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A guide for the conduct of high school mathematics clubs

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A GUIDE FOR THE CONDUCT OF HIGH SCHOOL MATHEMATICS CLUBS

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CHAPTER I

I. INTRODUCTION

Purpose of the study. The purpose of this study is threefold: (1) To make a brief survey of mathematics clubs over the country; (2) to justify such clubs as an essential part of the modern educational program; and (3) to assemble available material for use in organizing and conducting mathematics clubs in secondary schools.

Justification of the study. The need for this study is emphasized by four important factors: (1) Criticism to which the traditional procedures in the teaching of mathematics courses have been subjected; (2) the recent changes in the philosophy of education and in educational psychology and the effects of these changes on the teaching of mathematics; (3) the number of capable students who fail to pursue mathematics beyond the necessary requirements; and (4) the lack of any guide for the conduct of high school mathematics clubs.

Brief history of previous studies. Ingle's study of The Use of Mathematical Equipment in the High Schools of Indiana, as reported in 1935, was based on questionnaire returns from one hundred seventy-two schools.[1] (Senior high schools throughout Indiana with enrollments ranging from 50 to over 800 were included.)

[1] Gerald C. Ingle, "The Use of Mathematical Equipment and Teaching Aids in the High Schools of Indiana." Indiana University, 1935. (Unpublished thesis.)

Since he found only fourteen mathematics clubs in the one hundred seventy-two schools, we can conclude that this important and interesting phase of mathematics has been neglected. If teachers manifest no more interest than this report would seem to indicate, they have failed to utilize a valuable aid for getting pupils more interested in the fundamental knowledge of quantitative relationships. The smaller schools especially should encourage mathematics clubs to help take care of the enrichment problem. In general, more mathematics is offered in the larger schools, and it is not so necessary that these students have the privilege of belonging to a mathematics club. In the small school it may be possible to form this club in conjunction with the science department.

Another study of equal importance was made by Miss Crosset.[2] Crosset's study of Mathematics Clubs in the Senior High Schools of the United States, as reported in 1936, was based on questionnaire returns from thirteen hundred schools. (Senior high schools included in the survey ranged in enrollment from two hundred to nine thousand six hundred four. Senior high schools throughout the United States were included.) She found one hundred mathematics clubs in the thirteen hundred schools that were really functioning.

Method of gathering data for this study. On registration

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[2] Wilma Wilson Crosset, "Mathematics Clubs in the Senior High Schools of the United States." University of Colorado, 1936. (Unpublished thesis.)

day at the Indiana State Teachers College, the first summer term of 1938, questionnaires were handed to teachers of mathematics enrolling for the term. Fifty questionnaires were distributed, and thirty-three of these were returned. From this study three mathematics clubs were reported in the senior high school and one in the junior high school. The enrollment of the schools reporting ranged from forty-five to eleven hundred. Of the three high schools reporting, two were in Indiana and one in Ohio. The two Indiana high schools were Brazil and Clinton. The junior high school was also in Brazil.

The results of this survey follow very closely the results of the two previously mentioned theses.

CHAPTER II

II. STATUS OF MATHEMATICS IN THE HIGH SCHOOL PROGRAM

Justification of mathematics in the high school curriculum. Mathematics is not merely a tool but also a mode of thinking. Dr. Judd in the third yearbook of the National Council of Teachers of Mathematics has made this very clear. He says it is not merely a tool which we pick up when we wish to solve a problem and lay down again as soon as the problem is solved. Rather it is a mode of thought, which, once acquired, can never be laid down. Control of this mode of thought is one of the main characteristics distinguishing highly civilized people from primitive peoples. Hence mathematics is appropriate material for high school pupils to study.[1]

In this field of secondary mathematics, sound psychological principles are being tried; applications of these principles through the medium of mathematics clubs is often more conducive to true educational results than much of the work that has been done in the past in classroom practice.

Recent criticisms of the mathematics courses. Few subjects in the school curriculum have met with so much bitter criticism and opposition as have the various branches of mathematics. On this subject Miss Gurgle says:

For ages mathematics has had the reputation of being

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[1] H.F. Munch, "A Brief Professional Philosophy for the Teaching of High School Mathematics," The Mathematics Teacher. 29:334, November 1936.

> the hardest subject in the curriculum. Of course, according to the older pedagogy, the harder and more abstract the study, the greater was the resulting mental discipline. Mathematics is a symbolic language, and therefore requires the highest type of thinking in its mastery. Since the subject is no longer kept in the curriculum by being a universal requirement, its abolishment has been threatened. Teachers of mathematics, like those of Latin and Greek, have been compelled to justify the retention of their subject in the curriculum.[2]

Decrease of enrollment in the mathematics department. As a result of the cut in the requirements in mathematics for graduation, the per cent of enrollment in the mathematics department of the high schools decreased considerably from 1910 to 1928. One study shows the per cents of enrollment in algebra and geometry in certain years as follows:[3]

TABLE I

PER CENT OF SCHOOL ENROLLMENT TAKING ALGEBRA AND GEOMETRY IN DIFFERENT YEARS

(year)	1890	1895	1900	1905	1910	1915	1922	1928
Algebra	45.40	54.27	56.29	57.51	56.85	48.84	40.15	35.22
Geometry	21.33	25.34	27.39	28.16	30.87	29.55	22.68	19.90

The table indicates that the per cent of enrollment has

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[2] Marie Gurgle, "Recreational Values Achieved Through Mathematics Clubs in the Secondary Schools," The Mathematics Teacher. 18:214, April 1928

[3] Ernest R. Breslich, The Administration of Mathematics in Secondary Schools. (Chicago: The University of Chicago Press, 1933) p. 385.

fallen down slightly, but, in consideration of the greater number of subjects in the curriculum from which a pupil may choose and the larger enrollments in our schools today, there are more students taking algebra and geometry in the high schools than ever before. The number of pupils attending high school has increased from 2,200,389 in 1920 to 4,399,422 in 1930; in other words, enrollments have nearly doubled.

