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An Annotated Bibliography of Materials for a Secondary Level Geometry Course

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Abstract

The contention is made that high school students experience frustrations in their pursuit of learning Euclidean geometry. Three causes of frustration are assumed: inadequate comprehension of new concepts; lack of a sense of need or usefulness of concepts presented; a lack of initial or sustaining interest in the subject. A further presumption is made that appropriate utilization of multimedia in the study of geometry will alleviate some of these frustrations.

In light of these assumptions and with substantial support for them in literature reviewed, an annotated bibliography of multimedia intended for incorporation into the study of Euclidean geometry and directed at alleviating some of the students' frustrations is presented. The reviewing sources referred to for possible listings are included. Items selected for inclusion received favorable reviews in these sources, and their entries include complete bibliographic information, their contents, specific concepts to which they relate, and appropriate grade level to which they are directed.

AN ANNOTATED BIBLIOGRAPHY OF MATERIALS FOR A SECONDARY LEVEL GEOMETRY COURSE

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CONTENTS

TABLES

Chapter 1

STATEMENT OF THE PROBLEM

Introduction

As an exercise in frustration to test the mettle of their students, schools incorporate mathematics into their curriculum. To assure that all have an equal opportunity to participate in this exercise, schools require their students to register for it. In order to respond to the different abilities and interests of their students, schools provide varying degrees of frustration by offering assorted courses in mathematics, among which is the study of geometry. As a means of measuring how well the geometry teachers are carrying out this facet of frustration, they record the number of times the following statements and questions arise: I never did understand math. How much longer will we be on this? What's this stuff good for? I haven't understood anything being done this last quarter. I don't know how to ask questions about what I don't know.

Though these opening comments are meant to be taken in a lighter vein, several of them suggest consideration of a serious matter--students of geometry frequently encounter frustrations along the way. As a teacher of geometry for several years, the writer has known several of these students and has had conversations with other geometry teachers who coincidentally experience frustrations as well in attempting

to alleviate their students' difficulties with geometry. The possible explanations for the difficulties students meet in their study of geometry as well as the potential remedies for those difficulties could be discussed at great length, but within this paper, consideration is given to three proposed explanations and one possible remedy.

The Problem

An examination of the reasons which may account for students' frustrations in their study of geometry could be a lengthy one if it was to exhaust the various possibilities. However, in an attempt to offer a remedy for these frustrations, examination must, out of necessity, focus on a limited number of reasons for these students' difficulties; three proposed explanations are herein offered.

The first proposition is that the student may lack adequate comprehension of the concept(s) under consideration, and if this condition exists for any length of time, the existing difficulty becomes compounded. Typical of mathematics in general and geometry in particular is the fact that the learning of one concept is dependent upon the understanding of earlier ones,[1] and so the longer a student is lacking the necessary insights, the more difficult the situation becomes. One may look at the manner in which the

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[1]Richard Lansdown, "Retardation in Mathematics: A Consideration of Multi-Factorial Determination," Journal of Child Psychology and Psychiatry and Allied Disciplines, 19:182, April, 1978.

concepts are presented, examined, and worked with in attempting to account for this lack of understanding, or one may credit this deficiency to the fact that geometry offers several new concepts, or at least a more in-depth study of them, along with new problem-solving techniques never before encountered such as the writing of a proof or the usage of a compass. Because of the newness of many aspects of geometry, the student treads new ground without any prior experiences from which to draw comparisons or relationships.

A second proposition for why a student may experience frustration in geometry may be the failure to sense a need for, or a potential use of, the concepts considered. Frequently, students find themselves in geometry to meet the mathematics requirement imposed by the school, so their purpose for being there is to get the necessary credit out of the way. Even those students who enter geometry with a more receptive attitude get bogged down in a constant flow of information regarding those questionably arcane concepts appropriate to the various topics of geometry. The continued presence in a course which seemingly has little of value to offer leads to frustration which in turn may be followed by indifference. In their writings, Butler and Wren[2] attribute most of the cases of failure in geometry to apathy that develops due to poor motivation and lack of

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[2]Charles H. Butler and F. Lynwood Wren, The Teaching of Secondary Mathematics (4th ed.; New York: McGraw-Hill, 1965), p. 455.

insight as to the usefulness of geometry.

The final proposition considered in this paper is a lack of initial or sustaining interest in the course. Many kinds of students experience this type of frustration--those who have a favorable attitude toward mathematics but feel restricted by working within the framework of textbook content, those who are receptive to being in geometry but feel that they are in a routine into which no variety is allowed entry, and those who are in geometry solely to fulfill their mathematics requirement. Whatever the case may be, the narrow conformity to textbook content and related concepts diminishes the interests students may bring into the course and certainly does not stimulate any interest for those who had none to begin with.

The remedy suggested here for these proposed explanations for students' frustrations with geometry is the appropriate utilization of a variety of materials to accompany the presentation, the discussion, and the manipulation of the concepts which deal with the various topics contained in geometry. The materials whose use is being considered here refer to the broad spectrum of print and nonprint items--books, periodicals, films, filmstrips, posters, models, etc. This assumption that the usage of materials may alleviate the proposed sources of frustrations for geometry students gives rise to the purpose for which this paper was written--to compile an annotated bibliography of materials for use by a teacher or a student of geometry.

The materials included are intended to relate to geometry in one of three ways:

1. Integrate into the study of specific definitions, postulates, and theorems on which the concepts to be learned are based. The use of these materials should aid in explaining or expanding on the nature of these concepts and provide insights into their usage in related problem-solving situations;

2. Illustrate, investigate, incorporate those aspects of geometry that may be used in real life situations or careers;

3. Provide avenues for individual or class investigation into areas of study, problems, devices, and activities that use geometry. These materials might be referred to as enrichment or diversionary materials and as such may hold recreational or aesthetic appeal or may simply be looked at as fun to try or as a means of allowing one to go beyond the course's conceptual studies. Such material ranges from information on curve-stitching or string sculpture to studies and views of geometry in nature or art forms to puzzles requiring familiarity with terms or logical thinking to studies of triangles and additional concepts as they apply in trigonometry. The usage of this type of material would allow for reinforcement of past and present concepts as well as practice in the reasoning necessary to correctly apply those concepts--all of this done in a manner that may be perceived by students as less formal and therefore more

enjoyable.

Significance of the Study

Numerous bibliographies of mathematical materials do exist, and within them are listed geometry materials. The National Council of Teachers of Mathematics, for example, regularly publishes a bibliography of mathematical materials, and the subject-related magazines such as The Mathematics Teacher and School Science and Mathematics compile lists of mathematical materials and activities which have appeared in their publications. But such lists do not provide information regarding contents, possible uses of, or appropriate grade or age levels for effective use of the materials. Other types of bibliographies are more specific and offer information regarding activities, projects, or instructional strategies that have been used successfully in geometry instruction. This type of bibliography typically follows articles containing discussions, studies, or descriptions of geometry instruction. Bibliographies of this nature fall short of the kind that follows in that the contents and appropriateness of materials as they might relate to specific concepts are not identifiable from such listings. Granted, this sharing of methods and techniques which employ materials effectively are most beneficial, but the emphasis of the subsequent bibliography is to provide a multimedia list of relevant materials with which to plan successful and stimulating learning activities by integrating them into the study of geometry. In the apparent absence of a

bibliography that specifically consolidates and annotates materials that may be incorporated into the study of geometry, efforts were directed toward the compilation of such a bibliography. This bibliography could then serve as a ready-reference of items to be drawn from as time and necessity would indicate their usage to be beneficial. With such a list on hand, a geometry teacher could select materials relating to specific concepts to be considered and arrange to have those materials available at the time their implementation would support the consideration of the concepts; the teacher could choose from the list those items that readily demonstrate applications of particular concepts; the teacher could draw from the list items whose integration into the course could serve as enrichment for the class or whose availability would permit them to be offered as suggestions for independent study by a student.

Assumptions

Certain assumptions underlie the determination that the compilation of an annotated bibliography of geometry-related materials will be of value to the student and the teacher of geometry. The overriding assumption is that the appropriate and thoughtful integration of these related materials into the study of geometry will alleviate some of the sources of frustrations experienced by students in geometry. In particular, it is assumed that the utilization of these materials, both print and nonprint will: (1) promote a better understanding and learning of the geometrical con-

cepts on the part of the student, (2) help students perceive the study of geometry as being "enriched" because of the exposure to materials that may hold a personal interest or appeal, and (3) stimulate or sustain students' interest in the study of geometry and thus, act as a motivational factor for continued learning.

Definitions

A few definitions seem in order to clarify the bibliography's intended beneficiaries and the specific content area.

The students referred to are those in grades nine through twelve; the geometry being considered is that based on Euclid's system. His system contrasts with others because of his Parallel Postulate: Through a point outside a line not more than one parallel line can be drawn to the line. Other mathematicians found that within Euclid's system, this could not be proven, so this postulate served as a point of departure for other mathematicians to develop different systems of geometry. The concepts of geometry alluded to in this paper are those relating to topics commonly included in a high school geometry course: triangles--their distinguishing properties and the necessary conditions for them to be congruent or similar; quadrilaterals--the assorted kinds of four-sided figures and their distinguishing properties; circles--the particular relationships of arc, angle, and segment measures; constructions and locus problems--the location of points according to specified conditions through

the use of a compass and straightedge; coordinate geometry--the usage of the specific properties of geometric figures previously mentioned in combination with their positioning on a coordinate plane; transformations--the movements of a figure from one location to another according to various prescribed definitions; and areas and volumes of assorted plane figures and solids--the development of the formulas that represent these measures.

