school had used *Protein Synthesis* and *Energy Flow* with his students for the past two years.

This teacher first learned about the series from the videotape catalogue produced by his board. At one point, he had also planned to use some of the chemistry series, but found the content better suited to chemistry students than biology students.

He prefers *Concepts in Science* to all other instructional biology series. He once previewed a series called *The Biochemical Basis of Life*, but found the programs too long for classroom use. Although he sometimes uses programs from *The Nature of Things* and *Nova*, like the teacher from the northern school, he sees these other programs as more peripheral to instruction.

Overall, this teacher is satisfied with the content of the programs, but he would like to see "more emphasis on up-to-date concepts" and "more discussion and elaboration of mechanisms for OAC students."

Most of the time, he uses the programs to review or summarize concepts that he has just taught. Like the other teacher, he especially likes the 10-minute format. He claims that these "short and concise" programs are not overwhelming for students and are easy to integrate with instruction. Although he sometimes shows his students two programs during a single class period, he believes that showing more than two would be "information overload."

Also like the northern Ontario teacher, this teacher was not aware that there are guides that accompany the series but would like to acquire them.

On the day that the evaluator visited the school, the teacher used the first two programs from the *Homeostasis* series with his grade 13 biology students. He used the first program as a review for an examination and the second program for enrichment. After showing each program, the teacher reiterated important points and answered questions. One of the students asked that a part of the program be shown again.

According to this biology teacher, the first time students see the programs, "it knocks them out of their complacency." They do not expect to see instructional programs that have humor and animation — they are "totally surprised."

> "The computer graphics are the biggest plus of the series. There are lots of other programs that cover the topics just as well, but the computer graphics are the plus that make this series more useful. After being bombarded with films and blackboards, it is a different approach; this is new, novel, and fast. The graphics are used very well, and they really help to explain things."

Aside from enhancing students' interest in the topics, the teacher perceives the programs as useful because they provide good visual models of complex concepts. His closing comments were that the programs were "great" — "don't get rid of them."

3.3 Case 3: A Western Ontario High School

The third case study was conducted with a senior chemistry and physics teacher in a western Ontario city. The evaluator visited the school to discuss *Concepts in Science* with the teacher and to survey his students. Because of scheduling changes, it was not possible to observe any classes on the day of the visit.

For the past five years, the teacher had used *Concepts in Science* in both his chemistry and his physics course. He used *Structure of the Atom* and *Electron Arrangement and Bonding* with his advanced, grade 11 chemistry students; *Chemical Equilibrium* and *Organic Chemistry 1* with his grade 13 chemistry students; and *Wave-Particle Duality* with his grade 13 physics students. There were also several other series that he planned to use in the future.

He first learned about *Concepts in Science* from a TVOntario catalogue circulated to his department. At his request, the school's audiovisual technician videotaped the programs from the television broadcast. He claimed that off-air taping was far more convenient for teachers than borrowing programs from the board's audiovisual centre. Borrowing programs requires more advance planning, and often the programs are unavailable. In his own department, priority is given to the purchase of laboratory equipment, not audiovisual resources.

In addition to *Concepts in Science*, the teacher sometimes uses *Not Another Science Show*, *Cosmos*, and *The Nature of Things*, but only for special interest. He uses the *Concepts* series because the programs provide a good explanation of theoretical concepts, and he finds the humor sustains his students' attention.

When using a *Concepts* program for the first time, he uses the program to review material that he has just taught. After he becomes familiar with the program's content, however, he then uses it as the basis of his presentation. In his discussions with students, he tries to use the same examples used in the programs. Most of the time, he uses only one or two programs in a single class period, taking one week to show an entire series.

Unlike the other teachers who were interviewed, this teacher became aware of the teacher guides through the TVOntario catalogue. Although he acquired the guides, he has not found it necessary to use them.

In general, the teacher claims that he has been very satisfied with the content of the programs. Although the science curriculum has changed in the last five years, he still finds the material presented in the programs applicable at one level or another. He now uses certain chemistry programs, for example, with his grade 11 students that he previously used with grade 12 students.

The only series that the teacher dislikes from *Concepts in Science* is *The Mole Concept*. He claims that the programs move too slowly and devote more time than necessary to examples of fairly simple concepts. Apart from this one series, he describes all the others as "excellent."

According to this teacher, the *Concepts in Science* programs have improved over the past five years -- an improvement that he attributes to the use of more sophisticated, three-dimensional graphics. In his opinion, good graphics are absolutely essential to explaining very theoretical concepts and well worth the expenditure. He finds many science concepts impossible to explain or demonstrate without access to three-dimensional animated models.

He was especially impressed with the animation in the recent *Organic Chemistry* series, which he describes as "very effective." He maintains that his students also notice the difference:

> "With their computer backgrounds, they can distinguish simple graphics from computer graphics, and they clearly prefer the latter."

In addition to providing good visual models, the programs are perceived as valuable for enhancing students' interest. He finds that his students attend to the programs and enjoy the humor. He also believes that after viewing the programs, his students achieve a better understanding of the concepts:

> "The students might not understand everything the first time they see a program, but with a little backup work, the ideas sink in. They remember the examples and models from the programs — and this helps them."

Overall, he describes the *Concepts* programs as "worthwhile" and "good for presentation and review." Recently, he introduced the series to teachers at a nearby school, and they immediately borrowed the entire set. He claims that he will continue to use the programs and looks forward to acquiring the new ones. Like the others, he hopes TVOntario continues its production of *Concepts in Science*.

3.4 Comments

The opinions expressed by these three teachers mirror, to a large extent, the opinions of the teachers who responded to the mail survey. The case studies are of particular interest, however, in that they highlight several important issues.

First, the case studies alert us to the fact that some teachers still have difficulty obtaining programs, acquiring catalogues and guides, and accessing equipment. After more than twenty years of educational television in classrooms, the logistics of using television may have improved, but teachers in some schools — like the teacher in northern Ontario — still encounter tremendous obstacles. In situations such as this, the most remarkable finding is that teachers use the programs at all. When interpreting statistics of program sales or use, it is important to note that there are still some teachers in Ontario who would like to use the programs but for a myriad of reasons are unable to do so.

The case studies also provide insight into why teachers use the programs in their teaching. In all three cases, teachers claimed to use the programs because they contributed something to the teaching of science that they themselves could not provide — succinct explanations, good reviews, visual models, or demonstrations of potentially hazardous equipment. Even humor is seen to be an essential contribution; two of the teachers used the programs to make their presentations more interesting and enjoyable to students.

The animation, notably the computer-generated graphics, was perceived by each of the teachers as one of the most important features of the programs. Again, they value the animation because it contributes something to instruction that they themselves cannot provide: good visual models that elucidate complex scientific concepts.

The final issue emerging from these studies concerns the 10-minute format of the programs. The teachers commented that they especially liked the program length. The reason for this preference is that short, modular lessons such as these permit teachers maximum flexibility when integrating the programs with their instruction. By using one, two, or three programs in a class period, they can move through the material at a pace that suits their teaching needs, stopping for discussion or elaboration as often as they wish. By selectively choosing programs, or modules of study, they can build a presentation that suits their particular course, goals, and group of students. Longer programs are not as adaptable and always run the risk of providing too much potentially irrelevant information.

3.5 The Impact on Students

At each of the three sites, the students were surveyed to assess their perceptions of *Concepts in Science*. A total of 118 students, in grades 11 through 13, completed questionnaires. The sample included approximately equal numbers of males and females.

The first question on the survey asked students how easy or difficult it was for them to understand the programs. They were asked to rate the programs on a seven-point scale, ranging from 1 (very difficult) to 7 (very easy). Students assigned the programs a mean rating of 5.05, indicating that they found the programs fairly easy to understand.

Students were also asked how useful the programs were in helping them to understand the concepts they were studying. On a seven-point scale, the programs received a mean rating of 5.25. This suggests that students perceive the programs as useful in helping them to understand science concepts.

When asked how interesting or boring they found the programs, students were neutral in their response. On a seven-point scale (ranging from "very boring" to "very interesting") the programs received a mean rating of 4.32.

Students were most enthusiastic about the animation used in the programs. They found the animation useful in helping them to understand the concepts. On the seven-point scale (ranging from "of no use" to "very useful"), the animation received a mean rating of 5.82.

Overall, there were no significant differences in ratings between males and females or among students at the three sites. There was a slight tendency, however, for students from the western Ontario school to respond more favorably.

When asked what they liked best about the programs, students most frequently mentioned the animation (47 percent), the humor (18 percent), and cartoon sequences (10 percent).

> "The animation and visual aids helped make the programs easier to understand and provided some comic relief while discussing some intense subjects."
>
> "I like how they illustrated the concepts in the programs, showing us what they were, instead of just talking about them."
>
> "The music and cartoons gave some life to the subject and made it interesting."

"The presentation was very interesting and helpful. It was a lot better than reading science history out of a book. Also, the humor was great."

"The animation really helped. The light manner of the program helped me concentrate."

"The sense of humor and comical presentation keep one's attention focused."

"Cartoons and animation help you to understand the concepts by making you laugh -- help you remember what was explained."

When asked what they disliked about the programs, more than half the group claimed that there wasn't anything that they especially disliked. A small proportion of the students (less than 8 percent) remarked that the programs were too fast-paced:

"It went too quickly. There was so much information packed into a short time period; it was hard to remember it all."

"They seemed to cram a lot of information into a little space. If you miss something, it takes awhile to catch up."

"It's too fast for note taking."

Six percent of students claimed they disliked the music. One student, for example, described the background music as "repetitious and boring."

In conclusion, the results of this survey of senior science students suggest that they perceive these programs as useful to their science instruction. They find the programs fairly easy to understand; they view the animation as worthwhile; and they claim that the programs clarify difficult concepts in science. Although students tend to be neutral in their interest in these programs, they readily admit to liking the animation, the humor, and the cartoon sequences.

CHAPTER FOUR

CONCLUSIONS AND RECOMMENDATIONS

4.0 Conclusions

The purpose of this summative evaluation was to examine the impact of *Concepts in Science* on the teaching and learning of senior science in Ontario schools. A second purpose was to expand our general knowledge of what constitutes useful science programming for education. In view of these two concerns, this final chapter presents the major conclusions of the report and makes recommendations for future productions.

4.1 The Impact on Science Education

Fulfilling a teaching need

The results of the evaluation give strong indication that *Concepts in Science* fulfills a need in the senior science curriculum for good audiovisual resources. The survey results indicated that three-quarters of the teachers who were aware of the programs used them in their teaching. The programs are viewed by teachers as their "bread and butter" resources — there are very few other series that so closely correspond to the Ontario science curriculum. Teachers give strong indication that they will continue to use the series and recommend that more be produced.

