CONCRETE OPERATIONAL THOUGHT AS A CONSTRUCT AND ITS RELEVANCE TO SCHOOL EDUCATION IN PAKISTAN

BY

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Abstract

The state of children in Pakistan was reviewed with a view that it has important bearing upon future of Pakistan. The significance of childhood in the development of human mind was pointed out. The situation of primary education of children requires immediate attention from all angles. Psychology as a discipline is not playing any significant role in the improvement of primary education. Drop outs from schools was seen as one of the major problems of primary education in Pakistan. Significance of a psychological perspective for understanding the problem of drop outs was discussed. A psychological model which adopts a passive and mechanical view of human beings was rejected in the favour of a theoretical model which provides central role to children in the process of education. Various theories of psychology were discussed and evaluated in the context of child development. The cognitive development theory of Jean Piaget was selected as a framework which can be useful to undertake a psychological research on primary school children of Pakistan. A biographical review of Piaget was included to understand his contribution in child psychology. Piaget's theory of cognitive development and his concept of stages of development was described. By considering cognitive development as an important aspect of children's education, a cognitive development survey of primary school children was undertaken. It was assumeed that this survey will not only shed light on the cognitive development of children but will also be useful in clarifying some important issues in Piagetian psychology. The construct of concrete operation thought was taken as a significant aspect of theory of cognitive development which has direct relevance to primary school children. An assessment of concrete operational thought as a unitary construct was considered an important aspect of this work. A plan was proposed to clarify some of these issues by a large data, based upon a larger sample with sufficient range of cognitive development levels in children and collected with a battery containing enough cognitive development tasks to cover various ranges of cognitive levels. The results of survey were analysed from different angles. The reliability of the cognitive development tasks was established. Factor analysis was used to investigate the structure of the construct of concrete operational thought. The problem of decalage in the cognitive development theory was considered in the light of evidence available in the data. It was shown that this battery provided a good estimate of cognitive development levels of Pakistani children. It was shown that the construct of concrete operational thought is a valid and unitary construct which can be used for explaining certain problems in primary school education of Pakistan. The results of survey described cognitive developmental stages of primary school children. A sub-sample was used to point out a link between drop outs and cognitive development levels of children. Some classroom observations in primary schools were undertaken to establish that the educational practices are not in consonance with the cognitive development levels of children in schools. A class 1 textbook was analysed to show that its contents are not suitable for the given cognitive levels of children at this stage. Implication of this work for further research and psychology's contribution in primary education were discussed.

Dedication

To

The GC* years,
when I developed a courage to ask questions.

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* The Government College, Lahore, my alma mater.

Acknowledgements.

I owe too much as acknowledgements to the process of my intellectual development, of which the completion of present work is just one expression. In fact, I find it difficult to isolate distinct persons from the total ambience which is so important in any development.

Moving chronologically and only in the context of the present work, the beginning has to be by paying very high regards to Dr. Muhammad Ajmal, for whom only the word mentor conveys the nature of my relationship with him. He was my first real teacher and in many more meaningful ways continues to be so. Thanking him for his role as the supervisor of this work would be undermining his much broader role in my growth.

I owe it to Dr. Iftikhar-un-Nisa Hasan, the former Director of National Institute of Psychology, that her exuberant imagination thought of introducing Piaget at the Institute. She requested the British Council to send a Piagetian expert. Considering the difficulties involved, it would have not been possible to get interested in Piagetian work, except that Professor Kenneth Lovell introduced it and also that at certain critical moments Ali Kazim, a very warm friend and former Deputy Director of the Institute, pushed me to continue in this direction.

During the first phase of Piagetian research, development of a team of young and enthusiastic psychologists was crucial. It was Israr, Nargis, Durrani, Hanif, Sabiha and Nazia who struggled with me in understanding and applying Piagetian method without any external help available at that time. It was only with their dedication that we came up with such a good data. I have great regard for their help and owe them gratitude.

Sylvia Opper helped in refining *our* critical method. However, it was Michael Shayer who played critical role in encouraging and helping this work. At a later stage Shayer's support to Piagetian research at NIP proved crucial to take it to the level where it is now. My deep acknowledgments are due to them.

It was only Dr. Z. A. Ansari's proddings which, more or less, compelled me to complete this work. Except for his relentless insistence I would have not been able to complete and submit it. Now I feel like saying, "Thank you very much Dr. Ansari."

Mohammad Pervez

Contents

Chapter 1

INTRODUCTION

One significant viewpoint for looking at a society is a glimpse at the state of children in that society. There cannot be a better indication of the future of a society than the present situation of its children. Childhood is a vital beginning of human beings. What is so special and pivotal about humanity has its foundation in childhood. Truthfulness, candour, genuiness, creativity, imagination, spontaneity, expression, curiosity and unlimited urge for exploration – all these attributes of human eminence emanate from childhood. What makes human beings spiritually and mentally so outstanding among the creatures of this world has its roots in childhood.

Childhood is no longer considered as an incidental and useless period of human life. It is, now, taken as an integral part of basic characteristics of being human. However, it took considerable period of time of human thinking and scientific research to arrive at the present concept of childhood. In the recorded history of human thought – often in the form of folklore and mythology, the concept of child always occupied an important position. The archetype of child emerges in many forms manifesting important dimensions of human thought and emotion. Still, attitude towards child in real life was that of disdain. Parental love and affection gives to the child lot of care and warmth but it is to the person of child – not to the concept of childhood. The childhood itself was not given much importance. Realization of the importance of childhood is closely linked with the development of human society.

One can clearly see distinct attitudes towards children in tribal, feudal, patriarchal and authoritarian cultures. These attitudes changed with change in social, cultural and economic patterns in a society. Nevertheless, the significance of childhood in the mental development of human being was realized only in this century.

State of Children in Pakistan

Childhood in Pakistan is a reflection of Pakistani society, which is very diverse. One part of it lives in nomadic phase of social and economic development and another part of it has entered into industrial-technological era. Between these two extremes, the majority of Pakistani children are living in a situation which, in the context of last decade of the twentieth century, is far from being desirable. UNICEF's *The State of World's Children* provide some good bench-marks for assessing status of children in different countries. UNICEF considers mortality rate in 1000 children under five years of age the most important indicator of state of children. Taking U5MR, that is, Under 5 Mortality Rate, as a fundamental variable, UNICEF has divided its members into four categories: Very high U5MR – 142 to 189; High – 71 to 140; Middle – 22 to 35; and Low – 6 to 20. On almost all the indicators of the state of children Pakistan, along with 38 other countries, falls in the very high negative category.

Among the 129 countries listed in 1992 State of World's Children booklet (UNICEF, 1992), Japan is best with minimum U5MR, i.e., 6. The worst country is Mozambique with 189 U5MR. In the descending rank order of high U5MR, Mozimbique being at

1, Pakistan ranks at 33 with 158 U5MR. Most countries with U5MR higher than Pakistan belong to African continent. Only four Asian countries, Afghanistan, Bhutan, Nepal and Bangladesh have higher U5MR than Pakistan. One significant indicator of the state of children is the percentage of them suffering from moderate and severe under-weight. Among the 38 very high U5MR countries only 26 countries have data on this indicators. Of these 28 countries, only Bangladesh (66%), India (61%) and Yamen (53%) have higher percentage of underweight children than Pakistan. Fifty-two percent Pakistani children are suffering from underweight.