CHAPTER III

III. VALUE OF AND PURPOSE OF THE MATHEMATICS CLUB

Changes in educational philosophy and psychology. As more is learned concerning the nature of children and the ways in which they learn, there must necessarily be many changes in educational philosophy and psychology. Current theories have been questioned by the experts in the field for many years, but this attitude has only recently reached the teacher and the curriculum makers. The theory of mental discipline implies that there can be an increase in the ability to think through the proper kind of training. What really caused this implication was that only the better students took these courses (the weak being eliminated early) and did well, not wholly because of the subjects, but largely because of their intelligence. This theory would tend to limit our education to a group of the most intelligent. This type of philosophy is not well suited to the democratic ideals of this country. This same idea was expressed by the committee on reorganization of mathematics when they said:

> As more and more of the children of all the people came trooping up from the elementary schools they showed less acquiesence toward formalism, the narrowness, and social inutility of a curriculum which was neither fish nor fowl, which depended for its justification on a theory of mental gymnastics, and which seemed chiefly to produce low and failing marks on report cards.[1]

Our educational system has been and is now gradually

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[1] Reorganization of Mathematics in Secondary Education. p. 9.

shifting to the philosophy of Dewey whose basis of psychology follows that of Thorndike. Fundamentally this psychology denies the theory of mental discipline and admits of transfer of training only in so far as there are identical elements which can be distinguished by the student. Thorndike says:

> The answer which I shall try to defend is that a change in one function alters any other in so far as the two functions have as factors identical elements. The change in the second function is in amount that due to the change in the elements common to it and the first. The change is simply the necessary result upon the second function of the alternation of those of its factors which are elements of the first function, and so were altered by its training.[2]

Gates adds to this by saying:

> The difficulty is that . . . . . the common elements in the situation are so obscured by the details that they do not become potent except perhaps in the case of a few of the very bright pupils.[3]

Gates also says:

> The fact that transfer is greatest to situations which embrace the largest degree of identical elements implies the need of careful scrutiny of the subject matter utilized in education.[4]

While quantitative thinking is the most needed thing in our present "economic nightmare," our traditional courses in mathematics as presented are failing to "take." It is our task

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[2] E.L. Thorndike, Educational Psychology. 1903.

[3] I.A. Gates, Psychology for Students of Education. 1924. p. 369.

[4] Ibid., p. 370.

to supplement our teaching of algebra and geometry with various forms of activities conducted in such a way that they help develop pupils' interests in the fundamental knowledge of mathematics and its applications to social and economic problems. Hence, the need for mathematics clubs is evident.

There is also a second reason for scrutinizing our subject matter and teaching methods. Centralization and specialization of our civilization make it imperative that schools take over some of the functions that formerly belonged to the home. Children no longer learn the relationships of life that they did when the home was less dependent on outside agencies. The committee on reorganization of mathematics said:

> Changes have been taking place and doubtless in desirable directions, but high school subjects still, in a large part, have not been made functional with reference to contemporary life.[5]

As the school, by necessity, takes over more of the things that were once taught in the home, changes must be made to do away with much of the formal type of instruction and to substitute an environment which will encourage natural living on the part of the pupils. Kilpatrick expressed this idea by saying:

> The school now coming into being is and must increasingly be a place where actual living goes on.[6]

With this kind of a philosophy as a basis, schools will become more and more like laboratories and workshops, where

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[5] Reorganization of Mathematics in Secondary Education. p. 11.

[6] Kilpatrick, Education for a Changing Civilization. p. 65.

pupils will learn to do by doing rather than by studying about doing. We must go much farther than we have gone. It will take time, energy, and increased expenditure; but, if education is to meet the demands of our present and furture civilization, it must meet these everchanging demands.

Kilpatrick also said:

> Because of the educational decline in the family and community, and in accordance with a better insight into the learning process, the school must become a place where life, real experience, goes on. Only on this basis can our children learn what they need. All this will call for correlative changes in school equipment, textbooks, management, and objectives.[7]

Values of club work. Club work is forcing itself into school programs, not as subjects in the curriculum of studies, but as a part of a program of school activities recognized as desirable and accepted as a responsibility by schools in their efforts to provide ways and means for the realization of generally accepted aims of education. The major development of the school club movement has followed in the wake of changes taking place in educational philosophy, educational psychology, and principles governing educational practices. These changes may be illustrated by the following summary statements:

> Education is not a preparation for life; it is life. The child learns to do by doing. The school curriculum should be composed of functional activities representative of normal should be in accord with the interest and ability levels of the different age groups. Individual differences among pupils as to apptitudes and interests are to be taken into consideration in providing an educational program. Adolescents

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[7] Ibid., p. 85.

> are gregarious. Social or group approval is strong as a factor in the control of an educational situation. Pupils are to be provided with opportunities for self-expression in a variety of media. Provisions are to be made for exploration in a variety of activities. Opportunities are to be provided for the exercise of initiative. The educational program is to contribute to social adjustment. The educational program should include opportunities for training the individual to do better those desirable things which he will do anyway.[8]

The process of confronting the problems of life itself -- experience -- can be described as one of the characteristics of progressive education. "The child learns to do by doing" is the famous phrase. In pursuit of this maxim, activities and projects are emphasized. The use of creative imagination, youthful energy, and initiative are, it will seem, again in accord with the concept of the growth of character.

The development of school clubs has been a means of broadening the scope of school activities beyond the confines of the curriculum, with a consequent enlargement of the contribution the school makes toward the adjustment of the individual to society. At least one reason, and an important one, for the ready acceptance of club work in the high schools is the fact that changes in the school curriculum to meet new conditions in education are not readily accomplished. A great deal of inertia exists in the curriculum program. Because of this, new subjects and also old subjects presented from a new angle or by a new procedure, are often brought into the school as extra curricular

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[8] Marie M. Proffitt, "High School Clubs," Bulletin #18, 1934. United States Department of the Interior.

activities, that is, activities outside of or beyond the bounds and compass of the school curriculum. The school club fits very well into this scheme. The subject clubs represent a new method of attack or a different emphasis or both, for a curriculum subject. These new methods of procedure have not been accepted widely. Other clubs represent functional activities of a practical type in subjects not included in the curriculum of the school in which they are organized. An example of this type of functional and practical club is the 4-H club.

