1982

A comparison of Piagetian and psychometric measures of intelligence

Kathryn Ann Berntson
University of Northern Iowa

A comparison of Piagetian and psychometric measures of intelligence

Abstract

The ideas of Jean Piaget have sooner or later been applied to practically every aspect of education. These ideas are based on Piaget's theory that every individual progresses through four cognitive developmental stages: the sensorimotor stage, the preoperational stage, the concrete operational stage, and the formal operational stage. According to Piaget, during these stages an individual progresses from reflex reactions to the environment to the point, if and when he reaches the level of formal operations, he can think abstractly and test hypotheses.

A COMPARISON OF PIAGETIAN AND PSYCHOMETRIC MEASURES OF INTELLIGENCE

A Research Paper

Submitted to

The Department of Curriculum and Instruction

In Partial Fulfillment

of the Requirements for the Degree

Master of Arts in Education

University of Northern Iowa

by

Kathryn Ann Berntson

July, 1982

This Research Paper by: Kathryn Ann Berntson

Entitled: A Comparison of Piagetian and Psychometric Measures of Intelligence

has been approved as meeting the research paper requirement for the Degree of Master of Arts in Education.

July 16, 1982
Date Approved

Greg Stefanich
Director of Research Paper

July 16, 1982
Date Approved

Greg Stefanich
Graduate Faculty Adviser

July 16, 1982
Date Approved

Mary Nan Aldridge
Graduate Faculty Reader

July 16, 1982
Date Approved

Roger A. Kueter
Head, Department of Curriculum and Instruction

TABLE OF CONTENTS

Chapter 1

THE PROBLEM

Introduction

The ideas of Jean Piaget have sooner or later been applied to practically every aspect of education. These ideas are based on Piaget's theory that every individual progresses through four cognitive developmental stages: the sensorimotor stage, the preoperational stage, the concrete operational stage, and the formal operational stage. According to Piaget, during these stages an individual progresses from reflex reactions to the environment to the point, if and when he reaches the level of formal operations, he can think abstractly and test hypotheses.

A variety of tests have been developed and used to determine an individual's level of cognitive development or stage as proposed by Piaget. Most of these tests are a series of task interviews patterned after those developed by Piaget. Paper and pencil tests have also been developed to measure the same concepts as are measured in the task interviews.

Rather than employ one of these Piagetian tests to

measure an individual's level of intellectual development, most school systems use intelligence tests and/or standardized achievement tests. Perhaps there is a significant relationship between scores on these Piagetian tests and other more common measures of intellectual ability and achievement.

Statement of the Problem

Is there a relationship between scores on two measures of Piagetian development, a series of ten Piagetian task interviews and the Ankney-Joyce Reasoning Test, and scores on two traditional measures of intellectual ability and achievement, the Stanford-Binet IQ test and the SRA achievement tests?

The following hypotheses will be tested in this study:

1. There is a moderate, positive relationship between scores on ten Piagetian task interviews and Stanford-Binet IQ scores and SRA composite, math, science, and reading scores.

2. There is a moderate, positive relationship between scores on the Ankney-Joyce Reasoning Test and Stanford-Binet IQ scores and SRA composite, math, science, and reading scores.

3. The correlations involving the series of ten task interviews will be similar to those involving the Ankney-Joyce Reasoning Test.

Importance of the Problem

In this study, the results of two Piagetian tests of cognitive development are compared to the results of traditional ability and achievement tests. If the results of this study indicate that the Piagetian tests provide an accurate reflection of intellectual development, then there are numerous ways in which a classroom teacher could use the Piagetian test scores.

For example, DeAvila and Havassy (1974) have suggested that Piagetian tests could be used to test minority children. Intelligence and standardized achievement tests have often been criticized because they are not culture-free. Therefore, the results are not as accurate when used with minority students. That factor would not be as much of a problem in the Piagetian task interviews.

Teachers could also use knowledge of Piagetian test scores to make curriculum decisions. The test results might indicate that some students lack the cognitive development necessary for specific concepts which are taught. For example, simple geometric concepts are inappropriate for those students who cannot conserve length, area, or volume. Students who are not classified as concrete operational will find it difficult to understand that four times nine equals nine times four.

The selection of materials is a third area where teachers might effectively use knowledge of Piagetian test scores. Students who are concrete operational rather than formal operational should be exposed to concrete objects instead of abstract mental images. The students should be allowed and encouraged to manipulate all kinds of materials rather than learning only by reading or listening.

Finally, the correlations should also reveal the extent of the relationship between the two types of Piagetian tests. If the correlations of the two types of Piagetian tests with ability and achievement tests are relatively similar, then the classroom teacher should be able to use the Ankney-Joyce Reasoning Test as a much more convenient, efficient measurement of a group's level of cognitive development.

Assumptions

1. The Stanford-Binet IQ score is a valid measurement of intellectual ability.
2. SRA achievement scores are valid measurements of intellectual achievement.
3. The Ankney-Joyce Reasoning Test is a valid measurement of cognitive developmental level as described by Piaget.