Education of Children

Education is another significant factor in the state of children. The data on primary school enrollment ratio of children of corresponding age is not available in the UNICEF booklet while the ratio of literacy is given to be 47% for males and 21% for females. However, it is a well known fact that as far as educational status is concerned Pakistan is amongst the ten to fifteen least developed countries of the world. It is generally accepted that only about half of the children who should be in primary schools are enrolled. Among those who are enrolled in grade 1, only 49% reach the final grade of primary schools (UNICEF, 1992). Future of children is very closely linked with their education.

If Pakistan's future could be seen in the present of Pakistani children, it appears to be engulfed in difficulties. After more than four decades of its existence, Pakistan continues to face fundamental difficulties in almost all spheres of its national life. In view of its strong potentials with very good physical and human resources available to it, one could have expected much better from this young country. In the absence of a stable, democratic, responsible and rational political set-up, one major impediment to progress is lack of proper decision making processes. Most of the decisions, having immense national importance, are based upon either whims of its decision makers or day to day exigencies. Lack of rational and scientific inputs in the decision making practices is a sordid reality of the national life.

Scientific Research and Decision Making

Although there is hardly any scientific discipline that played a significant role in the development of Pakistan, the contribution of social sciences has been most dismal. The only social science that is given some importance is economics. Still, economic research is hardly ever used to formulate economic policies.

The discipline of psychology, like other social sciences, has seldom contributed anything towards the national developmental efforts. Psychology in Pakistan followed a deep rooted philosophical tradition that was inherited from the philosophical psychology in un-divided India (Ansari, 1989). It took a long time for Pakistani psychology to shed its arm-chair philosophical interests. Pakistani psychologists with their background in philosophy found analytical psychology closer to their interests. The orientation towards psycho-analysis generated a lot of interest in abnormal and clinical psychology. Some legendary philosopher-psychologist teachers played a pivotal role in setting up this trend. Most students in psychology, even now, complete their Master's degree with an ambition of becoming clinical psychologists. Although, for various reasons, even clinical psychology could not develop as a proper profession, its fascination kept many promising psychologists away from those fields in which Pakistani psychology could have played a more productive role.

Psychology and Education

A sample of articles published in Pakistani journals (Ansari, 1989) indicated that 50% articles were of purely theoretical nature, seven percent were case studies and 43% were related to empirical studies. The empirical articles were generally based upon study of college students using psychological tests.

Most of psychological research is mainly undertaken by Master's level students. It is done for fulfilling a partial requirement for their Master's degree. This research often consists in administering half baked psychological tests to fellow students. Most of these are either intelligence or personality tests. A survey of content area (Ansari, 1989) indicated that clinical psychology and psychological testing together form the largest area of research in Pakistan.

Unlike many developed countries, psychology in Pakistan remained unmindful of problems of children and their education. At most of the universities, educational psychology is taught in one form or other. At certain periods of time at certain universities, it was a full-fledged paper but more often than that it formed a part of what was called *Applied Psychology*. Where ever educational psychology formed a component of curriculum of MA/MSc Psychology, frequently the contents page of one of an under-graduate level American textbook formed the course outline. Obviously such an outline never refered to educational problems of Pakistan. Khan (1988), while reviewing position of educational psychology in Pakistan, noted that Pakistani teachers and students are familiarized with the subject matter of educational psychology through imported text books from abroad, The material in such text books is written clearly but the data on which it is based is foreign to the student-teachers and teachers both. Socio-cultural milieu which is generally presented in these text books is quite different.

The situation of teaching of child psychology is almost identical to the situation of educational psychology. Two other areas of psychology which could have contributed to education are guidance and counselling and testing and evaluation. These area are generally included in the paper of clinical psychology. Generally these are theoretical, however, even when these include some practical work they do not deal with actual educational situation in Pakistan. A number of attempts to start counselling and guidance services in Pakistan's educational institutions failed mainly because these were not rooted in Pakistan's specific socio-economic context.

Topics such as learning, cognition, motivation, individual differences, etc., are taught in various forms but are hardly ever related to the educational problems of Pakistan. University Grants

Commission (UGC) periodically undertakes exercise of revision of curriculums. In the latest such revision in 1989, not only that Educational Psychology does not fare among seven core courses, it is not even recommended as an area of specialization among 13 other such areas (University Grants Commission, 1989).

Theoretically speaking, psychology has remained an important part of the discipline of education in Pakistan. But, just like educational psychology within the discipline of psychology, psychology in the discipline of education did not play any significant role. Almost all the Institutes of Education and Research have departments of psychology or at least have psychologists on its teaching and research staff. Some psychology is always taught at almost all the levels of teachers' education and training. B.Ed. course could be taken as an example. As most of education in Pakistan is book oriented, textbooks can be considered illustrations of curricula. One textbook on educational psychology (Hussain, 1982) written for B.Ed student claims to *cover all topics of B.Ed*, is titled as *Nafsiat aur Taleem* (Psychology and Education). Like most of textbooks in Pakistan, it starts with elaborate definitions of psychology, of education and educational psychology with usual historical chronology. Human development is discussed purely in maturational context. Intellectual development is equated with the development of *IQ*. Then there are usual topics of emotional and social development. It is followed by some discussion on factors which influence development. Individual differences is the next topic and is followed by process of learning which, instead of discussing the process of learning, outlines learning theories, the usual Thorndike, Pavlov, Skinner and Kohler stuff. Motivation and Personality are next topics. Evaluation and Guidance is a more elaborate chapter with sub-topics on testing and examinations. There are platitudes here and there saying that various aspects of psychology is very important to education but without any indication of its implication in the real Pakistani situation. The situation of Pakistani child, education and schools are not mentioned any where. The concept or theory of cognitive development is conspicuous in this textbook by its absence.

With the present state of children and their education in Pakistan one would have expected some role for psychologists. The process of education – especially education of children – is such a rich psychological phenomenon that lack of Pakistani psychologists' interest in it is not understandable. It would be difficult to imagine any situation other than education in primary schools where so many different psychological processes would be found interplaying with each other. Cognition, motivation, perception, affection, learning, inter-personal perception, group dynamics, etc., all converge in the process of education in a primary school. Yet there is hardly any psychologist in Pakistan who took interest in primary schools of this country.

A scientific body of knowledge about Pakistani children is a prerequisite for any attempt to improve their condition. An attempt to take stock of educational and psychological research on Pakistani child (Pervez, Seema, 1989) confirmed the general impression that very little scientific research has been undertaken and important areas of vital importance has been ignored.

The most important impetus to psychological research in Pakistan came with the establishment of National Institute of Psychology. As this Institute was created by the federal ministry of education, its initial research agenda concentrated upon educational problems. When an offer was made to the Institute to embark upon a major research project, it was for the first time that Pakistani psychologist started a search for viewpoint to look at least one major educational problem of the country. A model was needed, sufficiently grounded in theory of reasonable scientific stature and having practical implications for education. It was decided to start from the start of education – primary education.

