A PROCEDURAL METHOD USED FOR TRACKING

IN MATHEMATICS AT THE MIDDLE SCHOOL LEVEL

Report of

An Action Learning Project

Presented To

The Graduate Faculty of the College of Education

University of Wisconsin - La Crosse

In Partial Fulfillment

Of the Requirements for the Degree

Master of Education-Professional Development

by

Robert D. Ratigan

July 1988

UNIVERSITY OF WISCONSIN - LA CROSSE

COLLEGE OF EDUCATION

Candidate: Robert Ratigan

I recommend acceptance of this development project in partial

fulfillment of this candidate's requirements for the degree

Master of Education - Professional Development.

Earle Munns   _7/25/88_
          Project Advisor   Date

This action learning project is approved for the College of Education.

William A. Schmidt   _7-25-88_
        Dean, College of Education   Date

Joy C. Greenlee   _August 1, 1988_
        Dean, Graduate Studies   Date

RATIGAN, Robert D. A procedural method used for tracking in
mathematics at the middle school level. Master of Education —
Professional Development, 1988. 40 p. (Dr. Earle Munns).

The purpose of this project was to determine whether the selection

of ability groups by the use of pretests and posttests was a valid

means for grouping students. The degree of success was measured by

comparing students raw scores on the pretest with their raw scores

on the posttest after the grouping and treatment had been completed.

During the first week of the first quarter of 1987, a review and

pretest were given to the seventh and eighth grade students. The

raw scores obtained from these tests were used to group the students

in mathematics for the 1987–88 school year. The Pearson Product

Moment Correlation formula produced a positive coefficient of .286

when comparing the pretest and posttest. This indicated a low corre-

lation, a definite but small relationship. Based on these findings,

the null hypothesis was rejected at the .01 level of confidence.

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CHAPTER 1

INTRODUCTION

Background

The Onalaska Middle School is in its twelfth year of operation.
The school is located in Onalaska, Wisconsin and currently houses
approximately six hundred fifth through eighth grade students.

The school is divided into six multi-aged groups of students
called pods. The school currently has three fifth-sixth grade pods
and three seventh-eighth grade pods.

The pods have four teachers. The pods include teachers of the
following subjects: science, language, social studies, and mathematics.
Each pod is responsible for the class groupings according to its
own criteria. At the Onalaska Middle School the seventh-eighth
grade pods are ability grouped in the area of mathematics.

The philosophy of the school is to expose the students to as
much mathematics and in as many medias as possible. Those students
needing help in basics will be given that help through title programs,
special education classes and extended individual work with the
classroom teacher.

On the other end of the spectrum, the school also provides
activities and courses for the gifted student of mathematics. The
Onalaska Middle School has a computer room with twenty-five Apple
computers. This arrangement allows classes to be held with each

student having his/her own keyboard, computer and monitor.

Those students who have shown a mastery of the curriculum through eighth grade may take courses for high school credit. The courses offered for high school credit are Algebra I and Algebra II.

Statement of the Problem

Tracking is a common method employed to group and educate children in our American schools. Students are grouped by ability and tracked through a school curriculum. This system has been used for many years and has many advocates. The system appears to be a quick and efficient way to assist students as they are ready to receive and understand the curriculum.

One benefit of this system is to provide material to students in a large group. This method allows for a common ground for all students enabling students to acquire peer help in addition to allowing teachers to spend time with small groups and one to one instruction.

Another benefit allows those students who complete the prescribed curriculum, to enroll in advanced courses. An example of this at the Onalaska Middle School is the offering of Algebra I and Algebra II to be taken for high school credit. These courses are available to seventh and eighth graders.

Opponents of tracking have many reasons for resistance to this educational plan. The National Education Association (NEA) addressed this plan in the NEA Today (January, 1988) issue. A

great number of professionals and parents believe tracking locks

students into classes where a stereotype as "less able" develops

and the opportunities to learn are diminished. Tracking critics

also feel that poor and minority students are more likely to be

placed in low ability groups and are less likely to be placed in

programs for gifted and college bound students.

Tracking is the product of the procedure used to determine

ability groups. The procedure used by the teachers to determine

ability groups may not be the best available avenue. This study

will evaluate the current ability grouping procedure used by this

writer at Onalaska Middle School and examine alternative methods

of determining ability grouping to find the most advantagous plan

for the Onalaska Middle School Mathematics Department.

Need for the Study

A successful endeavor includes evaluation and reassessment

from time to time. In the field of education, professionals have

a duty to evaluate and assess the programs that they are teaching.

The world of technology has expanded a great deal. Educators have

access to materials and electronic equipment that was never before

available. Students today have been exposed to a world at the

middle school level that the teacher who educates them had not been

exposed to until high school or later.

It is important to consider the changing home lives students

now have in comparison to the norm many years ago.

The field of education must consider many criteria when establishing educational programs. If the students were not tracked, some of the more able students may not be permitted to enroll in advanced courses which would be more challenging to them.

The pace of the courses may also lessen if the classes included students with a wide scope of learning styles and paces thus not allowing the entire group to be exposed to the same amount of material.

This study will investigate possible changes in assessment of mathematic skills which could meet the needs of the student of today.

The major objective of this study is to provide the best possible method(s) for evaluating students for ability grouping and/or placement. The end result will be to help the students by providing a method for grouping which will expose these students to the curriculum in the most meaningful manner for them.

Purpose of the Study

The Onalaska Middle School teachers group students with the use of a pretest. The results of the pretest allow teachers to group students according to the mastery the students display on the pretest.

The students proceed through the curriculum according to the needs of the groups that the students are placed in.