The school club is a necessary part of education in this period of transition from the formal and traditional school to the school of the future in which life is actually lived.

The amount of work now carried on by some schools as extra-curricular activities, including school clubs, represents so great a development that the question has been raised as to whether or not the extra-curricular activities will not eventually make a major contribution to the aims of secondary education. It is to be noted, however, in connection with this thought that there is a tendency to broaden the school curriculum by taking over the extra-curricular activities. Today, an activity that is treated as an extra-curricular activity in one school may be included in the curriculum of another school. This practice naturally operates against the rate of increase in extra-curricular activities. In the case of school clubs, the numerous phases of life-experiences included as activities, the organization of the work so as to make a strong appeal to the pupil for participation in the club program, and the opportunities afforded the members

for initiative warrant the statement that in many schools the work carried on by school clubs constitutes a large fraction of the total activities; these contribute directly and specifically to the pupil's adaptation to society about him.

History of mathematics clubs. Mathematics came into prominence in the higher institutions of learning near the middle of the nineteenth century. Although the objectives of those early courses were not the same as the present objectives, mathematics gained its foothold, and that was of prime importance. Near the end of the century, however, the secondary school curriculum was under reconstruction. To arouse the adolescent's interest, new mathematics courses were created. This was one of the fundamental reasons for the division of secondary education into the junior and senior high schools which took place in the early part of this century.

However, it was not long until criticism against mathematics was evoked. The unstable state of affairs was reflected in numerous ways, particularly in the new courses of study, frequent changes in the textbooks, and demands for reconstruction of the curriculum. C.B. Walsh, in giving a report at the convention of Teachers of Mathematics in the Middle States and Maryland in 1917, expresses his beliefs about the changes of that period:[9]

> This reformation will be ephermeral and not worth while unless it addresses itself to the settlement of certain fundamental problems which doubtless are the worthy causes of this restlessness. I refer to such searching queries as these:

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[9] C.B. Walsh, "A Tentative Program of Junior High School Mathematics," The Mathematics Teacher. 10:85, December, 1917.

How shall we gain and maintain the interest of the so-called non-mathematical student?

How shall we lessen the mortality in the mathematics courses of the ninth year?

How shall we enrich the practical content of our courses?

How much mathematics shall we require of all pupils?

Analyzing the foregoing, one can see that the question debated was: Enrichment of the course to hold the interest of the student, versus, decreasing mathematical requirements.

Some schools tried the plan of enrichment, resulting in a new institution, the mathematics club. Marie Gurgle, writing in the First Yearbook of Teachers of Mathematics, gives an account of the early mathematics clubs.[10] It is thought that the first club was organized at Shattuck School, a private school for boys in Fairibault, Minnesota. The idea of forming a mathematics club was approved by fifteen senior boys. These boys were made charter members of the club. Meetings of this club were held every two weeks. Before 1912, the mathematics classes of Horace Mann High School in New York City organized clubs which held meetings during recitation periods. These clubs were formed to enrich the classroom work. In 1913, Miss Gurgle formed a mathematics club among the boys from grades ten to twelve at the Scott High School in Toledo, Ohio, to increase interest in the subject of mathematics. Grade requirements for membership were "excellent" or "good." Programs of this club consisted of three features: a biography of some great mathematician with his contributions, a mathematical recreation, trick,

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[10] Marie Gurgle, and others, "Recreational Values Achieved Through Mathematics Clubs in Secondary Schools," First Yearbook of the National Council of Teachers of Mathematics, 1926. p. 195.

or fallacy, and a summary of some modern invention dependent upon mathematical principles. In 1914, students of several high schools in Chicago grouped together after school for special study. By 1916, clubs were widely distributed over this country, and there was one club in England of particular importance. Irene Brown was sponsor of this club in a school in London. She states:

> The club was formed to illuminate the bypaths of mathematics; to study certain interesting matters connected with mathematics that do not find a place in the usual classroom; to promote interest in the study of mathematics; to give the pupils glimpses of the future and incentives to further study; to develop an appreciation for the truth and beauty in mathematics, and our dependence upon it in practical life; and, to furnish an outlet for the pupils' social instincts.[11]

Shortly afterward came the war with greater demands for more practical and useful mathematics. At this time, there were not enough men in this country sufficiently trained in mathematics to enter the artillery schools; this shortage necessitated government preparatory schools in New York. Emergency courses in mathematics were offered in New York City for those interested in field artillery. After the war, the government recommended a course in the use of the slide rule for disabled soldiers. The teachers felt it was their duty to cooperate, and several slide rule clubs were formed among high school students. Clubs continued to grow in numbers until the depression of 1931 and 1932, when many teachers were required to teach more and larger classes. The added teaching load made extra-curricular activities almost impossible.

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[11] Irene M. Brown, "A Mathematics Club in a Girl's School," Journal of Education (British), 38:556, September 1916.

Values and purposes of the mathematics club. It is largely because of the failure of teachers to provide opportunity for exploring these mysterious by-ways that many high school pupils regard mathematics as a necessary evil, as something almost entirely apart from everyday life, as an affliction to be escaped as soon as the minimum requirement has been met. Work that has been considered drudgery may become a pleasurable pastime with the proper incentive. Someone has fittingly said, "The greatest problem to be solved by the mathematics teacher today is the problem of making mathematics interesting to the pupil."

In addition to the problem of arousing the dull or indifferent pupil from his lethargy, there is danger of not keeping the brighter and more original pupils working at concert pitch, so that while we are attempting to create interest, we may not kill that which already exists.

The mathematics club offers a solution to this problem.

The purpose of the mathematics club, therefore, is not merely to teach more formulas, equations, and theorems, but to allow the pupil to explore and discover for himself the many interesting and worth while pleasures that are to be found there.

Through the club the pupil comes to know that the queer looking portraits, that he may have seen in his algebra text, represent human beings, not greatly unlike himself.