Reaching a broad audience

The series are to be credited for so effectively spanning a broad learning audience. The programs are used by teachers in all the major science disciplines, at both general and advanced levels, and in all grades 9 through 13. Although there was some indication that the programs may be most suitable for senior students (grades 11 through 13) or students in advanced classes, they are nonetheless reaching a wide audience. Also, in spite of major changes to the senior science curriculum, the programs appear to have retained their relevance and usefulness.

Teacher approval

The evaluation also indicated that teachers are generally satisfied with all major aspects of the series — their content, their structure, and the style of production. Although a small number of teachers and students suggested possible areas for improvement, their general reaction was overwhelmingly favorable.

Pedagogical effectiveness

There is consensus among both teachers and students that the series play an important role in science education. Teachers use the series to contribute something to the teaching of science that they themselves cannot provide — succinct explanations, good reviews, humor, complex visual models, or even demonstrations that are too hazardous for the classroom. The students themselves claim that the programs improve their general understanding of difficult concepts and sustain their attention with the humor and animation.

In summation, these findings, backed by good records of sales in Ontario and elsewhere, indicate that *Concepts in Science* has had a favorable impact on science instruction in this province. The series fulfill teachers' expectations for useful programming and are perceived by science educators as valuable teaching resources.

4.2 Recommendations for Future Productions

This evaluation has raised several issues that may have an important bearing on production of future science programs. These issues are:

Animation

When discussing the use of the animation in the *Concepts* series, it should be stressed that there are actually two issues involved here. The first deals with the use of graphics and computer models to illustrate concepts, mechanisms, or processes. The second deals with the use of cartoon characters and events to add humor and maintain the audiences' attention.

There were few teachers in this study who disputed the importance of having graphics, particularly computer-generated graphics, to illustrate difficult scientific concepts. As many of the teachers pointed out, there is simply no better way of helping students to visualize complex scientific models or processes. The graphics are one of the principal reasons why teachers use the series.

There was a small group of teachers, however, who qualified their responses. These teachers claimed that the graphics were effective, but only for hard-to-visualize material, such as molecular or theoretical models. For organs, organisms, or even for some experiments, they would prefer video footage of the real thing. They argued that the programs would be more effective if the graphics were used more discriminately and were complemented by video of live things and events wherever possible and appropriate.

In conclusion, most teachers seem satisfied with the way in which animation is currently used in the programs. In the production of future series, however, it might be worthwhile to consider using both graphics and live footage, as some teachers in this study suggest. The use of live footage in certain segments would probably not have a significant effect on teachers' use of these series, but might have a slight effect on students' learning.

The use of cartooning in the programs was perceived by teachers as a quite different issue. Although teachers generally approve of the graphics, there is a small contingent who view the cartoon aspect of the programs as too juvenile, particularly for older students. In contrast, however, there were very few students in this study who shared this opinion.

The students who were surveyed like the cartoon characters and the humor and claim that they succeed in holding their attention.

Review segments

A small number of teachers throughout the study commented that they disliked the review segment at the beginning of each program. Others described the programs as too repetitious. They claimed that while repetition is generally a good instructional strategy, its use here seemed to slow the pace of the programs. Similar comments were volunteered by some of the students.

This seemed mostly a problem when teachers show several programs during a single class period. In this situation, the reviews are seen as unnecessary or even counterproductive. Since many teachers claim to show several programs in one sitting, the need for review segments should be carefully considered in the future productions of this length. It may be better to leave the review for the teacher than include it in the programs and run the risk of losing the learner's attention.

The 10-minute format

The results of this study also corroborate the findings of previous research indicating that 10-minute programs are easy for teachers to use and adapt to their own instruction. As evidenced in the case studies, teachers prefer the modular program because it permits them to pick and choose topics for their teaching needs. Short programs allow them more flexibility in structuring their presentations. Only a few teachers in this study disliked short programs because it was too difficult for them to book AV equipment for brief periods of time. From the success of these programs, it is recommended that this short format be considered for future productions.

Facilitating ETV use

Two findings emerged from this study concerning factors unrelated to the programs themselves, but potentially affecting their use. The first of these concerns the teacher guides, and the second, program scheduling.

A considerable number of teachers in the study commented that they were unaware of the teaching guides that accompany the series and said that they would be interested in acquiring them. The problem of ensuring that the guides reach the teachers — or even that they know about the guides — is by no means new. This finding has been borne out in numerous evaluations of other TVOntario materials. One possible way of making more teachers aware of the guides might be to advertise the availability of the guides on the videos themselves after the program credits, as is often done in broadcasts and the TVOntario academies.

The scheduling of the broadcasts is another concern. Teachers frequently complained that when changes were made in the broadcast schedules, they were not informed of the alternative dates when the programs would be shown. They claimed that the programs were not always run on time and that on occasion the programs shown were different from what was advertised. They strongly recommended that these scheduling problems be resolved to facilitate their off-air taping.

APPENDIX A

SERIES IN *CONCEPTS IN SCIENCE*

BIOLOGY

Energy Flow

Homeostasis

Protein Synthesis

Organic Evolution

Photosynthesis

Respiration

CHEMISTRY

The Mole Concept

Chemical Equilibrium

Electron Arrangement and Bonding

Electrochemistry

Organic Chemistry 1

Organic Chemistry 2

PHYSICS

Wave-Particle Duality

Structure of the Atom

Electricity

Nuclear Physics

Electromagnetism

APPENDIX B

VIDEOTAPE SALES IN ONTARIO

Table 10. Number of sales in Ontario

TITLE	Number sold (English)	Number sold (French)
Biology		
Homeostasis	60	17
Energy Flow	42	12
Protein Synthesis	47	16
Organic Evolution	39	3
Photosynthesis	32	—
Respiration*	—	—
	220	48
Chemistry		
The Mole Concept	71	8
Chemical Equilibrium	57	9
Electron Arrangement and Bonding	64	7
Electrochemistry	47	3
Organic Chemistry 1	40	—
Organic Chemistry 2*	—	—
	279	27
Physics		
Wave-Particle Duality	65	10
Structure of the Atom	57	11
Nuclear Physics	69	3
Electricity	49	3
Electromagnetism	36	4
	276	31
TOTAL SALES	775	106

*No figures available.

Table 11. Purchasers in Ontario

Purchaser	Percent of total sales	
	English	French
School boards	56 %	30 %
Individual schools	29 %	45 %
Media centres	7 %	18 %
Colleges	5 %	—
Universities	2 %	—
Ministry of Education	1 % (N=775)	7 % (N=106)

Table 12. Sales in Ontario by region

Region	Percent of total sales	
	English	French
Central Ontario	30 %	19 %
Ottawa Valley	12 %	23 %
Eastern	11 %	12 %
Western	10 %	7 %
Northwestern	9 %	—
Midwestern	9 %	—
Midnorthern	7 %	12 %
Niagara	7 %	—
Northeastern	5 %	27 %
	100 % (N=643)	100% (N=75)

Note: Although there were 775 English orders and 106 French orders for the series, it was possible to identify the region of sale for only 643 English orders and 75 French orders.

APPENDIX C

CHARACTERISTICS OF THE RESPONDENT GROUP

POSITION

Table 13. Position of respondents

Position	Proportion of respondents	
Teacher	81 %	(N=402)
Department head	11 %	
Resource teacher/coordinator	2 %	
Principal/Vice-principal	2 %	
Other	3 %	
No response	1 %	
	100 %	

COURSES

Table 14. Courses taught by respondents

Course	Proportion of respondents	
Biology	35 %	(N=402)
Chemistry	43 %	
Physics	32 %	
General science	59 %	

Note: Most teachers taught more than one course.

GRADES

Table 15. Grades and levels taught by respondents

Course	Proportion of respondents			
	Basic	General	Advanced	Total
Grade 9	4 %	20 %	28 %	54 %
Grade 10	3 %	18 %	29 %	50 %
Grade 11	3 %	19 %	30 %	52 %
Grade 12	1 %	13 %	24 %	38 %
Grade 13	—	1 %	61 %	62 %

Note: Most teachers taught more than one grade.

REGION

Table 16. Regional representation of sample

Region	Proportion of sample
Central Ontario	39 %
Western	10 %
Ottawa Valley	9 %
Midwestern	8 %
Niagara	7 %
Eastern	6 %
Northeastern	4 %
Midnorthern	3 %
Northwestern	2 %
Private schools	5 %
Other	1 %
	100 %

APPENDIX D

OBJECTIONABLE ELEMENTS IN CONTENT OR PRESENTATION

Table 17. Content or elements of presentation perceived as objectionable or offensive

1. Senior students perceive the series as too juvenile in presentation.
2. In the *Structure of the Atom,* there is a view of the Dark Ages and the church.
3. There is an elitist view of science.
4. The music is offensive to students.
5. Most figures or personalities in the examples are male.
6. In the fifth program of *Protein Synthesis,* the acceptor (code?) on the +RNA and the +RNA does not seem to be accurate according to present knowledge. Biology teachers don't like this.
7. Chickens, birds, and dogs seem to be picked on. I would rather you use cats.
8. The robot in electrochemistry can be rather sexist in its images.
9. Although the evolution tapes are well done, I question the decision of the authors in dismissing the creationist model with scarcely a sentence. Could not a statement be made to convey respect, if not credibility?
10. Evolution bothers fundamentalists. So what? The course is optional.
11. Maybe more emphasis on women's contributions to science — for example Lise Meitner in *Nuclear Physics* or Marie Curie in *Electromagnetism.* In light of new Science, Part 1 guidelines for sex equity, this needs attention.
12. Should be simple and to the point.

APPENDIX E

SELECTED COMMENTS

Table 18. Selected favorable comments: a need for more programs

Need more programs

1. More short programs (5-10 minutes) similar to the *Concepts* series will be valuable.
2. Please continue to produce these excellent programs. They are excellent teaching instruments.
3. Let's have some more!
4. These programs parallel the curriculum very well. I hope to see more programs from TVO. Keep up the good work.
5. Within the undoubtedly very strict budget constraints that TVO is subject to, it was very encouraging to see some attention paid to senior science. Please continue your efforts.

Grades 9 and 10

6. I would like to see something offered for grade 9 and 10 science.
7. Please make a few that are specific to OSIS at the grade 9 and 10 level, especially heat and ecology.
8. Need more programming, especially considering the wide topic use at the grade 9 and 10 level and more for general level.
9. *Please* make more series for grades 9 through 11 advanced and general courses, and also for the new topics currently being taught in grade 12 and OAC physics. The intermediate and general-level students need things like *Concepts in Science* more desperately than senior advanced-level students do. I don't understand why so little has been done for them. They have *Eureka!*, but it only covers a few of the topics.