The posttest is administered in the spring to assess the growth exhibited by the students in the groups they were assigned. The results of the posttest also give direction to the teacher in

terms of activities and approaches used and how successful these were.

The following fall after a review of the curriculum, the students are again given a pretest to aid in the new grouping for that year.

The purpose of this study is to examine other alternatives to handling the placement of students at the Onalaska Middle School. The research may indicate an alternative plan to tracking in addition to the procedure for evaluation.

Assumptions

The following assumptions were necessary in order to perform this study.

1. It is assumed that the items of the pretest and posttest will be a sampling of the core of the curriculum.

2. It is assumed that due to maturation, learning will take place between the pretest and posttest.

Limitations

The following limitations were encountered during this study.

1. The major limitation is the design being studied. This design uses no control group which is very limiting.

2. A limitation will be the size of the group being tested.

Definitions

In discussing ability grouping and evaluation models, several definitions are necessary. They are included for reference.

<u>Pod</u> A group of students housed in an area for instruction.

<u>Multi-aged</u> A group of students being taught, that has perimeters

of age range that can exceed in this case over two years.

<u>Pretest</u> A test used for placement that measures a child's knowledge

before instruction begins.

<u>Posttest</u> A test given after instruction in order to determine if

the students understood the material presented.

<u>Dependent variable</u> A variable that is based on a consequence or a

phenomenon that is the object of study or investigation.

<u>Treatment</u> The method used for instruction.

<u>Ability Grouping</u> The grouping together of people according to their

proficiencies in an academic area.

<u>Tracking</u> The placement of students into groups according to ability.

CHAPTER 2

REVIEW OF RELATED LITERATURE

Grouping

All students learn at their own speed. Each child is an individual

with individual wants and needs. Each student's personality traits,

environmental exposures and family life is different. Even when

children grow up in the same environment, they will differ in how

each perceive the experiences they have had. Consequently, each

student's ability in every facet of his or her academic life will

be based on these differences. Thus, education goals of developing

each child to his or her highest potential will have to take these

individual differences into consideration.

There are many forms of grouping that take place within the

framework of a school.

> Grouping is a process whereby a set of objects or a group of
> persons is divided into subjects or subgroups. Grouping in
> education is an organizational procedure by which a group of
> children is divided on some criterion in order to facilitate
> the learning process. Grouping takes place in a school district
> when children are directed to attend particular schools, in a
> school when children are selected by age and by knowledge of
> subject matter to attend a particular grade level of instruction,
> and within a grade level when certain standards are used in
> assigning children to particular classes. And finally grouping
> takes place within a classroom both by natural association to
> facilitate different purposes and by teacher determination to
> facilitate learning (Hawkes, 1971, p. 167).

The final type of the above grouping process is the target of

this review of literature, teacher determined grouping to facilitate

learning.

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Walter Borg (1966) defines heterogeneous grouping as groups of children with a wide range of intellectual ability. This form of grouping teaches students independence and is more concerned with the affective domain. Borg also states that the heterogeneous grouped students are more likely to do better on self-concept and belonging, and positive attitudes toward peers. When students are heterogeneously grouped in a subject area that has a curriculum that is non-sequential, meaning a student cannot move functionally to the next skill until the previous skill has been mastered, as in mathematics, the wide range of ability is not a positive learning environment.

Homogeneous grouping is defined in the Dictionary of Education as the classification of pupils for the purpose of forming instructional groups having a relatively high degree of similarity in regard to certain factors that effect learning (Goldberg, Passow, Justman, 1966). A form of homogeneous grouping is called ability grouping. Teachers organize their classrooms into groups of students with like ability. Many educators and parents assert that when schools group by ability, teachers are better able to target individual needs and students will learn more (Oakes, 1988). This is a major goal in education, to enhance the learning opportunities for students.

There are also other forms of homogeneous grouping. There is grouping in terms of the rate of mental growth and the rate of growth physically, socially and emotionally. Maturity plays a major role in this form of grouping (Kindred, Wolotkiewicz, Mickelson, Coplein, 1979).

There are two distinct reasons for ability grouping in the class-room. First, to increase a teacher's ability to obtain and keep

a student's attention when there are fewer students in an instructional group and second, to increase a teacher's ability to adapt methods of instruction and instructional materials to the aptitudes and preparations of individual children when there is a smaller group (Sorenson & Hallinan, 1986). Of these two reasons, the greatest concern seems to be the teachers' abilities instead of the students' abilities. An underlying assumption made by teachers and administrators is that ability grouping is seen as the best way to address individual needs and to cope with individual differences and greatly eases the teaching task (Oakes, September, 1986).

Since the turn of the century, there have been as many opponents to homogeneous grouping by ability as proponents, but in the 1980's school professionals are taking a long and hard look at ability grouping in the classrooms. Competency-based testing is on the rise in the educational institutions nationwide. In the Onalaska, Wisconsin public schools, (La Crosse Tribune, May 24, 1988) 49 of the 7th grade students failed the competency-based test in mathematics. A number of possible reasons for this failure can be ascertained. The school's curriculum may not match the state's curriculum which establishes the criteria for the test. And possibly the teaching technique used in 7th grade mathematics needs to be evaluated. The students at Onalaska Middle School are grouped homogeneously according to ability. This is not just one school district's problem, but a nationwide debate as to why students' scores are lower. Curriculum adjustments can be made statewide through conscientiousness and

consistency. Grouping procedures is a more complex problem to adjust. Some of the issues involved in grouping are: (1) ability grouping and academic achievement; (2) access to knowledge; and (3) ability grouping and social impact. Each of these issues will be discussed separately.

