

The Psychological Clinic

VOL. II. No. 5.

OCTOBER 15, 1908.

SOME FACTORS AFFECTING GRADE DISTRIBUTION.

LEONARD P. AYRES,

General Superintendent of Schools, Porto Rico, 1906-8.

In Charge of Backward Children Investigation,

Russell Sage Foundation.

Students and critics of our public school systems are giving more and more attention to the record of the figures printed in the annual reports of superintendents and school boards. They are seeking to discover whether the record which lies embedded in the statistical statements of actual conditions is one of accomplishment or of failure. As they thumb the pages of school reports in quest of evidence, they cannot escape the impression that the records are only fragmentary. Born of real or fancied administrative necessities, colored oftentimes by a local point of view, the printed statistical tables may throw light upon educational questions, but it is incidental to their main purpose. As the published figures are analyzed with a view to gain an answer to specific queries, the consciousness deepens that the light which the figures shed is rarely simple and pure, but is highly complex—a synthesis of the most varied elements. It is not with any pretension of exhausting the subject, but in the hope of clarifying in some degree current conceptions as to the elements which enter into one of the simpler statistical statements regarding schools, the number of children in each grade, that the present study has been undertaken.

In recent discussion much has been made of the falling off in the number of children in the successive grades, from the first to the eighth. Writers, who have otherwise the most varied points of view, have perceived in such numerical decrease a test of the efficiency of school systems. Those of a more gifted imagination have seen in them evidence of a conspicuous failure of our schools to accomplish the purpose for which they are designed, while those more cautious by nature have not hesitated to make it a

reproach upon certain cities that their upper grades contained relatively fewer pupils than those of other localities.

The feeling that these grade records embody facts of far-reaching consequence is widespread. It reveals itself in a more general publication of the figures in question. Such tables are appearing in reports of city schools, where they have heretofore been lacking. The latest report of the Commissioner of Education of the State of New York contains a summary of the facts for the cities of the State, and the forthcoming report will go into further details, giving not only the number in the grades, but the ages of pupils in each of the grades for the cities of the State. The Report of the United States Commissioner of Education for 1906 gives the grade distribution of the school children in 127 cities. The report now in press will, we are advised, contain similar data for 1907 for upwards of seven hundred towns and cities. The Russell Sage Foundation has in preparation a compilation of these and other data from the reports of the hundred largest cities in the United States for the past ten years.

Side by side with this more abundant presentation of the original data have appeared certain attempts at an interpretation. In the school reports we find an occasional, not always a very enlightening comment upon the reasons of this falling off in the grades. It is in part upon an interpretation of such figures that Commissioner Draper of New York State bases the cogent argument for industrial education which gave such marked distinction to his last annual report. Nor will it be forgotten that the interpretation of such figures added to the heat if not to the light of the discussion at the meeting of the Department of Superintendence at Washington in February last.

The most conspicuous effort to interpret these figures is found in Dr. E. L. Thorndike's study of the "Elimination of Pupils from School," published by the United States Bureau of Education as a bulletin in February, 1908. It appears that the distribution of pupils in the several grades is the basic fact of his discussion. Seeking by complicated and unexplained processes to eliminate from these figures all other elements, he deduces from them certain general propositions as to the number of pupils who leave school at each grade. There has not been an universal acceptance of his conclusions. There is a feeling that in some cases at least there is no such exodus from the schools and at such early grades as his conclusions indicate. Unfortunately, the published study does not afford the means of verifying or confuting the conclu-

sions. Nor does it afford a means whereby other cities not included in the computations can be compared with those which are so included.

Yet there can be no doubt that Dr. Thorndike's contribution has stirred up a great deal of interest, and has led to such a scrutiny of the grade statistics as they have not received before. It prompts to further study. It is clear that the grade figures are the resultant of a considerable number of forces. Among these forces Dr. Thorndike selects one, that of elimination, and seeks to detach it from the elements with which it is associated. He clearly recognizes the existence of these other elements, but it may well be that the concentration of his study upon one element only has led to an undue emphasis and an exaggeration of its importance. Be that as it may, it would appear to the writer that the treatment of important elements, incidental only to the main theme of Dr. Thorndike's study, is perhaps too scanty for those who have not given this matter the long and patient study which Dr. Thorndike tells us he has devoted to it. The general proposition that the grade distribution of pupils in the public schools is the resultant of several forces may be readily assented to by many who have no very clear idea of what those forces are. It is the purpose of the present study to make clear, if possible, some of the forces which produce this complex result.