A psychological investigation aimed at making some contribution towards more and better education for Pakistani children needs to start with a detailed review of of problems of literacy and primary education in Pakistan.

Primary Education and Literacy in Pakistan

Pakistan emerged as an independent state in 1947. It owes its existence to the claim of nation-hood and demand for an independent country by the Muslim religious minority in the British Indian empire. Islam started spreading in the Indian subcontinent in the 7th century A.D. Subsequently for four centuries India saw a firm Muslim rule. With British colonialization of India and not being rulers any more, the Muslims felt themselves pushed into a position of a disadvantaged minority in relation to the indigenous Hindu population and culture. After being completely defeated in 1857 by the British forces the Muslims, largely, developed an isolationist attitude. This resulted in their alienation from the modernizations brought into India during the period of British rule. On the other hand Hindus rather welcomed British rule as giving a change of masters. They, under the British patronage seized the opportunities of education, jobs and trade. With the prospect of India achieving political freedom, the Muslims felt that by the rule of majority in a democratic set-up they would be suppressed by the Hindu majority. Thus came the demand for an independent Pakistan.

Situation of Literacy and Education in 1947

With stabilization of the British Raj in India the educational tradition of Muslims started disintegrating. The tradition was part of the aristocratic Mogul empire and was very well serving the needs of that period. New educational traditions, which were mainly geared to support industry and trade were seen with great suspicion by the Muslims. Moreover the Muslim population was so reluctant to take any interest in new opportunities that economically and educationally it became a distinctly disadvantaged community. The Muslim majority regions that came to constitute Pakistan were industrially among the most backward parts of British India. Out of total industrial establishments in undivided India, only 9.6% of it fell to Pakistan's share (Bhatia, 1979). A very large majority of its population was dependent upon primitive agricultural economy. Few modern states started their independence on such a tenuous basis and under such several initial difficulties as Pakistan (Mydral, 1968 cited in Bhattia, 1979).

Problem of obtaining reliable statistics continues to exist as ever but in the early years of its existence an educational census was not even possible. However, it is a secure assumption that the rate of literacy was less than 20%. It was not only the low rate of literacy that was causing concern, the existing educational system was being questioned. In 1947 Rahman (1953) said that Pakistan's existing educational system, as conceived by Macauley was intended to serve a narrow, utilitarian purpose. The growth of this system has been largely a matter of artificial improvisations. It was generally condemned for lack of realism. It was not able to adjust itself to the needs of a changing society. Rehman thought that this system, at the cost of ignoring spiritual values, emphasised only literacy. (Rahman, 1953). The situation before 1947 has been summarized by Haq (1953). Even during last days of British raj, indigenous institutions continued to exist. In place of these indigenous institutes, which were not efficient any more, a considerable number of primary schools under a British patronage had grown in the country. This period saw enactment of legislation for the expansion of primary education but there was a wide gap between legislative provisions and educational practice. Programmes of primary education were invariably not supported by financial inputs required for their implementation. According to the estimates of Haq (1953) only 37% of the primary school age children were in the primary schools.

Pakistan came into existence as a federation of five different provinces and some princely states of British India. All of its federating units were at different stages of social and economic development. On one extreme was Baluchistan, very thinly populated and living in a tribal stage of economy and culture. The other extreme was East Bengal, very densely populated, intensively cultivating jute and rice, but surprisingly with a much better rate of literacy than the rest of the country. This uneven development continues to be one of the difficulties in Pakistan's many problems.

Developmental Efforts in Literacy and Education

The most important aspect of more than four decades' history of Pakistan is its political instability. Lack of a stable and persistent political structure has adversely effected development of social and economic institutions. The history of Pakistan can be divided into six periods. These periods can be ascribed as the initial period (1947-57) followed by the regimes of Ayub (1958-68), Yahya (1968-71), Bhutto (1971-77), Zia (1977-1988) and a post-Zia period (1988 onward). It is enough to comment that none of these periods was one of a normal political change or development.

The political leadership that was responsible for the creation of Pakistan, despite its difficulties in almost every sphere of life in the early period of Pakistan's existence, was mindful of educational situation. The first all Pakistan Educational Conference was convened in November, 1947. While inaugurating the conference the Education Minister said that government's first concern must inevitably be a determined and vigorous attack on the formidable problem of illiteracy and its evil consequences. He said that state should provide universal, compulsory and free education to children. This was seen as a primary requisite for training in democracy (Rahman, 1953). However, as we will see, this determination could never be translated into a reality.

Almost all the periods of Pakistan's history saw educational *declarations* by their respective *regimes*. None of these failed in emphasizing the importance of education in the national development. However, achievement of literacy and mass education remained as elusive as ever. All Pakistan Educational conference (1947), Report of National Commission on Education (Ayub regime), National Educational Policy (Bhutto regime) and National Educational Policy (Zia regime) were consistent in attaching great importance to primary education. While policies are just declarations of intentions, at a more concrete level, these are reflected in annual budgets and five year developmental plans of governments.

All Pakistan Educational conference resolved that a free and compulsory education be introduced for five years of school going age. Subsequent years saw some more legislation in this direction, but just like legislations of the British period, these remained dormant.

Pakistan's First Five year Plan for economic development was prepared in 1954-1955. Like all subsequent plans, it contained a section on education. This plan, more or less repeating the resolve of the All Pakistan Educational Conference, reiterated that universal primary education is a major goal of national planning. However, after being overwhelmed by the problem, it says that the amount of resources required to achieve universal primary education are such that the present size of economy cannot sustain it. Therefore, let the economy of the country expand to such an extent that it is able to absorb the cost of this magnitude (Government of Pakistan, 1956). The plan contemplated adding 4000 new schools to the existing 14000. This plan that was to be a plan for 1955-60 was approved by the government in 1957 and mostly remained un-implemented.

National Commission on Education presented its report in 1959. This report repeated what had already been said in the First Five Year Plan. It said that with less than 50% of our primary school age group children are in schools and with constantly increasing child population, achievement of providing compulsory schooling requires tremendous effort (Government of Pakistan, 1959). This report mentions that the ratio of drop out in the primary schools, in some cases, is as high as 75%. The report emphasised in general terms the need for the universal primary education but was not very specific about how and when it will be achieved. It is very elaborate in discussing various aspects of primary education but as the subsequent period proved, it was not of any help to improve literacy in the country.

The second Five Year Plan (1960-65), while reviewing the First Plan, said that the accomplishments during the First Plan period, by no means negligible, were in several respects disappointing. No significant improvement in the quality of school education was made. Primary school enrollment did not increase to the extent expected. In connection with the training of teachers, no increase was registered at the primary level. Four thousand new primary schools were to be added but only 2400 were added. Similarly, enrollment was planned to be increased by one million but only 440 thousand could be increased. In terms of West Pakistan (which is the present Pakistan) the Second Plan set its objective to increase the ratio of enrollment in primary school age group from present 36% to 56% at the end of the plan period, i.e., 1965 (Government of Pakistan, 1960).