Chapter 2

REVIEW OF THE LITERATURE

On the whole, the literature written by mathematics educators as well as by people in the general field of education strongly supported the usage of materials to facilitate the understanding of new concepts. Sifton, in her article, promoted the use of visual aids in teaching mathematics, suggesting that the impact a picture may make on the mind often bears a more lasting effect than written or spoken words.[1] In the summary of their study and conclusions regarding fear-reducing techniques to teach mathematics to students, Resek and Rupley encouraged the use of concrete examples and visual representations to introduce new concepts or approaches to solving problems.[2] In a similar vein, Butler and Wren encouraged the usage of "sensory experiences", as they called them, particularly in helping students gain insights into new ideas that initially are not as easily understood through reading or abstract

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[1]Edith Sifton, "Multi-Sensory Aids: Some Theory and a Few Practices," Multi-Sensory Aids in the Teaching of Mathematics, Eighteenth Yearbook of the National Council of Teachers of Mathematics (New York: AMS Reprint Co., 1966), p. 2.

[2]Diane Resek and William H. Rupley, "Combatting 'Mathophobia' With a Conceptual Approach Toward Mathematics," Educational Studies in Mathematics, 11:427, November, 1980.

reasoning.[3] Another writer, Hartung, viewed the implementation of various materials as using additional learning aids that function much like a textbook:

> ...they serve to clarify concepts and processes, explain how a principle works, or bring background situations and data from the outside world into the classroom. Because they help students get increased meaning and understanding these learning aids tend to increase interest and promote the development of favorable attitudes.[4]

Meder offered an added dimension for the need to integrate supplementary materials into instruction: to assist in meeting the individual needs of the students who learn in different ways. The additional materials would allow for the presentation of ideas in different formats with different emphases which would likely reach more students than the single textbook approach.[5] In conducting a study regarding a classroom teacher's influence on students using library materials, Blazek used two junior high mathematics classes and their teacher as subjects. He found a number of sources supporting his assumption that the use of a variety of media (like that found in a library) is indeed of instructional value due to the appeal that can be made to

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[3]Butler and Wren, op. cit., p. 113.

[4]Maurice L. Hartung, "Motivation for Education in Mathematics," The Learning of Mathematics: Its Theory and Practice, Twenty-first Yearbook of the National Council of Teachers of Mathematics (Washington, D. C., 1953), p. 54.

[5]Albert E. Meder, Jr., "Using the Library in High School Mathematics," School Libraries, 6-10:12, March, 1959.

various students' approaches to learning.[6] Although not specifically indicating that multimedia should be used in instruction, Wehmeyer and Jonassen in separate writings leave the reader with that impression. Wehmeyer stated that most people learn via all of their senses, but that individuals develop their own style of information intake, storage, and retrieval.[7] The inference that might be taken from this is that the use of various types of materials to present new ideas could be advantageous because of their appeal to individual learning styles--one type of material being more meaningful than another for a particular person. Jonassen, too, echoed similar comments in his examination of the conclusions found in research studies of various cognitive styles and controls of learners and concluded that a very basic consideration in designing instructional strategies is allowing for learners' individual approaches to "the processing of various stimuli."[8] Here, too, similar implications are suggested regarding the appropriateness of using a variety of materials to promote the learning of ideas.
In general, the contention of the literature read was that

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[6]Ron Blazek, Influencing Students Toward Media Center Use (Chicago: American Library Association, 1975), pp. 40-3.

[7]Lillian B. Wehmeyer, "Media and Learning: Present and Future--Part I: The Present," Catholic Library World, 50:151, November, 1978.

[8]David H. Jonassen, "Cognitive Styles/Controls and Media," Educational Technology, 19:28, June, 1979.

the use of multimedia is a valid and necessary consideration in instructional planning for reasons that could well be summarized in a comment by Langrehr: "Individualizing or personalizing instruction does not involve isolating the learners, but necessitates offering each student a choice in what to learn and how to go about learning it."[9]

Before continuing, it should be pointed out that while the literature found was most encouraging of the use of multimedia for instructional purposes, there were frequent expressions of caution regarding the selection of materials and provision for an appropriate framework in which to use them. Such was the message conveyed in Van Hoozer's article in which she said that the use of media is not essential but rather it is the thinking process they invoke that holds instructional value, so careful analysis and identification of problems or needs must be made in order to utilize appropriate media.[10]

Regarding the second purpose for which additional materials might serve as a remedy--to provide students with illustrations and demonstrations of uses and needs for what they are learning--again, strong support can be found in the literature. Unquestionably, writers expressing opinions regarding the teaching of mathematics, consistently urged

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[9]John Langrehr, "Match the Materials and the Learners," Audiovisual Instruction, 23:22, September, 1978.

[10]Helen Van Hoozer, "Back to Basics: Same Song, Second Verse," Audiovisual Instruction, 24:45, April, 1979.

teachers to provide their students with insights as to how the concepts they are learning can be applied. Using additional materials as a vehicle for providing these insights is stressed by Meder, pointing out that the use of a textbook alone can often be an obstacle in trying to achieve this purpose.[11] Both Wilderman[12] and Bell[13] in separate articles encouraged the usage of materials as a means of presenting students with the applications of concepts being learned, pointing to the advantage of using concrete methods to illustrate the usage of abstract relationships in real life situations. Fawcett and Cummins voiced a similar opinion, adding that the usage of supplementary materials is a means of "bringing mathematics to life in the classroom"[14] thus lending a certain richness to the instruction.[15] While not specifically addressing the need or benefit of providing students with illustrations of the applications of concepts they are being taught, Tyler urged the development of media

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[11]Meder, op. cit., p. 11.

[12]Ann M. Wilderman, "Mathematics: Yesterday, Today and Tomorrow," Teacher, 93:49-50, March, 1976.

[13]Kate Bell, "The Making and Use of Slides for the Teaching of Mathematics," Multi-Sensory Aids in the Teaching of Mathematics, Eighteenth Yearbook of the National Council of Teachers of Mathematics (New York: AMS Reprint Co., 1966), p. 289.

[14]Harold P. Fawcett and Kenneth B. Cummins, The Teaching of Mathematics from Counting to Calculus (Columbus, Ohio: Charles E. Merrill Publishing Co., 1970), p. 4.

[15]Ibid., p. 37.

that would enrich learners' inadequate backgrounds and provide them with awarenesses of the demands imposed on them by their ever-changing society.[16] An inference one might make from this is that students' educational experiences (including geometry) can be far more fulfilling when provided with insights as to a meaning, a purpose, or a situation to which they can apply what they are learning.

With respect to the final proposition--that materials can assist in providing students with interest and motivation toward learning mathematical concepts--the literature once again provides considerable support. A survey conducted by Pagni of students' reactions to procedures carried on in mathematics classrooms illustrates a point which several other writers made: students found the class to be more interesting and fun when outside materials were used as opposed to being bored when the same repetitive routine was followed.[17] Mitzman,[18] Tunis,[19] and Butler and Wren[20] encouraged the usage of additional materials as a means of

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[16]Ralph W. Tyler, "Utilization of Technological Media, Devices, and Systems in the Schools," Educational Technology, 20:13-4, January, 1980.

[17]David L. Pagni, "Mathematics Classroom Procedures-A Student's Perspective," School Science and Mathematics, 78:702, December, 1978.

[18]Barry Mitzman, "Seeking a Cure for 'Mathephobia'," American Education, 12:12, March, 1976.

[19]Harry B. Tunis, "Career Education--Out With the New Math?" School Science and Mathematics, 78:145, February 1978.

[20]Butler and Wren, op. cit., p. 123.

breaking from the routine and providing students with a view of mathematics that they may not have thought existed. In their study of the interrelationship of students' abilities, achievements, and attitudes regarding the study of mathematics, Brassell and fellow colleagues reported that students often perceived mathematical activities divorced from the textbook as enjoyable and that this perception in turn reduced their anxiety toward mathematics and helped their performance in the subject.[21] Similarly, in search of continued support of his study, Blazek identified several writers he found who urged the use of a variety of materials to supplement the teaching of mathematics because such usage stimulated students' interest and increased their mathematical competencies.[22] Jones' survey of teachers as to what they felt impeded the stimulation of curiosity within their students showed that, among other things, rigid conformity to curricula was a major factor.[23] If one reasons a bit farther from that statement, the implication seems to be that if some variety is permitted into the teaching of a subject, the curiosity of the student could very well be ignited. In a similar view, Hartung, too, suggested that

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[21]Anne Brassell, Susan Petry, and Douglas M. Brooks, "Ability Grouping, Mathematics Achievement, and Pupil Attitudes Toward Mathematics," Journal for Research in Mathematics Education, 11:27, January, 1980.

[22]Blazek, op. cit., pp. 45-7.

[23]R. Stewart Jones, "Teachers Who Stimulate Curiosity," Education, 101:162, Winter, 1980.

the overuse of any single device lessens the interest of a student, whereas, the variety of experiences that the effective usage of outside materials can bring to a class attracts students' attention which in turn stimulates interest.[24] Langrehr stressed that: (1) students assessed as low in motivation and creativity need to work with materials that are high in these two characteristics; (2) students low in educational experience or intelligence need to work with materials equal to their capabilities to prevent frustration; and (3) students high in motivation, creativity, educational experiences or intelligence would probably develop their capabilities faster with usage of materials which match these characteristics.[25] Therefore, one might presume from his conclusions that a variety of multimedia on a subject, selected carefully, could reduce frustrations, increase motivation, and stimulate growth within individual students. With a somewhat different approach, both Meder[26] and Scott[27] promoted the provision of supplementary materials to allow students to pursue their own areas of interest, to find some aspect of mathematics that they could work with independently.