New guidelines

10. I hope TVO continues to develop quality video material to support our new science guidelines.
11. We need more programs for new OSIS courses in science and society — new units in astronomy and consumer chemistry.

12. Keep producing science materials of this quality and continue the resource support. Deal with specific curriculum elements of recent vintage (e.g., genetic engineering, biodiversity, stellar evolution, fractal math).

13. Would appreciate similar programming keyed to our new curriculum emphasis — for modern atomic theory in OAC and gases in grade 11 chemistry. Also, help for Industry and Society (SCH 3A1), more on atomic and molecular arch (OAC). Any help on hand to visualize concepts would be appreciated.

Chemistry

14. I'd like to see a lot more of these programs developed in chemistry to replace the old chemistry study films that are worn out.

15. It would be helpful to cover the placement of the electrons in the energy levels for the Bohr atom for year three SCH.

16. Produce a tape on "buffering" to accompany *Homeostasis*.

17. I wish there were more for acid-based chemistry.

Physics

18. I hope that TVO continues to put out new series; suggested topics: sound, motion, mechanics, acid bases, heat, and fluids.

19. Let's have more: thermodynamics, applications, STS.

20. Would it be possible for you to produce a series for grade 11 covering sound?

Biology

21. I would like to see a description or explanation of some of the techniques used to discover the concepts (e.g., Calvin's experiments, separating cell organelles by centrifuge, electrophoresis, gene splicing, recombinant DNA technology). Showing how science develops concepts is not only interesting but fulfills one of the requirements of science education.

22. Keep up the good work! How about programs on heart, lung, and digestion?

French

23. I need as much media help in français, please, as soon as possible. Both versions (English and French) must be available at the same time.

Senior science

24. There seems to be little suitable AV material for senior science, so I think they are quite worthwhile.

Astronomy

25. Need a program on astronomy/astrophysics.

Earth science

26. There should be earth science programming too!

Society and industry

27. I'd like societal applications in industry and hospitals, etc., or environmental-concerns-type video (e.g., ozone depletion, acid rain, or global warming).

Table 19. Favorable comments: pedagogical effectiveness

The importance to teaching

1. This has been an enormous help in teaching concepts not easily visualized or not done experimentally. I can't imagine teaching wave-particle duality without the video series.

2. I find the *Concepts* series I use almost essential to my presentation in some units!

3. Even while I have taught grade 13 biology for 21 years, I have found I have appreciated the odd "new twist" or nuance which I have picked up from various TVO programs.

4. The programs are in general excellent, and for some topics (e.g., protein synthesis), I built the whole topic around the programs. For others, I select the parts that are most useful.

5. These series provide me with an alternative mode of delivery. They can be used to introduce, confirm, and review difficult concepts.

6. All of the programs I use (in the chemistry series) have been useful, and the teacher guides have some excellent activities and suggestions.

7. Keep up the good work. It is appreciated.

The impact on students

8. Students really think that these videos help them understand the topics taught.

9. Thanks for your interest and your help. Just remember, if you can help me make it *fun* to learn science, I'll be most appreciative. Kids like humor with their "medicine."

10. Students enjoyed the series on atomic structure.

Correspondence with the curriculum

11. The quality is good, but the unique feature that makes them so useful is their suitability for *our* curriculum. Programs made in the U.S. or U.K. must be adapted while yours already fit right in.

12. These programs are enjoyable and review pertinent information; they coordinate well with required course material.

The quality of production

13. The series is well organized and should be useful in class for a variety of sections and techniques. Good stuff!

14. The use of computer-enhanced animation really captures the interest of the students. Quantum theory was actually enjoyed by my OAC chemistry class.

15. Compared with other videos or films on similar concepts, they're superior.

16. Excellent work!

17. Good commentaries. Logical sequence of programs.

The 10-minute format

18. I like the fact that they are short. I also use *Nova, Vista,* and *The Nature of Things,* but they are too long or not as specific in content as yours are.

19. What makes them effective is that they are short and seem to deal with "our course." There is no excess.

20. Short segments are good. One can jam one in at the end of a class lesson where there would be too little time for a long video.

The need for science programs

21. These are one of the few resources specifically produced for the OAC courses at this time and are frequently used as a result.

Table 20. Suggestions for improvement

Better service

1. If anyone in Toronto is actually listening to cries from the colonies, can we in the Ottawa Valley get to see TVO? Please. If you only pave half of southern Ontario, we could probably afford it.

2. I am reluctant to use *any* of the programs and have refrained from doing so because of copyright laws. I find it time-consuming in finding out when these rights (the right to show to students) expire for our board. I require programs that I can use *every* year (as I see fit) and not only when the board is granted permission for copying for group viewing.

3. Many new programs are *not* run when advertised. We are *never* told an alternate date. Sometimes the series is not run on time, and if taped, one only gets put off the series. Also, recently an *Electricity* series showed some programs twice and others not at all. This whole area *needs* improving *a lot.*

4. The programs should be aired more frequently than one per year.

5. As a science teacher, I'm quite happy to be able to utilize *Concepts in Science.* As head of science, and after discussing the utilization level of your material, we found out that the main reason why the material is not fully used is the fact that teachers would like your productions to reflect the concepts in a specific unit of the new science programs. One cassette in a whole course (e.g., six cassettes for the six mandatory units of science, grade 9 advanced). Also, series should be totally available in French since a lot of francophone schools and immersion schools lack resources.

Video of real events

6. Animation is very useful for helping students visualize abstract ideas like atoms or light quanta. TVO should also consider developing programs that use live footage.

7. Reduce the animation — use a mix.

8. I would like to see more "experimental" programs that show experiments we cannot do in the classroom.

9. Where possible (and I'm sure cost would blow it), real film of real experiments is far superior.

The Mole Concept

10. *The Mole Concept* is terrible, and I find it a complete waste of time to show it.

11. *The Mole Concept* is more confusing to the students then it is useful.

12. I really like the *Nuclear Physics* program, but the others (e.g., *The Mole Concept)* don't really get the point across well.

13. I used *The Mole Concept* for my classes but stopped using them due to negative student reaction. As well, there just is not time to use all the programs. You must either lock yourself into all six programs or not use them at all. I previewed the *Electrochemistry* set but have not used them. They are better than *The Mole Concept*, but I still cannot justify spending the time on them.

Repetition

14. The beginning of each series is repetitive and boring.

15. Too much repetition. Tape number six in a series is always very low in new material.

16. The programs in a series tend to be a little too repetitive in the beginning. I don't need this repetition since I usually show two or three in the series at one time.

17. Perhaps the recap at the start of each program isn't necessary if the teacher stops and reruns the tape. The need for self-contained "mini-lessons" is less important.

Pace

18. Programs take too long to make relatively simple points.

19. Because I use two to three segments per class, I find the review or repetition a little draggy! A slightly faster pace would be acceptable.

20. The programs are very slow-paced and draggy. The repetition of fact — although sometimes a good strategy for learning — often bores the viewer, making the programs less effective than they would be if they were more to the point and presented at a quicker pace.

Difficulty level

21. I would be a good idea in the future to match the degree of difficulty to the grade for which a topic is specified in the ministry guidelines (e.g., photosynthesis is a grade 9 topic).

22. For better use of these materials, it would help if they could be developed and identified to fit specific units of the science courses (e.g., SNC1A grade 9 advanced, the six units available on one cassette, on another cassette, grade 10, etc.).

Content

23. Check the presentation information section on the *Electron Arrangement and Bonding* — aggregate section.

24. Please try to update the content with the new guidelines and address advanced rather than general courses.

Length

25. It is too bad they were made as short series — hard to fit in the curriculum.

26. Segments are too short. They need more depth.

Animation

27. More sophisticated animation or none should be used.

28. Please revamp some of the chemistry programs by adding animated computer graphics and lively narrative.

Resource package

29. I would like to develop or see developed a series of fill-in-the-blank questions that could summarize the main ideas or concepts portrayed in or displayed in each ten-minute segment of the series. These would be extremely useful in review for the students. After they have left the classroom, they would have not only their memory to rely on, but a written summary they have completed.

Music

30. Please revamp some of the chemistry programs by adding rock music.

Cartoons

31. A year of 80 periods should *not* be built around 36 ten-minute cartoons.

Narration

32. Please put another voice to interrupt the monologue.

Miscellaneous

33. Still need more resources available in schools — VCRs, TVs, etc., to make better use. When I book a machine for one 10-minute show, 10 other teachers cannot make use of it at that time. This is particularly awkward in semester schools with 70-minute classes.

34. I feel there is a place for short "clips" to support classroom teaching. Perhaps they should be more "stand alone" in nature to allow for more flexibility of use.

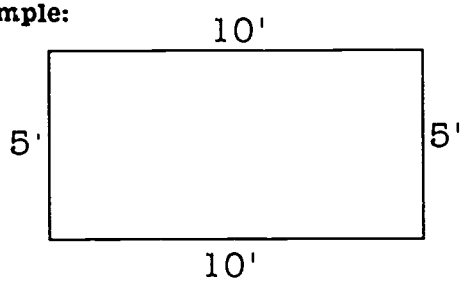
35. I would like to show programs, but there isn't very much space time under the new course outlines in science.

36. *Eureka!* series was a good prelude to the other programs.

37. Produce a good set of visuals on laser disc and let the teacher do the talking.

perimeter The distance around the sides of a figure such as a square or rectangle. To find the perimeter, measure the lengths of the sides and add.

Example:



P = 10' + 5' + 10' + 5' **P** = 30'

period [.] A punctuation mark used to mark the end of a sentence or to show an abbreviation.

Examples:
Lisa bought a new dress.
Dr. and Mrs. Wilson

Also see **abbreviation.**

perpendicular lines Two intersecting lines that form right angles.

Also see **angle.**

phrase A group of words that has meaning but is not a complete sentence. A phrase does not contain a subject and a predicate.

Examples: in the park
at the beach

Also see **preposition** and **prepositional phrase.**

pi [π]

A letter in the Greek alphabet; a letter that represents approximately 3.14159, the ratio of a circumference of a curve to its diameter.

Also see **circumference.**

planet

A heavenly body in the solar system; a planet moves around the sun. There are nine planets in the solar system:

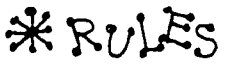
Mercury	Saturn
Venus	Uranus
Earth	Neptune
Mars	Pluto
Jupiter	

An easy way to remember the planets in the order of their distance from the sun:

My Very Easy Method—Just Set Up Nine Planets.

plural

The form of a word that means more than one.