The next Third Five Year Plan (1965-70) was not very candid on the failings of the previous plan. However, it said that the Third Five Year Plan's objective was to increase the enrollment from present 45 to 70 by 1970. The plan also set out its objective on the drop out problem. It said that at present just 20% of the children starting the primary school are retained in the school till the end of primary school stage. It suggested various methods to increase the retention to at least 50% level (Government of Pakistan, 1965).

By the time of Fourth Five Year Plan (1970-75) was set up, there was a new regime. Here we find a frank assessment of the situation. This assessment revealed that the achievement of the goal of universal primary education has receded with the lapse of time and Pakistan today has one of the highest rate of illiteracy in the world. During the period 1951-70 the percentage of children attending primary schools increased from 35% to 50%, showing as increase of 17% over a period of 20 years. However, as far as putting up any practical solution for the problem of literacy was concerned, this plan was not in any way different from the previous plans. In vague and unspecific terms the plan said that in order to provide universal primary education up to class five by 1980, the

Fourth Plan will be set to accelerate the growth of education (Government of Pakistan, 1970).

The next regime, for the initial years, preferred to work through annual development plans rather than five year plans. However, latter on it started work on the Fifth Five Year Plan (1978-83). The Fifth Plan was preceded by an elaborate Educational Policy by the Bhutto regime. This policy was not much different from the previous plans. The Fifth Plan, with the change of a regime in 1978, mostly remained un-implemented.

Continuing the tradition, Zia regime also came up with another *National Education Policy* in 1978 (Government of Pakistan, 1979). This policy, while acknowledging that nearly half of nation's children do not go to school, made a very ambitious but unrealistic claim of attaining universal enrollment for boys of 5-9 age group by 1987. Nevertheless, for girls this target was postponed till 1992. A document of Ministry of Education prepared in 1986 (Ahmad, M & Aziz, M.A., 1987) does not seem to take a stock of what was expected to be achieved by 1986-87. This document does not contain any indication about enrollment ratios in 1984, 1985 or 1986.

Post-Zia period saw quick succession of three *political* governments but none of these lasted for sufficient period to either come up with their own *educational policy* or leave any impact on the situation of literacy.

Table 1.1 is a snapshot of all the six five year plans (or plan periods). This table is based upon Bhatti (1986). It shows participation rate of primary school going age children of the country from 1955 to 1988.

Table 1.1

Participation Rate of Primary School Age Children.

Plan	Plan Period	Bench Marks	Target	Achievement
		%	%	%
I	1955-60	52	58	3
II	1960-65	36	56	45
III	1965-70	45	70	46
IV	1970-75	46	65	54
V	1978-83	54	68	48
VI	1983-88	48	75	48

Note: These figures are calculated from the Development Plans of the Government of Pakistan.

During a period of thirty years (1955 -1980) if all the efforts have resulted into an increase from 36% to 48%, it is an alarming situation. One recent description of the pathetic status of development of primary education in Pakistan was provided by an educationist and bureaucrat who since more than ten years he has been very close to the primary education and literacy scene in Pakistan. His statement in a conference on children was reported in a newspaper (Staff, 1991). While noting that population is growing at the rate of 3.2% per annum and the fertility rate is 6.2, he estimated that if the current rate of development continues, it will take us 165 years to attain 70% literacy. This statement has been made in the context of a policy statement of present political government that it is aiming to raise literacy to 70% by the end of this century.

Demographic Characteristics of Pakistani Population

Before looking into the latest statistics on literacy and primary education available in Pakistan, let us consider some demographic aspects of population of Pakistan which are important in the present context.

1. Distribution of Population. Pakistan is divided into four provinces, technically under four provincial governments, forming a federation in the Federal Government at Islamabad. Baluchistan which has the largest area, 43.6%, is very thinly populated and has only 5.1% of the total national population. Major cities and most of the districts of the Punjab and Sindh are very densely populated. Punjab and Sindh together contribute about 78.7% into the national population while they occupy only 43.5% of land (Population Census Organisation, 1984).

2. Urban and Rural Population. One very important characteristic of Pakistani population is its distribution into urban and rural areas. 71.7% of its total population is rural (Population Census Organisation, 1984). The economic pattern and standards of living in the rural areas is markedly different from the cities. Most of the rural population is dependent upon a primitive agricultural economy. Villages are highly underdeveloped. Most of these are without electricity, clean drinking water, telephone and even without proper link of roads to the cities.

3. Age Distribution. By distributing age groups into five year intervals, we get the highest population in the 5-9 years age group. This is 16.04% of the total population. It is important to note because roughly this is the primary school age group. In the total population, 31.34% is less than 10 years old. If we go further to the less than 15 years age group, it is 44.5% of total population (Population Census Organisation, 1984).

4. Male and Female Distribution. Difference in the male and female population is significant. Contrary to a general pattern of higher number of women in the world population, in Pakistan for every 100 women there are 111 men (Population Census Organisation, 1984). This is generally considered a result of discrimination against girl-child which leads to higher death rates among girls.

Present Situation of Literacy and Primary Education

A major source of educational statistics in Pakistan in population census. However, before looking at the census data one should note that an individual's status of being literate is determined by individual's answer to a question. However, there is no objective verification of literacy of the respondent. The other problem is definition of literacy. In 1972 census, status of literacy was determined by "Whether a person can read and write with understanding?" For 1981 census the criterion was changed to "Whether a person can read a newspaper and write a simple letter?" Population Census Reports (Population Census Organisation, 1984) gives data of 1972 and 1981 census. This data is reproduced in Table 1.2.

Table 1.2 shows that during a period of about nine years literacy has risen from 21.71% to 26.17%, an increment of 4.46%, which comes to a yearly increase of 0.49%. Data expected from 1991 census is not available yet. However the pace of increase in literacy during 1972-1981 has been so slow that we cannot expect any substantial difference in the last ten years or so. In order to look at the amount of illiteracy confronted in Pakistan Table 1.3 has been derived from Table 1.2.

Table 1.2

Percentage of Literates in Pakistan.

	1981			1971		
	Both	Male	Female	Both	Male	Female
Punjab						
All Areas	27.42	36.82	16.81	20.71	29.10	10.74
Rural	20.01	29.56	9.38	14.75	22.85	5.21
Urban	46.72	55.23	36.72	38.95	47.83	28.04
Sindh						
All Areas	31.45	39.74	21.64	30.17	39.09	19.22
Rural	15.57	24.54	5.21	17.58	27.47	5.77
Urban	50.77	57.77	42.23	47.43	54.50	38.38
NWFP						
All Areas	15.70	25.85	6.48	14.52	23.14	4.74
Rural	13.18	21.73	3.82	11.02	18.98	2.16
Urban	35.77	46.96	21.88	33.70	44.71	19.85
Baluchistan						
All Areas	10.32	15.20	4.32	10.06	14.82	4.17
Rural	6.10	9.82	1.75	5.61	9.16	1.25
Urban	32.16	42.42	18.54	32.29	42.39	19.20
Pakistan						
All Areas	26.17	35.05	15.99	21.71	30.17	11.62
Rural	17.33	26.24	7.33	14.34	22.57	4.69
Urban	47.12	55.32	37.27	41.50	49.95	30.91

Figures of Population census of 1981 indicate 73.8% of illiteracy in the adult population. Its distribution is not even. The lowest rate of illiteracy is in the urban male (43.1%), and the highest is in the rural females (93.2%). The urban population is much better than the rural population and males are much better than females. The worst case is rural females of Baluchistan where literacy is 1.25%.