With the findings provided by the review of litera-

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[24]Hartung, op. cit., pp. 54-5.

[25]Langrehr, op. cit., p. 20.

[26]Meder, op. cit., p. 13.

[27]Joseph J. Scott, "Mathematics Enrichment Through Projects," School Science and Mathematics, 66:737, November, 1966.

ture, it seems apparent that the teaching of geometry-related concepts can be enhanced by the appropriate usage of additional materials beyond the textbook, and that the frustrations students of geometry frequently experience can be remedied by the incorporation of these materials into the instruction of geometry.

Chapter 3

METHODOLOGY

The entries in the following bibliography represent those materials, both print and nonprint, which have received favorable reviews regarding content and potential usage in the study of concepts related to a high school geometry course. It should be realized here that nonprint materials for geometry besides including films, filmstrips, posters, games, and other items which are usually considered to fall into this category, may also include models or devices which have separate pieces that can be moved or assembled in different ways to allow for a variety of shapes and forms to evolve, and computer programs which provide for geometry-related concepts to be dealt with through the use of computer software. Therefore, inclusion in the bibliography implies that the item, regardless of its format, has received a favorable recommendation for use and that its content would support the study of the concepts of geometry.

The sources which were searched to find recommended materials were The Booklist, School Library Journal, Media Review Digest (formerly Multi-Media Reviews), Previews (now incorporated into School Library Journal), The Arithmetic Teacher, The Mathematics Teacher, School Science and Mathematics, Curriculum Review, The Two-Year College Mathematics Journal, The American Mathematical Monthly, The Computing

Teacher, and Arrowhead AEA's Computer Assisted Instruction. As a group, these sources provide evaluative reviews by people knowledgeable of the subject matter. In particular, The Booklist and School Library Journal provide reviews of both print and nonprint; Media Review Digest and Previews supply reviews of nonprint materials; The Arithmetic Teacher, The Mathematics Teacher, and The American Mathematical Monthly review both print and nonprint (including computer software in the case of The Mathematics Teacher) materials with a major emphasis on print materials; School Science and Mathematics, The Two-Year College Mathematics Journal, and Curriculum Review offer reviews of print materials only; and The Computing Teacher and Computer Assisted Instruction provide reviews of educational computer programs. These identified reviewing sources as a group would:

1. Permit equal access to print and nonprint materials. As indicated above, some sources review print only or else nonprint while others review both; within the group that reviews nonprint materials, there are some which review computer software while others do not. This combination of sources would allow for an equal access to a variety of formats that are reviewed;

2. Provide access to materials suitable for varying degrees of capabilities within high school students to learn geometry. All of the identified sources include reviews of materials appropriate for use at the secondary level. The Arithemetic Teacher, however, reviews materials suitable

for students in the kindergarten to eighth grade age group; it was included as a means for locating materials which might present geometry concepts in a less complex manner and therefore, be of value for students experiencing difficulties. The Mathematics Teacher and School Science and Mathematics are primarily aimed at secondary school audiences and therefore, offer reviews of materials for use at that age level. The Two-Year College Mathematics Journal and The American Mathematical Monthly review materials which are usable at the high school or university levels and therefore, provide access to materials that might be somewhat more sophisticated in presentation but yet require no more mathematical background than a high school geometry student would be involved in learning. These two sources would allow for the identification of materials which would challenge more perceptive high school geometry students to add to or expand upon their current geometrical understandings. The remaining sources contain reviews of materials suitable for use in kindergarten through high school with no one audience given priority over another. Thus, this combination of sources seemed to allow for equal access to a balanced representation of material for a variety of age groups and therefore, for different levels of student capabilities for learning geometry;

3. Allow for a representation of materials reviewed in terms of varying degrees of emphases. Within the identified sources, there are several whose entire contents are

devoted to mathematics or math-related discussions, articles, activities, or materials--The Arithmetic Teacher, The Mathematics Teacher, School Science and Mathematics, The Computing Teacher, The Two-Year College Mathematics Journal, The American Mathematical Monthly--and as such, speak to an audience particularly interested in mathematics. Within the contents of these sources, one finds information regarding mathematical activities and materials suitable to various grade levels of students as previously mentioned. In light of these two considerations and the understanding that none of these sources has as a major function that of being a reviewing tool, one must realize that the reviews which are presented are done so under these areas of emphases.

The remaining sources--The Booklist, School Library Journal, Curriculum Review, Previews, Media Review Digest, Computer Assisted Instruction--direct their efforts according to other guidelines. Their audience represents a broad spectrum of interests. Their contents include discussions, articles, activities, or materials that may relate to the broad range of offerings in a school's curriculum with no single subject area having priority over another. As indicated earlier, these sources include materials suited to secondary school students, but in all cases, include materials for other grade levels as well, some lower and some more advanced. In all cases, this last group of sources has as one of their primary functions that of reviewing materials, so again, one must realize that the reviews which are pre-

sented are subject to a different set of guidelines as compared with the first group;

4. Provide direction to reviews located in sources other than those identified through the use of the Media Review Digest which includes as its reviewing sources not only some of those already identified but others as well.

Sources from 1975 through June, 1981 were searched page by page for reviews of appropriate materials by going through the sections of each source designated for reviews. Because of the interest in nonprint materials as well as print materials, the 1975 cut-off date was chosen. A list of nonprint material currently available for order is nonexistent, so items of nonprint beyond 1975 may no longer be produced and, therefore, unavailable. In addition to this problem, nonprint media prior to 1975 (and in some cases after 1975) are likely to be dated in information and visual representations. While certain aspects of geometrical concepts are basically unchanging no matter what the time period, certain illustrations, particularly in the area of applications and current uses of concepts, may have images that are dated, lacking in information, or no longer valid.

The items finally selected for inclusion in the following bibliography are compiled and organized in the following manner:

1. Complete bibliographic information is provided--title, author/producer, publisher/distributor and their address, copyright date; in the case of a film or filmstrip,

the time required to show it or the number of frames it has and whether it is in color or black and white is included; in the case of a kit, the identification of its components is included; the type of format is indicated and set off for quick and easy identification; the source in which the item's review was found is also included. Due to frequent fluctuations in cost, the price is not included.

2. An annotation containing a brief description of the contents and the grade or age level for which it is most suited accompanies each entry. The annotation represents the writer's summary of information gathered from reading the review. Exceptions to this were made in two cases: (1) films illustrating possible career applications; (2) Computer Assisted Instruction programs. In the first case, film reviews regarding the kind of information and illustrations to be expected were so broad that one was unable to assess whether geometrical relationships would be illustrated or even be contained in the presentation. Therefore, those films which could be secured through Arrowhead AEA were previewed by the writer, and those which were found to demonstrate applications of geometry were included in the bibliography. In the second case, the computer programs were readily accessible to the writer and were personally examined and reviewed by the writer to determine their usefulness.

3. Entries are listed alphabetically according to title under the following subdivisions--triangle, quadri-

lateral, circle, construction/locus, coordinate geometry, transformation, and area/volume. An appendix follows the last subdivision's list and includes those items whose incorporation into the study of geometry was determined to be of value but whose reviews did not permit identification of specific concepts that would be supported by their use.

4. Items which were determined to relate to more than one subdivision are listed under each appropriate subdivision. However, additional listings of an item after the first time only indicate the title and a reference to the first listing for the remaining information.

Limitations

In consulting the bibliography of compiled geometry-related materials, one must evaluate the entries in light of several limitations. One such limitation is the scope of concepts from Euclidean geometry being dealt with. The concepts considered are those which underlie discussion of only some topics commonly found in secondary school geometry studies--triangle, quadrilateral, circle, construction/locus, coordinate geometry, transformation, and area/volume. Other concepts certainly exist and in different systems of geometry, even those concepts being considered would be altered. Thus, the scope of geometrical thinking which might find support from the listed bibliographic entries is limited.

A second limitation involves the sources for the items entered. In selecting materials only from the iden-

tified periodicals, one's basis for selection is narrowed to what was chosen to be reviewed in those periodicals. Most assuredly, these few periodicals could not encompass all the reviews of the materials available. What also should be made clear is that bibliographies which list geometry-related materials and activities were not consulted for possible entries in the following bibliography. These bibliographies, while they contained potentially useful items for the intended bibliography, were only lists, and the content and value of the material listed could not be determined unless looked up further for a review which might or might not have existed. Consideration of geometry-related activities using appropriate materials was beyond the scope of this paper. The purpose of compiling the bibliography that follows was to provide a list of materials whose integration into the study of geometry would in some way alleviate students' frustrations in their study, <u>not</u> to suggest how to use these materials.