In our study we shall proceed from the known fact of unequal numbers in the several grades. It will be our purpose to exhibit the various factors which tend to increase or decrease this inequality. We shall see, moreover, that many of the causes at work have nothing whatever to do with the efficiency of the school system, and others have little relation to it.

In the course of his study of elimination, Dr. Thorndike reaches the conclusion that the amount of elimination is comparatively unrelated to the efficiency of the school system and deprecates any inferences as to the latter from the rate of elimination which results from his studies. Our studies have led us to similar results in comparing the grade inequalities of different cities. Any conclusions as to the relative merits of different systems should be reserved until all the elements entering into the observed grade inequalities have been carefully gauged.

Figures showing grade distribution in city school systems form the simplest and most common sort of statistical information bearing on this subject. Wherever such figures are printed their most prominent characteristic is the diminution in the numbers

of children in the successive grades. Thus the report of the Board of Education of Chicago for 1906 gives the average membership in that city as follows:

First grade	43,560
Second grade	34,330
Third grade	32,814
Fourth grade	30,004
Fifth grade	28,056
Sixth grade	22,540
Seventh grade	17,643
Eighth grade	12,939

Here the most casual inspection of the figures shows us that the second grade is far smaller than the first, the third considerably less numerous than the second, and so on until we reach the eighth grade, which is considerably less than one-third as large as the first. Nor should it be supposed that Chicago is exceptional in this respect. On the contrary, very many cities show even greater disparities in their grade distributions.

The natural conclusion of the casual student of such figures is that the pupils are dropping out of school all the time, and hence the number in each grade diminishes as the grades advance. In the cases cited, that of Chicago, the immediate interpretation of the figures is that of each forty-three children entering the first grade, no more than thirteen reach the eighth and still fewer graduate. That such a conclusion is not justified is made evident by a study of some of the factors contributing to bring about the disparity in numbers noted in the several grades. The assumption that the grades should normally be about equal in numbers rests upon the very common idea that substantially the same number of children enter school each year, that they advance with fair regularity from grade to grade, and that they remain until the completion of the elementary course.

In fact, all of these suppositions are erroneous. To begin with, there is a certain natural decrease in the number of children with advancing age which is due to death; so that we may always expect to find fewer persons with each advancing year of age. Secondly, there is an increase in the size of each successive and younger generation of children which is due to the natural increase in population. Looked at from the standpoint of the age fourteen, each younger generation is larger. Looked at from the standpoint

of the age seven, each older generation is smaller than the preceding. It is obvious that there are in New York State more five year old children to-day than there were five years ago, and hence at the present time more five-year-olds than ten-year-olds. These two elements—that of death and that of the increased size of each succeeding generation—contribute to form the *factor of population*.

All children do not advance regularly from grade to grade; some of them are left behind to repeat a year or two. This is the *factor of retardation*.

All children do not complete the elementary schools. In some localities few and in others more leave the early or primary grades, but in all localities great numbers leave the grammar grades upon reaching the age of fourteen years. This is the *factor of elimination*.

It is not denied that other factors may and undoubtedly do affect the size of grades in certain cases and localities. Among such possible factors may be mentioned the influx of children whose schooling has already been begun in other places, the tide to and from private and parochial schools, and the enrollment of immigrant children who enter the schools at comparatively advanced age. But such factors are local and irregular in their influence and undoubtedly compensatory to a certain extent in their action. On the other hand, the three factors of population, retardation, and elimination are always present.

POPULATION.

Two elements contributing to form the *factor of population* have been mentioned: decrease by death and the natural increase in successive age generations caused by an increasing population. If for the moment we assign an age to each grade, beginning with seven years as the age of pupils in the first grade, and if we suppose for the sake of argument a stationary school population in which 1000 pupils enter school each year, none die, and none drop out, we have a grade distribution as follows:

Grade Distribution in a Stationary Population with No Deaths.

First grade	1000	children	7	years old
Second grade	1000	"	8	"
Third grade	1000	"	9	"
Fourth grade	1000	"	10	"

Fifth grade	1000	children	11	years	old
Sixth grade	1000	"	12	"	
Seventh grade	1000	"	13	"	
Eighth grade	1000	"	14	"	

In the United States the annual death rate for the ages of five to fifteen is 3.8 per 1000. It is not, of course, exactly 3.8 for each of the ages, but for the sake of simplicity and because of its relative insignificance we may apply it equally to note its effect.