4. The ten Piagetian task interviews are a valid measurement of cognitive developmental level as described by Piaget.

Limitations of the Study

1. The subjects of this study are fourth graders with a relatively middle-class, agricultural background. Results of this study should only be generalized to similar groups.

2. Some of the questions on the two Piagetian tests are very similar. Therefore, results of the ten task interviews may be affected by the administration of the Ankney-Joyce Reasoning Test.

3. The ten task interviews must be administered individually to each student. Therefore, the results of this Piagetian test may be affected by the feelings, attitudes, etc. of the researcher.

Definition of Terms

1. ability--Stanford-Binet IQ score

2. achievement--the composite, math, science, and reading scores of the SRA achievement tests

3. Piagetian tests--task interviews or a written test designed to measure an individual's stage or level of development as described by Piaget

Summary

A variety of Piagetian tests have been developed to ascertain the intellectual level of individuals. However, most school systems use intelligence tests and/or standardized achievement tests to measure a student's

level of intellectual development. This study attempts to determine whether there is a relationship between scores on two Piagetian measures of development and scores on two traditional measures of intellectual ability and achievement. If results of this study indicate a strong relationship between the two types of tests, teachers could use the Piagetian tests to test minority children, make curriculum decisions, and/or select materials.

Chapter 2

REVIEW OF RELATED LITERATURE

The results of various Piagetian measures of cognitive development have sometimes been compared to more traditional measures of intellectual ability and achievement. The results of these comparisons have been mixed. Some researchers have found rather high correlations, while others have found little or no relationship between the two types of measurement. Many researchers have emphasized the strength of the relationship between the two types of tests. However, others seem to be more concerned about the effect of such factors as the age of the individuals involved or the subject which is chosen. In most of these studies, IQ scores were commonly used as measures of intellectual ability, while course grades and scores on typical achievement tests were used as measures of intellectual achievement.

Many researchers who have compared the results of Piagetian and typical IQ tests stress the idea that IQ is a much better predictor of success on the Piagetian tests than age. Feigenbaum (1963) tested 90 children from nursery and elementary schools who were classified

as "bright normal." He discovered that, in some cases, younger subjects with higher IQs performed better on Piagetian tests than older children with lower IQs. The performance on Piagetian tasks of bright and average fifth and seventh grade boys was compared by Keating (1975). According to this study, the fifth grade bright students performed at a more advanced level than the seventh grade average students, even though the fifth grade boys were two full years younger. The results of a study conducted by Keasey and Charles (1961) indicate that even though the retarded subjects had lived an average of 11.41 years longer than the normal subjects, they had no better grasp of the concept of conservation of substance. Achenbach (1969) and Stephens, Manhaney, and McLaughlin (1972) are other researchers who would agree that Stanford-Binet IQ scores have a more significant relationship than chronological age to performance on Piagetian tasks.

On the other hand, there are some researchers who believe that the age of the individuals involved significantly affects correlations of Piagetian and IQ scores. Jordan and Jordan (1975) reviewed 36 studies of 44 groups of normal children from the preoperational to the formal operational levels of development. They discovered that

the correlations of scores of Piagetian tests with scores on intelligence tests were significantly higher when all of the subjects within that particular study fell within a narrow age range. Kuhn (1976) also stressed the importance of age in studies correlating Piagetian and IQ test scores. She correlated the results of test scores of 52 first through third graders and 56 fifth through seventh graders. Correlations of .80 for the concrete tasks and .32 for the formal tasks indicate that the relationship between Piagetian and psychometric assessments diminishes with advancement in the ages and stage levels of the individuals involved.

While some researchers have emphasized the age factor in correlations of Piagetian and psychometric measures of intelligence, others seem to be more concerned about the various aspects of intelligence which both types of tests were designed to measure. Some research seems to indicate that there is very little relationship between these two types of measurement. However, in general, an examination of the research reveals that there is a positive, moderate correlation of Piagetian and IQ test scores. In other words, the two types of tests appear to measure, to at least some extent, some of the same aspects of intelligence.

One of the more interesting studies which discusses the various aspects of intelligence measured by the two types of tests was done by DeAvila and Havassy (1974). In this study, Piagetian and IQ test scores of Mexican-American children were compared to the test scores of other children in the same communities. The results indicated no ethnic group differences on the Piagetian measures of cognitive development. On the other hand, there were consistent ethnic group differences on the IQ test scores. This would seem to indicate that Piagetian and IQ tests do in fact measure different aspects of intellectual maturity. DeVries (1973) would undoubtedly agree with these findings. According to her research, Stanford-Binet scores are poor predictors of performance on most of the Piagetian tasks. She states, "To a very large extent, Piagetian tasks do appear to measure a different intelligence and a different achievement than do psychometric tests" (pp. 751-753). Stephens, McLaughlin, Miller, and Glass (1972) also believe that Piagetian reasoning tasks involve abilities separate from those measured by standard tests of intelligence.