Ability Grouping and Academic Achievement

An in-depth two year study of the effects of ability grouping was done by the Horace Mann – Lincoln Institute of School Experimentation in the 1960's. According to one of the findings of this study, when each ability level was taken separately, the effect of ability grouping on academic achievement in each of the five ability levels was almost identical. Goldberg states that narrowing the range of ability levels does not result in consistently greater academic achievement for any group of pupils (Goldberg et al., 1966).

A study on ability grouping and academic achievement was done by Sorenson & Hallinan (1986). The results showed that overall, students in homogeneous classes gained as much in achievement as students in heterogeneous classes. Homogeneous grouping provides fewer opportunities for learning than heterogeneous grouping but greater utilization of those opportunities.

In a summary of a study done by Slavin in 1986, "within class grouping is effective for mathematics instruction, but more research needs to be done to draw conclusions in other areas" (Flygare, 1986, p. 77).

A University of Michigan study of 109 programs in public schools in America by James A. Kulik states "many people have thought that grouping students by ability will have negative effects on the achievement and self-concept of the lower ability groups. Our research does not support this theory" (USA Today, May 16, 1988). Students need to have instruction geared to their specific ability.

There has been a large amount of research on the topic, but many reviews of these studies agree that no distinct advantage of homogeneous grouping over heterogeneous grouping can be established.

Access To Knowledge

This is the factor that has overwhelming support by educators and parents opposed to the idea of homogeneous grouping by ability. In the Goldberg study (1966), there was a significant amount of learning and learning opportunity when classrooms were grouped heterogeneously or by broad degrees of abilities, due to the presentation of larger quantities of material. In this type of classroom grouping, the high, average, and low achievers were all in the same room so the teacher then provided the students with more material than if the classroom was composed of average and low ability students.

On the other hand, in Kindred et al. (1979, p. 97) the authors state, "if a staff is concerned with forming a group of students of age 13 or 14 who are ready to study algebra, they had better be very similar in mathematics background and their ability to think abstractly." This promotes the idea of enrichment classes for the accelerated

students.

A study by Shavit & Featherman (1988) on tracking and teenage intelligence shows that the type of curriculum track will develop cognitive abilities in different ways. College preparatory tracks and academic skills are compared to vocational tracks and a practical training curriculum. These two tracks definitely present a different curriculum. Thus, students in college preparatory tracks make more gains in cognitive abilities and verbal skills while students in the vocational tracks or sometimes less able students lose ground.

Educational equality and fairness should be a significant consideration when looking at the homogeneous versus heterogeneous grouping. All students should be exposed to the same curriculum. Without equality of access to knowledge, students in the different groupings will have considerably different types of knowledge and opportunities to develop different intellectual skills. In mathematics, the high ability grouped students focus primarily on mathematical concepts and the low ability grouped students are given the basic computational skills and math facts (Oakes, September, 1986).

Social Impact

In John Goodlad's, A Study of Schooling, it was found that more than half of the mixed ability (heterogeneous groups) classes developed the friendliest relationships among peers. Tracking offers more advantages to students in the top tracks than to students in the lower tracks. When the lowest achieving and worst behaved students are grouped together, everyone in the class performs below potential.

High track students are the most visible, vocal and respected members of the school population (Oakes, October, 1986).

Linda Grant & James Rothenberg conducted a study of ability grouping of primary school students in three midwestern school districts. The study concluded that within class ability grouping for reading actually produces negative social and academic outcomes. Teachers create a warmer and more positive classroom climate with the high ability groups and show less expectations for the slower groups (Bracey, 1987).

Kindred et al. (1979) felt that students of various talents, when grouped heterogeneously, recognized the differences among the group members and came to respect each for his or her uniqueness. This reflects the goals of the educational system of treating each student as an individual. Differences among students can enhance the learning situation because of these differences.

Social impact is of second importance to supporters of both homogeneous and heterogeneous grouping. Brighter students may think of themselves as better than the students of lesser ability, whereas, less able students can feel they are inferior. Negative attitudes toward school, self-esteem and responsibility can exist (Hawkes, 1971).

Homogeneous versus heterogeneous grouping has been a very controversial topic since the turn of the century and more will be written in the future. Each teacher must take into consideration the findings from the studies done.

CHAPTER 3

METHODS

Introduction

Kindred (1979) stated that there is nothing magic about any
one grouping philosophy when it comes to guaranteeing results.

The objective of any grouping should be to help attain certain
educational goals (Hawkes, 1971).

This researcher will outline the procedures used to ability
group students in mathematics at Onalaska Middle School. The
procedures will encompass review, administration and evaluation of
the mathematics pretest used at Onalaska Middle School for the
purposes of grouping. Also included will be a description of
the groupings and results of the posttest. These results help determine
the validity of the methods employed by this researcher in the
mathematics classes at the Onalaska Middle School.

The treatment of the statistics will involve the comparison
of the pretest and posttest scores in order to show the successes
and failures of the grouping arrangement. The students will be
numbered in a way so that identification by number will not reveal
the names of any individual.

Instrumentation

During the last five years, the ability grouping procedure used at the Onalaska Middle School has been based on criteria determined by the mathematics department. The basic design used was the one group pretest-posttest design with modifications.

The pretest-posttest (see Appendix A) used was the same test during those five years. The test is comprised of one hundred mathematical problems ranging from addition of whole numbers and progressing through geometry. The test contains five problems in each area with the exception of percent which has ten problems. Within each group of problems, the concepts, application and computations of those skills are being evaluated. These skills are related to the school's mathematics curriculum. The results of the test are then used by the teacher of each respective pod to aid in the ability grouping of the students according to their test results.