But when mathematics is related with everyday affairs, its connection is usually financial, or, at least, strictly useful. Mr. Newhall, in discussing the work of his club and some of the different and difficult subjects that its members chose

to study, says:

> Even if the students do not acquire perfectly clear notions about these rather vague subjects, it does no harm to at least set them thinking. This is perhaps the most valuable result of the work of our club. It sets the boys to thinking and stimulates their imagination. They find that there is more of interest in the subject of mathematics than they had dreamed. Our investigations are not very profound, to be sure, and will result in no contributions to the sum of mathematical knowledge, but the boys enjoy the meetings, and, I think, profit by them, and as these are two distinct objects of this mathematics club, I feel that it has proved itself worth while.[12]

The mathematics club offers a splendid opportunity to emphasize the financial suicide being committed daily by bank nighters, slot machine addicts, chain letter artists, and installment buyers. Everywhere, children as well as adults, are constantly being tempted by the lure of various types of gambling schemes that are rapidly increasing in number.

The point has been reached where one can hardly go to a moving picture performance without being thrown into contact with some form of "screeno" or "bank night." Everywhere people are being led to believe that they are going to be the lucky one this time, and that they can get "something for nothing."

The hopeful customer at the "bank night" hastily shoves a quarter through the cashier's window for a ticket, and violently forces his way through the crowd of two thousand other people, also fired with the hope that they may win. Usually the film shown is of a very inferior grade, for which the entrance fee and two or three hour's time is a very high price to pay.

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[12] Zula Reed, High School Mathematics Clubs," The Mathematics Teacher. 18:342, October, 1925.

One can hardly drop into the corner drug store or stop on the road while traveling, without finding slot machines, punch boards, and pin ball games. And how appealing to the imagination the manufacturers can make these machines!

Not long since, the "prosperity-by-mail" fad swept the country like a pampas-fire, and postal authorities have found it equally as hard to stop.

A great amount of mathematics is involved in obtaining the possible results of these schemes for the investors.[13] The Los Angeles Times quoted Dr. D. Victor Steed, mathematics professor at the University of Southern California, on the problem. His calculations showed that "if it takes 15,625 persons to contribute $1,562.50 to one person, a total of 244,140,625 letters must be circulated for each of the original 15,625 to receive a like amount. This is more than twice the population of the United States. It would involve $24,414,062.50."

America is today entering a distinctly accentuated installment serfdom, alluring to the victim, grinningly understood in its true character as a manacle by the jailer. A total of approximately $8,000,000 was the 1925 figure for the total of purchases on the installment plan in the United States. Around ninety per cent of the automobiles and radios are sold on time payments. The percentages for other articles are almost as great. Probably the most common rate of interest is 1/25 of one per cent per day on the net value of the article purchased. This rate of

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13 "Chain Letter Prosperity by Mail," The Literary Digest. May 18, 1935.

interest, if calculated on a yearly basis, amounts to 14.6 per cent a year. Since only 75 to 80 per cent of the face value is advanced, in the case of short time cash loans, the actual rate charged is correspondingly increased.

Mr. Gegenheimer[14] writes that his club is answering the following question: "What shall we do for the bright pupils?"

Miss Meeks[15] writes that the mathematics club has tried to bridge the gap between textbook study and actual application.

A well conducted mathematics club will have something of value for all kinds of pupils. We may state our purpose and explore it in the same manner that we would explore a theorem.

> If a mathematics club is alive and alert, then it will be of value to all members of the class.[16]

Miss Russell[17] believes that the purposes of the mathematics club should be to round out and supplement mathematics courses in the high school. Many students will find that they particularly like and enjoy mathematics, and most certainly these students should be given an opportunity to make use of their talents in this particular subject. We can afford them this opportunity by means of the mathematics club.

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[14] Zula Reed, "High School Mathematics Clubs," The Mathematics Teacher. 18:342, October, 1925.

[15] Anna R. Meeks, "Recreational Aspects of Mathematics in the Junior High School," The Mathematics Teacher. 29:342, January, 1936.

[16] N. Anning, "High School Mathematics Clubs," The Mathematics Teacher. 26:70, February 1933.

[17] Helen Russell, "Mathematics Clubs," The Mathematics Teacher. 17:283, May 1924.

Miss Russell informs us that the mathematics club will do the following things for the students:

> 1. Especially good students may form a group to continue with the study of branches of the subject not taught during the regular session.
> 2. The club will help the less fortunate members who are experiencing difficulties with their work in mathematics.
> 3. The club will give the students an opportunity to see mathematics from different angles and viewpoints than they see in the classroom. For example:
>
> a. History of the subject.
> b. Practical applications of mathematics in everyday life.
> c. They can have opportunity to find "fun" in mathematics.
> d. Some interesting social contacts with their fellow students are made possible through the mathematics club.[18]

The mathematics club should be something more than a laboratory in which textbook information is applied. It should give each of its members an opportunity to exercise his initiative and to develop whatever abilities for leadership he may possess.

Organization of the mathematics club. In order to guarantee sucess, the sponsor must make sure that the organization of the club is planned with great care. Everyone in the school should be informed concerning the club and pupils should have an active part in its formation. Perhaps the best time to bring the club to the attention of the student body would be during an assembly program.

To find a convenient meeting time will doubtless be one of the first problems confronting the newly formed group. If the school program permits, some free hour should be utilized for this

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[18] Ibid., p. 283.

purpose as attendance will be better and interest more easily maintained than when meetings occur after school hours.

The number of meetings will vary. Some clubs meet weekly, while others only meet monthly. In large measure the number of meetings will depend upon the enthusiasm of the students and sponsor. The meetings may vary in length, but, with the exception of social meetings, one hour will be sufficient time.

Social meetings may be held at night or after school, depending on the distance members need to travel to reach the meeting. Attractive out-of-door programs arranged for Saturday mornings should bring many to the meeting. Many mathematical situations suggest themselves for outdoor treatment, such as measuring the height of inaccessible objects by the shadow method.