Yet, most of the research seems to indicate that there is at least a moderate relationship between Piagetian and psychometric tests. According to Hathaway (1972),

both types of tests assess "general intelligence," although Piagetian measures assess some traits not assessed by traditional measures. He believes that the two types of measurement are neither totally distinct nor totally identical. Freyberg (1966) and Kaufman (1971) are two other writers who would agree that the ability to think logically in a Piaget-type experimental situation is at least somewhat different from the ability to score high on conventional intelligence tests.

Kuhn (1976) is one of the few researchers to suggest possible reasons why the correlations between Piagetian and psychometric assessments are relatively moderate. According to her "differentiation hypothesis," all mental tests are highly correlated early in life. She believes that the general mental ability factor becomes differentiated as specialized skills and abilities are developed. Therefore, the correlations between different kinds of mental tests diminish with age. She also suggests that formal operations measures may be inferior assessment instruments compared to those for concrete operations. Therefore, the results are not as highly correlated to traditional psychometric assessment measures.

There are obviously many researchers who have compared the results of Piagetian and IQ tests. On the

other hand, there have also been many studies comparing Piagetian test scores with various measures of intellectual achievement. Most of these studies use either course grades or typical achievement tests as the measures of achievement.

The results of studies comparing success on Piagetian tests with course grades have been mixed. In a study of 44 students enrolled in an introductory college genetics course, Walker, Mertens, and Hendrix (1979) found a significant relationship between the number of formal tasks completed and the final grade in the course. Similarly, a study conducted by Sayre and Ball (1975) revealed that formal junior and senior high school students receive significantly higher science grades than nonformal students. On the other hand, Albanese, Brooks, Day, Koehler, Lewis, Marianelli, Rack, and Tomlinson-Keasey (1976) found that scores on Piagetian tests were not effective as course grade predictors. Barnes (1977) compared the final semester physics grades of 338 students with the Piagetian levels of intellectual development of those students. The results of this study reveal a low correlation coefficient for the grades A, B, and C, and none for D or F.

The researchers who compared Piagetian tests with

typical achievement tests rather than course grades also seem to have a difference of opinion regarding the relationship between the two types of measurements. According to Hathaway (1972), Piagetian measures add significantly to the prediction of school achievement. Dudek, Lester, Goldberg, and Dyer (1969) correlated the results of Piagetian tests with scores of the same subjects on the California Achievement Scale. According to the results of this study, the Piagetian tests show substantial correlations with achievement. Also, Wolcott (1978) discovered through her research that the means of math concept scores and total math scores were directly related to some Piagetian tasks. DeVries (1973) would strongly disagree with Hathaway, Dudek, and Wolcott. She correlated the results of Piagetian tests and the Metropolitan Achievement Test and found a correlation of only .20 between conservation of number and arithmetic achievement. DeVries believes that achievement tests and Piagetian tests measure generally different aspects of cognitive functioning.

Most of the researchers seem to be primarily concerned with the strength of the relationship between Piagetian tests and measures of achievement. However, there were also a few who considered the relationship between

Piagetian tests and achievement test scores in various subjects. For example, Lawson, Nordland, and DeVito (1975) found that correlations of Piagetian scores were higher for science achievement tests than similar tests for math or English. According to Jordan and Brownlee (1979), the mechanics of language and grammar were correlated more highly than comprehension and vocabulary. On the other hand, Kaufman and Kaufman's (1972) study revealed relatively similar correlations for arithmetic, spelling, and reading.

Just as many researchers discussed the influence of age on the correlations of Piagetian and IQ scores, research has also been done on similar correlations with achievement scores. According to Jordan and Jensen (1979), Piagetian tests are better predictors of math achievement for first and second grade children rather than older children. They believe that the correlations for older children are lower because the performance of those children on Piagetian tests reaches a ceiling level.

Summary

It is apparent that the researchers have been unable to develop any definite conclusions about the relationship between Piagetian and the more traditional intelli-

gence and achievement tests. Some researchers found rather high correlations between the two types of measurement, while others found little or no correlation. Also, some researchers believe age is an important aspect to be considered, while others do not. In the case of achievement tests, some researchers believe that the subject which is chosen is an important factor in these correlations, while others do not. However, in general, the research seems to indicate that there is a positive, moderate degree of correlation between Piagetian tests and more traditional measures of intelligence.

Chapter 3

DESIGN OF THE STUDY

Introduction

This research paper describes a study conducted during the 1981-82 school year in which the results of two measures of Piagetian development were correlated with the results of two traditional measures of intellectual ability and achievement. Following is a description of the procedures, the sources of data, the methods of gathering data, and the data-gathering instruments which were used in the study.

Procedures

Two different kinds of information were necessary in order to complete this study. The subjects' scores on traditional measures of intellectual ability and achievement were obtained. Scores on typical Piagetian measures of intellectual maturity were also determined.

In this study, Stanford-Binet IQ scores were used to determine the subjects' levels of intellectual ability. Intellectual achievement was measured by the subjects' SRA composite, math, science, and reading scores. The

Ankney-Joyce Reasoning Test and a series of ten task interviews were the two Piagetian measures which were used.