- To form the plural of most nouns, add *s*.

Examples:	girl	girl*s*
	truck	truck*s*
	pin	pin*s*
	shoe	shoe*s*
	flower	flower*s*
	steps	step*s*

- Add *es* to singular nouns that end in the following letters:

  s ss sh ch x z

  Examples:

gas	gas*es*
mass	mass*es*
bush	bush*es*
church	church*es*
fox	fox*es*
buzz	buzz*es*

- Add *es* to some words that end in *o*.

  Examples:

potato	potato*es*
hero	hero*es*

  Some exceptions:

radio	radio*s*
piano	piano*s*

- When singular nouns end in a consonant and *y*, change the *y* to *i* and add *es*.

  Examples:

story	stor*ies*
baby	bab*ies*
lady	lad*ies*

- For most nouns ending in *f* or *fe*, change the *f* to *v* and add *es*.

  Examples:

knife	kni*ves*
loaf	lo*aves*
thief	thie*ves*
half	hal*ves*

- Some nouns have the same spelling for singular and plural forms.

  Examples:

deer	deer
sheep	sheep
moose	moose
trout	trout

MORE →

plural, cont.

- Some nouns form plurals by changing their spelling.

Examples:

man	men
child	children
goose	geese
foot	feet
mouse	mice
woman	women

Also see apostrophe and verbs.

p.m.

Post meridiem, used to show the time from after noon to midnight.

Examples:

3:00 p.m. 8:30 p.m. 11:59 p.m.

possessive nouns

See apostrophe.

predicate

Word or words in a sentence that tell something about the subject.The predicate includes a verb and often includes objects or words that modify or complement the verb or a noun.

Examples:

Phillip *lost his tennis racket.*
Pat *is talking on the phone.*
Mom *gave me a cookie.*
Her sister *is a doctor.*

prefix

A syllable added to the beginning of a word to change the meaning of the word.

SOME COMMON PREFIXES

Prefix	Meaning	Example
auto-	self	automatic, autograph
bi-	two	bicycle, bilingual
com-	with, together	compound, commit
con-	with	connect, conform
de-	down, from	deflate, depart
dis-	not	dishonest, disappear
ex-	out	export, exclude
mis-	wrong	misspell, misplace
non-	not	nonliving, nonskid
pre-	before	preschool, prepaid
re-	again, back	reheat, return
trans-	across	transform, transport
tri-	three	tricycle, triplets
un-	not, opposite of	unhappy, unclean
uni-	one	unicycle, unicorn

preposition

A word that relates a noun or pronoun to some other word in a sentence. A preposition is followed by an object and begins a prepositional phrase.

Example:
He put the present *on the table.*

SOME COMMON PREPOSITIONS

about	around	by	in	on	toward
above	at	down	into	out	under
across	before	during	near	over	until
after	behind	for	of	through	with
along	below	from	off	to	without

prepositional phrase

A phrase beginning with a preposition and ending with a noun or pronoun. The phrase modifies a noun, pronoun, verb, or adjective and shows a relationship in time or space.

Example:

In a few minutes, the man *on the boat* will dive *into the water.*

present tense

See verb.

presidents of the United States

See chart of **Presidents of the United States** on opposite page.

primary colors

In art, the colors red, yellow, and blue. Combinations of these primary colors may be mixed to produce all other colors.

product

The result of multiplying one number by another number; the answer to a multiplication problem.

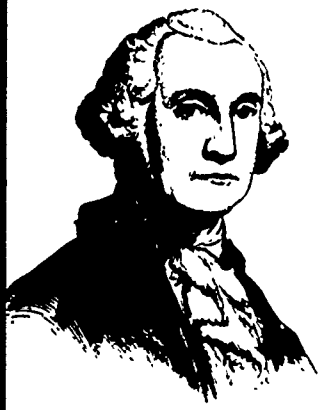
Examples:

$$\begin{array}{r} 6 \\ \times\ 2 \\ \hline 12 \end{array}$$ The number 12 is the product.

$75 \times 22 = 1{,}650$

The number 1,650 is the product.

Also see **casting out nines** and **multiplication.**



PRESIDENTS OF THE UNITED STATES

	Name	Term
1st	George Washington	1789-1797
2nd	John Adams	1797-1801
3rd	Thomas Jefferson	1801-1809
4th	James Madison	1809-1817
5th	James Monroe	1817-1825
6th	John Quincy Adams	1825-1829
7th	Andrew Jackson	1829-1837
8th	Martin Van Buren	1837-1841
9th	William H. Harrison	1841
10th	John Tyler	1841-1845
11th	James K. Polk	1845-1849
12th	Zachary Taylor	1849-1850
13th	Millard Fillmore	1850-1853
14th	Franklin Pierce	1853-1857
15th	James Buchanan	1857-1861
16th	Abraham Lincoln	1861-1865
17th	Andrew Johnson	1865-1869
18th	Ulysses S. Grant	1869-1877
19th	Rutherford B. Hayes	1877-1881
20th	James A. Garfield	1881
21st	Chester A. Arthur	1881-1885
22nd	Grover Cleveland	1885-1889
23rd	Benjamin Harrison	1889-1893
24th	Grover Cleveland	1893-1897
25th	William McKinley	1897-1901
26th	Theodore Roosevelt	1901-1909
27th	William H. Taft	1909-1913
28th	Woodrow Wilson	1913-1921
29th	Warren G. Harding	1921-1923
30th	Calvin Coolidge	1923-1929
31st	Herbert Hoover	1929-1933
32nd	Franklin D. Roosevelt	1933-1945
33rd	Harry S. Truman	1945-1953
34th	Dwight D. Eisenhower	1953-1961
35th	John F. Kennedy	1961-1963
36th	Lyndon B. Johnson	1963-1969
37th	Richard M. Nixon	1969-1974
38th	Gerald R. Ford	1974-1977
39th	James E. Carter, Jr.	1977-1981
40th	Ronald W. Reagan	1981-1989
41st	George H. W. Bush	1989-

pronoun A word used in place of a noun. A word that refers to a noun.

SINGULAR PRONOUNS

I, me, my, mine, myself
you, your, yours, yourself
he, him, his, himself
she, her, hers, herself
it, its, itself

PLURAL PRONOUNS

we, us, our, ours, ourselves
you, your, yours, yourselves
they, them, their, theirs, themselves

pronunciation key A list of symbols that shows how letters in words are pronounced.

SAMPLE PRONUNCIATION KEY

ă	*f*at	ŏ	l*o*t	ŭ	c*u*t	ə	*a*lone
ā	s*a*y	ō	g*o*	ûr	f*ur*	ə	ite*m*
âr	sh*a*re	ô	f*or*	ûr	t*er*m	ə	pencil
ä	f*a*ther	ô	t*au*ght	ûr	f*ir*m	ə	at*o*m
ĕ	l*e*t	ô	s*aw*	ûr	w*or*d	ə	circ*u*s
ē	b*e*	oi	f*oi*l	ûr	h*ear*d	zh	gara*g*e
ĭ	*pi*t	o͝o	b*oo*k	th	ba*th*	zh	mea*s*ure
ī	f*i*ght	o͞o	b*oo*t	th	ba*th*e	zh	vi*s*ion
îr	p*ier*ce	ou	*ou*t				

proofreading symbols Symbols used by an editor or proofreader to let the writer or printer know what changes or corrections are to be made in written or printed material.

Symbol	Meaning	Mark on Paper	Corrected
⋕	begin a new paragraph	He ran fast. ⋕The race ended.	He ran fast. The race ended.
ʌ	insert a letter or word	The rʌace	The race
ʌ,	insert a comma	A bright cheerful young boy	A bright, cheerful young boy
⊙	insert a period	She sat down⊙	She sat down.
℘	take out	Anns went home.	Ann went home.
cap	make a capital	The white house	The White House
lc	make a lower case	at the Park	at the park
'	insert an apostrophe	Tims bat	Tim's bat
" "	quotation marks needed	Get ready.	"Get ready."
⁀	close up space	An ani mal	An animal

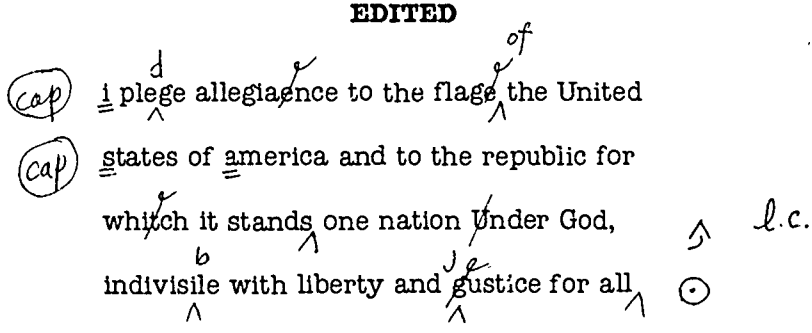
proofreading symbols, cont.

Example:

UNEDITED

i plege allegiaence to the flage the United states of america and to the republic for whitch it stands one nation Under God, indivisile with liberty and gustice for all

EDITED

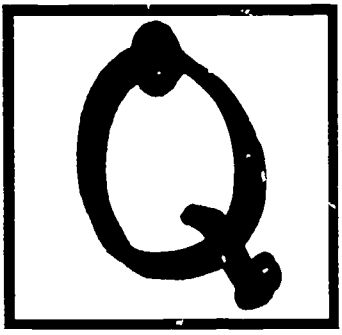


FINAL

I pledge allegiance to the flag of the United States of America and to the republic for which it stands, one nation under God, indivisible, with liberty and justice for all.

proverb A short, wise saying that tells a truth.

Examples:
Better safe than sorry.
One good turn deserves another.
A stitch in time saves nine.
He who hesitates is lost.
The only way to have a friend is to be one.



quotation The exact words said or written by someone else.

Example:
"Ask not what your country can do for you; ask what you can do for your country."
John Fitzgerald Kennedy

quotation marks [" "] A pair of punctuation marks used to show spoken or written conversation, words, and titles.

*RULES

- **Direct Quotation** Place quotation marks at the beginning and end of the exact word or words said or written by someone.

  Examples:
  Judy said, "My work is almost finished."
  "Why can't I go?" asked Don.

- **Divided Quotation** When a quotation is divided, place quotation marks only around exact words spoken.

  Examples:
  "My favorite ice cream flavor," said Tim, "is strawberry."
  "I'm hungry," said Jim. "What's for dinner?"

MORE →

- **New Speaker** Use quotation marks in written conversation and start a new paragraph every time the speaker changes.