When a club is first organized, the sponsor needs to do the leading and guiding. After the initial stage, however, the sponsor should be inconspicuous, but ready to step in when necessary. The students should be made to feel that it is their club, and they should operate by themselves with only occasional help from the advisor. Of course, some students will be able to do this to a greater extent than others.

Miss Anning gives the following hints in regard to the organization of the club:

> There will, of course, be a faculty sponsor. He should be like a spare tire, inconspicuous, but ready when needed. The simile is a poor one because the tire should be full of wind; the teacher in this situation should be silent, or at least heard from as seldom as possible. The choice of officers, names, and constitution should come from the members. Without external stimulus, the president will preside, the secretary will record, and the various committees will 'comit' as efficiently as the average corresponding group of adults.

> Indeed, the student group that cannot generate sufficient energy for this part of its activities cannot long survive and will soon not need any faculty advice.[19]

Critical suggestions should be given only in private to individual members, and, if possible, only when sought.

In the study made by the writer of different club organizations, it was found that the members were usually enrolled for at least a semester at a time. The only requirement for membership was a passing grade in mathematics for the preceeding semester, if the student was enrolled in a mathematics class.

It is a good idea to select the president from the senior members of the club, thus placing the main responsibility on the more mature pupils, as well as eliminating the possibility of a member holding the presidency for more than two semesters.

An intriguing name for the club attracts boys and girls of high school age. Although many schools use just the name "Mathematics Club," others have used such names as "The Radicals," "The Mystic Circle," "The Magic Circle," "The Naperian Club," "The Pythagoreans," "The Mystic Hexagon," "The Cartesian Oval," "The Pascal Triangle," "The Euclidian Circle," "The $f(x)$," "The Wrinkle Club," "The Circle of Truth," "(x, y, z)," "Triangle," and "Parabola."

Simple little items of routine can be made appealing to boys and girls of high school age. For example, having members answer roll call by saying "plus," and then having another member say "minus" for the absent members. Records may be kept of voting,

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[19] N. Anning, "High School Mathematics Clubs," The Mathematics Teacher. 26:71, February 1933.

attendance those who participate in the program, and those who solve puzzles.[20]

The club constitution of the Shortridge High School of Indianapolis, Indiana, is as follows:

> Article I. The name of this organization shall be the Shortridge High School Mathematics Club.
>
> Article II. The object of this club shall be the study of some phase of mathematics not usually presented in the courses in high school mathematics, and to promote the spirit of good feeling and scholarship among students interested in the subject.
>
> Article III. (A) Students in Mathematics IV or above whose standing at the time of election is A or A plus and whose previous record in the subject averages B are eligible to membership.
>
> (B) The club shall be limited to forty members.
>
> Article IV. Members may be proposed by any member of the club at any meeting. Such names shall then be referred to a committee which shall report at the next regular meeting upon the question of eligibility; provided, however, that if at the time such a name is presented, a statement of the student's record is also presented. Then the services of such committee are not necessary.
>
> Article V. A member may withdraw from the club upon written request, which will be recorded in the minutes of the club.
>
> Article VI. The officers of the club shall be a president, a vice-president, a secretary, a program committee, and a sponsor. It shall be the duty of the president to preside at all meetings of the club, and, in case of his absence, the vice-president shall preside. The secretary shall keep a record of the proceedings and a list of the names of the members with the dates of admission to membership. The officers' term of office shall be one semester.
>
> Article VII. The program committee shall consist of three members elected by the club, the president, and the sponsor. The committee will provide a program for meetings of the

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[20] Thelma Jobe, "Types of Programs and Needed Equipment for Mathematics Clubs," Teachers College Journal. 5:95, September 1933.

club and shall notify members who are to take part.

Article VIII. The constitution may be amended by a two-thirds vote of those present at any regular meeting, provided that the proposed amendment shall have been proposed and read at the previous meeting; and provided also that a majority of the members are present.[21]

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[21] Wilma Wilson Crossett, "Mathematics Clubs in the Senior High Schools of the United States," University of Colorado. Unpublished thesis, 1936.

CHAPTER IV

IV. CLUB ACTIVITIES

Historical. Members of the mathematics club who are interested in the history of mathematics can find many interesting topics to write about. To mention but a few: mathematics in machinery; time-tellers; time; history of numbers, calendars, design; history of coins; mathematics in music; mathematics in snowflakes; mathematics found in puzzles, cathedrals, banks; geometric forms in advertising and commercial art; early Greek mathematicians; mathematics among the Chinese, Hindus, Egyptians, Romans, and Arabs; bridges; bridge construction; history of some mathematicians; ancient architecture; decimal system; and, mathematical instruments. Writing on a particular topic not only stimulates interest, but it opens up new lines of thought, and mathematics becomes more than just the traditional values derived from computation.

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Preparation of demonstration materials. Many times during the regular class period teachers cannot find time enough to instruct pupils in the making of demonstration materials. Geometry models and special devices for use in the classroom can be made by pupils in the mathematics club to illustrate some theorem or to clarify some mathematical concept. Frequently the pupils poorest in thinking out logical demonstrations will make the best models.

Some models can be made of tin. These models can be filled with sand or water to illustrate volume proofs. Other substances that can be used in the manufacture of classroom models are celluloid, metal foil, wooden boxes, plaster-of-paris, and many other modern synthetic plastic materials.

The most important step for pupils working with solids is the construction of these solids with their own hands, using small sticks and modeling clay.

The use of a thread model of a cylinder to show the pupils the ever-amazing transition from the cylinder to the double cone is important.

Every club should start a collection of models that have been made by and used for demonstrations by its members. The most valuable models are those that the pupils design and construct with their own hands in their own home shop.

Great spiritual uplift comes to some people from the mere contemplation of many mathematical relationships in nature. A deep respect for such creation begets an abiding faith in the creator.

In our teaching and in our clubs let us try to catch the vision ourselves, and through the beauty and truth of mathematics help our boys and girls to see and believe.

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[illegible] Charles V. [illegible], "[illegible] ematics," School, Science, and Mathematics.