Grade Distribution Showing Decrease Through Death.

First grade	1000	children	7	years	old
Second grade	996.2	"	8	"	
Third grade	992.4	"	9	"	
Fourth grade	988.6	"	10	"	
Fifth grade	984.9	"	11	"	
Sixth grade	981.1	"	12	"	
Seventh grade	977.4	"	13	"	
Eighth grade	973.7	"	14	"	

It will thus be seen that the element of death alone will account for a decrease of some 26 or 27 in the progress of each 1000 children from the first grade to the eighth.

But death is a far smaller element in making up the factor of population than is the increase of population. How great a factor the two together constitute we may perhaps roughly measure by applying to the problem the figures given for each age group from seven to fourteen years inclusive in the aggregate population of the United States according to the late census.

At that time there were in the United States 1,787,019 children seven years old. Those fourteen years old numbered 1,556,112. There are plainly two reasons why the children fourteen years old are less numerous than those seven years old: First, there were fewer children born fourteen years ago than seven years ago; second, of the children born fourteen years ago a larger proportion have died than among those born seven years ago. In less degree this is true of the eight year old children compared with the seven-year-olds. So those of nine will be slightly less numerous than those of eight. The number of children at each age from seven to fourteen will gradually diminish. By dividing the number of fourteen year old children by that of those seven years old, we can readily find how many fourteen-year-olds there

are to be expected when there are, say, 1000 seven-year-olds. By means of such relative figures we may show how many children there are in the United States as a whole at the ages of eight, nine, etc., for each 1000 at the age of seven. Stating this in the form of a supposititious grade distribution, we have the following:

*Grade Distribution as Influenced by the Two Elements,
Death and Increase of Population.*

First grade	1000	children	7	years old
Second grade	985	"	8	"
Third grade	964	"	9	"
Fourth grade	938	"	10	"
Fifth grade	920	"	11	"
Sixth grade	904	"	12	"
Seventh grade	889	"	13	"
Eighth grade	871	"	14	"

The foregoing shows most conveniently the tapering off in numbers of the population as the age increases. As before explained, this tapering off, resulting in an apparent diminution in the upper ages, is in reality caused by successive increases in the lower ages. Were we to state it in other terms to make this clear, we might take the age of fourteen as the basis for computing our relative figures. In that case, instead of saying that for each 1000 children seven years old there are 871 at the age of fourteen, we should say that for each 1000 at the age of fourteen we may expect to find 1148 seven years old. This is simply the same proposition stated in different terms.

It is not claimed, of course, that the figures in the table constitute an absolute measure applicable to any school system. Their value lies rather in giving a typical measure of the attenuation to be allowed for from influences of population under normal circumstances. The age distribution of the population is not, of course, uniform throughout the country. In some localities in fact very considerable variations from the standard are found. Neither do school grades correspond exactly with ages. Nevertheless, if children enter at the age of seven they will be at least fourteen upon reaching the eighth grade, and we shall not be far out of the way if we state that under perfect school conditions of progress and retention of pupils we could in no case expect to find more than 87 per cent as many children in the eighth grade as in the

first grade. This is a constant and very considerable factor in bringing about disparity in the number of children in the several grades, and it is one which has been entirely overlooked in much of the current discussion of the problem.

RETARDATION.

It is almost a truism to say that all pupils do not advance regularly from grade to grade. It is a fact of which all educators are keenly aware. But just how many pupils fail to advance and at what points in the school course, and most important of all, for what causes, are questions as yet relatively unanswered. There is not even any general agreement as to how "percentage of promotions" shall be computed, and indeed practice is very diverse in the matter. Some information on the subject may be gleaned from a study of school reports. The most recent reports from five large cities give the following statement:

City	Per Cent of Promotions
New York	79
Chicago	83
Cincinnati	80
Columbus	78
Kansas City, Mo.	71