A third limitation concerns the items listed in the following bibliography. Their inclusion was based upon a favorable opinion expressed by a knowledgeable reviewer and then subjected to the opinion of the writer as to whether the review indicated potential usage for learning geometrical concepts. So one must bear in mind that the value and usefulness of any material ultimately lies in the user's framework and needs. Only one opinion regarding the quality of the actual item is represented; the writer has not viewed

the material but is suggesting the use of it solely from interpretation of the review. Exceptions to this were made in the two cases referred to earlier: films containing information about careers were subjected to the writer's evaluation after previewing them for demonstration of geometric applications; Computer Assisted Instruction programs were examined and reviewed by the writer to determine the concepts to which they related and how beneficial their usage would be in learning those concepts. Therefore, the user of the following bibliography must weigh the potential use of an item in light of the manner of inclusion.

A fourth limitation to be aware of is the time period from which the selected reviewing sources were used. 1975 to June, 1981 may have excluded materials which may have provided good support in examining geometric concepts or included materials which offer inaccurate or dated information with respect to present day situations. The latter part of this statement may be particularly true with respect to illustrations of applications of geometry concepts in today's job market for example. Another consideration with respect to this time factor is that the nonprint materials from early in this time period may no longer be in production and, therefore, unavailable for use. As indicated earlier, no list of nonprint materials currently available exists to which one could turn to find out if they are still available for order.

A fifth limitation is in the following bibliography's

concluding appendix. This section includes geometry-related materials, just as the preceding subdivisions do. However, included here are items whose contents were not distinguishable enough from their reviews to determine specific subdivisions under which to enter them. The potential user of the bibliography must understand that the appendix entries may integrate well into the study of any of the concepts related to the specific subdivision titles and therefore, should refer to this section for additional materials which may be usable as well for a specific concept.

A sixth and final limitation considers the assumptions made regarding the contributing factors to students' frustrations in studying geometry. To be sure, there exist other sources of frustration for students in geometry, but only three have been singled out and addressed. It is to these sources of frustration that the items listed in the following bibliography are aimed at remedying.

Chapter 4

SUMMARY

The annotated bibliography that evolved contains seventy-four different entries. An examination of the entries and the sources from which they were gathered seems in order at this point. In portions of the following examination, the entries are categorized as print or nonprint. For this discussion, print refers to books and spirit masters; nonprint refers to films, filmstrips, kits, computer programs, and posters.

As previously mentioned, seventy-four different items were selected for the bibliography, twelve of which were listed in more than one section. The following table indicates the total number of entries per section, subdivided into categories of print and nonprint items.

Three specific topic sections--triangle, quadrilateral, and area/volume--obviously accumulated the most entries which seems appropriate in light of the frequency with which students are required to work with these figures and their related concepts throughout a typical high school geometry course. While it is good that these very basic topics receive the attention they do, it is unfortunate that other topics are lacking similar support. The study of topics such as construction/locus and coordinate geometry is often difficult for students because of their unfamil-

iarity with the concepts involved; certainly quality instructional materials incorporated with the study of such topics would be invaluable if available.

Table 1

Number of Items by Section of the Bibliography

Section	Print	Non-print	Total
A. Triangle	8	10	18
B. Quadrilateral	5	7	12
C. Circle	4	3	7
D. Construction/Locus	4	4	8
E. Coordinate Geometry	0	4	4
F. Transformation	7	2	9
G. Area/Volume	8	6	14
H. Appendix	19	7	26
Total	55	43	98

Surprisingly, the circle, whose figure is familiar to most students and one fundamental to the study of geometry, has few entries. Once again, the study of concepts peculiar to the circle could certainly be promoted by usage of appropriate instructional materials if only they were reviewed and available.

Not surprising is the number of entries which could be integrated with many facets of geometry. The appendix section whose total number of entries is greatest, contains several such items. As frequently happens, an area of study

like geometry, though made up of several independent concepts, is viewed in terms of its individual components operating simultaneously. Availability of such materials is extremely important; while an item may not effectively illustrate a particular concept, it may instead offer a more realistic setting, illustrating a concept operating in concert with others rather than in isolation.

One final comment regarding information on this table: since the study of transformations deals with the movement of points in manners prescribed by definitions, what better way to reinforce or illustrate such work than by film which uses motion as one vehicle for messages? Yet this section's entries are primarily print materials; unfortunately the two nonprint items do not include films. Again, it seems that the study of still another aspect of geometry could be furthered if only appropriate materials were reviewed and available.

In further examination of the contents, Table 2 illustrates the type of media, categorized as print or nonprint, and the number of each type that comprises the annotated bibliography.

This breakdown illustrates something that has been true for a number of years with respect to geometry: the materials relating to the study of geometry are predominantly print materials. As a single type of media, books constitute the most entries; taken as a group, the nonprint entries barely exceed the total number of print entries. An addi-

tional consideration that should be made here is that the majority of the computer programs included are the print-out variety which are question/answer or statement/reason types. In a majority of these cases then, though the medium is different, the emphasis is still on the printed word.

Table 2

Number of Bibliography Items by Type of Media

Media	Number
Print	
Books	32
Spirit masters	4
Total	36
Nonprint	
Films	12
Filmstrips	6
Kits	1
Computer programs	18
Posters	1
Total	38

This is not to diminish the value that geometry-related print materials contribute to its study, but so many concepts in geometry--measurement, congruence, similarity, symmetry, perpendicularity, and parallelism to name a few--can be demonstrated so well via visual presentations and movements, and it seems unfortunate that more has not been done with these concepts of geometry. Add to this the fact

that so many of these concepts relate to concrete figures like circles, triangles, quadrilaterals, other polygons and related solids, and the insufficient nonprint support becomes even more disappointing.

A final table provides a means for examining the contributions made by each review source to the final group of entries used in the bibliography. The table includes a list of sources followed by the number of reviews found in each arranged according to type of media--print or nonprint--and organized in columns headed by the year of publication of the entry reviewed. Because the information is organized in this manner, one may compare not only the number of items found per review source, but also the number of usable items according to media type within each review source as well. Similarly, with the information organized as it is, one may note any changes which occur from one year to the next regarding the number of geometry-related materials found usable according to type of media.

Not included in Table 3 are four film entries that were found in Arrowhead AEA's 16mm film catalog and previewed by the writer. Sources through June, 1981 were searched, but as is often the case, previous years' copyrighted materials were usually reviewed. Therefore, since the materials reviewed and selected did not exceed a 1980 copyright, no 1981 column was necessary.

With respect to the number and kind of entries contributed by each source, some findings could reasonably

Table 3

Number of Bibliography Items by Review Source, Year, and Type of Media

Sources	Years												Sub-total		Total
	1975		1976		1977		1978		1979		1980				
	P*	NP*	P	NP	P	NP	P	NP	P	NP	P	NP	P	NP	
AMM	1		1	1	4		1		1				8	1	9
AT													0	0	0
Bklt		1			1		2		3	1			6	2	8
CAI						1						15	0	16	16
CT												2	0	2	2
CR									4	1	1		5	1	6
MT	3		1	1	2	1	1	1	1		2		10	3	13
Pr		1				1		1		4		1	0	8	8
SLJ					1								1	0	0
SSM			1		1		1						3	0	3
TYCMJ					1		2		1				4	0	4
Sub-total	4	2	3	2	10	3	7	2	10	6	3	18	37	33	70
Total	6		5		13		9		16		21		70		70

*P = print, NP = nonprint

AMM—The American Mathematical Monthly, AT—The Arithmetic Teacher, Bklt—The Booklist, CAI—Computer Assisted Instruction, CT—The Computing Teacher, CR—Curriculum Review, MT—The Mathematics Teacher, Pr—Previews, SLJ—School Library Journal, SSM—School Science and Mathematics, TYCMJ—The Two-Year College Mathematics Journal

have been expected; others were surprising. In many cases, the intention of the publication was clear by the type of media reviewed and by how many reviews were given. Computer

Assisted Instruction, Computing Teacher, and Previews offered reviews of nonprint material only which is each ones area of emphasis; Booklist, American Mathematical Monthly, and Mathematics Teacher offered reviews of print and nonprint materials, though more print than nonprint items were found relating to geometry in each case. Naturally, because of its intended function, Booklist had far more reviews in general than did either American Mathematical Monthly or Mathematics Teacher, though American Mathematical Monthly and Mathematics Teacher had far more reviews than expected since neither publication's primary purpose is to be a reviewing tool. School Library Journal had surprisingly few usable offerings among its multitude of reviews considering that its primary function is to provide reviews of a wide spectrum of materials.

Not surprising was the absence of reviews of any usable geometry materials in Arithmetic Teacher. The audience to which Arithmetic Teacher relates does not commonly study geometry in any great depth, so very few such materials are likely to be considered by its reviewers. Computing Teacher being a newer publication with fewer publications per year could not offer as many reviews as other publications; since the reviewing done in it is also kept at a minimum, few reviews of geometry-related programs could be expected.

Somewhat surprising was School Science and Mathematics' few reviews in general. For all intents and pur-

poses, School Science and Mathematics and Mathematics Teacher are directed at the same audience to convey similar kinds of information and activities. However, Mathematics Teacher had a far greater number of reviews which naturally allows for a greater possibility of locating reviews of geometry-related materials.

In looking at the total number of usable entries by year of copyright, a tendency to find more geometry-related materials as time progresses can be noted, though exception to this is found in 1976 and 1978. Of note here is that of 1980's twenty-one total entries, seventeen of the nonprint ones are computer programs and fifteen of these were found in Computer Assisted Instruction, a locally available source. The number of 1980 entries minus those of which are computer programs leaves a remainder which causes one to question the reason for an apparent shortage or absence of geometry-related materials in other media formats. However, this shortage or absence of such materials may not be real. For example, the programs reviewed in Computer Assisted Instruction are made known and available only to the people who are in the Arrowhead AEA's territory; therefore, individuals not served by Arrowhead AEA may be unaware that such materials exist and are theirs for the asking. Thus, the absence of a variety of media formats from reviewing sources does not necessarily mean the media do not exist; it may be that attention has simply not been given to them yet.