Mathematical recreations. Newhall defines a mathematical recreation as any subject with a mathematical bearing or basis, which has an intrinsic interest, a possible value in mathematics teaching, and that are not included in the traditional courses.[1]

These recreations may be of several kinds, a few of them being: puzzles, games, and tricks.

The amount of material for recreational programs is vast and far-reaching. To keep variety in the club program, it is advisable to have at least three features for each meeting, for example: (1) a biographical or historical report, (2) a report on some scientific discovery or invention, (3) and, a mathematical game, trick, or fallacy, or an interesting geometrical construction. To encourage the more timid members to participate, one can resort to a full program of mathematical tricks or problems occasionally.

An interesting club program might include the making of mathematical cross-word puzzles.

Another amusement that proves to be very entertaining is the dictionary game. In playing this game, the students look up the origin of mathematical terms. Then they make up catch questions, as "What mathematical word sounds as if the parrot were missing?" The answer is polygon.

The singing of songs of a mathematical nature, combined with the poetry of mathematics, will make a very interesting

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[1] Charles W, Newhall, "Recreations in Secondary Mathematics," School, Science, and Mathematics. 15:283, April 1915.

program. Many students will be amazed at the relationship between poetry and mathematics. The pupils will also be interested in riddles and in playing numbers games.

The club might sponsor tournaments in chess, dominoes, monopoly, and chinese checkers.

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"SONGS"

Merrill, Helen A., "Three Mathematical Songs," The Mathematics Teacher. 25:36-37, January 1932.

"POEMS"

Bandman, Chester G., "Some Higher Aspects of Secondary School Mathematics," The Mathematics Teacher. 19:46-51, January 1926.

Buchanan, S.M., Poetry and Mathematics. (New York: The John Day Company, Inc., 1929)

Fezandie, Margaret, "A Word to the Foolish," The Mathematics Teacher. 19:100, February 1926.

Fezandie, Margaret, "First Aid in Algebraic Fractions," The Mathematics Teacher. 19:101, February 1926.

Gillies, Robert C., "Love Mathematical," The Mathematics Teacher. 12:124-201, March 1920.

Hagen, Irene G., "The Changeable Changeless Naught," The Mathematics Teacher. 19:102-103, February 1926.

Hunter, W.L., "Figures," The Mathematics Teacher. 17:367, October 1924.

Hunter, W.L., "Math.," The Mathematics Teacher. 19: 77, February 1926.

Hunter, W.L., "So Let Me Teach," The Mathematics

Teacher. 18:58, January 1925.

Merrill, Helen A., "So Let Me Work," The Mathematics Teacher. 19:99, February 1926.

Percival, W.P., "A Mathematics Teacher's Creed," The Mathematics Teacher. 19:184, March 1926.

Smith, David Eugene, "The Call of Mathematics," The Mathematics Teacher. 19:282-289, May 1926.

Smith, David Eugene, "The Poetry of Mathematics," The Mathematics Teacher. 19:289-296, May 1926.

"Recreation -- A Group of Six Poems," The Mathematics Teacher. 19:487-489, December 1926.

"The Poetry of Mathematics," The Mathematics Teacher. 19:291-296, May 1926.

Play production. Practically all high school students enjoy taking part in and giving plays. This can be a splendid project for the members of the mathematics club that are dramatically inclined. This is an inspiring way to advertise the club, and it can be used as a source of making money to buy books for the mathematics library.

Many plays are available in The Mathematics Teacher, also in School, Science, and Mathematics.

Some of these plays are suitable for small groups, and others can be used for large groups.

No attempt will be made to classify the plays as to value and interest to the club members.

PERIODICAL ARTICLES

"DRAMATICS"

Anning, Norman, "Socrates Teaches Mathematics," School, Science, and Mathematics. 23:581-584, June 1923.

Brownell, Ella, "Mathesis," The Mathematics Teacher. 20:459-465, December 1927.

Cohen, Dena, "A Problem Play," The Mathematics Teacher. 29:78-83, February 1936.

Cowley, E.B., "Mathematical Fantasy," School, Science, and Mathematics. 33:535-536, May 1933.

Crawford, Alma E., "A Little Journey to the Land of Mathematics," The Mathematics Teacher. 17:336-342, October 1924.

Fletcher, R.W., "Quarter After Ten," Texas Outlook. 15:31-35, May 1931.

Forrest, Louise A., "Euclid, Agrarian Arbitrator," The Mathematics Teacher. 25:22-26, January 1932.

Graff, Margaret, "Euclid Dramatized," School, Science, and Mathematics. 21:381-383, April 1921.

Harding, P.H., "A Mathematical Victory," School, Science, and Mathematics. 17:475-482, June 1917.

Hatcher, Francis B., "A Living Theorem," School, Science, and Mathematics. 16:39-40, January 1916.

Hatton, Caroline, "Falling in Love With Plane Geometry," The Mathematics Teacher. 20:389-402, November 1927.

Hauch, E.B., "Good Morning! A Commercial Play With No Superfluous Words," Business Education World. 18:140-142, October 1937.

Leps, J.M., "Radical Dream: a Playlet for Puppets," School, Science, and Mathematics. 33:279-287, March 1933.

McSorley, Kathryn, "Mock Trial of B versus A," School, Science, and Mathematics. 18:611-621, October 1918.

Miller, F.B., "A Near Tragedy," The Mathematics Teacher. 22:472-481, December 1929.

Miller, F.B., "An Idea That Paid," The Mathematics Teacher. 25:470-479, December 1932.

Miller, F.B., "Out of the Past," The Mathematics Teacher. 30:366-370, December 1937.

Patterson, E.B., "Everyman's Visit to the Land of the Mathematicians," The Mathematics Teacher. 31:7-18, January 1938.

Pitcher, Wilhelmina, "Alice in Dozenland," The Mathematics Teacher. 27:390-396, December 1934.

Pitcher, Wilhelmina, "The Mathematics Club Meets," The Mathematics Teacher. 24:197-207, April 1931.

Rafery, G., "Eternal Triangle," The Mathematics Teacher. 26:85-92, February 1933.

Russell, C.A., "More Than One Mystery," The Mathematics Teacher. 26:477-481, December 1933.