Sources of Data

The data necessary for this study was obtained from various sources. The Stanford-Binet IQ scores were recorded from the cumulative folder of each subject. The SRA achievement tests were administered by each subject's classroom teacher during September, and the composite, math, science, and reading scores were recorded. Scores of the Piagetian measures were obtained through the administration of both the Ankney-Joyce Reasoning Test and the series of ten task interviews.

Methods of Gathering Data

Fifty fourth graders were the subjects for this study. The random number table was used to determine which of the approximately 150 fourth graders in the school system were to be included in the sample. After the sample was determined, permission to participate in the study was obtained from the parents of the students involved. The subjects of this study have basically a middle-class, agricultural background, so results of

this study should only be generalized to students of similar backgrounds and ages.

The Stanford-Binet IQ scores were then obtained from the cumulative folder of those students included in the sample. Similarly, the SRA composite, math, science, and reading scores of those students were recorded after the tests were completed in September. The Ankney-Joyce Reasoning Test was administered by the researcher in two one-hour sessions. Within the following three-week period, the series of ten task interviews was administered by the researcher to each subject individually in fifteen-minute sessions.

Description of Data-Gathering Instruments

One of the Piagetian measures used in this study was the Ankney-Joyce Reasoning Test. This test is an objective test developed by Paul Ankney and Lyle Joyce to provide an alternative to the individual Piagetian task interviews. Ten concepts were selected as an indication of concrete operational reasoning in an individual. Conservation of weight, conservation of length, conservation of area, conservation of volume, one-to-one correspondence, class inclusion, transitivity, Euclidean space, spatiality, and velocity are the ten concepts which were

chosen. The tasks which Piaget used to investigate these concepts were then translated into written, objective items. Three questions were developed for each concept in order to obtain a more accurate measure of an individual's development on each concept under investigation. Subjects were classified as concrete operational on a particular concept if at least two of the three items related to that concept were answered correctly. The subjects were considered to be concrete operational when at least eight of the ten concepts were achieved.

Statistical analysis of this test by its authors resulted in a .83 reliability coefficient using the Kuder-Richardson formula. Also, the performance of 129 subjects on the test correlated at .63 with their performance on five task interviews related to concepts on the test.

The other Piagetian measure which was used in this study involved a series of ten task interviews. The concepts represented in these task interviews correspond to the ten concepts selected for the Ankney-Joyce Reasoning Test. All of the tasks used in these interviews were either identical to those described by Piaget, or otherwise were very similar in nature. Following is a list of the ten tasks and the book by Piaget in which a de-

scription of that task may be found:

1. conservation of weight
   The Child and Reality
2. conservation of length
   The Child's Conception of Geometry
3. conservation of area
   The Child's Conception of Geometry
4. conservation of volume
   The Child's Conception of Number
5. one-to-one correspondence
   The Child's Conception of Number
6. class inclusion
   Genetic Epistemology
7. transitivity
   Genetic Epistemology
8. Euclidean space
   The Child's Conception of Space
9. spatiality
   The Child's Conception of Geometry
10. velocity
    The Child's Conception of Movement and Speed

A description of each of the ten task interviews used in this study is included in Appendix A.

Summary

In this study, the results of four different tests of intellectual development were recorded for each of the 50 fourth graders included in the sample. The Stanford-Binet IQ scores were obtained from the cumulative folders

of the students. The SRA achievement tests were administered by each subject's classroom teacher during September, and the composite, math, science, and reading scores were recorded. The Ankney-Joyce Reasoning Test, an objective test developed as an alternative to the Piagetian task interviews, was administered by the researcher in two one-hour sessions. Scores on this test were represented in terms of the raw score on the test, as well as the total number of concepts which were achieved. Finally, the series of ten task interviews was administered by the investigator to each subject individually in fifteen-minute sessions, and the number of concepts which were achieved was recorded.

Chapter 4

ANALYSIS OF THE DATA

The data used in this study includes various scores from four different tests administered to a sample of 50 fourth graders. This sample was drawn from fourth graders who live in a small, middle-class, agricultural community in the Midwest. A mean IQ of 110.9 with a standard deviation of 11.6 indicates a relatively homogeneous group with slightly above-average ability. Finally, all of the subjects were approximately nine years old, and 27 of the 50 students were girls.

Various test scores from this sample of fourth graders were used to test three hypotheses. These hypotheses described the relationship between Piagetian and traditional measures of cognitive development, and also compared the results of two types of Piagetian tests.

The first hypothesis in this study stated that there was a moderate, positive relationship between scores on ten Piagetian task interviews and Stanford-Binet IQ scores and SRA composite, math, science, and reading scores. The correlations of the task interviews with these IQ and achievement test scores were all positive. However, the

correlations were all rather low, ranging from .29 with the SRA reading scores to .45 with the SRA science scores.