Regarding each year's number of print versus non-print materials making up the entries used, one observation made earlier is reaffirmed by this table's information: print material is the predominant type of media with respect to geometry materials. Only 1980's totals take exception to this.

One final observation remains. Of the sources searched, Mathematics Teacher, Booklist, Computing Teacher, Curriculum Review, and School Library Journal (though virtually none of its reviews were ultimately used) provided the most informative reviews. They presented the reader with substantial information regarding the item's contents and sufficient details to give the reader insights as to how the item could be put to use.

Chapter 5

ANNOTATED BIBLIOGRAPHY OF GEOMETRY MATERIALS

The following list shows the abbreviations and to what they refer as they are used to identify the review sources in the bibliography entries.

AMM	The American Mathematical Monthly
Bklt	The Booklist
CT	The Computing Teacher
CR	Curriculum Review
MT	The Mathematics Teacher
Pr	Previews
SLJ	School Library Journal
SSM	School Science and Mathematics
TYCMJ	The Two-Year College Mathematics Journal

A. TRIANGLE

Bye 3. % William Ashby,* Arrowhead AEA, 1235 5th Ave. S., Fort Dodge, IA 50501, 1980. Run time: 5 min.
(computer program)

Lists fifty Pythagorean triples, i.e., possible measures for legs and hypotenuse of a right triangle. Provides a means of reinforcing the Pythagorean theorem.
Grade level: 7-college.
Review: By the writer.

Bye 5. % William Ashby, Arrowhead AEA, 1235 5th Ave. S., Fort Dodge, IA 50501, 1980. Run time: varies.
(computer program)

Calculates missing part(s) of a right triangle. Allows for three problem situations: hypotenuse unknown; one leg measure unknown; both leg measures unknown but

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*This computer program and those throughout the bibliography that have Mr. Ashby's name following them are available through Arrowhead AEA. No authors' names have been recorded for these particular programs.

equal. Provides students opportunity to work through or check related problems given on teacher-prepared worksheets. Grade level: 7-college.
Review: By the writer.

Congruent Triangles. Bruce and Catherine Cornwell. International Film Bureau, Inc., 332 S. Michigan Ave., Chicago, IL 60604, 1978. Color. 7 min. (16mm film)

Visually presents the sufficient conditions to prove triangles congruent for three different cases: SAS, ASA, and SSS. The generating of the congruent parts, the color highlighting of them, and the movement of one triangle to its congruent counterpart to show the "fit" make this film an effective instructional device. Grade level: 9-12.
Review: MT, January, 1979, p. 69.

Dot Paper Geometry. Charles Lund. Cuisenaire Co. of America, Inc., 12 Church St., New Rochelle, NY 10805, 1980. (book)

Exercises are classified under seven headings: Intro. to Polygons and Their Properties; Fractions, Decimals, and Percents; Area of Polygons; Angle Measure; More Prediction Problems; Masters for Teachers; and Quizzes. Pages of masters contain worksheets suitable for doing activities listed under other headings. Offers many activities accompanied by instructions, sample exercises, and follow-up questions. Grade level: 7-12
Review: MT, May, 1981, p. 391.

Experiencing Geometry. James V. Bruni. Wadsworth Publishing Co., 10 Davis Dr., Belmont, CA 94002, 1977. (book)

A rich source of informal and intuitive learning experiences that are arranged for by analyzing photographs and figures, constructing models, folding paper, tracing drawings, and using a compass. Activities are clearly pictured and explained. Chapters include sections on triangles, quadrilaterals, symmetry, perimeter and area, the Pythagorean theorem, congruence and similarity, circles, transformations, measuring solids, and the Platonic solid. Grade level: 9-college.
Review: MT, January, 1978, p. 74.

Geo II. c/o William Ashby, Arrowhead AEA, 1235 5th Ave. S., Fort Dodge, IA 50501, 1980. Run time: varies. (computer program)

Provides three different proofs showing two triangles congruent. Student selects reasons for state-

ments made from a specified list of postulates, theorems, and definitions. Grade level: 10-12.
Review: By the writer.

Geometry in Modules, An Informal Course. Muriel Lange. Addison-Wesley Publishing Co., Jacob Way, Reading, MA 01867, 1975. (book)

Directed at those who have difficulty with a formal high school geometry course. Organized as a self-study, discovery approach to geometry with new terms presented pictorially. Modules are devoted to measurement, congruence and parallelism, and circles and spheres. Grade level: 10-12.
Review: AMM, October, 1978, p. 692.

Informal Geometry Activities. J. D. Gawronski, G. R. Prigge, and K. E. Vos. J. Weston Walch, Publisher, P.O. Box 658, Portland, ME 04104, 1979. (spirit masters)

Fifty ditto masters designed to accompany classroom instruction. Include problems covering congruence, circles, similarity, area, and an additional few on closed curves, networks, and tessellations. Problems are presented sequentially and clearly and are easy to solve. Grade level: 7-12.
Review: CR, September, 1980, p. 347.

Journey to the Inside of a Triangle. Bruce and Catherine Cornwell. International Film Bureau, 332 S. Michigan Ave., Chicago, IL 60604, 1976. Color. 8½ min. (16mm film)

With animation and musical accompaniment (no narration), points, lines, circles, and triangles proceed through their roles in locating incenters, circumcenters, centroids, and orthocenters for a variety of triangles. Repeated showings of this film are suggested to enhance its effectiveness as a teaching aid in the study of these key points of a triangle. Grade level: 9-12.
Review: MT, April, 1978, p. 294.

Modeling the Universe: With Buckminster Fuller. Baylis Glascock, Producer. Pyramid Films, Box 1048, Santa Monica, CA 90406, 1979. Color. 14 min. (16mm film)

A film whose visual observations seem to offer support for Fuller's theory that a hierarchy of triangular forms are the basic structure in our physical environment. Grade level: 9-college.
Review: Bklt, December 15, 1979, p. 620.

Puzzling Your Way into Geometry. Pat Stallings. Activity Resource Co., Inc., P.O. Box 4875, Hayward, CA 94540, 1978. (book)

A collection of twenty cross-number puzzles specifically designed for use in high school geometry classes. Puzzles contain sets of problems that relate to specific topics such as angles, congruent triangles, circles, the Pythagorean theorem, and areas of polygons. Others relate to trigonometry, simultaneous equations, and solving equations Solution keys for all puzzles are included. Grade level: 9-12.
Review: MT, January, 1979, p. 76.

Similar Triangles. Bruce and Catherine Cornwell. International Film Bureau, 332 S. Michigan Ave., Chicago, IL 60604, 1976. Color. $7\frac{1}{2}$ min. (16mm film)

With musical background and color animation (no narration), similarity of triangles is presented. Color coding and movement of triangles effectively demonstrate the necessary relationships among corresponding angles and sides in order for triangles to be similar. Grade level: 9-college.
Review: AMM, October, 1978, p. 691.

Tangram. Alan Slasor. Pyramid Films, Box 1048, Santa Monica, CA 90406, 1975. Color. 3 min. (16mm film)

Presents a fascinating interplay of solving tangram puzzles and the creation of familiar as well as abstract patterns out of the puzzle's geometric shapes. Has workbook with puzzles and questions that relate tangrams to geometry. Grade level: Pre-school-college.
Review: Bklt, February 15, 1976, p. 865.

Tangram Geometry in Metric. Juanita Brownlee. Activity Resource Co., Inc., P.O. Box 4875, Hayward, CA 94540, 1975. (book)

Uses the Chinese tangram as a vehicle for students to examine properties and definitions of specific polygons--right isosceles triangles, assorted quadrilaterals, and various other kinds of polygons. Concepts of symmetry, congruence, similarity, perimeter and area, angle measure, and the Pythagorean theorem underlie the exercises using the tangram. Grade level: 7-12.
Review: MT, January, 1978, p. 77.

Trian. c/o William Ashby, Arrowhead AEA, 1235 5th Ave. S., Fort Dodge, IA 50501, 1977. Run time: 5-10 min. (computer program)

Calculates measures for the three missing parts of a triangle for which the user does not supply measures. Four cases are offered: SAS, ASA, AAS, SSA. Allows student to observe the effects of one dimension change on the remaining parts of the triangle. Grade level: 7-12.
Review: By the writer.

Trigonometry. Gamco Industries, P.O. Box 1911, Big Springs, TX 79720, 1979. 8 units each with 2-7 filmstrips and 2-7 cassettes. Color. 42-66 fr. 14-23 min. (filmstrip)

Includes: Angles; Trigonometric Functions; Right Triangles; Oblique Triangles; Trigonometric Equations; Graphing; Inverse Trig Functions; Identities. Especially valuable to the study of geometry are those units dealing with angles, triangles, and graphing. Filmstrips are accompanied by problems and solutions. Grade level: 10-college.
Review: Pr, October, 1979, p. 70.

Visual Masters on the Pythagorean Theorem. Stephen S. Lowell. J. Weston Walch, Publisher, P.O. Box 658, Portland, ME 04104, 1979. (spirit masters)

Thirty-three pages of visual masters that lead into the development of the Pythagorean theorem. Though some diagrams are quite detailed, the proofs involved are clear and simple. Grade level: 7-12.
Review: CR, September, 1980, p. 347.