Table

Percentage of Illiterates in Pakistani Population.

	Both	Male	Female
All Areas	73.8	64.95	84.01
Rural	82.67	73.76	92.67
Urban	52.88	44.68	62.73

UNICEF (1992) figures for 1990 describe 47% male and 21% female literacy. This shows that in comparison to 1972-1981 the improvement in 1981-1992 period is substantially better. However, these are probably estimates provided by the government and are likely to be distorted towards a more optimistic picture. In the absence of any scientific research aimed at determining literacy rate in Pakistan many specialists at national and international level suspect that in fact it is not higher than 15%. Whether we accept the UNICEF figure of about 34%, population census's 26.17% or 15% none of these is a satisfactory situation.

Sources of informal education in Pakistan are few. There is a strong tradition of religious education of children in mosques but as most of it consists of recitation of Holy Quran in Arabic language, it hardly adds to functional literacy. There has not been any significant campaign for adult literacy. Therefore primary education is the only real source of literacy in Pakistan. 1981 Population Census reports contain tables showing ratio of students to 5-24 year age population which is 14.82% (Population Census Organisation, 1984). However, these reports are not useful for determining enrollment ratios in primary schools. Table 1.4 shows UNESCO (1984) Statistical Yearbook's primary school age population's enrollment ratio in Pakistan for year 1981.

Table

Primary School Age Group Enrollment Ratio in 1981.

	%
Total	44
Boys	57
Girls	31

Table 1.5 is based upon Bhatti (1986) and indicates a slightly better picture for 1982-83.

Table 1.5

Percentage of 5-9 Year Age group Children Enroled in Primary Schools during 1982-83.

Total	48
Boys	57
Girls	34

Table 1.6 shows figures of enrollment ratio as indicated by UNICEF (1991) that is lower than that of Table 1.5.

Table

Primary School Enrollment Ratio (1986-89).

Male	51
Female	28

Considering the data in Table 1.6 as the latest and more objective, we can see that till 1989, 49% of boys and 72% of girls who should have been in schools, are not in the schools. In many cases schools do not exist for the prospective pupils, and on the other hand, in many communities although the schools are there, either the children have never entered into the schools or have left the schools without completing primary education, never to come back again.

So far we were looking at what is outside the school. We have seen that more than two third of the adult population has never entered into the schools (or left the school without attaining literacy) and about half of the school going age children are not in the schools. Now let us have a look into what is happening in schools.

Table 1.7 has been adopted from UNESCO (1982, 1984) figures.

Table

Percentage in Various Classes of Primary Schools

	Grades				
Years	1	2	3	4	5
1970	32	22	18	15	12
1979	32	22	17	16	13
1981	35	21	17	15	12

Table 1.7 is a snapshot of 1970, 1979 and 1981. Nevertheless it indicates the magnitude of drop outs during the primary school stage. As children go into the higher classes their number keeps on consistently decreasing. The drop is consistent but much higher in the earlier classes than the later classes. Table 1.8 has been tabulated on the assumption that if ratio of children in various classes remains constant for the next five years what would be the ratio of drops outs in the transition into various classes.

Table 1.9 shows drop-out situation as determined by Rukunnuddin & Farooqi (1988) for the period 1977 to 1983.

Table 1.8

Percentage Drop-outs over Classes

Class Transition	% of Drop-outs
1-2	40.0
2-3	19.0
3-4	11.8
4-5	20.0
1-5	65.7

Table 1.9

Percentages of Drop-outs in Primary Level.

Year	Boys	Girls
1977-78	55	58
1978-79	56	61
1979-80	57	63
1980-81	58	62
1981-82	54	61
1982-83	53	62

There is a general consensus that at least five years schooling is needed to attain literacy. The above table indicates that of the total boys in the primary schools in 1982-83, only about 47% would have completed their primary education and achieved functional literacy. The remaining 53% would have dropped out of the school thus added to the number of illiterates. The figure for girls is more depressing. Only 38% would have continued their primary education while remaining 62% would have dropped-out. UNICEF (1992) tells us that percentage of grade 1 enrollment reaching final grade of primary school in 1985-87 is 49.

Overall impact of this situation can be summarised into the following: Only about half of school going age children are in the schools. Of the children in the schools only about half are likely to attain functional literacy, therefore, of the total school going age population just one fourth is likely to achieve literacy. With the current rate of literacy at 32% and population growth rate of 3.2% the situation is far from satisfactory. If the present situation continues to exist, there is a very thin possibility of Pakistan ever achieving the oft repeated national goal of universal primary literacy.

Many problems of primary education are ascribed to insufficient economic inputs into the sector. However drop out is considered an economic wastage by the economic planners. The existence of a primary school in a community is the major part of the economic commitment. However, one can debate if the drop out is due to insufficient economic inputs or due to other non economical factors.

Structure of Primary Education

According to the constitution of Pakistan, which despite many jolts, continues to be the basis for the administrative set-up, the responsibility of providing education is shared between the federal government and the provincial governments. The federal government provides the basic policy framework while implementation of policy in the field is the responsibility of the provincial governments. The most important problem is the lack of any direct control or contribution of the local community in the affairs of education.

The Federal Ministry of Education is responsible for the formulation of the national policy and providing central services, especially guide-lines in curriculum development. It guides and assists the provincial educational departments in the implementation of educational policy and carrying out the developmental plans in accordance with the policy. The allocation of capital expenditure is done by the federal government while the recurrent expenditure is provided by the provincial governments (Pritchard, 1975).

It is very difficult to describe the actual state of primary education in Pakistan because there are wide gaps in the levels of implementations of the policies and in the policies and the actual practices. The feedback from the schools and its long journey through various levels of administrative structure is so slow that by the time the federal government is fully cognizant of the state of implementation of its policy, it is already in the process of changing its previous policy. As a general practice, each subsequent regime makes it a point to declare that the policy of the previous regime was faulty, therefore it is leaving the previous policy and introducing a new policy.

With some exceptions of well to do upper middle class of cities, education starts with primary school education. For the majority of the population there is no concept of pre-school education, nurseries or kindergarten etc. Officially primary school consists of 5 years of schooling, starting at the age of 5. Most of the rural schools tend to add another year in it as a preparatory grade - the fact that is denied to the authorities. The age for entering into the school is also very flexible. After successful completion of the primary school, which essentially means passing in the grade 5 annual examination, for a large majority that is enough of education, while some children will go to the middle school which often will be in a different place and in a different village.

According to a previous policy, introduction of automatic promotion from one grade to the next grade was to be adopted. The recent policy is not explicit on this issue. However, rather invariably, the system is based upon promotions in the grade being dependent upon passing of annual examinations. If a child is unable to pass the examination, this means repeating the same grade again. With some exceptions, the schools are sex segregated with male teachers for boys and female teachers for girls.