Table 1

Correlations of Student Performance on Ten Task Interviews with Student Performance on the Ankney-Joyce Reasoning Test and SRA Achievement Tests

	Task interviews
Ankney-Joyce Reasoning Test (raw score)	0.34
Ankney-Joyce Reasoning Test (categorized score)	0.46
Stanford-Binet IQ test	0.37
SRA composite score	0.34
SRA math score	0.30
SRA science score	0.45
SRA reading score	0.29

The second hypothesis stated that there was a moderate, positive relationship between scores on the Ankney-Joyce Reasoning Test and Stanford-Binet IQ scores and SRA composite, math, science, and reading scores. Scores on the Ankney-Joyce Reasoning Test were represented in terms of the raw scores, as well as the total number of concepts achieved out of the ten concepts represented on the test. An analysis of the correlations of these two scores with IQ and SRA achievement test scores again indicated a posi-

tive relationship between the two types of tests. Also, all of the correlations were low as in the case of the task interviews. The correlations of both scores were the lowest with the SRA reading scores, with a correlation of .23 with the raw scores and .26 with the categorized scores. The highest correlation with the raw scores was .42 with the SRA math scores, while the highest correlation with the categorized scores was .49 with the IQ scores.

Table 2

Correlations of Raw Score and Categorized Score Performance on the Ankney-Joyce Reasoning Test with Student Performance on the Ten Task Interviews, Stanford-Binet IQ Test, and SRA Achievement Tests

	Raw score	Categorized score
Task interviews	0.34	0.46
Ankney-Joyce Reasoning Test (raw score)	1.00	0.88
Ankney-Joyce Reasoning Test (categorized score)	0.88	1.00
Stanford-Binet IQ test	0.40	0.49
SRA composite score	0.31	0.35
SRA math score	0.42	0.41
SRA science score	0.36	0.42
SRA reading score	0.23	0.26

The third hypothesis stated that the correlations involving the series of ten task interviews were similar to those involving the Ankney-Joyce Reasoning Test. A cross-tabulation of the number of task interviews achieved with the number of concepts achieved on the Ankney-Joyce Reasoning Test resulted in a correlation coefficient of .46. This indicated a moderate, positive relationship between the two types of tests.

Table 3

Cross-tabulation of Student Performance on Ten Piagetian Task Interviews Compared with Performance on the Ankney-Joyce Reasoning Test

		Ankney-Joyce Reasoning Test								
		2	3	4	5	6	7	8	9	
Task interviews	4	0	1	0	0	0	0	0	0	1
	5	0	1	0	1	0	0	0	0	2
	6	1	0	0	0	1	0	1	0	13
	7	0	2	3	5	1	1	0	0	12
	8	2	1	1	3	1	3	2	0	13
	9	0	1	0	5	4	4	0	0	14
	10	0	0	0	0	0	3	1	1	5
		3	6	4	14	7	11	4	1	50

However, when the two types of tests were compared in terms of preoperational versus concrete operational performance, the correlations were much lower. A cross-tabulation of the preoperational versus concrete operational performance on ten task interviews and the Ankney-Joyce Reasoning Test resulted in a correlation coefficient of .11. This would seem to indicate little relationship between the two types of tests.

Table 4

Cross-tabulation of Preoperational (0-7) Versus Concrete Operational (8-10) Performance on Ten Piagetian Task Interviews and the Ankney-Joyce Reasoning Test

		Ankney-Joyce Reasoning Test		
		Low score (0-7)	High score (8-10)	
Task interviews	Low score (0-7)	17	1	18
	High score (8-10)	28	4	32
		45	5	50

Summary

Analysis of the data from this study revealed a con-

sistently positive relationship between each type of Piagetian test of cognitive development and the two traditional measures of intellectual ability and achievement. However, none of the correlations were high, ranging from .23 to .49. Also, the results of comparisons of two types of Piagetian tests seemed to depend on whether the data was represented in terms of the number of concepts which were achieved, or in terms of the levels or stages which the subjects of the study had reached. The correlations were higher in the former situation.

Chapter 5

SUMMARY AND CONCLUSIONS

A variety of Piagetian tests have been developed to ascertain the intellectual level of individuals. However, most school systems use intelligence tests and/or standardized achievement tests to measure a student's level of intellectual development. This study attempts to determine whether there is a relationship between scores on two Piagetian measures of development and scores on two traditional measures of intellectual ability and achievement. If results of this study indicated a strong relationship between the two types of tests, teachers could use the Piagetian tests to test minority children, make curriculum decisions, and/or select materials.

It is apparent that the literature offered no definite conclusions about the relationship between Piagetian and the more traditional intelligence and achievement tests. Some investigators found rather high correlations between the two types of measurement, while others reported little or no correlation. Also, some researchers believed age was an important aspect to be considered, while others disregarded this factor. In the case of achievement tests, some researchers

believed that the subject area which was chosen was an important factor in these correlations, while others did not. However, in general, the research seemed to indicate that there was a moderate degree of correlation between Piagetian tests and more traditional measures of intelligence.

In this study, the results of four different tests of intellectual development were recorded for each of the 50 fourth graders included in the sample. The Stanford-Binet IQ scores were obtained from the cumulative folders of the students. The SRA achievement tests were administered by each subject's classroom teacher during September, and the composite, math, science, and reading scores were recorded. The Ankney-Joyce Reasoning Test, an objective test developed as an alternative to the Piagetian task interviews, was administered by the researcher in two one-hour sessions. Scores on this test were represented in terms of the raw score on the test, as well as the total number of concepts which were achieved. Finally, the series of ten task interviews was administered by the researcher to each subject individually in fifteen-minute sessions, and the number of concepts which were achieved was recorded.