Was Pythagoras Chinese? Frank J. Swetz and T. I. Kao. National Council of Teachers of Mathematics, 1906 Association Dr., Reston, VA 22091, 1977. (book)

An extensively annotated translation of a chapter extracted from one of the most important Chinese mathematical works dating to third century B.C. Provides twenty-four problems concerning properties of right triangles and the ancient Chinese solutions for them. Grade level: 7-12.
Review: TYCMJ, March, 1978, p. 87.

B. QUADRILATERAL

Bye 6. % William Ashby, Arrowhead AEA, 1235 5th Ave. S., Fort Dodge, IA 50501, 1980. Run time: varies. (computer program)

Program presumes student has worksheet containing quadrilaterals and information regarding their parts. Program questions student about figure to arrive at most appropriate classification of figure. Includes a short self-test (8 questions) on classifying quadrilaterals. Grade level: 7-college.
Review: By the writer.

Curiosities of the Cube. Ernest R. Ranucci and Wilma E. Rollins. Thomas Y. Crowell Co., 10 E. 53rd St., New York, NY 10022, 1977. (book)

Offers a variety of exercises requiring the investigation of the cube. Involves the dissecting of a cube and creating designs from its parts, figuring the cross sections of a cube, and constructing a cube. Requires a basic understanding of plane geometry and algebra on the part of the user. Grade level: 9-12.
Review: Bklt, December 1, 1977, pp. 608-09.

Dot Paper Geometry. Refer to entry in Sec. A.

Experiencing Geometry. Refer to entry in Sec. A.

Geo I. % William Ashby, Arrowhead AEA, 1235 5th Ave. S., Fort Dodge, IA 50501, 1980. Run time: varies. (computer program)

Provides three proofs relating to parallel lines with a list of specific postulates, theorems, and definitions from which the student selects reasons for the statements made. Grade level: 10-12.
Review: By the writer.

Geo III. % William Ashby, Arrowhead AEA, 1235 5th Ave. S., Fort Dodge, IA 50501, 1980. Run time: varies. (computer program)

Presents three different proofs involving parallelograms. Specific postulates, theorems, and definitions are provided from which the student selects reasons for statements made. Grade level: 10-12.
Review: By the writer.

Geomet. % William Ashby, Arrowhead AEA, 1235 5th Ave. S., Fort Dodge, IA 50501, 1980. Run time: varies. (computer program)

Provides three proofs dealing with parallel lines. Student is given a list of postulates, theorems, and definitions from which to select reasons for statements made. Grade level: 10-12.
Review: By the writer.

Geometry in Modules, An Informal Course. Refer to Sec. A.

Los 7. % William Ashby, Arrowhead AEA, 1235 5th Ave. S., Fort Dodge, Ia 50501, 1980. Run time: 5-10 min. (computer program)

Contains three different (but similar) groups of 15 statements regarding parallelogram properties and projections. Student chooses from always true, sometimes true, or never true as answers with immediate feedback regarding choice made. Grade level: 10-12.
Review: By the writer.

Proof. % William Ashby, Arrowhead AEA, 1235 5th Ave. S., Fort Dodge, IA 50501, 1980. Run time: 5-30 min. (computer program)

Presents nine different proofs classified as easy, medium, and hard for which the student supplies reasons from a specified list of choices. Figure for each is a parallelogram with diagonals. Grade level: 10-12.
Review: By the writer.

Tangram. Refer to entry in Sec. A.

Tangram Geometry in Metric. Refer to entry in Sec. A.

C. CIRCLE

Circle Circus. Bruce and Catherine Cornwell. International Film Bureau, 332 S. Michigan Ave., Chicago, IL 60604, 1979. Color. 7 min. (16mm film)

Properties of a circle are examined by constructing circles via computer animation. No narration. Grade level: 10-college.
Review: Pr, October, 1979, p. 70.

Experiencing Geometry. Refer to entry in Sec. A.

Geo IV. % William Ashby, Arrowhead AEA, 1235 5th Ave. S., Fort Dodge, IA 50501, 1980. Run time: varies. (computer program)

Offers four proofs involving circles. Specific postulates, theorems, and definitions are given from which the student selects the reasons for statements made. Grade level: 10-12.
Review: By the writer.

Geometry in Modules, An Informal Course. Refer to entry in Sec. A.

Geometry Workshop on Circles. E. Richard Churchill and Linda R. Churchill. J. Weston Walch, Publisher, P.O. Box 658, Portland, ME 04104, 1979. (kit: spirit masters w/ cassettes)

A set of ditto masters with cassettes providing information about the circle and instructions for use of compass and straightedge to complete certain problems on the masters. Designed to familiarize user with arcs, radii, central angles, inscribed angles, and area of circles. Grade level: 7-12.
Review: CR, September, 1980, p. 347.

Informal Geometry Activities. Refer to entry in Sec. A.

Puzzling Your Way into Geometry. Refer to entry in Sec. A.

D. CONSTRUCTION/LOCUS

Experiencing Geometry. Refer to entry in Sec. A.

Geometry: Constructions and Transformations. Iris Mack Dayoub and Johnny W. Lott. Dayott Associates, 12508 Over Ridge Rd., Potomac, MD 20854, 1977. (book)

Contains 75 constructions and 63 transformations designed to bring concreteness to some of the abstractness of transformations and to encourage students to make their own constructions and attempt to justify them. Suggested as an accompaniment to a traditional geometry course, though a nontraditional Mira, a transparent plastic reflector, is to be used to make constructions "easier and more fun." Grade level: 9-12.
Review: MT, October, 1978, p. 631.

Geometry Workshop on Circles. Refer to entry in Sec. C.

How to Draw a Straight Line. A. B. Kempe. National Council of Teachers of Mathematics, 1906 Association Dr., Reston, VA 22091, 1977. (book)

A republication of an 1877 monograph describing mechanical techniques for constructing a straight line without the use of a straightedge. Grade level: 10-college.
Review: AMM, February, 1978, p. 131.

Scooby-Doo Locates the Locus. Hanna-Barbera, Producers. Barr Films, 3490 E. Foothill Blvd., Pasadena, CA 91107, 1978. 1 filmstrip with 1 cassette. Color. 66 fr. 10 min. (filmstrip)

Using simple devices, the cartoon gang learns some geometric principles regarding locus problems. Grade level: 7-12.
Review: Pr, October, 1978, p. 54.

Sculpture with String. Warner Educational Productions, Box 8791, Fountain Valley, CA 92708, 1975. 2 filmstrips with 1 cassette. Color. 65-72 fr. 14-15 min. (filmstrip)

Designs are shown being constructed with step by step instructions provided. Teachers should expect to provide necessary reinforcement and demonstration of some steps. Finished designs with their major content are provided. Grade level: 6-college.
Review: Pr, November, 1976, p. 24.

Stained Glass Tessellation Posters. Creative Publications, P.O. Box 10328, Palo Alto, CA 94303, 1977. Set of 11. Color. (posters)

Recreations of actual stained glass windows. Accompanied by guide sheets explaining the patterns of tessellation involved and activities to try. Grade level: 7-12.
Review: MT, December, 1977, p. 785.

Tessellations: The Geometry of Patterns. Stanley Bezuszka, Margaret Kenney, and Linda Silvey. Creative Publications, P.O. Box 10328, Palo Alto, CA 94303, 1977. (book)

Provides exercises requiring construction techniques to create tessellations. Creation of desired tessellation patterns reinforces familiar geometric concepts and gives user cause to question why some tessellations may or may not be possible. Initiates an artistic approach to geometry and creates an awareness of geometry in the world. Grade level: 4-12.
Review: AMM, December, 1978, p. 841.

E. COORDINATE GEOMETRY

Analytic Geometry. Gamco Industries, P.O. Box 1911, Big Springs, TX 79720, 1980. 9 filmstrips with 9 cassettes. Color. 40-50 fr. 25-33 min. (filmstrip)

Includes: Points and Lines; Distance and Midpoint Formulas; The Slope of a Line; Writing Equations; Parallel and Perpendicular Lines; Conic Sections, Circles and Parabolas, Parabolas-Translation, Ellipses, Hyperbolas. The first four of this set would be found especially relevant to the study of geometry.
Review: Pr, October, 1980, p. 76.

Graph 1. c/o William Ashby, Arrowhead AEA, 1235 5th Ave. S., Fort Dodge, IA 50501, 1980. Run time: 10-15 min. (computer program)

Prints the graph of a line with respect to a x- and a y-axis that are calibrated. The student is to determine the slope of the line based on its graph. Grade level: 10-college.
Review: By the writer.

Plot. Steketee Educational Software, 4639 Spruce St., Philadelphia, PA 19139, 1980. Run time: varies. (computer program)

A program for 16K Apple II or Level II TRS-80 which displays the graph of a line in the slope-intercept form. Initial graph is retained on the screen as variations on its equation may be graphed as well, allowing student to make comparisons and observations of equation changes and graph outcomes. Provisions in the program provide for graphing simultaneous equations and nonlinear functions from algebra, trigonometry, and calculus. Grade level: 9-college.
Review: CT, v.8, #6, 1980-81, p. 59.

Trigonometry. Refer to entry in Sec. A.