  Examples:

  "What's your favorite food?" asked Betsy while they were waiting for the bus.

  "Pizza," replied Charlie, with a hungry look in his eye.

  "Oh, I like to eat hot dogs," answered Betsy.

  "I love all foods," sighed Charlie.

- **Special Words** Use quotation marks with words used to show a special sense.

  Examples:

  The "expert" made three mistakes.

  The engine started with a "bang."

- **Short Works** Use quotation marks with titles of short works like stories, poems, television programs, reports, short plays, or musical compositions.

  Examples:

  "Sesame Street" is my brother's favorite program.

  My report is called "Apes."

- **Quote within a Quote** Use single quotation marks when you quote within a quotation.

  Example:

  The parent explained to the teacher, "My child told me, 'I don't have to do a report,' but is that true?"

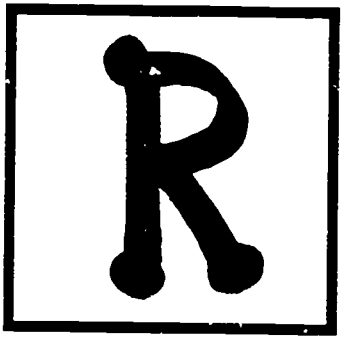
quotient The answer to a division problem.

Examples:

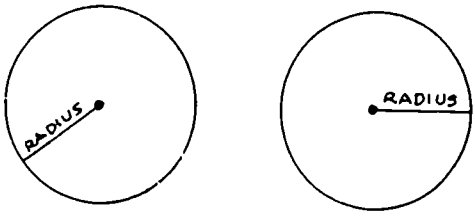
$$2\overline{)16}\quad 8$$ The number 8 is the quotient.

$24 \div 6 = 4$ The number 4 is the quotient.

Also see **casting out nines** and **division.**



radius The shortest distance from the center of a circle to any point on the circle.



ratio The relationship or comparison in size, amount, or number between two things.

Example:
10 children and 1 scout leader
The ratio is 10 to 1 or 10:1.

remainder The number left when one number cannot be divided evenly by another number.

Example:

$$2\overline{)5}\quad 2$$
$$4$$
$$1 \text{ remainder}$$

Also see **casting out nines** and **division.**

renaming Naming numbers with a different set of numbers; regrouping numbers; used to regroup numbers to the next place value.

HELP

1. Add the digits in the ones place first.

	ones
467	7
+287	+7
	14

2. Write the 4 in the ones column and give the 1 ten to the tens column. Add the digits in the tens column.

	tens
① 467	①6
+287	+8
4	15

3. Write the 5 in the tens column and give the 1 hundred (10 tens) to the hundreds column. Add the column.

	hundreds
①① 467	①4
+287	+2
54	7

4. Write the 7 in the hundreds column.

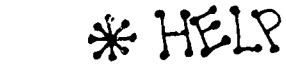
467
+287
754

Also see **borrowing** and **casting out nines.**

right angle *See* angle.

Roman numerals A number system used by the Romans in which 7 basic letters were given specific values.

I = 1
V = 5
X = 10
L = 50
C = 100
D = 500
M = 1,000



- When a letter is repeated, its value is repeated.

  I = 1
  II = 2
  X = 10
  XX = 20
  C = 100
  CCC = 300

- When a letter *follows* a letter of greater value, its value is *added* to the greater value.

  XV = 15 (10 + 5)
  LX = 60 (50 + 10)

- When a letter of smaller value is *before* a letter of greater value, its value is *subtracted* from the greater value.

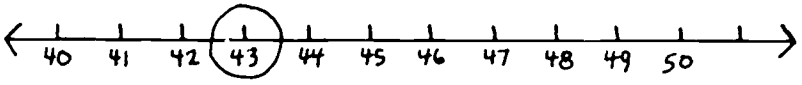
  IV = 4 (1 from 5)
  XL = 40 (10 from 50)
  CD = 400 (100 from 500)

root word *See* base word.

rounding Writing a whole number to the nearest ten, hundred, thousand, or greater place value. Use rounding when you don't need an exact number.

- For numbers 1, 2, 3, 4, round down to the lower 10, 100, 1,000, etc.

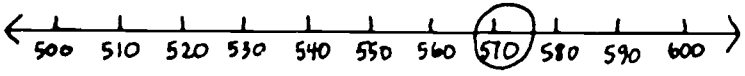
  Example: Round 43 to the nearest 10.



43 rounded is 40

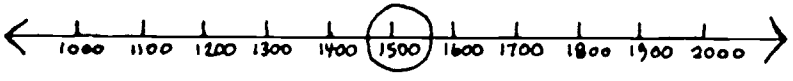
- For numbers 5, 6, 7, 8, 9, round up to the higher 10, 100, 1,000, etc.

  Example: Round 572 to the nearest 100.

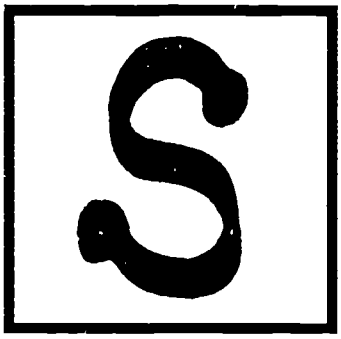


572 rounded is 600

Example: Round 1500 to the nearest 1000.



1500 rounded is 2000



schwa [ə]

An unstressed or unaccented vowel sound in a syllable. The (ə) can represent any vowel.

Examples: about..... ə -bout'
item .....i' təm
April .....A' prəl
parrot .....par' ət
circus .....cir' cəs

semicolon [;]

A punctuation mark that shows a separation in a sentence not as complete as a period, but more complete than a comma.

* RULES

- Use a semicolon between two separate thoughts in a sentence not connected by *and, but, or, so, for, yet,* or *nor.*

  Example:
  I have an idea; Jerry has a good idea, too.

- Use a semicolon between a list of things if the things contain commas.

  Example:
  The class officers are Carol Brown, President; Terry Smith, Vice-President; Bob Robb, Secretary; and Roy Toy, Treasurer.

- Use a semicolon before a conjunctive adverb (an adverb that connects) when it separates two strong statements.

  Example:
  Climbing this mountain is difficult; however, it is very exciting.

sentence

A group of words that tells a complete idea or thought. Sentences have a subject and a predicate.

*KINDS OF SENTENCES

- **Declarative** (Statement) A sentence that tells or states an idea and ends with a period.

  Example: We will go to the zoo.

- **Interrogative** (Question) A sentence that asks something and ends with a question mark.

  Example: What time is the game?

- **Imperative** (Command or Request) A sentence that tells you to do something; the imperative sentence can end with either a period or an exclamation mark.

  Examples: Don't touch the oven!
  Please pass the paper.

- **Exclamatory** (Exclamation) A sentence that shows excitement or surprise and ends with an exclamation mark.

  Examples: I found five dollars!
  What an exciting show!

sequence

The order or following of one thing after another. Sequencing in stories tells what happens first, next, and last.

Example:

Incorrect Sequence

She ate breakfast.
Paula woke up early.
She rode her bike to school.

Correct Sequence

Paula woke up early.
She ate breakfast.
She rode her bike to school.

silent letter

A vowel or consonant that is not sounded in a word.

Examples:

knot .....The *k* is not sounded.
gnaw .....The *g* is not sounded.
czar.....The *c* is not sounded.
wrong.....The *w* is not sounded.
psychic .....The *p* is not sounded.

simile

A comparison in which two unlike things are compared; the words *as, like,* or *than* are used.

Examples:

Bob was as red *as* a lobster.
Jim is *like* a starved animal.
Katie has grown taller *than* a giraffe.

singular

The form of a word that means one of something.

Examples:	book	eye
	cola	girl
	crayon	turkey

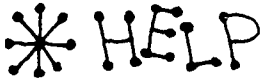
Use the word *a, an,* or *the* in front of a singular noun.

Examples: a toy
an alligator
the cart

Also see **apostrophe, pronoun,** and **verb.**

spelling rules

For every spelling rule in the English language, there is usually at least one exception.



For all words:

1. Look at the word. Say the word.
2. Listen to the sounds the letters make.
3. Picture the word in your mind.
4. Memorize the tricky parts of the word.
5. Say the word again and write it.

- When adding prefixes to a word, the spelling of the base word stays the same.

  Examples: un lucky *un*lucky
  re wind *re*wind

- When adding the suffix *-ly* to words ending in *l,* keep the final *l* and add *ly.*

  Examples: real *ly* real*ly*
  beautiful *ly* beautiful*ly*

- When adding the suffix *-ness* to words ending in *n,* keep the final *n* and add *ness.*

  Examples: sudden *ness* sudden*ness*
  mean *ness* mean*ness*

- When adding a suffix beginning with a vowel to a base word ending in silent *e*, drop the silent *e* and add the suffix.

  Examples:

have *ing*	hav*ing*
nice *est*	nic*est*
please *ed*	pleas*ed*

- When adding a suffix beginning with a consonant to a base word ending in a silent *e*, keep the final *e*.

  Examples:

nine *ty*	nine*ty*
grace *ful*	grace*ful*
amuse *ment*	amuse*ment*

  Exceptions:

argue *ment*	argu*ment*
judge *ment*	judg*ment*
nine *th*	nin*th*
true *ly*	tru*ly*

- When adding a suffix to a base word that ends in *y* with a consonant before it, change the *y* to *i* and add the suffix.

  Examples:

happy *ness*	happi*ness*
greedy *est*	greedi*est*
hurry *ed*	hurr*ied*

  Exceptions:

cry *ing*	cry*ing*
bury *ing*	bury*ing*
try *ing*	try*ing*
copy *ing*	copy*ing*

- When adding a suffix to a base word that ends in *y* with a vowel before it, keep the *y*.

  Examples:

relay *ing*	relay*ing*
play *ing*	play*ing*

  Exceptions:

pay *ed*	pa*id*
say *ed*	sa*id*
day *ly*	da*ily*

- In words of one syllable with one vowel followed by one consonant, double the final consonant when adding a suffix.

  Examples: run *ing* — run*ning*
  thin *er* — thin*ner*
  stop *ed* — stop*ped*

- When adding a suffix that begins with a vowel to a word of two or more syllables that ends with a consonant, double the final consonant when the word ends with a consonant-vowel-consonant and the accent is on the last syllable.

  Examples: be gin *ing* — begin*ning*
  re fer *ing* — refer*ring*
  o mit *ing* — omit*ting*

- If a word ends in *x, z, ch, sh,* or *ss*, add *es* to form the plural.