Analysis of the data from this study revealed a consistently positive relationship between each type of Piagetian test of cognitive development and the two traditional

measures of intellectual ability and achievement. However, none of the correlations were high, ranging from .23 to .49. Also, the results of comparisons of two types of Piagetian tests seemed to depend on whether the data was represented in terms of the number of concepts which were achieved, or in terms of the levels or stages which the subjects of the study had reached. The correlations were higher in the former situation.

Conclusions

Several conclusions may be drawn as a result of this study. Obviously neither the Piagetian task interviews nor the Ankney-Joyce Reasoning Test were good predictors of IQ scores or achievement test scores. The correlations between the two types of measurement ranged from .23 to .49. Also, according to both the ten Piagetian task interviews as well as the Ankney-Joyce Reasoning Test, many fourth graders were still preoperational, even though most of them were nine or ten years old. Over 30% of the students were classified as preoperational on both Piagetian tests. Finally, the Ankney-Joyce Reasoning Test was a much more difficult measure of cognitive development than the task interviews. Five students were classified as concrete operational using the Ankney-Joyce Reasoning Test, while 32 students met

the necessary qualifications with the task interviews. Perhaps the questions on the written test did not accurately represent the concepts included in the task interviews. Also, it appears that the criterion level for passing each concept was arbitrarily established at two out of three by the authors of the test. If the criterion level was set at one out of three, the correlations between the two types of tests might be much higher.

BIBLIOGRAPHY

Achenbach, T.M. Conservation of illusion-distorted identity: its relation to MA and CA in normals and retardates. Child Development, 1969, 40, 663-679.

Albanese, M.; Brooks, D.W.; Day, V.W.; Koehler, R.A.; Lewis, J.D.; Marianelli, R.S.; Rack, E.P. & Tomlinson-Keasey, C. Piagetian criteria as predictors of success in first year courses. Journal of Chemical Education, 1976, 53, 571-572.

Ankney, P. & Joyce, L.K. The development of a Piagetian paper-and-pencil test for assessing concrete operational reasoning. (Doctoral dissertation, University of Northern Colorado, 1974). Dissertation Abstracts International, 1975, 35, 5947A. (University Microfilms No. 75-5396)

Barnes, G. Scores on a Piaget-type questionnaire versus semester grades for lower division college physics students. American Journal of Physics, 1977, 45, 841-847.

DeAvila, E.A. & Havassy, B.E. The testing of minority children: a neo-Piagetian approach. Today's Education, 1974, 63 (4), 72-75.

DeVries, R. Evaluation of cognitive development with Piaget-type tests: study of young bright, average, and retarded children. Chicago, Illinois: Illinois University, 1971. (ERIC Document Reproduction Service No. ED 075 065)

DeVries, R. Relationship among Piagetian, IQ, and achievement assessments. Child Development, 1974, 45, 746-756.

Dudek, S.Z.; Lester, E.P.; Goldberg, J.S.; & Dyer, G.B. Relationship of Piaget measures to standard intelligence and motor scales. Perceptual and Motor Skills, 1969, 28, 351-362.

Feigenbaum, K.D. Task complexity and IQ as variables in Piaget's problem of conservation. Child Development, 1963, 34, 423-432.

Freyberg, P.S. Concept development in Piagetian terms in relation to school attainment. Journal of Educational Psychology, 1966, 57, 164-168.

Goldschmid, M.L. Different types of conservation and non-conservation and their relation to age, sex, IQ, MA, and vocabulary. Child Development, 1967, 38, 1229-1246.

Goodnaw, J.J. & Bethon, G. Piaget's tasks: the effects of schooling and intelligence. Child Development, 1966, 37, 573-582.

Hathaway, W.E. The degree and nature of the relations between traditional psychometric and Piagetian developmental measures of mental development. 1972. (ERIC Document Reproduction Service No. ED 075 485)

Jordan, V.B. & Brownlee, L. Summary and Review: correlational studies of Piagetian tasks and various measures of reading achievement. Los Angeles, California: 1979. (ERIC Document Reproduction Service No. ED 174 933)

Jordan, V.B. & Jensen, C.M. Summary and review: correlational studies of measures of Piagetian cognitive development and mathematics achievement. Los Angeles, California: 1979. (ERIC Document Reproduction Service No. ED 173 739)

Jordan, V.B. & Jordan, L.A. Relative strengths of IQ, mental age and chronological age for predicting performance on Piagetian tests. Denver, Colorado: 1975. (ERIC Document Reproduction Service No. ED 111 510)

Kaufman, A.S. Piaget and Gesell: psychometric analysis of tests built from their tasks. Child Development, 1971, 42, 1341-1360.

Kaufman, A.S. & Kaufman, N. Tests built from Piaget's and Gesell's tasks as predictors of first grade achievement. Child Development, 1972, 43, 521-535.