From these figures it appears that we shall not greatly err if we assume that it is reasonable to expect that about 80 per cent of the pupils in a system will be advanced at each regular time of promotion, and that 20 per cent will fail to be so advanced. If each year 20 per cent fail, the first grade will contain in our supposititious case the 1000 pupils just entered, as well as some who entered the year before, some who entered two years before, and a few who entered three years before, or even earlier. The actual number in the first grade will be 1250 and not 1000. Now, if the same rules hold for the other grades, and no pupils drop out, that is, if all stay to complete the course, no matter how long it takes, each grade will contain the same number as the first, namely, 1250. In other words, if we have four-fifths of the normal progress, or that planned by the course of study, we shall have five-fourths of the normal number of pupils in each grade. That is, if the factor of population were inoperative, we should have under these conditions the following grade distribution:

*Grade Distribution when 80 Per Cent of the Pupils are
Promoted, All Finish, and the Population
Factor Does not Enter.*

First grade	1,250
Second grade	1,250
Third grade	1,250
Fourth grade	1,250
Fifth grade	1,250
Sixth grade	1,250
Seventh grade	1,250
Eighth grade	1,250
	<hr/>
	10,000

But we know that these conditions are never found. Pupils who find themselves in some grade lower than the eighth at the age of fourteen, fifteen, or sixteen do not remain to complete the course. They drop out. This brings us to the third factor, that of

ELIMINATION.

A study of the age distribution of pupils in the schools of the five largest cities in the United States shows, after allowing for inaccuracies of age returns, which are proverbial, that in the main the decrease in the ages of school children in these years is slight, following substantially the laws of population already explained. There is a relatively marked falling off at the age of thirteen, followed by a very marked decline in numbers at the ages of fourteen, fifteen, and sixteen. That is to say that comparatively few pupils will remain in school after the age of fourteen, many drop out at that age, and some anticipate it and leave at the age of thirteen. The data from these cities gives us very nearly the following table when the figures are reduced to relative terms:

Children of 10 years	104
Children of 11 years	102
Children of 12 years	100
Children of 13 years	90
Children of 14 years	50
Children of 15 years	25
Children of 16 years	12

From these figures we may assume as a reasonable approximation, that in the elementary schools 10 per cent of the children will have left at thirteen years of age, that 50 per cent will have left at fourteen, half of the remainder at fifteen, and again half of these at the age of sixteen.

Now, if pupils in school advanced with substantial regularity, so as to reach the upper grades by the time they attained the age of thirteen or fourteen, it is evident that elimination would not be a very powerful factor in bringing about grade disparity, and would be operative only in the highest grades. But we know that pupils of these ages are found in the intermediate grades in no inconsiderable numbers. This brings into operation the factors of retardation and elimination in combination.

To show what the result is we may have recourse again to a supposititious case, but one this time which more nearly approaches conditions as found in our schools than do those cited heretofore. Suppose we have a school system where the population is stationary, where 1000 new pupils enter the schools at the age of seven each year, where there is a uniform rate of promotion of 80 per cent, and where 10 per cent of the pupils leave at the age of thirteen, 50 per cent by the time they are fourteen, 50 per cent of the remainder at fifteen years, and half of those left drop out at sixteen years of age. Under these conditions we shall have the following age and grade distribution:

Age and Grade Distribution. Stationary Population. Retardation and Elimination both Operative.

Grades	AGES.										Total
	7	8	9	10	11	12	13	14	15	16	
First	1000	200	40	8	2						1250
Second		800	320	96	25	5	1				1247
Third			640	384	150	50	13	1			1238
Fourth				512	413	203	72	14	1		1215
Fifth					410	412	221	57	11	1	1112
Sixth						328	356	137	36	8	865
Seventh							237	184	74	22	517
Eighth								105	84	38	227
	1000	1000	1000	1000	1000	998	900	498	206	69	7671

In this table we have for the first time a grade distribution closely approximating those commonly found in the school systems of our cities. The familiar characteristics are present: the falling off in size of the successive grades, the presence of substantially

equal age groups until we reach the age of thirteen, when there is a slight falling off followed by a much sharper drop; and the small size of the eighth grade as compared with the first. We have well illustrated, too, the fact that while retardation results in holding in the first and each of the other primary grades many more children than the number entering school each year, in the upper grades the combination of retardation and elimination accounts for the depletion which is so noticeable; yet the result is not, as has been so often stated, to bring into our schools a greater number of children than those who would be present if all progressed normally. To state this in terms of school administration, doing away with retardation would not do away with the problem of "part time," nor would it have the effect of reducing the number of school sittings or schoolrooms required, nor would it result in any financial economy. The economies effected would be educational rather than material. They would consist in giving a more extended education to a larger proportion of the children entering school.