  Examples: box *es* — box*es*
  buzz *es* — buzz*es*
  church *es* — church*es*
  lash *es* — lash*es*
  dress *es* — dress*es*

- Memorizing this rhyme will help you remember the *ie* and *ei* rule.

  I before *e*
  Except after *c*,
  Or when sounded as *a*
  As in n*ei*ghbor or w*ei*gh.

  Examples: s*ie* ve
  rec*ei* ve

  Exceptions: consc*ie* nce
  soc*ie* ty

states *See* United States of America.

straight angle *See* angle.

stress mark [′] A mark used with words of more than one syllable to show which syllable is said more strongly.

Examples: accent (ac′ cent)
repeat (re - peat′)

PRIMARY STRESS OR ACCENT MARK (′)

Another name for stress mark is primary accent mark. Shows which syllable is said louder than any other syllable.

Examples: vanish (van′ ish)

SECONDARY STRESS
OR ACCENT MARK (′)

Shows which syllable is said with force but not as loud as the syllable with the greatest stress.

Examples: invitation (in′ vi - ta′ tion)
multiply (mul′ ti - ply′)

subject A word or group of words about which something is said in a sentence.

Examples:
Cindy is crying.
A tall tree was hit by lightning.
The mountains in Alaska are very high.

Also see sentence.

subtopic *See* **main topic and subtopics** and **outline.**

subtraction The process of taking away one number from a another number. The remaining amount is called the difference or remainder.

Example:

$$\begin{array}{r} 8 \\ -2 \\ \hline 6 \end{array}$$

The number 6 is the difference or remainder.

WORDS THAT TELL YOU WHEN TO SUBTRACT

How many are left?
Decrease by . . .
How many remain?
Find the difference between . . .
How many fewer . . .
less
take away
minus

PARTS OF A SUBTRACTION PROBLEM

$$\begin{array}{rl} 56 & \text{minuend} \\ -36 & \text{subtrahend} \\ \hline 20 & \text{difference or remainder} \end{array}$$

Also see **borrowing** and **casting out nines.**

subtrahend The number being subtracted from the minuend in a subtraction problem.

Example:

$$\begin{array}{r} 7 \\ -\,5 \end{array}$$ The number 5 is the subtrahend.

Also see **minuend** and **subtraction.**

suffix A syllable added to the end of a word to make a new word.

SOME COMMON SUFFIXES

Suffix	Meaning	Example
-able	can do	capable
-ance	state of being	resistance
-ed	past tense	annoyed
-er	person who does	teacher
-er	state of being more	warmer
-est	state of being most	biggest
-ful	full of	beautiful
-ish	somewhat like	babyish
-ist	one who does	artist
-ive	tending to	impressive
-less	without	hopeless
-ly	characteristic of	fatherly
-ment	act or state of	amusement
-ness	quality of	darkness
-ship	condition of	hardship
-sion	act or state of	confusion
-tion	act or state of	election
-y	state of	rainy

sum The answer to an addition problem.

Example:

$$\begin{array}{r} 52 \\ +38 \\ \hline 90 \end{array}$$ The number 90 is the sum.

Also see **addition.**

syllable A part of a word that is pronounced separately. Dividing a word into syllables makes it easier to pronounce.

Every syllable has at least one vowel that you see and hear.

Examples:

cat	1 vowel = 1 syllable
per - son	2 vowels = 2 syllables
i - de - a	3 vowels = 3 syllables

Sometimes a syllable has more than one vowel. The second vowel is silent.

Examples: treat
be - tween

- A one-syllable word cannot be divided.

  Examples: dog
  mice

- Divide compound words between the two words.

  Examples: play-ground
  fire-fighter

syllable, cont.

- Divide words between a prefix and the base word.

  Examples: *re*-turn
  mis-place

- Divide words between the base word and a suffix.

  Examples: help-*ful*
  cool-*ness*

- If there are two or more consonants between two vowels, divide the word between the first two consonants.

  Examples: la*d*-*d*er
  chi*l*-*d*ren

- If the first vowel in a word is short and is followed by one consonant, divide the word after the consonant.

  Examples: r$\breve{o}$b-in
  m$\breve{a}$g-ic

- If the first vowel in a word is long and is followed by one consonant, divide the word before the consonant.

  Examples: sp$\bar{i}$-der
  l$\bar{o}$-cate

- If a vowel is sounded alone in a word, that vowel forms a syllable by itself.

  Examples: dis-a-gree
  u-nit

- If two vowels are together in a word and each makes a separate sound, divide the word between the two vowels.

  Examples: *gi*-ant
  i-*de*-*a*

- If a word ends with a consonant followed by the letters *le*, divide the word before the consonant.

  Examples: ta-*ble*
  bi-cy-*cle*

synonym

A word that has the same meaning as another word in the same language.

Examples:

beautiful lovely, pretty, attractive

loud noisy, boisterous, uproarious

Also see antonym and thesaurus.

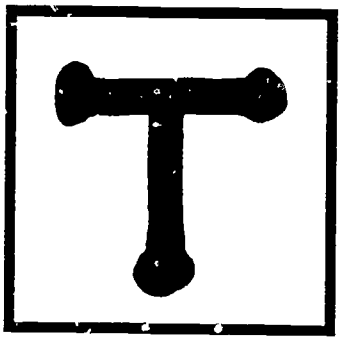


table of contents

A listing found in the beginning of a book or magazine that tells the chapter titles, topics, or subjects found in the book and the number of the page on which they begin. Sometimes it is written simply as *Contents*.

Example:

Table of Contents

Chapter		Page
I.	Indian Tribes of the Plains	1
II.	Homes of the Plains Indians	7
III.	Foods	12
IV.	Religion	18

their - there - they're

The word *their* is an adjective that tells *ownership*.

Examples:

They enjoyed *their* trip to Disneyland.
These are *their* books.

The word *there* is an adverb that means *in that place*.

Examples:

Who is *there?*
We will go *there* later.

The word *they're* is a contraction. *They're* means *they are.*

Example:
I am glad *they're* here now.
They're driving to Toledo.

thermometer An instrument that measures temperature; an instrument with a glass bulb and tube marked with a scale and containing mercury or other liquid which rises or falls as the temperature changes.

Also see **Celsius thermometer** and **Fahrenheit thermometer.**

thesaurus A book of synonyms or words that have similar meanings. Some thesauruses also include antonyms, or opposites, for each synonym.

Example:
large — big, huge, massive, enormous, immense, grand, gigantic.
Antonym: small, little, tiny, petite.

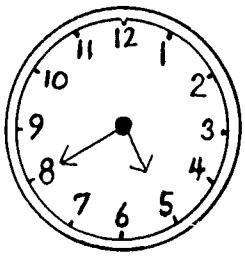
time The moment when something occurs. The duration of or how long events and happenings take.

The two hands on a clock or watch tell what time it is.

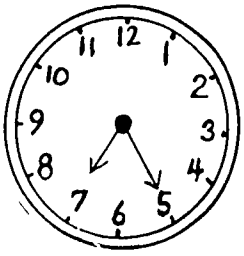
The *hour hand* is the *shorter* hand. It tells the hour.

The *minute hand* is the *longer* hand. It tells how many minutes before or after the hour.

MORE →



5:40 or
20 minutes before 6



7:25

TIME

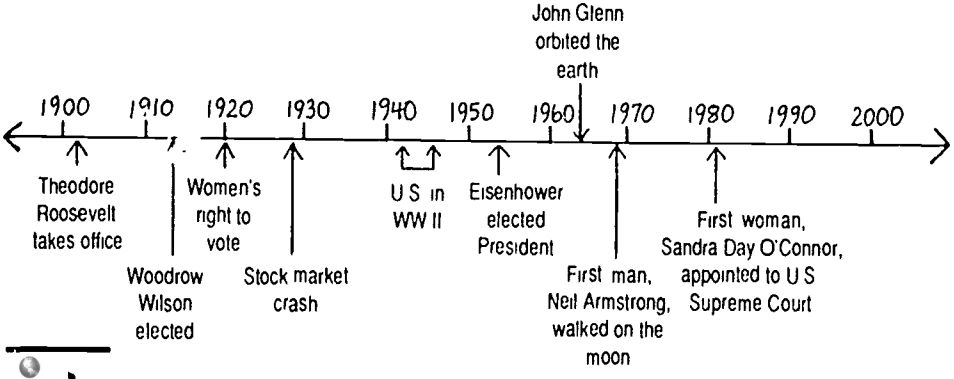
60 seconds (sec.)	1 minute (min.)
60 minutes	1 hour (hr.)
24 hours	1 day (d.)
7 days	1 week (wk.)
4 weeks	1 month (mo.)
52 weeks	1 year (yr.)
12 months	1 year
10 years	1 decade
100 years	1 century (c.)
1000 years	A millennium

Also see **calendar.**

time line

A diagram that gives information about historical happenings, dates, and events at a glance.

Example:



time zones

There are 4 time zones in the continental United States: Pacific, Mountain, Central, and Eastern. Alaska and Hawaii are in separate time zones.

Also see **United States of America map** on page 132.

to - too - two

The word *to* shows the way or gives direction.

Examples:
Please come *to* my party.
We read words from left *to* right.

The word *too* means also or more than enough.

Examples: I am tired, *too.*
I ate *too* much.

The word *two* means a number.

Examples:
Tom has *two* pets: a dog and a cat.
I ate *two* pieces of cake.

topic sentence

The sentence in a paragraph that tells the main idea of a paragraph. The topic sentence is often the first sentence in a paragraph.

Also see **main topic and subtopics** and **paragraph.**

Tropic of Cancer

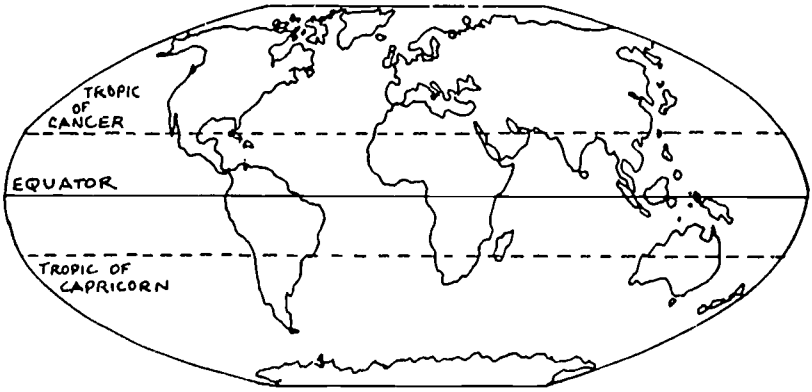
An imaginary line 1600 miles (23° 27') north of the equator; the northern boundary of the tropical zone. In the tropics, where the sun shines down almost straight at noon every day, the weather is very warm.