The schools are administered by District Education Officers (DEO) - separate male and female officers in many cases. A district, which is a basic administrative unit in Pakistan, covers a total population from half to two million people. The DEOs are under regional directorates of education which take care of 5 to 10 districts. The directorates are under provincial departments of education. Provincial departments of education are headed by provincial ministers of education with an elaborate bureaucratic set-up. It may be noted here that during martial law in the country, which is a frequent phenomenon, the head of state nominates all the provincial governors and these governors nominate their provincial ministers. Therefore all the decision making and control travels directly from the top to the bottom.

Primary school teachers are appointed by DEOs. Officially a primary school teacher is at least a matriculate (ten years of schooling) with another year's study for the primary teaching certificate (PTC). However, some teachers continue to be without any training and even without matriculation. The course for professional training (PTC) in most cases lasts for 9 months. Again there are wide discrepancies between what he/she actually learns. Even the contents of the course are rather flexible in practice. PTC is a formal *certificate* for obtaining the job of teaching and in fact is nothing to do with his/her actual teaching competence.

Role of the Community in Primary Education

With the political and administrative set-up outlined above, it does not leave any scope for participation of the local community in primary education. Besides the above limitations, following a historical hang-up from the colonialized period, school is associated with the *government*. Due to lack of political participation during most of more than four decades of history in Pakistan, the masses by and large are alienated by whatever is done by the government. As the school is also part of the *government* there is very little active participation by the community. Literacy and education is fully supported at the level of an ideology. However parents, especially in the rural areas are very pragmatic about the utility of primary education. Policies do emphasis participation of local communities in the affairs of primary schools but in reality no such participation exists. In some cases schools do get some support from the local community in the form of land for school, help for building school premises and making available some other material facilities to schools. These are exceptions rather than rule.

Educational Motivation

Despite the intention to make primary education universal and compulsory since a long time, it continues to be voluntary. Parents' motivation to send children to school is a very important factor. However due to economic as well as social factors the motivation continues to be rather weak.

Rural agricultural economy hardly demands any literacy. The rural areas are fairly entrenched in *oral tradition*. Most of the administrative, economic and social systems are doing fine without literacy. At the present level of economy, the relationship between economic development and education is not clear. Most of the education available in the rural areas at the best, leads a person towards low status and low salary jobs which are not better paid than semi-skilled (which do not require any education) or unskilled industrial labour or farming.

One important reality of educational planning in Pakistan is lack of integration between the policy and the practice. Planning is undertaken at a very high level. The feedback from the actual situation in the schools, as pointed out earlier, is very limited, very slow and often due to vested interests of various levels of bureaucratic structures, misleading.

The situation of the governments control over schools is rather paradoxical. The government enjoys all the financial and policy controls. However, supervision of this control is so weak that a school teacher has all the autonomy on the earth. Inspection of schools is very ineffective (Pritchard, 1975). Very elaborate schemes of curriculum development, teacher training, audio-visual aids for the schools etc. tend to disintegrate between the federal ministry of education and the classroom of an ordinary school. The only tangible effect the planning can achieve is the hardware part of education, which essentially means a building for the school, salary of teachers and some furniture or equipment. At the present level of integration between various aspects of the system, everything else is vague and fluid to implement and if claimed to have been implemented, very difficult to monitor and assess.

Typical primary school.

Physical Environment. Except for some privileged schools in some cities, the physical conditions in the primary school of Pakistan are very depressing. School buildings are inadequate and unsuitable. Number of classrooms are much less than the number of classes. Many groups of pupils are taught in the open. During rains the children are packed into small rooms or sent home. The classrooms lack appropriate lighting and ventilation. The prevalent furniture for the pupils to sit on are mats and even the shortage of mats make pupils sit on the floor. They keep their books beside them and write on their slates, wooden boards or notebooks on their knees. The classroom environment is stark and bare without any drawings or charts on the walls (Pritchard, 1975). In the down town schools of the urban areas the conditions are not much better but much more crowded.

Equipment. A black board and chalk is the only standard equipment available to most of the schools. Impact of a very ambitious project to provide primary school teaching kit to schools, have been so far very limited and selective.

For the pupils text-books and something to write on is the only equipment available. These are purchased by the parents. For the earlier grades a wooden board *(Takhti)* is used and later on slate and notebook is introduced.

Teachers. The situation of teachers' qualification and training has been noted above. Many primary schools continue to be a single room and a single teacher school. The teacher attends to the classes in shifts. However urban schools are larger with more staff and bigger buildings.

Despite the low status and salary, the teacher holds a special position in the community. He is custodian of an old educational tradition. This tradition is transferred to him, not mainly during his training, but by the basic spirit of educational methodology by which he himself was educated. This tradition is based upon an authoritarian image of teacher who bestows *knowledge* upon the pupil. The conception of a pupil is that of an empty vessel which is to be filled by knowledge. Out of the ten or eleven years' educational exposure of a new teacher, he merely spends about nine months in *training*. The teachers' training institutes are also mostly staffed by *senior* teachers, whereas *senior* means more firmly based in the traditional concept of education. Therefore, despite some attempts to change the contents of the teachers training courses, the basic educational methodology continues to be the same. In a basically illiterate society, the teachers own sojourn in the educational process is quite a source of pride for him. Therefore in the classroom he evokes the same process through which he himself was educated for good ten years and was latter on even *trained*. His conception of education is some thing (i.e., the contents of the text-books) which is given to the pupil and the role of the pupil is to take it and preserve it fully by memorising it. As far as the contents of knowledge are concerned, these are all written in text-books. There is absolutely no conception of pupil's ability to construct knowledge. The idea of a child's own experience of reality being a source of knowledge just does not exist for the primary school teacher. He judges his ability as a teacher in terms of exercise of his authority and passing on the contents of the text-books to pupils and as a result of that child reproducing these effectively during the examinations. As it will be elaborated below the above mental make up of the teacher, with the given curriculum and examination and application of teaching methodology are the components of a vicious circle, which is very difficult to break by introducing change at some levels of the system.

Curriculum. What is the curriculum in the primary schools of Pakistan? This is a difficult question to answer. First of all let us note that planning, developing and providing curricula is the responsibility of the federal government. The Curriculum Wing of the Federal Ministry of Education develops outlines of the curricula. These outlines are sent to the provincial governments. On the basis of above outlines provincial departments of education get textbooks written and printed. It is obligatory on each school in the country to use the text-books published and prescribed by the government. These books are purchased by the parents of children. This part of the curriculum can be called the published curriculum. It is expected that in order to implement the curriculum, the teachers will be provided with teachers' guide books in accordance with the curriculum and they will be trained on the contents and the method of the new curriculum. However, these aspects lag much behind the expectations. Guidebooks are available, if at all, to very few teachers. Training available is only minimal, and its effectiveness is very doubtful.