The school year begins with a general review of the curriculum. This review is completed for the purposes of refreshing the student's memory of skills which have not been frequently used since their last school attendance in the spring.

The review covers the Onalaska Middle School Mathematics curriculum which follows the state mandate for competency-based instruction. The review begins with addition of whole numbers and progresses through the curriculum finishing with geometry. This pretest review takes approximately three, forty-five minute class periods.

The test is given to the entire group with the students given as much time to finish as needed.

The results are machine scored and the instructors use the result sheets to group the students.

Upon scoring the pretests, the students are placed in groups according to the raw scores that were achieved on the pretest. The highest scores on the pretest are analyzed for possible placement in Algebra I. These students are given additional tests to determine if their background allows them to successfully attempt Algebra I for high school credit. The remaining students are placed in four groups. The highest and lowest groups are closely scrutinized for specific skills which they are proficient or deficient in.

The course the students follow for the year is then set up taking into consideration the curriculum of the school and the areas of the pretest which need the most reinforcement.

The following fall, the students are assessed using the same test. These results are used to obtain new groups and assess the effectiveness of the groups from the preceding school year.

Appendix B shows the mathematical use of the pretest and posttest by raw scores after assigning a random number to the students.

Statistical Treatment of the Data

The treatment of the test scores used was the Product Moment Correlation. This is the most commonly used correlation index (Ary, 1985). This test permits the comparison of two sets of raw scores. A variation

allows for a mathematical formula which determines equivalent results without the conversion to z-scores.

The Product Moment Correlation was developed by the English statistician Karl Pearson. It is defined as the mean of the z-score products. The z-score takes into consideration the mean and the standard deviation.

When using a large number of subjects, the z-scores can be eliminated as mentioned above and replaced with a mathematical formula. The students were assigned a random number.

s = number assigned to each subject

The raw scores for the pretest and posttest for each student are recorded.

X = the pretest raw score

Y = the posttest raw score

The degree of correlation between the pretest and posttest is the final result of the mathematical process.

r = the Pearson Product Moment Coefficient of Correlation

The total number of subjects is also included in the formula.

N = the number of paired X and Y scores

The remaining sections of the mathematical formula are derived from the above information.

ΣX = the sum of the scores in the X distribution

ΣY = the sum of the scores in the Y distribution

ΣXY = the sum of the products of paired X and Y scores

ΣX^2 = the sum of the squared scores in X distribution

ΣY^2 = the sum of the squared scores in Y distribution

The formula for the mathematical treatment for two sets of raw scores showing the correlation using the information on the previous page is the Pearson Product Moment Coefficient of Correlation.

$$r = \frac{\Sigma XY - \dfrac{(\Sigma X)\ (\Sigma Y)}{N}}{[\Sigma X^2 - \dfrac{(\Sigma X)^2}{N}\ ]\quad [\Sigma Y^2 - \dfrac{(\Sigma Y)^2}{N}\ ]}$$

CHAPTER 4

CONCLUSIONS

Summary

In the previous chapter, the procedures used in this study were
described in detail. In this chapter, this researcher will present
the results of the pretest and posttest and discuss the implications
of the results.

During the first week of school in the fall of 1987, a group
of fifty-two students were given a review and the pretest. The same
fifty-two students were assessed by means of the same test during the
first week of school in the fall of 1988. These students were also
presented a review as they were in the previous fall.

The subjects tested ranged in age from twelve to fourteen years
of age during the pretest and from thirteen to fifteen years of age
during the posttest.

The samples consisted of twenty-one males and thirty-one females.

Test Results

The raw scores for each student on the pretest and posttest
were recorded for each student and presented in Appendix B. Each
student was assigned a number which was selected in a random drawing.
The purpose of a number selected by this means was to allow the students
to remain anonymous.

The pretest and posttest in Appendix A consisted of one hundred problems.

The mean scores for the pretest and posttest were 45.1 and 58.3 respectively. The range for the pretest was 71 with a high score of 81 and a low score of 10. The posttest yielded a range of 74 with a high score of 91 and a low score of 17. A complete list of the students' scores can be found in Appendix B.

Correlation Outcome

Using the Product Moment Correlation developed by Karl Pearson, a comparison of the pretest to the posttest was conducted.

The raw scores for the pretest are listed under X in Appendix B. The posttest raw scores are listed under Y in Appendix B.

A mathematical formula rather than z-scores was used to complete the calculations. A positive correlation of .286 was produced after the calculations were computed.

The purpose of this study was stated in Chapter 1. This researcher intended to prove or disprove the following null hypothesis: There is no significant correlation at the .01 level of confidence between pretest and posttest results at the Onalaska Middle School in the area of mathematics in the seventh and eighth grade level after ability grouping for one year.

Since a positive correlation of a .286 was obtained after the statistical treatment was applied, the null hypothesis can be rejected. The strength of correlation (see Appendix C) reflects a low correlation, a definite but small relationship.

Conclusions

Since the one group pretest-posttest design was employed to conduct the research, a closer look at this method of grouping students should be conducted.

The lack of a control group creates the possibility of variables which are not accounted for. The change that is brought about may be caused by extraneous variables rather than the treatment.

Two extraneous variables which could produce this change are history and maturation.

The history variable accounts for events which take place between the pretest and posttest which are not included in the treatment. An emphasis on a particular community event in this area of study could create an additional influence in that subject area.

The second extraneous variable is maturation. This area includes the individual growth of the subjects themselves. During the course of this one year study, the students are growing both mentally and physically. This variable takes into consideration learning experiences present during this length of time.