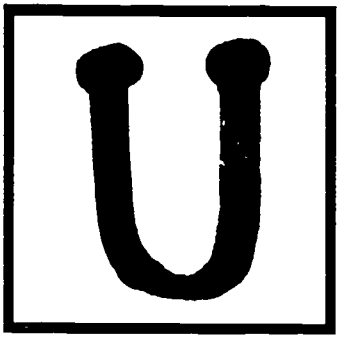
Also see **latitude.**

Tropic of Capricorn

An imaginary line 1600 miles (23° 27') south of the equator; the southern boundary of the tropical zone. The sun is almost directly overhead at noon every day, and the temperatures are quite high.

Also see **latitude.**





United States of America

A republic comprising 50 states and Washington, D.C., the District of Columbia, the nation's capital. Forty-eight states are located in continental U.S.A; Alaska is in North America and Hawaii in the South Pacific. The U.S.A. has coastlines on three oceans: the Atlantic, the Pacific, and the Arctic. In this land of contrasting environments, altitudes range from 282 feet below sea level in Death Valley, California, to 20.320 feet above sea level, the peak of Mt. McKinley in Alaska.

Also see **United States of America list** on pages 130 and 131 and **United States of America map** on page 132.

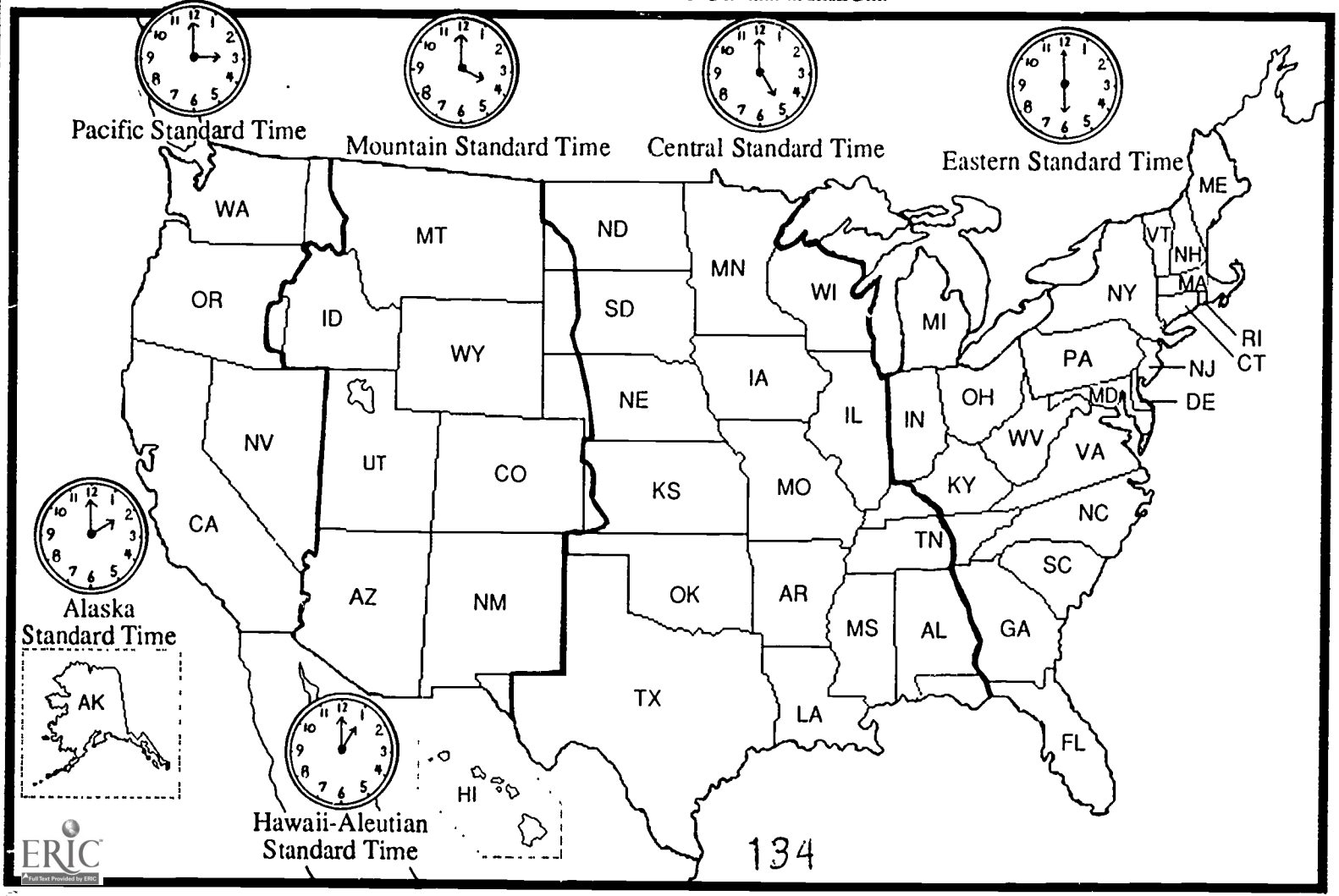
UNITED STATES OF AMERICA

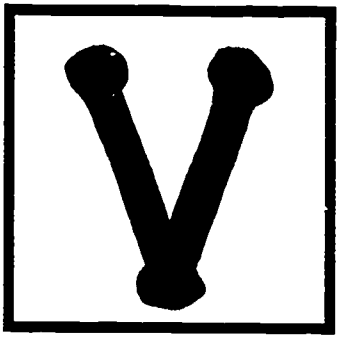
State	Abbrev.	Capital	State Nickname	State Flower	State Bird	Admitted
Alabama	AL	Montgomery	Heart of Dixie	Camelia	Yellowhammer	1819
Alaska	AK	Juneau	Last Frontier	Forget-Me-Not	Willow Ptarmigan	1959
Arizona	AZ	Phoenix	Grand Canyon State	Saguaro	Cactus Wren	1912
Arkansas	AR	Little Rock	Land of Opportunity	Apple Blossom	Mockingbird	1836
California	CA	Sacramento	Golden State	Golden Poppy	Calif. Valley Quail	1850
Colorado	CO	Denver	Centennial State	Rocky Mt. Columbine	Lark Bunting	1876
Connecticut *	CT	Hartford	Constitution State	Mountain Laurel	Robin	1788
Delaware *	DE	Dover	First State	Peach Blossom	Blue Hen Chicken	1787
Florida	FL	Tallahassee	Sunshine State	Orange Blossom	Mockingbird	1845
Georgia *	GA	Atlanta	Empire State of the South	Cherokee Rose	Brown Thrasher	1788
Hawaii	HI	Honolulu	Aloha State	Hibiscus	Hawaiian Goose	1959
Idaho	ID	Boise	Gem State	Syringa	Mountain Bluebird	1890
Illinois	IL	Springfield	Land of Lincoln	Native Violet	Cardinal	1818
Indiana	IN	Indianapolis	Hoosier State	Peony	Cardinal	1816
Iowa	IA	Des Moines	Hawkeye State	Wild Rose	Eastern Goldfinch	1846
Kansas	KS	Topeka	Sunflower State	Sunflower	Western Meadowlark	1861
Kentucky	KY	Frankfort	Bluegrass State	Goldenrod	Cardinal	1792
Louisiana	LA	Baton Rouge	Pelican State	Magnolia	Brown Pelican	1812
Maine	ME	Augusta	Pine Tree State	White Pine Cone	Chickadee	1820
Maryland*	MD	Annapolis	Old Line State	Black-eyed Susan	Baltimore Oriole	1788
Massachusetts*	MA	Boston	Bay State	Mayflower	Chickadee	1788
Michigan	MI	Lansing	Wolverine State	Apple Blossom	Robin	1837
Minnesota	MN	St. Paul	Gopher State	Lady's Slipper	Loon	1858
Mississippi	MS	Jackson	Magnolia State	Magnolia	Mockingbird	1817
i	MO	Jefferson City	Show Me State	Hawthorn	Bluebird	1821

Montana	MT	Helena	Treasure State	Bitterroot	Western Meadowlark	1889
Nebraska	NE	Lincoln	Cornhusker State	Goldenrod	Western Meadowlark	1867
Nevada	NV	Carson City	Silver State	Sagebrush	Mountain Bluebird	1864
New Hampshire *	NH	Concord	Granite State	Purple Lilac	Purple Finch	1788
New Jersey *	NJ	Trenton	Garden State	Purple Violet	Eastern Goldfinch	1787
New Mexico	NM	Santa Fe	Land of Enchantment	Yucca	Roadrunner	1912
New York *	NY	Albany	Empire State	Rose	Bluebird	1788
North Carolina *	NC	Raleigh	Tar Heel State	Dogwood	Cardinal	1789
North Dakota	ND	Bismarck	Flickertail State	Wild Prairie Rose	Western Meadowlark	1889
Ohio	OH	Columbus	Buckeye State	Scarlet Carnation	Cardinal	1803
Oklahoma	OK	Oklahoma City	Sooner State	Mistletoe	Scissortail Flycatcher	1907
Oregon	OR	Salem	Beaver State	Oregon Grape	Western Meadowlark	1859
Pennsylvania *	PA	Harrisburg	Keystone State	Mountain Laurel	Ruffed Grouse	1787
Rhode Island *	RI	Providence	Little Rhody	Violet	Rhode Island Red	1790
South Carolina *	SC	Columbia	Palmetto State	Carolina Jessamine	Carolina Wren	1788
South Dakota	SD	Pierre	Coyote State	American Pasqueflower	Ring-necked Pheasant	1889
Tennessee	TN	Nashville	Volunteer State	Iris	Mockingbird	1796
Texas	TX	Austin	Lone Star State	Bluebonnet	Mockingbird	1845
Utah	UT	Salt Lake City	Beehive State	Sego Lily	Sea Gull	1896
Vermont	VT	Montpelier	Green Mountain State	Red Clover	Hermit Thrush	1791
Virginia *	VA	Richmond	Old Dominion	Dogwood	Cardinal	1788
Washington	WA	Olympia	Evergreen State	Coast Rhododendron	Willow Goldfinch	1889
West Virginia	WV	Charleston	Mountain State	Rhododendron	Cardinal	1863
Wisconsin	WI	Madison	Badger State	Wood Violet	Robin	1848
W[illegible]g	WY	Cheyenne	Equality State	Indian Paintbrush	Meadowlark	1890

*[illegible]es one of the 13 original states

UNITED STATES OF AMERICA





verb A word that shows action or state-of-being (what the subject is).