F. TRANSFORMATION

Creating Escher-Type Drawings. E. R. Ranucci and J. L. Teeters. Creative Publications, P.O. Box 10328, Palo Alto, CA 94303, 1977. (book)

Offers elementary explanations of how to use translation, rotation, and reflection techniques to create tessellations in a plane of figures containing curved lines. Contains many illustrations to enhance expla-

nations and entice the reader. Grade level: 10-college.
Review: AMM, February, 1978, p. 131.

Experiencing Geometry. Refer to entry in Sec. A.

Exploring Transformational Geometry. Lowell Leake, Jr. J. Weston Walch, Publisher, P.O. Box 658, Portland, ME 04104, 1979. (book)

Provides an activity oriented and problem-solving approach to transformations. Emphasizes the interrelation of algebra and geometry throughout. Introduces concepts of image, preimage, rotation, reflection, glide reflection, and lines of symmetry to name a few. Presumes an understanding of some basic geometric concepts regarding congruent triangles, perpendicular lines, parallel lines, and parallelograms for example. Grade level: 9-12.
Review: MT, December, 1979, p. 709.

Geometric Forms in Nature. Coronet Instructional Media, 65 E. South Water St., Chicago, IL 60601, 1977. Color. 12 min. (16mm film)

Illustrates various geometric forms that appear in both living and non-living things. Symmetry in various shapes is repeatedly displayed. Certain shapes are frequently presented in different settings suggesting geometry's closeness to nature. Grade level: 7-college.
Review: Pr, March, 1978, p. 5.

Geometry: Constructions and Transformations. Refer to entry in Sec. D.

100 Geometric Games. Pierre Berloquin. Charles Scribner's Sons, 597 Fifth Ave., New York, NY 10017, 1976. (book)

Puzzles with solutions for mathematicians as well as nonmathematicians. Several puzzles involve moving points, segments, or figures according to given criteria to create new figures. Others require studying a group of figures to find the one which is not merely a rotation of the other figures. Includes solving chessboard games and finding the number of triangles or other polygons in a given figure. Grade level: 10-college.
Review: MT, May, 1977, p. 474.

The Perceptive Eye: Art and Math. Lillian F. Baker and Doris J. Schattschneider. Allentown Art Museum, 5th and Court Sts., Allentown, PA 18105, 1979. (book)

A deliberate attempt to show mathematics as a means

of analyzing art as well as creating it. Using objects belonging to the museum's collection, transformational aspects of geometry--rotation, translation, and reflection--as well as ratio and proportion, and perspective are illustrated. Supplementary notes regarding projects and bibliographies on art-math activities for students accompany this imaginative work. Grade level: 7-college.
Review: AMM, June-July, 1979, p. 513.

Spirit Masters on Transformational Geometry. Lowell Leake, Jr. J. Weston Walch, Publisher, P.O. Box 658, Portland, ME 04104, 1979. (spirit masters)

Fifty pages of spirit masters that contain points, lines, or triangles with instructions to perform certain reflections, translations, or rotations. Questions on the masters attempt to elicit guesses on future generalizations. Grade level: 9-12.
Review: CR, September, 1980, p. 347.

Stained Glass Tessellation Posters. Refer to entry in Sec. D.

G. AREA/VOLUME

Bye 1. c/o William Ashby, Arrowhead AEA, 1235 5th Ave. S., Fort Dodge, IA 50501, 1980. Run time: 2-3 min. per problem. (computer program)

Deals with the formulas for volume of spheres, pyramids, prisms, cylinders, and cones. Student supplies values for known dimensions; the computer calculates the measure for the unknown. Allows student to observe and compare changes in dimensions with volume capacity. Grade level: 7-college.
Review: By the writer.

Curiosities of the Cube. Refer to entry in Sec. B.

Discovering Form in Art. Paul Burnford Films, Producer. BFA Educational Media, 2211 Michigan Ave., Santa Monica, CA 90406, 1979. Color. 20 min. (16mm film)

An attempt to convince the viewer that form is everywhere. Presents the sphere, cone, cylinder, cube, and pyramid as five basic art forms, and provides several illustrations of them, their variations and combinations in various settings. Grade level: 4-10.
Review: Pr, January, 1980, p. 16.

Dot Paper Geometry. Refer to entry in Sec. A.

Experiencing Geometry. Refer to entry in Sec. A.

Geometry in Modules, An Informal Course. Refer to entry in Sec. A.

Geometry Workshop on Circles. Refer to entry in Sec. C.

Informal Geometry Activites. Refer to entry in Sec. A.

Map Projections in the Computer Age. Coronet Instructional Media, 65 E. South Water St., Chicago, IL 60601, 1976. Color. 10½ min. (16mm film)

Though incidental to the thrust of the film, geometric forms--the sphere, cylinder, cone, and circle--consistently present themselves as the basic forms with which cartographers work. Both the reading of maps and the selection of form in preparing a map involve familiarity with these geometric forms. Grade level: 4-12. Review: By the writer.

Puzzling Your Way into Geometry. Refer to entry in Sec. A.

Real World Measurement. From the Life Skills Series. Society for Visual Education, 1345 Diversey Pkwy., Chicago, IL 60614, 1979. 4 filmstrips with 4 cassettes. Color. 60 fr. each. 10 min. each. (filmstrip)

Includes: Linear Measurement; Volume and Capacity; Mass (Weight) and Temperature; Finding Area. Deal with metric and American systems of measurement. Math involved is simple enough for junior high with situations and pictures sophisticated enough to have appeal to high school students. Includes a teacher's guide and activities with each strip. Grade level: 7-10. Review: Pr, February, 1980, p. 37.

Volume. % William Ashby, Arrowhead AEA, 1235 5th Ave. S., Fort Dodge, IA 50501, 1980. Run time: 2 min. (computer program)

Calculates the volume of any of the following: sphere, cone, prism, cube, pyramid, rectangular solid, cylinder, frustum of a cone, and truncated prism. Student supplies the needed dimensions for selected figure; program prints the required formula and the volume that results. Grade level: 7-12. Review: By the writer.

H. APPENDIX

Ages of Mathematics Series. Vol. 1: The Origins. Michael Moffatt. Vol. 2: Mathematics East and West. Charles F. Linn. Vol. 3: Western Mathematics Comes of Age. Cynthia Cornwell Cook. Vol 4: The Modern Age. Peter D. Cook. Doubleday & Co., Inc., 501 Franklin Ave., Garden City, NY 11530, 1977. (book)

A series for serious students of mathematics who have a familiarity with a broad spectrum of mathematics. Provide a historical outline of the development of different mathematical systems as devised by various cultures, as well as the influences and contributions particular individuals made possible. Grade level: 7-12.
Review: SLJ, January, 1977, pp. 103-04.

Applications of Secondary School Mathematics. Bernice Kastner. National Council of Teachers of Mathematics, 1906 Association Dr., Reston, VA 22091, 1978. (book)

Primarily written to serve as a reference book for secondary mathematics teachers who have had little experience with physics, chemistry, biology, music, or economics. Chapters are devoted to specific topics with necessary background information provided as well as problems and exercises for classroom use. Grade level: 10-12.
Review: SSM, November, 1979, p. 633.

Applied Technical Mathematics. Merwin J. Lyng, L. J. Meconi, and Earl J. Zwick. Houghton Mifflin Co., 2 Park St., Boston, MA 02107, 1978. (book)

Organized into three parts: (1) applications involving the four basic operations with whole numbers, fractions, decimals, percents, and the hand-held calculator; (2) formulas frequently used from algebra, geometry, and trigonometry; (3) applications of mathematics in the areas of power and energy, manufacturing, and graphic arts. Grade level: 10-college.
Review: TYCMJ, November, 1978, p. 291.

The Beautiful String Art Book: 100 Projects You Can Create. Raymond Gautard. Sterling Publishing Co., Inc., 2 Park Ave., New York, NY 10016, 1978. (book)

Presents projects of both familiar and abstract designs with a list of necessary supplies, nailing and threading instructions, graph patterns and methods of enlarging them, and color photographs of the finished products. Grade level: 7-12.
Review: Bklt, January 15, 1979, p. 804.

Building: The Fight Against Gravity. Mario Salvadori. Atheneum Publishers, 597 Fifth Ave., New York, NY 10017, 1979. (book)

Presents a simple "mathless" approach to teaching the principles of architecture. Introduces the forces of construction--tension and compression--together with the basic forms of building as well as the more complex constructions of a suspension bridge or a domed ceiling. Explanations are clear, well organized and aptly supported by drawings. Excellent directions accompany activities for constructing models. Grade level: 7-12.
Review: Bklt, January 15, 1980, p. 714.

Bye 4. % William Ashby, Arrowhead AEA, 1235 5th Ave. S., Fort Dodge, IA 50501, 1980. Run time: 5 min. (computer program)

Prints out the following information regarding angle measures and diagonals of regular polygons whose number of sides range from 3 to 12: number of sides, total measure of interior angles, measure of one interior angle, measure of one exterior angle, total measure of exterior angles, number of diagonals that can be drawn. Grade level: 7-college.
Review: By the writer.

Construction Work: The Carpenter. Coronet Instructional Media, 65 E. South Water St., Chicago, IL 60601, 1976. Color. 14 min. (16mm film)

Student and teacher take turns talking about and illustrating the necessary skills and knowledge required to be a carpenter. Identify geometry and drafting as sources of valuable information. Emphasize importance of precision in finding and determining measurements and show some of the instruments used to find measures. Grade level: 1-12.
Review: By the writer.