Keasey, C.T. and Charles, D.C. Conservation of substance in normal and mentally retarded children. The Journal of Genetic Psychology, 1967, 3, 271-279.

Keating, D.P. Precocious cognitive development at the level of formal operations. Child Development, 1975, 46, 276-280.

Kuhn, Deanna. Relation of two Piagetian stage transitions to IQ. Developmental Psychology, 1976, 12, 157-161.

Lawson, A.E.; Nordland, F.H.; & DeVito, A. Relationship of formal reasoning to achievement, aptitudes, and attitudes in preservice teachers. Journal of Research in Science Teaching, 1975, 12, 423-431.

Lawson, A.E. & Renner, J.W. A quantitive analysis of responses to Piagetian tasks and its implications for curriculum. Science Education, 1974, 58, 545-559.

Piaget, J. The child and reality. New York: Grossman Publishers, 1973.

Piaget, J. The child's conception of movement and speed. New York: Basic Books, Inc., 1970.

Piaget, J. The child's conception of number. London: Routledge & Kegan Paul Ltd., 1952.

Piaget, J. Genetic epistemology. New York: Columbia University Press, 1970.

Piaget, J. & Inhelder, B. The child's conception of space. London: Routledge & Kegan Paul, 1956.

Piaget, J.; Inhelder, B.; & Szeminska, A. The child's conception of geometry. New York: Basic Books, Inc., 1960.

Sayre, S. & Ball, D.W. Piagetian cognitive development and achievement in science. Journal of Research in Science Teaching, 1975, 12, 165-174.

Stephens, B.; Manhaney, E.J.; & McLaughlin, J.A. Mental ages for achievement of Piagetian reasoning assessments. Education and Training of the Mentally Retarded, 1972, 7, 124-128.

Stephens, B.; McLaughlin, J.A.; Miller, C.K. & Glass, G.V. Factorial structure of selected psycho-educational measures and Piagetian reasoning assessments. Developmental Psychology, 1972, 6, 343-348.

Walker, R.A.; Mertens, T.R.; & Hendrix, J.R. Formal operational reasoning patterns and scholastic achievement in genetics. Journal of College Science Teaching, 1979, 8, 156-158.

Weisman, L.I. & Safford, P.L. Piagetian tasks as classroom evaluative tools. The Elementary School Journal, 1971, 71, 329-338.

Wolcott, D.M. Selected concrete logical Piagetian tasks as they relate to mean and item scores on the math concept section of the Stanford Math Achievement Test, Form A. State University College of Arts and Science, 1978. (ERIC Document Reproduction Service No. ED 173 153)

APPENDIX A

1. Conservation of mass
A. Materials--two balls of clay of equal size
B. Procedure--Examine two balls of clay and then change one piece into a doughnut shape. Is there more or less clay in one piece than the other, or is there the same amount of clay in each piece? Why?

2. Conservation of length
A. Materials--four straws, plastic animals
B. Procedure--Use the straws to represent paths followed by the animals. Lay one straw on the table. Lay the second straw parallel to the first and move it forward one or two inches. Compare the distances traveled by the two plastic animals. Would the two animals have just as far to walk or would the distances be different? Why? Lay another straw on the table. Cut the last straw into small pieces and make a zig-zag path. Compare the distances traveled by the two animals. Would the two animals have just as far to walk or would the distances be different? Why?

3. Conservation of area
A. Materials--two sheets of green paper, wooden blocks, plastic animals
B. Procedure--Use two sheets of green paper to represent two fields and ten wooden blocks to represent five barns in each of those fields. In one field all of the barns should touch each other while in the other field they should not. Compare the amounts of grass in each field. Does one of the fields have more or less grass, or is there the same amount of grass in each field? Why?

4. Conservation of volume
A. Materials--two identical clear, plastic glasses; one short, wide glass; one tall, thin glass; colored water
B. Procedure--Fill one of the identical plastic glasses half full of red water. Fill the other plastic glass to exactly the same level with blue water. Pour the red water into the short, wide glass and the blue water into the tall, thin glass. Is there more, less, or the same amount of water in each glass? Why?

5. One-to-one correspondence
A. Materials--two identical plastic containers, marbles,

corn
B. Procedure--Drop one marble into one of the plastic containers and one kernel of corn into the other container. Continue this procedure, dropping one kernel of corn in the container every time a marble is dropped in the other one. Stop this process at a time when each container has exactly the same number of objects. Are the same number of objects in each container? Why?

6. Class inclusion
A. Materials--a poster with pictures of various pets
B. Procedure--Look at the poster. How many pets are there? How many dogs are there? Are there more pets or more dogs?

7. Transitivity
A. Materials--three rectangular solids, three inches (blue), four inches (white), and five inches (green) in length
B. Procedure--Lay the three inch and four inch rectangular solids on the table. What color is each one? Which one is longer? Remove those rectangular solids. Lay the four inch and five inch rectangular solids on the table. What color is each one? Which one is longer? Remove those rectangular solids. Is the blue rectangular solid longer, shorter, or the same length as the green rectangular solid? Why?