Action	State-of-Being
sell	is
help	are
jump	am
eat	seem

* RULES

PRESENT TENSE

- In the present tense, verbs tell about something that happens or exists now.

- If the subject is first or second person singular, do not add an ending to the verb.

  Examples:
  I *swim* in the pool today.
  You *run* in the park in the morning.

- If the subject is third person singular, add *s* to the verb.

  Examples:
  She *sings* today.
  He *plays* baseball today.

MORE →

Exception: Add *es* to verbs ending in *s, x, z, ch, sh,* or *ss.*

Examples: Cory *boxes* daily.
She *pushes* the stroller.

- If the subject is plural, do not add an *s* to the verb.

Examples:
We *swim* in the lake.
Sally and Kevin *excercise* daily.

Helping Verbs

- Some verbs have helping verbs.

Some Common Helping Verbs

am	do	might
are	does	must
can	is	shall
could	may	should

Example: Jack *should* eat his dinner.

- Some verbs in the present tense help the *-ing* form of the main verb and show continuing action.

Example: Eddie *is painting* the walls.

PAST TENSE

- In the past tense, verbs show something that has already happened. The letters *d* or *ed* are added to regular verbs to form the past tense.

Examples: bake baked
jump jumped

- If a verb ends with a consonant followed by *y*, change the *y* to *i* and add *ed*.

Examples:	worry	worr*ied*
	hurry	hurr*ied*
	fry	fr*ied*

- If a verb ends in a vowel followed by a consonant, double the consonant and add *ed*.

Examples:	stop	stop*ped*
	beg	beg*ged*
	prefer	prefer*red*
	omit	omit*ted*
Exceptions:	enter	enter*ed*
	offer	offer*ed*

Helping Verbs

- Use the helping verbs *has, have,* or *had* with the past participle form of a verb to show that something *happened in the past.*

Examples:
Sara *has played* ball before.
Paul and Kathy *have seen* that movie.
Karen *had showered* earlier.

verb, irregular

A verb that changes its spelling in the past tense and past participle form and does not have the *-ed* form.

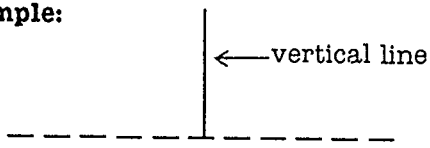
MORE →

SOME COMMON IRREGULAR VERBS

Present	Past	Past Participle
begin	began	begun
blow	blew	blown
bring	brought	brought
choose	chose	chosen
do	did	done
draw	drew	drawn
drink	drank	drunk
eat	ate	eaten
go	went	gone
grow	grew	grown
lay	laid	laid (to set)
lie	lay	lain (to rest)
ring	rang	rung
swim	swam	swum
wake	woke	woken

vertical line A line that runs straight up and down, perpendicular to the horizon.

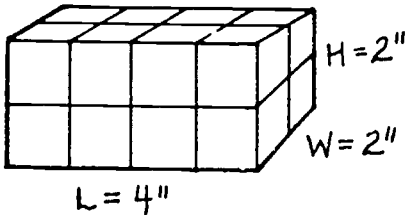
Example:



volume The amount of space inside a solid figure usually measured by a cubic centimeter, cubic inch, cubic foot, or cubic yard.

- To find the volume of a cube or rectangular prism, multiply the length times the width times the height.

$V = L \times W \times H$
$V = 4" \times 2" \times 2"$
$V = 16$ cu. in.

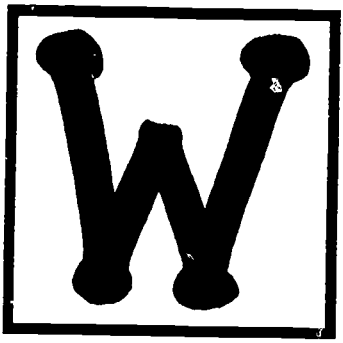


vowel Any letter of the alphabet that is not a consonant and sometimes *w* and *y*.

Long Vowel Sounds		Short Vowel Sounds	
ā	āpe	ă	căt
ē	ēqual	ĕ	hĕn
ī	īce	ĭ	pĭg
ō	ōpen	ŏ	ŏtter
ū	ūse	ŭ	cŭb
ȳ	flȳ		

vowel digraph Two vowels together that make one sound.

DIGRAPHS AND EXAMPLES		
ai	**ee**	**oo**
tr*ai*n	gr*ee*n	b*oo*k
j*ai*l	f*ee*t	g*oo*d
au	**ew**	**ou**
c*au*ght	ch*ew*	*ou*t
h*au*nt	m*ew*	c*ou*ch
aw	**ie**	**ow**
p*aw*	p*ie*s	sn*ow*
cr*aw*l	cr*ie*s	b*ow*l
ay	**ie**	**ow**
pl*ay*	stor*ie*s	h*ow*
h*ay*	th*ie*f	c*ow*
ea	**oa**	**ue**
p*ea*ch	b*oa*t	gl*ue*
*ea*t	gr*oa*n	bl*ue*
ea	**oo**	**ui**
h*ea*d	m*oo*n	s*ui*t
br*ea*d	sp*oo*n	fr*ui*t



weather - whether

The word *weather* refers to atmospheric conditions.

Example:
The *weather* will be cold and wet on Monday.

The word *whether* suggests a question.

Example:
I don't know *whether* she will go.

we're - where - were

The word *we're* is a contraction that means *we are*.

Example:
We're in the kitchen.

The word *where* is an adverb that tells or asks location.

Example:
Do you know *where* the cat is?

The word *were* is a past tense form of the verb to be.

Example:
We *were* in school yesterday.

whole number

An integer. Any number in the set (0, 1, 2, 3, ...)

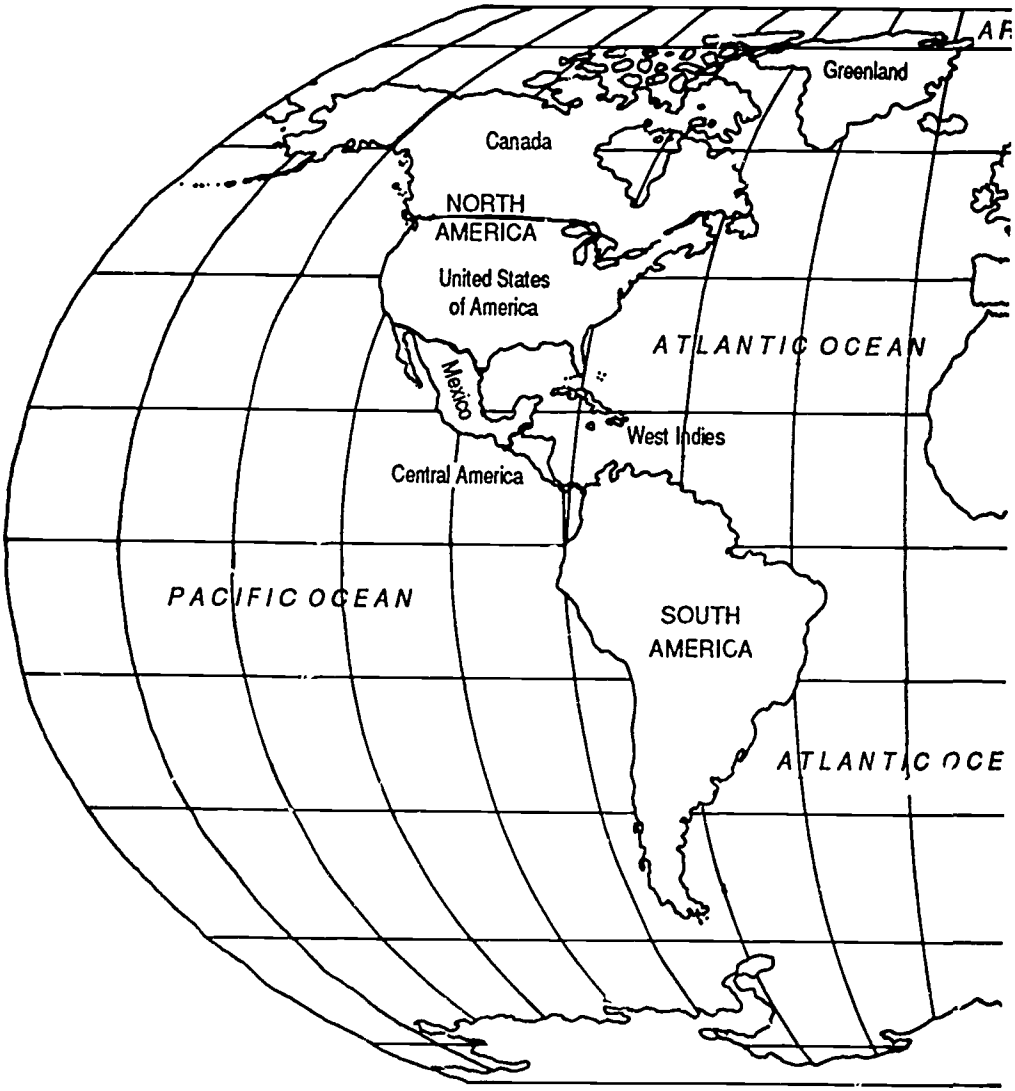
Also see integer.

world

The earth. The world is round. The circumference of the world at the equator is 24,902 miles (40,075 kilometers). The circumference when measured around the world at the poles is 24,860 miles (40,007 kilometers).

Also see **map of world** on pages 140 and 141.

THE WORLD


Greenland
Canada
NORTH
AMERICA
United States
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ATLANTIC OCEAN
Mexico
West Indies
Central America
PACIFIC OCEAN
SOUTH
AMERICA
ATLANTIC OCE


CTIC OCEAN
ASIA
Union of Soviet Socialist Republics
EUROPE
Korea
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NOTES

If you have any questions, comments, suggestions, or possible additions to offer **The KNOW IT ALL,** please let us know.

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The KNOW IT ALL
Resource Book for Kids

helps students find their own answers to questions about grammar, punctuation, measurement, and more. With this classroom resource, teachers can spend more time teaching, and students can improve independent work skills and gain confidence.

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Josh Deiler, student

The KNOW IT ALL is chockfull of the kind of information we all learn but don't always remember. As a new teacher, this is a fabulous, straightforward refresher.

Elizabeth Marks, teacher

About the Author

Patricia R. Peterson developed this book during her years teaching students of many levels—in regular classrooms and in gifted and learning disabled programs. She found this reference to be an asset in both enrichment and remediation programs.

The author holds a Bachelor of Science degree from Northern Illinois University. She received the Shipp Award in 1985 as the Outstanding Teacher of the Year at the Latin School of Chicago.

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