Euclidians. Guillevic. Unicorn Press, P.O. Box 3307, Greensboro, NC 27402, 1977. (book)

A collection of poems done by a contemporary European poet. The poems, done with simplicity but a touch of humor, are about Euclidean things such as a cone, a rhomboid, and parallels. Grade level: 10-college.
Review: AMM, April, 1978, p. 296.

Geometry and the Liberal Arts. Dan Pedoe. St. Martin's Press, Inc., 175 Fifth Ave., New York, NY 10010, 1978. (book)

Contents are designed to appeal to the non-mathematically oriented reader. Focuses on persons and historical events significant in the development of geometry. Brings a touch of humanity to a subject seemingly removed from such ties at times. Grade level: 10-college.
Review: AMM, October, 1978, p. 696.

The Geometry of Art and Life. Matila Ghyka. Dover Publications, Inc., 180 Varick St., New York, NY 10014, 1977. (book)

An exploration of the relationships of geometry, art, and life to each other. Author draws from ideas expressed by famous mathematicians to trace the applications of a spatial science to architecture, painting, and decorative art. A good background in geometry would allow the book to have greater appeal to the reader. Grade level: 10-college.
Review: SSM, November, 1978, p. 631.

Geomte. ℅ William Ashby, Arrowhead AEA, 1235 5th Ave. S., Fort Dodge, IA 50501, 1980. Run time: 5-10 min. (computer program)

Designed to serve as a teacher's aid. Contains three different (but similar) true-false geometry quizzes with twenty questions each. Cover many concepts included in geometry. Grade level: 10-college.
Review: By the writer.

Mathematics Activities Handbook for Grades 5-12. Michael C. Hynes and Douglas K. Brumbaugh. Parker Publishing Co., ℅ Prentice-Hall Inc., Box 500, Englewood Cliffs, NJ 07632, 1976. (book)

Activities designed to enrich classroom routines are grouped under the metric system, algebra, probability and statistics, rational numbers, daily living, measurements, geometry, graphs, and number theory. Each activity includes goals and behavioral objectives, materials needed, appropriate grade level for use, and comments to the teacher regarding the activity and ideas to emphasize in its use. Grade level: 5-12.
Review: SSM, December, 1976, p. 721.

Mathematics, An Everyday Experience. Charles D. Miller and Vern E. Heeren. Scott, Foresman & Co., 1900 E. Lake Ave., Glenview, IL 60025, 1976. (book)

Takes a cultural approach to basic mathematics (including geometry) and presents problems and material in settings familiar to many students. Designed for students not interested in a strong mathematics emphasis. Grade level: 10-college.
Review: AMM, April, 1976, p. 299.

Mathematics: An Introduction to Its Spirit and Use. Readings from Scientific American, W. H. Freeman & Co., 415 Madison Ave., New York, NY 10017, 1979. (book)

Forty articles to stimulate intellectual and aesthetic appreciation of mathematics as a fundamental part of human culture. Articles are grouped into sections on history, numbers and algebra, geometry, statistics and probability, symbolic logic and computers, and applications. Grade level: 10-college.
Review: Bklt, May 1, 1979, pp. 1357-58.

Mathematics: Ideas and Uses. David Russell. D. Van Nostrand Co., 135 W. 50th St., New York, NY 10020, 1979. (book)

Presents a variety of settings and exercises showing how mathematics is used in various real life applications. Areas of mathematics touched on are logic, sets, the computer, consumer math, geometry, topology, statistics, probability, and some calculus. Requires familiarity with high school algebra. Grade level: 10-college.
Review: TYCMJ, January, 1980, p. 60.

Mathematics--Life's Number Game. Coronet Instructional Media, 65 E. South Water St., Chicago, IL 60601, 1978. (16mm film)

A construction worker, a musician, a business owner, an auto racer, and an aviator tell about various mathematical information they must know for their work. Geometrical applications are most evident in the aviator's and the construction worker's presentations. Grade level: 7-9.
Review: By the writer.

Mathematics: Problem Solving Through Recreational Mathematics. Bonnie Averbach and Orin Chein. W. H. Freeman & Co., 660 Market St., San Francisco, CA 94104, 1980. (book)

Presents problem-solving through the use of games

and puzzles. Exercises are marked in one of three ways: those with detailed solutions, those with answers only; those with helpful hints only. Various aspects of mathematics are treated including geometry, logic, algebra, and arithemetic. Material is organized so as to allow user to select work of his choice. Grade level: 10-college.
Review: MT, April, 1981, pp. 301-02.

Mathematics Through Paper Folding. Alton T. Olson. National Council of Teachers of Mathematics, 1906 Association Dr., Reston, VA 22091, 1975. (book)

Presents paper folding activities ranging from the very simple to the more complex. May be used to generate discussion and conjectures of what is to be proven later; to provide insights regarding certain relationships of circles, polygons, or symmetry for example; or to simply act as a source of recreation. Activities often include large-scale drawings and a listing of related theorems. Grade level: K-12.
Review: MT, January, 1976, pp. 86-7.

Perspective: Understanding Space. Educational Audio Visual, 29 Marble Ave., Pleasantville, NY 10507, 1979.
2 filmstrips with 2 cassettes and 20 spirit masters. Color. 84-102 fr. 16-20 min. (filmstrip)

Shows how various stages of construction from preliminary sketches and early decision-making to the final elevation of a structure rely on a knowledge of mechanical perspective with one, two, and three vanishing points. Provides diagrams and explanations for constructing a cube and other more complex figures. Grade level: 7-college.
Review: Bklt, March 15, 1980, pp. 1070-71.

Photogrids. Sol LeWitt. Rizzoli International Publications, Inc., 712 Fifth Ave., New York, NY 10019, 1978. (book)

An artist provides a pictorial presentation of geometry as found in familiar as well as unexpected places. 432 color photos show grid forms as the make their appearances in the physical world. Grade level: All ages.
Review: Bklt, June 1, 1978, p. 1540.

Practical Mathematics. Claude Irwin Palmer, John A. Jarvis, Leonard A. Mrachek, and Samuel Fletcher Bibb. McGraw-Hill Book Co., 1221 Ave. of the Americas, New York, NY 10020, 1978. (book)

Directed at technology and trade students. Informa-

tion and problems are application oriented and involve arithmetic, algebra, geometry, and trigonometry. Presents rule or technique along with various examples and comments, followed by related problems. Answers included to odd problems. Grade level: 11-college.
Review: TYCMJ, September, 1978, p. 225.

A Sourcebook of Applications of School Mathematics. A Joint Committee of the Mathematical Association of America and the National Council of Teachers of Mathematics. NCTM, 1906 Association Dr., Reston, VA 22091, 1980. (book)

Primarily a teacher reference to problems that have direct applications to everyday activities. Sample listings under "H" include Halloween, hamburgers, hang gliding, heating, highways, hockey, home, and hunting. Offers statistical information and mathematical formulas for several problems considered. Grade level: 10-12.
Review: CR, January, 1981, p. 65.

Taxicab Geometry. Eugene F. Krause. Addison-Wesley Publishing Co., Inc., Jacob Way, Reading, MA 01867, 1975. (book)

Assuming the reader to be familiar with Euclidean geometry, the presentation is intended to expose the reader to a simple but concrete non-Euclidean geometry and examine its possible applications. Grade level: 9-12.
Review: MT, February, 1977, p. 185.

Verbal Problems VI--Geometry. Microphys Programs, 2048 Ford St., Brooklyn, NY 11229, 1980. (computer program)

A series of programs designed to select and generate problems for students to work on, have checked and graded, all without teacher effort. Homework Mode: student is given problems, takes them home, returns them to be checked by the computer; Classwork Mode; student is given problems and in turn finds the answers and has them graded while sitting at the computer; Test Mode: student is given problems and returns answers to the teacher; Text Mode: teacher creates problems to be typed and duplicated for a class of students. At present for PET computers. Grade level: 9-12.
Review: CT, v. 8, #5, 1980-81, p. 42.

Waiting Sheets on Informal Geometry. Wilbur Labbe. J. Weston Walch, Publisher, P. O. Box 658, Portland, ME 04104, 1979. (spirit masters)

Fifty pages of ditto masters which ask students

to connect dots, look for words, find areas, manipulate tangrams, guess angles, and break codes. Grade level: 7-12.
Review: CR, September, 1980, p. 347.

The Wood Shell. Circle Oak Production, 73 Girdle Ridge Dr., Katonah, NY 10536, 1980. Color. 30 min. (16mm film)

Shows the construction of a house from ground level to finished exterior. Applications of geometry are observed in the parallel structures built, the angles measured and created for fit, determining the slope of the roof, and determining areas of floors and walls.
Grade level: 7-12.
Review: By the writer.

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ABSTRACT

The contention is made that high school students experience frustrations in their pursuit of learning Euclidean geometry. Three causes of frustration are assumed: inadequate comprehension of new concepts; lack of a sense of need or usefulness of concepts presented; a lack of initial or sustaining interest in the subject. A further presumption is made that appropriate utilization of multimedia in the study of geometry will alleviate some of these frustrations.

In light of these assumptions and with substantial support for them in literature reviewed, an annotated bibliography of multimedia intended for incorporation into the study of Euclidean geometry and directed at alleviating some of the students' frustrations is presented. The reviewing sources referred to for possible listings are included. Items selected for inclusion received favorable reviews in these sources, and their entries include complete bibliographic information, their contents, specific concepts to which they relate, and appropriate grade level to which they are directed.