The final shortcoming of the one group pretest-posttest design is the assessment of the pretest itself. In almost all instances, a person will naturally do better on an evaluation the second time, even without instruction during the interval.

The one group pretest-posttest design leaves results which may be uninterpretable.

Recommendations

The following recommendations are made pertaining to the one group pretest–posttest design.

1. An identical study should be conducted using a control group. Without a control group, the experimenter cannot assume that the change between the pretest and posttest is brought about by the experimental treatment.

2. An identical study should be conducted using a different subject area. Individual students may show a gain in relation to their attitude or aptitude in a specific subject area and not exhibit the outcome due to the treatment.

3. An identical study should be conducted using a shorter treatment time. An extraneous variable such as maturation, the changes in the students, can create change over a period of time.

4. An identical study should be conducted in a different geographical area. Some communities may emphasize a greater interest in a subject due to a local situation.

5. A similar study should be conducted using a different age level. The students in the age level of this study are experiencing some very important changes not only physically but also mentally and emotionally.

6. A different method of grouping using the pretest–posttest results as a guideline rather than the boundaries for the groups should be considered.

7. In the review of the literature, the use of heterogeneous
   grouping appears to offer more benefits than a homogeneous
   grouping. This form of grouping should be explored with
   the following considerations used for the development
   of the groups; academic achievement, access to knowledge,
   and social impact.

The exploration of the above possible research studies can
help aid the groupings of the classroom.

A grouping which can take into consideration not only academic
achievement which the one group pretest-posttest does, but also
weigh access to knowledge and social impact appears to have the
greatest chance for success.

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APPENDIX A

APPENDIX A

7th and 8th Grade Math Pre-test

Addition of Whole Numbers		Subtraction of Whole Numbers	

Addition of Whole Numbers

(1)
```
    8
    9
    7
  + 6
```
A. 28
B. 29
C. 30
D. 31
E. NG

(2)
```
   46
   39
   95
   62
  + 89
```
A. 331
B. 31
C. 341
D. 311
E. NG

(3)
```
    3258
   14534
  271689
  +  478
```
A. 289,459
B. 29,959
C. 299,959
D. 289,959
E. NG

(4)
```
   6897
   2649
  + 3518
```
A. 13064
B. 13074
C. 13062
D. 13065
E, NG

(5)
```
  32,754
  26,249
  80,643
  27,506
  + 11,483
```
A. 178,585
B. 177,635
C. 178,635
D. 178,645
E. NG

Subtraction of Whole Numbers

(6)
```
    75
  - 24
```
A. 91
B. 51
C. 31
D. 21
E. NG

(7)
```
    600
  - 232
```
A. 369
B. 378
C. 168
D. 367
E. NG

(8)
```
    3472
  - 2187
```
A. 1325
B. 1285
C. 1313
D. 1315
E. NG

(9)
```
  69,023
  - 59,750
```
A. 9273
B. 9373
C. 10,273
D. 11,270
E. NG

(10)
```
  50302
  - 4327
```
A. 4975
B. 5975
C. 46,985
D. 45,975
E. NG

Multiplication of Whole Numbers

(11)   324   A. 2264
         x 7   B. 2258
                 C. 2268
                 D. 2148
                 E. NG

(12)   53   A. 1911
         x 37   B. 1961
                 C. 1761
                 D. 1931
                 E. NG

(13)   129   A. 9001
         x 69   B. 8911
                 C. 1935
                 D. 9011
                 E. NG

(14)   6938   A. 2,823,766
        x 407   B. 2,825,766
                 C. 2,853,766
                 D. 2,813,766
                 E. NG

(15)   3085   A. 1,189,810
        x 386   B. 1,290,810
                 C. 1,180,810
                 D. 1,190,810
                 E. NG

Division of Whole Numbers

(16)   6) 500   A. 833 R 3
                 B. 83 R 2
                 C. 812 R 2
                 D. 83 R 3
                 E. NG

(17)   20) 680   A. 34
                 B. 32 R 2
                 C. 340
                 D. 304
                 E. NG

(18)   48) 9657 A. 201 R 9
                 B. 21 R 9
                 C. 200 R 57
                 D. 1101 R 9
                 E. NG

(19)   17) 7823 A. 460 R 3
                 B. 406
                 C. 46 R 3
                 D. 406 R 3
                 E. NG

(20)   423) 8883 A. 221
                 B. 21 R 10
                 C. 21
                 D. 2220
                 E. NG