8. Euclidean space
A. Materials--two identical bottles, colored water, worksheet showing one bottle on a flat surface and the other tipped at an angle
B. Procedure--Fill one of the bottles with colored water until it is one-third full. Ask the student to draw a line on the worksheet which illustrates the height of the liquid when the bottle is level. Place the second bottle near the first and tip it at an angle. Ask the student to draw a line on the worksheet which would indicate the height of the same amount of liquid if the bottle were tipped like the second bottle.

9. Spatial relations
A. Materials--two jars of different sizes and shapes, colored water, three pictures of each jar as the water was poured from one to the other
B. Procedure--Fill one jar with water and then pour most of the water into the other jar. Ask the student to ar-

range the six pictures in order to show the amount of water in each jar at each stage of the process.

10. Velocity

A. Materials--cardboard jogging tracks (The tracks should be portions of two concentric circles and should begin and end at the same place.)

B. Procedure--Two joggers run around these paths. They begin and finish at the same time after running for four minutes. Did the runner on one of the tracks run faster, slower, or at the same rate as the other runner? Why?

APPENDIX B

Student	Task interviews	Ankmey-Joyce Reasoning Test (raw score)	Ankmey-Joyce Reasoning Test (categorized score)	Stanford-Binet IQ score	SRA composite score	SRA math score	SRA science score	SRA reading score
1.	8	19	8	114	235	213	338	244
2.	8	12	3	114	267	243	266	274
3.	10	15	7	107	241	197	239	267
4.	9	16	5	132	374	294	322	355
5.	5	15	5	104	248	184	239	288
6.	7	16	5	105	301	284	300	315
7.	9	9	3	105	256	158	308	286
8.	9	16	6	106	301	225	315	310
9.	8	14	4	121	351	326	322	293
10.	7	17	5	125	351	281	322	355
11.	7	14	5	112	250	221	286	261
12.	8	19	7	102	250	229	279	259
13.	8	16	6	119	346	287	363	328
14.	9	18	6	115	279	243	300	310
15.	8	8	2	108	276	243	338	281
16.	7	12	4	115	322	294	315	325
17.	8	17	5	100	235	243	260	237
18.	9	16	5	108	231	205	260	261
19.	6	23	8	125	276	273	330	277
20.	7	15	4	113	223	171	260	227
21.	8	21	7	112	297	289	286	277
22.	9	17	6	109	223	209	279	227
23.	9	16	6	119	297	255	286	307
24.	7	15	4	104	250	262	246	234
25.	7	12	3	99	231	221	239	223

26.	10	20	8	132	351	302	363	332	
27.	8	21	7	131	394	321	286	361	(girls)
28.	10	21	7	131	387	294	447	398	
29.	8	12	2	89	153	158	260	172	
30.	10	22	9	128	326	287	363	300	
31.	8	19	7	99	235	209	330	256	
32.	4	15	3	89	178	184	239	190	
33.	7	17	7	104	235	270	300	165	
34.	8	14	5	130	362	297	381	367	
35.	7	15	5	99	253	246	266	269	
36.	9	17	5	114	293	264	363	305	
37.	9	19	7	118	301	300	322	293	
38.	9	19	5	83	200	217	253	210	
39.	7	16	5	118	301	243	330	300	
40.	6	12	2	96	215	175	286	244	
41.	7	12	3	97	283	246	308	288	
42.	8	17	5	116	326	232	381	374	
43.	7	17	6	108	309	310	279	305	
44.	9	17	5	107	238	239	273	256	
45.	6	16	6	99	162	142	231	210	
46.	9	21	7	117	309	279	354	305	
47.	9	18	7	118	264	246	372	269	
48.	10	20	7	109	305	273	315	318	
49.	5	13	3	103	259	193	253	315	
50.	8	21	8	119	331	262	391	345	(boys)
$\bar{X}$	7.9	16.4	5.4	110.9	277.6	244.8	304.9	283.4	(total)
$\bar{X}$	7.9	15.9	5.3	113.2	283.6	247.1	294.3	285.7	(girls)
$\bar{X}$	7.9	17.0	5.5	108.3	270.7	242.0	317.3	280.6	(boys)
SD	1.4	3.3	1.7	11.6	55.8	45.6	48.0	51.4	(total)
SD	1.2	3.5	1.6	9.6	50.2	45.1	36.4	40.9	(girls)
SD	1.6	3.1	1.9	13.3	62.0	47.2	57.1	62.4	(boys)

HILLSBORO UNION HIGH SCHOOL DISTRICT 3JT

645 N.E. Lincoln Hillsboro, Oregon 97123
Telephone (503) 640-4604

Office of the Superintendent

August 18, 1980

Ms. Kathy Berntson
1929 Grant St.
Blair, Nebraska 68008

Dear Ms. Berntson,

Thank you for writing about my Piagetian concrete-reasoning test. You are very welcome to use the test in your graduate project. If you would like, I will send you a test booklet, answer sheet, answer key, directions for administering the test, and so on.

I hope this reaches you before your school starts. It would be nice to hear the results you obtain.

Sincerely,

Paul Ankney

PAUL ANKNEY
Staff Development Specialist