Schlauch, H.M., "Point-College," School, Science, and Mathematics. 31:448-454, April 1931.

Schlierholz, T., "A Number Play in Three Acts," The Mathematics Teacher. 17:154-169, March 1924.

Scott, Erma, "Geometry Humanized," The Mathematics Teacher. 21:92-101, February 1928.

Skerrett, Josephine, "Mathematical Nightmare," The Mathematics Teacher. 22:413-417, November 1929.

Slaught, H.E., "The Evolution of Numbers -- An Historical Drama in Two Acts," The Mathematics Teacher. 21:305-315, October 1928.

Smith, H.A., "Case of Mathew Mattix," The Mathematics Teacher. 26:286-291, May 1933.

Snyder, R.L., "If; a Play Showing the Importance of Mathematics," The Mathematics Teacher. 22:482-486, December 1929.

Whitaker, Helen, "The Math. Quest," School, Science, and Mathematics. 20:457-462, May 1920.

Yeshman, A., "How to Get Fired," Business Education World. 17:626-629, April 1937.

"Flatland," School, Science, and Mathematics. 14:583-587, October 1914.

Exhibits. An activity that can arouse great interest in a club and also in the classwork is the preparation of an exhibit. This is one way to get people interested in mathematics, and to draw attention to departmental work. Mathematics exhibits are a means of increasing both interest and efficiency in mathematics.

Bulletin boards made of cork should be placed in each mathematics room. Upon these boards the work of the different classes in mathematics should be placed from day to day in order that the pupils, and also visitors, can observe what is being done in their own and in other classes.

Papers should be chosen for posting on the basis of neatness, importance of subject matter, care in development of proofs, unusually good independent work, and special reports.

A friendly spirit of rivalry will usually exist among the students, and a desire on the part of all to be well represented, especially in the annual mathematics exhibit, will make the work a pleasure.

When exhibited work is taken down from the bulletin board, it should be filed under the proper heading, so that any particular kind of material is always available.

In addition to written work, geometric models and other special devices for use in the mathematics classroom can be made by the pupils in the clubs to illustrate some theorem or to clarify some mathematical concept, and these can be made a part

of the permanent exhibit.

A mathematical exhibit might not only educate and influence the public to be more tolerant towards mathematics, but might even create a greater demand for the subject.

PERIODICAL ARTICLES

"USE OF EXHIBITS"

Broverman, Benjamin, "The Mathematics Exhibit at the Century of Progress," High Points. p. 30-31, December 1934.

Georges, J.S., "Supplementary Projects: Procedure," The Mathematics Teacher. 26:467-470, December 1933.

Georges, J.S., "Supplementary Projects: Procedure," The Mathematics Teacher. 26:283-285, May 1933.

Gregory, M.C., "Mathematics Exhibit," The Mathematics Teacher. 23:382-384, October 1930.

Harris, Louise M., "Exhibit Your Mathematics," High Points. p. 22-25, December 1934.

Moore, L., "Mathematics Exhibit, World's Fair, Chicago," The Mathematics Teacher. 26:482-486, December 1933.

Mossman, Edith L., "A Mathematics Room That Speaks for Itself," School, Science, and Mathematics. 33:425-430, April 1933.

Ramseyer, John A., "The Mathematics Laboratory -- A Device for Vitalizing Mathematics," The Mathematics Teacher. 28:228-233, April 1935.

Reeve, W.D., "Exhibit of High School Mathematics -- Its History and Educational Value," School, Science, and Society. 2:191-197, August 7, 1915.

Wilson, Ruth, "A Unique Mathematics Exhibit," The Mathematics Teacher. 30:128-129, March 1937.

Collection of library materials: A project that will be of great benefit to the mathematics club and also of interest to the members will be the collection of mathematical books and pamphlets. Of course, if the club is without funds, it will take a little time to raise enough through dues or some money-making scheme to buy at least one or two books.

Much of the most useful material is now available only in scattered periodical literature and in advertising brochures and pamphlets, and it is difficult to make such fugitive materials accesible to our students. There are many government bulletins on mathematical topics that can be had for a few cents by sending to Washington, D.C.

Sources of material are very numerous. Much material can be had from popular magazines and newspapers. There are advertising pamphlets published by the Bell Telephone Company, Ford Motor Company, Westinghouse Electric Company, Johannsen Gauges, Gruen Watch Guild, and many others that contain material of value to the mathematics club.

Another important part of the library is the picture division. We may find materials that are in the form of illustrations that cover a wide field of mathematics. For example, there may be a folder on Egypt, containing photographs and drawings taken largely from advertisements, illustrations of costumes and people, the pyramids, the Sphinx, and many other phases of art, architecture, and industry in Egypt. There may also be a folder

containing striking pictures of modern engineering achievements such as airplanes, trains, factories, dams, and industrial processes. Much free or inexpensive material can be secured from different sources to help build up the mathematics library.

Another collection that would be useful would be a collection of plays for the department.

The purpose of the project is not to replace the books on the history of mathematics or on the recreations, but rather to supplement them, and by creating and cultivating student interest, to encourage them in the use of such books.

PERIODICAL ARTICLES

"LIBRARY NEEDS"

Antwerp, Van B., "Supplementary Mathematics Through the Library," National Elementary Principal. 12:285-287, June 1933.

Barnes, Augusta, "Making Mathematics Interesting," The Mathematics Teacher. 17:404-410, November 1924.

Forrester, Gertrude, "A Home-Room Teacher's Bookshelf of Free and Inexpensive Materials," Secondary Education. 7:30-33, February 1938.

Lloyd, D.E., "Bibliography of Popular Mathematics," School, Science, and Mathematics. 38:186-193, February 1938.

Miller, G.A., "Mathematical Encyclopedias," School, Science, and Mathematics. 12:27-30, January 1912.

Miller, G.A., "New Mathematical Periodicals," School, Science, and Mathematics. 22:276-280, March 1922.

Reene, W.D., "References for Teachers," The Mathematics Teacher. 15:303-307, May 1922.