Working with Fractions

(21)   Reduce $\frac{6}{18}$

A. $\frac{1}{2}$ B. $\frac{1}{3}$

C. $\frac{2}{3}$ D. $\frac{1}{6}$

(22)   Reduce $\frac{9}{15}$

A. $\frac{3}{5}$ B. $9\frac{1}{6}$

C. $\frac{2}{5}$ D. $1\frac{6}{15}$

(23)   Make a mixed numeral

$\frac{29}{5}$

A. $5\frac{4}{9}$ B. $4\frac{9}{5}$

C. $25\frac{4}{5}$ D. $5\frac{4}{5}$

(24)   Make an improper fraction

$4\frac{5}{8}$

A. $\frac{32}{8}$ B. $\frac{37}{8}$

C. $\frac{17}{8}$ D. $\frac{29}{8}$

(25)   Rename 3 as twelfths

$\frac{}{12}$

A. 3   B. 36

C. 12   D. 4

Adding Fractions

(26) $\frac{3}{8}$

$+\frac{1}{2}$

A. $\frac{1}{4}$

B. $\frac{7}{8}$

C. $\frac{2}{5}$

D. $\frac{4}{10}$

(27) $\frac{5}{6}$

$+\frac{1}{3}$

A. $\frac{2}{3}$

B. $1\frac{1}{2}$

C. $\frac{7}{6}$

D. $1\frac{1}{6}$

(28) $4\frac{3}{4}$

$+2\frac{2}{3}$

A. $6\frac{5}{7}$

B. $7\frac{5}{12}$

C. $6\frac{5}{12}$

D. $7\frac{1}{2}$

(29) $3\frac{3}{10}$

$+5\frac{1}{5}$

A. $8\frac{1}{2}$

B. $8\frac{4}{15}$

C. $8\frac{3}{5}$

D. $8\frac{1}{5}$

(30) $4\frac{2}{3}$

$+1\frac{3}{5}$

A. $5\frac{5}{8}$

B. $5\frac{13}{15}$

C. $6\frac{4}{15}$

D. $6\frac{4}{5}$

Subtracting Fractions

(31) $\dfrac{9}{10}$

     $-\dfrac{4}{10}$

    A.   5

    B. $\dfrac{5}{10}$

    C. $\dfrac{1}{2}$

    D. $\dfrac{1}{5}$

(32) $6\dfrac{3}{4}$

     $-\,2\dfrac{1}{2}$

    A.   5

    B. $9\dfrac{1}{4}$

    C. $8\dfrac{1}{4}$

    D. $4\dfrac{1}{4}$

(33) $14\dfrac{1}{3}$

     $-\,6\dfrac{1}{4}$

    A. $8\dfrac{7}{12}$

    B. $7\dfrac{11}{12}$

    C. $\dfrac{25}{4}$

    D. $8\dfrac{1}{12}$

(34) $5\dfrac{1}{3}$

     $-\,2\dfrac{3}{5}$

    A. $2\dfrac{2}{5}$

    B. $2\dfrac{11}{15}$

    C. $2\dfrac{6}{15}$

    D. $\dfrac{4}{15}$

(35) $14\dfrac{3}{8}$

     $-\,6\dfrac{2}{3}$

    A. $8\dfrac{1}{5}$

    B. $7\dfrac{1}{8}$

    C. $7\dfrac{17}{}$

    D. $7\dfrac{1}{3}$

Multiplying Fractions

(36) $\dfrac{3}{4}$ x 16

    A.   12

    B.   7

    C. $\dfrac{3}{64}$

    D. $1\dfrac{1}{3}$

(37) $\dfrac{4}{5}$ x $1\dfrac{1}{4}$

    A. $1\dfrac{1}{5}$

    B.   5

    C. $2\dfrac{1}{5}$

    D.   1

(38)

   $1\dfrac{8}{15}$ x $\dfrac{5}{12}$ x $\dfrac{3}{4}$

    A. $\dfrac{2}{3}$

    B. $\dfrac{1}{10}$

    C. $\dfrac{1}{6}$

    D. $\dfrac{1}{3}$

(39) $3\dfrac{3}{4}$ x $1\dfrac{1}{5}$

    A. $3\dfrac{3}{20}$

    B. $4\dfrac{1}{2}$

    C.   3

    D. $4\dfrac{4}{5}$

(40) $5\dfrac{5}{7}$ x $6\dfrac{3}{5}$

    A. $\dfrac{3}{7}$

    B. $3\dfrac{3}{7}$

    C. $37\dfrac{5}{7}$

    D. $30\dfrac{3}{7}$

Dividing Fractions

(41) $\frac{1}{2} \div 3$

    A. $1\frac{1}{2}$

    B. 6

    C. $\frac{1}{5}$

    D. $\frac{1}{6}$

(42) $\frac{2}{3} \div \frac{1}{4}$

    A. 2

    B. $1\frac{1}{3}$

    C. $\frac{1}{6}$

    D. $2\frac{2}{3}$

(43) $1\frac{1}{2} \div \frac{5}{7}$

    A. $2\frac{4}{5}$

    B. $2\frac{1}{10}$

    C. $1\frac{1}{14}$

    D. $\frac{10}{21}$

(44) $\frac{3}{4} \div 3\frac{3}{8}$

    A. $\frac{4}{18}$

    B. $\frac{2}{9}$

    C. $2\frac{17}{32}$

    D. $\frac{6}{27}$

(45) $7\frac{5}{8} \div 2\frac{1}{2}$

    A. $3\frac{1}{20}$

    B. $2\frac{1}{20}$

    C. $6\frac{7}{9}$

    D. $19\frac{1}{16}$

Working with Decimals

(46) Write as a decimal
$$\frac{6}{100}$$

    A. .60   B. 6.100

    C. .06   D. .006

(47) Write as a decimal
$$\frac{59}{10,000}$$

    A. .00059

    B. .59

    C. 59.100

    D. .0059

(48) Write as a fraction

.9

    A. $\frac{9}{100}$ B. $\frac{9}{10}$

    C. $\frac{1}{9}$ D. $\frac{90}{100}$

(49) Write as a fraction

3.004

    A. $3\frac{1}{250}$ B. $3\frac{4}{1000}$

    C. $3\frac{4}{100}$ D. $3\frac{1}{25}$

(50) Write as a decimal
$$2\frac{3}{4}$$

    A. 2.34

    B. .11

    C. 2.3

    D. 2.75

Adding Decimals

(51)   .3
        .8
    + .9

A. 2.0

B. .20

C. .020

D. 2.2

E. NG

(52)   .37 + .7

A. .107

B. .044

C. .44

D. 1.07

E. NG

(53)   64.12
      52.42
    + .8317

A. 117.4717

B. 117.7717

C. 1173.717

D. .01173717

E. NG

(54)