As pointed out earlier, with very poor feedback from schools it is not possible to say what curriculum is in fact being used. There has not been any empirical study to answer this question. However, anyone who has gone through typical primary schooling in Pakistan, knows very well that in the given tradition of teaching style, the teacher has just one interpretation of the curriculum. It is the memorisation of the contents of the text-books. However the curriculum as set up by the federal ministry of education and the text-books published imply different conceptions. The published curriculum expects conceptual learning. The teacher, without understanding the implied conception of the curriculum, takes the contents at the face value and thinks that memorisation of these will do the trick. When the pupil is asked to memorise a specific content, he may try to integrate it into his cognitive structure. Here he faces two problems. Firstly, there is no help available from the teacher to make the content cognitively meaningful. Secondly, the cognitive demand level of the content may not match to his cognitive ability. Pupils with higher cognitive abilities are able to integrate the contents even without any help from the teaching method and this integration helps in better memorisation. However for the pupils with lower level of cognitive development, the contents remain meaningless, as these cannot be integrated into their existing cognitive system. For these children not only are the contents difficult to memorise, they are a source of frustration also. Although the examination system does not demand understanding of concepts, their understanding does help in better performance in the examinations.

Primary school curriculum, therefore, needs to be reviewed at two levels: the curriculum as intended by the authorities responsible for setting up the curriculum, and the curriculum as interpreted and implemented by the teachers in the classroom. There are indications that the published curriculum is not matched to the cognitive developmental levels of pupils in primary schools.

Teaching

The teaching method in the primary school can be simply described as mechanical memorisation of the literal contents of text-books. During this memorisation, the ability to read, somehow or other, naturally develops. Writing is taught by mechanical copying of alphabets and words. Mathematics starts with memorisation of counting which is followed by memorisation of arithmetical tables and then basic arithmetical functions.

This teaching method is supported by the examination system that demand reproduction of all the material which was memorised. That which is taught by way of science and social studies is also memorisation of the contents in the text-books.

The above teaching method does not leave any possibility of exploration on the part of the pupil. He/she remains a passive receiver. There is little interaction between the teacher and the pupil. There is no scope for the inquiry method. Although all the new text-books have been written with the claims of encouraging conceptual learning, when one looks at the effective curriculum in the classroom, one never encounters the practice of conceptual learning.

Role of Educational Psychological Research

The problem of literacy and primary education in Pakistan is closely linked up with political and economic development. Basically it requires a strong commitment from both the political leadership and the economic resources. However in the present given situation educationists and psychologists can play their limited role. Much of the meagre resources available to the primary education are not being utilized effectively. The enrollment level in grade 1 indicates that there is a willingness to send more children to schools than what actually are retained till the completion of primary school or till the attainment of literacy. Present educational practice indicates that what is *given* to a child entering a primary school is devoid of any mental or emotional interest for him. The child's lack of interest and eventual boredom leads to his alienation from the prevailing educational practice. Children's frustration is carried to parents in homes and ultimately results into yet another drop-out from the school.

While the economists in Pakistan have started to stress more inputs in education, their thinking is generally limited to its hardware. Any change in the educational scene is not possible without changing the educational practice in the classroom. We have noted above that declaration of change in the educational policies, change in the curriculum and change in teachers training do not seem to affect the educational practice. In fact the most important agents of any potential change are teachers and pupils, but there has been little direct concentration upon either of these. There is a need to understand the mental abilities of children on the one hand and the educational ideology of teachers on the other hand. The educational ideology of teachers as they practice it within the framework of their socio-cultural background and mental capabilities and limitations, is one of the major obstacles in the process of change. With the present level of integration between the seat of control at the top levels and the grass roots of education, it is not possible to effect a real change. However, educational and psychological research can be helpful in bridging this gap. What is required is an empirical assessment of the educational practice in the classroom. This assessment may include the cognitive abilities of children, the effective curriculum as practised by teachers in the classroom and dynamics of interaction between pupils, teachers and the educational content. An educational model based upon the understanding of the above can be helpful in the training of teachers at such level that he is able to understanding the process of education as the child's ability to construct knowledge. The teacher needs to consider the cognitive functioning of children and present the educational content at a level where it evokes the cognitive abilities of children. This practice not only will address the existing cognitive abilities of children but can be expected to help in the cognitive growth of children. A practical demonstration of such a model even at one school can show that making the contents of education cognitively meaningful for children can raise their involvement with the process of education and reduce the drop-out rate in the primary schools. Such an effort can spearhead a movement towards some real change in the primary school education in Pakistan.

In effect one is drawing an analogy between the educational system in England in the first half of the nineteenth century, and the educational problems of Pakistan today. With hindsight, one is suggesting that given an almost complete lack of *gearing* between central government bureaucracy and the schools, the only effective move of intervention is a *pump-priming* exercise in a few actual classrooms with a few actual teachers. By applying what has been learnt in the West about the cognitive development of children, and teaching methods intended to utilise effectively the pupil's mind to a particular school an exemplar can be created. Such an exemplar could change the practice in Pakistan Primary Schools, as a bush-fire spreading, far more effectively, than further intervention *from the top*. Alternatively, it may suggest to central government a more effective means of intervening so as to increase literacy.

Research on Primary School Children of Pakistan

The limited role which psychologists have played to ameliorate the current situation of literacy and primary education in Pakistan can be explained by lack of any significant research on children and primary education of Pakistan. One effort to take stock of research on Pakistani child was made by National Institute of Psychology in collaboration with the Curriculum Wing of the Federal Ministry of Education in 1986 (Pervez, 1989). All the researches related to Pakistani child and conducted at almost all the institutions engaged in psychological and educational research were reported and reviewed.

It appears that one favourite area of psychological research in Pakistan has been child rearing practices. Maximum number of psychological researches were undertaken in this area (Ahmad, Karim, Najam & Hasan, Rizvi, Siddique, 1989). However, none of these reflected upon the effects of rearing practices on the school education of children. A number of studies in psycho-analytical tradition were interesting in their own right but had no implications for education of children (Rizvi, 1989). A large number or correlational investigations were aimed at discovering relationship of academic achievement with many variables such as intelligence, family education, socio-economic status, personality, achievement motivation, etc., etc. (Chaudhary, Najam & Hasan, 1989). However, all such studies fell short of developing causal models for explaining academic achievement. Some interest was also shown in problems of special children (Chaudhary, 1989). One specific line of concern was effect of mass media on children (Ahmad, 1989). Many researches on the problem of drop-out were conducted at some institutions of education. All of these researches were basically descriptive, trying to arrive at the correct rate of drop-out. However, these failed to develop a model for comprehensive explanation of drop-out phenomenon. Some of the drop-out studies, which tried to go into reasons, were contended with listing a large number of factors responsible for drop outs. No analysis was attempted except declaring these factors interrelated.

One also finds two sets of researches on child development, development of language and development of cognition. Studies on language development were limited to determining the level of vocabulary used by children (Chaudhary, 1989). This possibly can have some implication on textbook writing. In the field of cognitive development one finds an occasional interest at the Institute of Education and Research, Lahore. However, like many other Piagetian researches, these appear to be motivated by curiosity to confirm the notion of stages. These studies do not go beyond replications. Some efforts were also made to investigate development of science concepts and processes in children. Some of these deal only with the high school children. There are no effort to see the cognitive development in the context of overall educational process. Researches undertaken at National Institute of Psychology (Ansari, 1989) are basically related to the present study. Most of psychological and educational research in Pakistan was work of students and very few of these were published in some refereed research journals.