Sharwell, Truman, "Books That Help Make Mathematics Interesting," The Mathematics Teacher. 19:419-428, November 1926.

Stone, Charles A., "The Supplementary Project in Mathematics," School, Science, and Mathematics. 24:905-912, December 1924.

Taylor, S.H., "Mathematics Library and Recreational Programs," School, Science, and Mathematics. 30:626-654, June 1930.

Wright, H.C., "Mathematical Articles of Interest," School, Science, and Mathematics. 15:622-623, October 1915.

"A Brief List of Mathematical Books," The Mathematics Teacher. 18:477-489, December 1925.

Visual aids. Visual education is a recent development, and educators predict that it will become more and more important. Other departments have made more use of visual education than has the mathematics department, but teachers of mathematics are now taking advantage of these helpful devices. It is reasonable to expect the use of visual aids in mathematics to become extensive.

Slides and motion pictures are useful in developing an appreciation for mathematics. There are many possibilities for the use of films in geometry, employing the technique that is now used in the cartoon films. A few good films have been made following this idea, showing constructions and their geometric relations. The mathematics club can profitably take advantage of the many films that can be used to give reliable information on mathematics and subjects closely allied to it. Many of these films can be obtained free of charge, while others may be rather expensive.

"The Benefactor," a three-reel motion picture on the life of Thomas A. Edison is an excellent picture to use. This film can be obtained without charge from the Publication Bureau, General Electric Company, Schenectedy, New York. The General Electric Company has some other films of mathematical interest that are well described in their pamphlet "Lecture Service, Motion Pictures, and Lantern Slides."

Other sources of films are: The Argonaut Distributing

Corporation, 5 Columbus Circle, New York City; the New Jersey State Department of Public Instruction; and, Mr. Charles H., Sampson of the Massachusetts Department of Education has completed a film entitled, "Definitions of Plane Geometry." Any club wishing to develop a screen project should first obtain a copy of "1000 and 1" from the Society for Visual Education, Inc., 130 West 46th Street, New York City.

Slides of a mathematical nature may be obtained from Indiana University, The Keystone Company, General Scientific Supply Company, Chicago Apparatus Company, Ball State Teachers College, and Indiana State Teachers College.

If the mathematics club has members interested in photography, they may be set to work obtaining pictures illustrating various mathematical forms and principles such as symmetry, circular and Gothic windows, compound curves, eccentric and concentric circles, proportion, similarity, triangles, triangular bracing, and parabolas formed by suspended cables. All of these and many more are to be found in the fields of architectural and structural design.

Lantern slides of any of these pictures will make them more readily available for classroom use or for a mathematics club program. Etched glass slides with drawings of geometry propositions can be made by members of the mathematics club capable in drawing.

Another visual aid of value is the bulletin board. (See page 49 for further information on the construction and uses of the bulletin board.) If illustrative material is shown to the

pupils, the room should have a bulletin board. Let the members of the club help in the collection of proper materials for this board. The board should be placed so that it is easily seen. It should be of such materials and workmanship that the effect on the room is pleasing and the display attractive.

Posters may be thought of as illustrative materials to be displayed to the students by placing them on the walls or bulletin boards. The posters usually contain some explanatory sentence or word.

Designs in the nature of posters that contain a combination of figures and colors are ornamental. Designs most useful in the geometry room are those based on geometric figures, such as, circles, triangles, and squares. It is through these visual aids that an appreciation of geometry in art, architecture, and nature is developed.

PERIODICAL ARTICLES

"VISUAL AIDS"

Engle, T.F., "Some Suggestions for Using Amateur Photography in Mathematics Courses," School, Science, and Mathematics. 33:506-510, May 1933.

Fordney, C.L., "Visual Aids at the World's Fair," Nations School. 13:55-57, May 1934.

Punnett, Margaret, "Mathematical Films," The Mathematical Gazette. 21:149-151, May 1937.

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Brooks, Robert P., The School Club Develops Creative Power. Bulletin (Ninth Yearbook) April 1930. Vol. 9:551, (Washington, D.C.: Department of Elementary School Principals, National Educational Associations)

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Meyer, Harold P., The School Club Program. (New York: A.S. Barnes and Company, 1931)

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Teacher. 25:84, February 1932.

Anning, Norman, "High School Mathematics Club," The Mathematics Teacher. 26:70-76, February 1933.

Bernstein, Selig, "A Mathematics Club Paper," High Points. 17:68, June 1935.

Bierman, A.O., "Organization and Value of Club Work in the School Program," National Education Association. Department of Classroom Teachers. Fifth Yearbook. p. 85-88.

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Brooks, R.P., "School Club Develops Creative Power," Bulletin of the Department of Elementary School Principals. 9:551-554, April 1930.

Brown, Irene M., "A Mathematical Club in a Girls' School," Journal of Education. (British) 38:556, September 1916.

Cox, P.L., "Clubs," School and Home. 14:10-15, January 1931.

Elwood, R.L., "High School Clubs," High School Teacher. 8:18-19, January 1932.

Gegenheimer, Frank C., "Mathematics Clubs," School, Science, and Mathematics. 16:791-792, December 1916.

Gulden, Minerva, "Mathematics Club Program," The Mathematics Teacher. 17:350-358, October 1924.

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Hunter, William, "Figures," The Mathematics Teacher. 17:367-368, May, 1924.

Jobe, Thelma, "Types of Programs and Needed Library Equipment for Mathematics Clubs," Teachers College Journal. 5:92-94, September, 1933.

Kelly, J.E., "School Clubs," Industrial Arts Magazine. 19:59, February, 1930.

Levinson, R., "X,Y,Z Club," High Points. 14:48-51, November, 1932.

McElroy, E.W., "How School Clubs Function," Better Homes and Gardens. 10:44, March, 1932.

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Reed, Zula, "High School Mathematics Club," The Mathematics Teacher. 18:341-363, October, 1925.

Russell, Helen, "Mathematics Clubs," The Mathematics Teacher. 17:283-289, May, 1924.

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Steward, M., "Mathematics Club of the Pontiac High School," The Mathematics Teacher. 23:25-29, January, 1930.

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