   38.7 + .0069

A. .00456

B. 28.7069

C. 38.7069

D. 45.6

E. NG

(55)   38.6 + .235 + 15

A. .676
B. 38.985
C. 38.850
D. 53.835
E. NG

Subtracting Decimals

(56)   9.5
    − 5.6

A. .39

B. 3.9

C. 4.1

D. 4.9

E. NG

(57)   7.05
    −4.37

A. 3.27

B. 2.68

C. 2.78

D. .0268

E. NG

(58)

   2740.981
   −589.642

A. 2151.339

B. 2141.339

C. 1651.339

D. 2161.339

E. NG

(59)

  29 − .206

A. 28.7940

B. .177

C. 29.206

D. 28.793

E. NG

(60)   470.03 − 55.87

A. 414.26
B. 14.18
C. 413.16
D. 414.16
E. NG

Multiplying Decimals

(61)   .29
       x .9

     A.   2.69

     B.   .271

     C.   .198

     D.   .191

     E.   NG

(62)   .876
       x .009

     A.   .7884

     B.   .0007884

     C.   .007894

     D.   .007884

     E.   NG

(63)   .25 x 25

     A.   13.75

     B.   6.25

     C.   625.00

     D.   5.25

     E.   NG

(64)   .85 x 2.4

     A.   .2040

     B.   2.016

     C.   1.440

     D.   2.040

     E.   NG

(65)   3.64
      x 6.25

     A.   22.7500
     B.   3.0940
     C.   2275.00
     D.   22.7480
     E.   NG

Dividing Decimals

(66) $8\overline{)10}$

     A.   125

     B.   1.25

     C.   1 R. 2

     D.   1.2

     E.   NG

(67) $12\overline{).0048}$

     A.   .04

     B.   4

     C.   .004

     D.   .0004

     E.   NG

(68) $.8\overline{)71.264}$

     A.   89.8

     B.   8.908

     C.   89.08

     D.   80.98

     E.   NG

(69) $.25\overline{)20.575}$

     A.   8.23
     B.   82.03
     C.   82.3
     D.   .823
     E.   NG

(70) $1.5414 \div 734$

     A.   .0021
     B.   2.1
     C.   .021
     D.   .21
     E.   NG

Ratios

(71)   A. $\frac{85}{100}$

Write 88%
as a fraction
in lowest   B. .88
terms   C. $\frac{22}{25}$

                 D. $\frac{88}{100}$

                 E. NG

(72)   A. 16%

Write $.05\frac{1}{3}$ B. $5\frac{1}{3}\%$
as a percent

                 C. 5.3%
                 D. 5%
                 E. NG

(73)   A. 20%

Write $\frac{1}{5}$ B. $\frac{1}{5}\%$
as a %

                 C. 50%
                 D. 2%
                 E. NG

(74)   Write $6\frac{2}{3}$ as a fraction
       in lowest terms

       A. $6\frac{2}{3}$ B. $3\frac{1}{3}$

       C. $6\frac{33}{50}$ D. $\frac{1}{15}$

(75)   Write 2.8% as a decimal

                 A. .28
                 B. 2.8
                 C. 2.08
                 D. 28.
                 E. NG

Percent

(76)   What is 30% of 40?

       A. 10
       B. 12
       C. $\frac{3}{4}$
       D. $266\frac{2}{3}$

       E. NG

(77)   12 is 7.5% of what?

       A. 90
       B. 160
       C. 16
       D. $266\frac{2}{3}$

       E. NG

(78)   .8 is what % of 400?

       A. .32%

       B. $3\frac{1}{5}$

       C. 50%
       D. $\frac{18}{25}$

       E. NG

(79)   1.2 is 60% of what?

       A. 20
       B. 1.8
       C. 2
       D. .2
       E. NG

(80)   What is $16\frac{2}{3}\%$ of 60?

       A. 10
       B. 9.996
       C. $\frac{1}{2}$

       D. 996.0
       E. NG

Percent continue

(81) $\frac{3}{4}$ is what % of 2?

    A. 37.5%
    B. 30%
    C. 40%
    D. 42.5%
    E. NG

(82) What is 6.5% of 1200?

    A. 78
    B. 7.8
    C. 780
    D. 7800
    E. NG

(83) 3 is what % of 12?

    A. 9%
    B. 50%
    C. 25%
    D. 36%
    E. NG

(84) 12 is 30% of what?

    A. 82
    B. 42
    C. 36
    D. 40
    E. NG

(85) What is 125% of 60?

    A. 7.5
    B. 75
    C. 48
    D. 7500
    E. NG
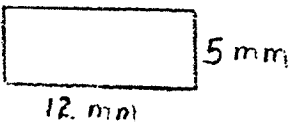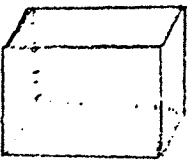
Exponents

(86) Give the numerical value of 5^3.

    A. 5000
    B. 15
    C. 555
    D. 125
    E. NG

(87) Write 1/1000 as a power of 10.

    A. 1000
    B. $\frac{1}{1000}$
    C. $\frac{1}{10^3}$
    D. 10^{-3}
    E. NG

(88) Write 70,000 in scientific notation.

    A. 7×10^4
    B. 7^4
    C. 7×10^3
    D. $10,000^7$
    E. NG

(89) Give the numerical value of 10^7.

    A. 700
    B. 100,000,000
    C. 70
    D. 10,000,000
    E. NG

(90) Write the standard numeral for 5.3×10^2.