Summarizing our three modifying factors of Population, Retardation, and Elimination, we may compare in one table the effect which each one of these separately, and finally the three working together, will have on the grade distribution of a community, when 1000 children enter the first grade.

Grade Distributions Showing Modification by Different Factors.

Grades	No Modifying Factors	Death Only	Death and In- crease of Population	Retarda- tion and Elimina- tion	Population, Retardation and Elimination
First	1000	1000	1000	1250	1250
Second	1000	996	985	1247	1228
Third	1000	992	964	1238	1193
Fourth	1000	988	938	1215	1138
Fifth	1000	984	920	1112	1023
Sixth	1000	981	904	865	782
Seventh	1000	977	889	517	459
Eighth	1000	973	871	227	198
Total	8000	7891	7471	7671	7271

This final distribution which we have as the resultant of the combined modifying influences of the factors of Population, Retardation, and Elimination, may well appear extreme to anyone who has not devoted considerable study to the phenomena of grade

distribution. At first sight the disparity in numbers between the 1250 children in the first grade and the 198 in the eighth seems unreasonably large, while on the other hand the total of the eight grades, 7271, seems too small when we remember that the first grade contains 1250. Are similar conditions really found in our city school systems? We may gain light on this point by comparing our supposititious case with the grade distributions found in some of our cities, taking in each case 1000 pupils in the first grade as a base and using relative figures to facilitate comparison.

Grade Distributions on Basis of 1,000 Pupils in First Grade.

Grades	Supposititious Case—All three Factors operative	Jersey City, N. J. 1903	Newark, N. J. 1903	New York City 1907
First	1000	1000	1000	1000
Second	982	756	871	838
Third	954	614	784	823
Fourth	910	519	635	768
Fifth	818	445	477	690
Sixth	625	344	361	525
Seventh	367	226	236	375
Eighth	158	166	174	262
Total	5814	4070	4538	5281

We have here the answer to our question. Very evidently the grade distributions found in our city school systems are not radically dissimilar from the distribution resulting from the application of our several hypotheses in the supposititious case. One characteristic difference, however, is noticeable. Whenever we take figures giving the grade distribution of an actual school system, we find a greater disparity between the numbers of children in the first and second grades than we do in our supposititious case. In city school systems we invariably find very many more first grade than second grade children. In our supposititious case we find only a few more. But it must be remembered that the difference between the figures in our supposititious case is largely the result of the modification resulting from the influence of the population factor, whereas in actual school systems the percentage of promotion from the first grade to the second is almost invariably lower than it is in the case of the higher grades. A larger proportion of children enter the first grade late in the year and so fail of promotion, than is the case in the other grades. As the conditions

in this respect vary greatly in different localities, it is obvious that any standard which has for its basis the number of children in the first grade will be of little utility as a criterion for judging the number we may fairly expect to find in each of the other grades. To have recognized in our hypothetical case the unequal distribution of retardation by grades—being greater in the lower, and less in the upper grades—would have introduced complications into our calculations which were deemed unnecessary, since our purpose was rather to demonstrate the existence of these factors, than to propose an exact measurement.

As a result, then, of our study we may formulate the following general rules which will serve as tolerably accurate criteria for judging the grade membership in American city school systems under substantially normal conditions of population and school administration:

- (1) During the eight years following their entrance into the school system we may count on about 27 in each 1000 of these children being removed by death.
- (2) Owing to the factor of population, composed of the two elements of death and increase of population, we may expect to find normally for each 1000 children in the first grade no more than 871 in the eighth.
- (3) A not uncommon measure of advance in our large city school systems is to have four-fifths of the pupils promoted at each regular time of promotion, and to have one-fifth fail.
- (4) It is safe to count on 10 per cent of the children leaving on reaching the age of thirteen years, 50 per cent by the time they are fourteen, 50 per cent of the remainder at fifteen, and again 50 per cent of the remainder at the age of sixteen.

In general it appears, then, that the grade distribution is the resultant of such diverse elements, that without the most careful analysis conclusions as to any of these elements are liable to go astray. The reader who is familiar with school reports and current educational discussion will not fail to recall instances in which the existence of one or more of the modifying factors has been ignored. We shall have accomplished our purpose if we have brought out clearly the simple fact that at least three factors have an important share in producing the distribution of pupils by grades which is commonly observed in our elementary schools.