    A. 5300
    B. 530
    C. 106
    D. 5.3100
    E. NG

Signed Numbers

(91)   −7 + −8 =   A. −15
                     B. −1
                     C. 1
                     D. 15
                     E. NG

(92)   8 − (−3) =   A. 5
                     B. −11
                     C. 11
                     D. −5
                     E. NG

(93)   −7 x +5 =   A. 30
                     B. −35
                     C. 28
                     D. 35
                     E. NG

(94)   −20 − −5 =   A. −4
                     B. −3
                     C. −25
                     D. −15
                     E. NG

(95)   Which is the smallest number:
           4, −3, 0, −4

        A. 4
        B. −3
        C. 0
        D. −4

Geometry

(96) Find the perimeter of
      this rectangle.

      A. 34
      B. 17
      C. 60
      D. 12
      E. NG

      5 mm, 12. mm

(97) Find the area of this
      square.

      A. 81
      B. 36
      C. 162
      D. 9
      E. NG

      9"

(98) What is the total number
      of degrees in the triangle?

      A. 270
      B. 150
      C. 180
   D. 360
      E. NG

      120, 30

(99) What is the radius of
      this circle?

      A. 50
      B. 25
      C. 13
      D. 12.5
      E. NG

(100) What is the volume of a
      solid 4 cm wide, 7 cm long,
      and 2 cm high?

      A. 30   B. 56   C. 13
      D. 14   E. NG

APPENDIX B

APPENDIX B

Product Moment Correlation
Using Pretest and Posttest Scores

Subjects	X-scores	x	x^2	Y-scores	y	y^2	X^2	Y^2	XY
1	81	+36	1296	91	+33	1089	6561	8281	7371
2	72	+27	729	88	+30	900	5184	7744	6336
3	73	+28	784	88	+30	900	5329	7744	6424
4	68	+23	529	86	+28	784	4624	7396	5848
5	73	+28	784	85	+27	729	5329	7225	6205
6	64	+19	361	84	+26	676	4096	7056	5376
7	64	+19	361	82	+24	576	4096	6724	5248
8	63	+18	324	83	+25	625	3969	6889	5229
9	66	+21	441	79	+21	441	4356	6241	5214
10	73	+28	784	79	+21	441	5329	6241	5767
11	77	+32	1024	79	+21	441	5929	6241	6083
12	64	+19	361	76	+18	324	4096	5776	4864
13	35	−10	100	74	+16	256	1225	5476	2590
14	49	+ 4	16	74	+16	256	2401	5476	3626
15	72	+27	729	72	+14	196	5184	5184	5184
16	49	+ 4	16	72	+14	196	2401	5184	3528
17	43	− 2	4	69	+11	121	1849	4761	2967
18	55	+10	100	68	+10	100	3025	4624	3740
19	54	+ 9	81	66	+ 8	64	2916	4356	3564
20	57	+12	144	67	+ 9	81	3249	4489	3819
21	58	+13	169	63	+ 5	25	3364	3969	3654
22	47	+ 2	4	62	+ 4	16	2209	3844	2914
23	45	0	0	59	+ 1	1	2025	3481	2655
24	47	+ 2	4	58	0	0	2209	3364	2726
25	49	+ 4	16	57	− 1	1	2401	3249	2793
26	46	+ 1	1	55	− 3	9	2116	3025	2530
27	42	− 3	9	55	− 3	9	1764	3025	2310
28	33	−12	144	52	− 6	36	1089	2704	1716
29	29	−16	256	50	− 8	64	841	2500	1450
30	49	+ 4	16	50	− 8	64	2401	2500	2450
31	39	− 6	36	49	− 9	81	1521	2401	1911
32	39	− 6	36	48	−10	100	1521	2304	1872
33	46	+ 1	1	48	−10	100	2116	2304	2208
34	35	−10	100	48	−10	100	1225	2304	1680
35	27	−18	324	44	−14	196	729	1936	1188
36	21	−24	576	45	−13	169	441	2025	945
37	28	−17	289	43	−15	225	784	1849	1204
38	18	−27	729	40	−18	324	324	1600	720
39	22	−23	529	41	−17	289	484	1681	902
40	40	− 5	25	39	−19	361	1600	1521	1560

Subjects	X-scores	x	x^2	Y-scores	y	y^2	X^2	Y^2	XY
41	33	−12	144	38	−20	400	1089	1444	1254
42	25	−20	400	37	−21	441	625	1369	925
43	14	−31	961	36	−22	484	196	1296	504
44	16	−29	841	34	−24	576	256	1156	544
45	19	−26	676	30	−28	784	361	900	570
46	26	−19	361	34	−24	576	676	1156	884
47	14	−31	961	26	−32	1024	196	676	364
48	10	−35	1225	18	−40	1600	100	324	180
49	27	−18	324	17	−41	1681	729	289	459
50	54	+ 9	81	76	+18	324	2916	5776	4104
51	49	+ 4	16	72	+14	196	2401	5184	3528
52	46	+ 1	1	48	−10	100	2116	2304	2208

APPENDIX C

APPENDIX C

Strength of Correlation Table

Correlation Value	Approximate Descriptive Meaning
Less than .20	Slight positive almost negligible relationship
.21 to .40	Low correlation, definite but small relationship
.41 to .70	Moderate correlation; substantial relationship
.71 to .90	High correlation; marked relationship
.91 to 1.00	Very high correlation; very dependable relationship
0	No Correlation
Less than −.20	Slight negative almost negligible relationship
−.21 to −.40	Low negative correlation
−.41 to −.70	Moderate negative directional correlation
−.71 to −.90	High negative directional correlation
−.91 to −1.00	Inverse relationship