Psychological and educational research on Pakistani children lacks any direction or theoretical orientation. Any serious applied research – especially in the area of such a wholesome process as education – requires an appropriate theoretical framework. There has been a strong tendency in the history of education to consider education an isolated process. However, education, and in particular school education, cannot be separated from the context of the student who in this case is a child. Childhood in fact is the pivotal stage in the developmental process of human beings. Therefore, education can only be properly understood with reference to child development.

Theories of Child Development

As pointed out earlier, although the child was all the time there in the human history, the concept of childhood developed fairly late. For a very long time child was considered a mini adult – just like other human beings, only smaller in size, lesser in intelligence and limited in knowledge and experience. Absence of a distinct concept of childhood can be discerned from paintings of middle ages in which not only dresses but also features and expressions of children were not different from that of adults. In the medieval social life children were treated just like adults. Concept of childhood, somehow or other, appers to be linked with the socio-economic development of a society. Medieval attitudes towards children were, perhaps, basically authoratarian and feudal attitudes. That is why the attitudes towards children in the many developing countries continue to be what is considered medieval in the developed part of the world. In such countries, where basic modes of behaviour and thinking continues to be authoratarian and feudal, children are expected to work like adults. Discipline is harsh and children are expected to conform to the proper standards of behaviour, as early as possible. It is assumed that they need training in correct behaviour just like domestic animals. However, in many developed countries, what is a routine treatment of children in third world is prohibited by law.

Philosophical Roots

Two distinct traditions of concept of childhood can be traced to two outstanding men in the history of western thought, John Locke (1632-1704) and Jean Jacques Rousseau (1712-1778).

Locke's *Essay Concerning Human Understanding* established him as father of empiricism in philosophy and father of learning theory in psychology. While looking at his famous dictum that human mind is a *tabula rasa*, one should assume that child's mind is not different from any other mind. However, while outlining *Some Thoughts Concerning Education*, he became one of the first thinkers to realize that children have their own cognitive capacities which set limits to what can be taught to them. He suggested that since childhood is a formative period, it merits careful attention of adults. He saw external forces, or what was to be called in modern terms, *nurture*, as the driving force in the development of children. Locke mentioned principles of association, repetition, modelling and reward and punishment. These principles later on became corner-stones of learning theories. However, in the middle of 17th century, as a psychologist, he was too ahead of his time (Crain, 1980).

In comparison to Locke's thinking which later on developed into what is now recognised as environmentalists' and learning theorists' view point, Rousseau can be called father of developmentalists. Rousseau believed that the development of children should primarily be left to their natural unfolding, that is, to their internal forces. In contrast to Locke's support for *nurture*, Rousseau will appear to favour *nature*. His revolt against established social order made him suspicious of social influences on the growth of children. Children, he believed, are born with their own individual natures, and adults, for the sake of their need for reason and social order, must not snatch this individuality (Clarke-Stewart & Friedman, 1987). He was the first important thinker to invite attention about child's inborn capabilities to learn and develop. He said that child has his own way of seeing, thinking and feeling. Childhood has a special place in the sequence of human life. Nevertheless it is ignored by adults because they are more concerned about the future of a child and tend to dismiss his present. "Rousseau introduced several key ideas into developmental theory.... He proposed that development proceeds according to an inner biological timetable. For the first time we have a picture of development unfolding fairly independently from environmental influences. Children are no longer shaped by external forces.... They grow and learn largely on their own.... Rousseau suggested that development unfolds in a series of stages" (Crain, 1980, pp. 13, 14). Beside providing theoretical foundations for a concept of childhood, Rousseau can also be called a forerunner of a tradition which is now called child-centred education.

Bilogical Precursors

Charles Darwin (1809-1882) fundamentally changed the way in which scientists thought about development of species, of societies and of human beings. Development was a central idea in *Origin of Species*. Darwin inspired scientists to look for changes in and across different species. Later on parallels were drawn between development of human beings and development of other species. Life cycle of human beings – from a watery existence in mother's womb to crawling, creeping and then into the maturity – was compared to development from water-dwelling organisms, through lower animals, to primates and then finally to homosapians. It was assumed that ontogeny, that is the development of individual, follows the pattern of phylogeny, that is the development of species. This lead to a tradition of a very careful and minute observations of children's behaviour. As this line of investigation was in the context of survival of species in natural environment, it matured into a new science of ethology. Konarad Lorenz and Niko Tinbergen played the central role in developing modern ethology. Ethology gave a number of interesting concepts and new ways of looking at behaviour. One important concept which has direct bearing on child development is *imprinting*. It is not the type of learning which was being talked about by Locke, Pavlov or Skinner. It is a very distinct type of learning which occurs only at a specific maturationally determined point in the life of an organism and leaves a remarkably permanent effect. John Bowlby, while looking at emotional problems of orphan children turned towards ethology and developed an ethological view of child development. Bowlby is recognised for his emphasis on mother/infant bond. He explained childhood in terms of various phases of attachment (Crain, 1980). The major role of ethologists have been drawing attention to apparently minor and meaningless behaviours of children. They stressed upon viewing child behaviour in naturalistic and evolutionary context.

Development as Maturation

Unfolding of a natural sequence of development in the context of biological development of an organism is now called maturation. The most influential proponent of maturational theory of child development was Arnold Gesell (1880-1961). "In Gesell's hand Rousseau's idea of an inner development force became the guiding principle behind extensive scholarship and research. Gesell showed how the maturational mechanism, while still hidden, manifests itself in intricate developmental sequences and self regulatory processes" (Crain 1980, p, 23).

Psychoanalytical Theories of Development

Sigmund Freud's theory of psychosexual development cannot be called a theory of child development. However, no one else has laid as much emphasis upon the developments during the childhood as Freud. This theory assumes a series of biologically determined stages. The biological drives arise from the source of sexual and erotic feelings, which shift from mouth to anus and then to genitals. Each of these stages involves some major central problems whose resolution determines the personality structures that emerge from that stage of development. Although major implications of psycho-analytical theory are on understanding inner feelings, impulses and phantasies, it has influenced many parents and educationists who refrain from automatically discipling some unwanted behaviours in children and instead try to understand emotional reasons behind it (Crain, 1980). Anna Frued developed psychoanalytical thoery in more specific context of children. Interest in psycholoanalysis of children and some theoratical developments can also be seen in Melanie Klein but it is not in the context of developmental psychology. Carl Jung and Erik Erikson extended concpts of human development but they were essentially not refering to children. Educational experiment of A.S. Neil, which became fomous as Summerhill School, was an attempt to implement Freudian concepts in educational practices but it never developed into a proper theoretical framework. Bruno Bettelheim's work on autistic children has some educational implication but development of his tradition remained limited.

Psychoanalytical theories are inseparable from their practical application. Therefore, these are critically linked with with treatment of mental illness. Nevertheless, mental health is an important aspect of education and cannot be ignored.

Gestalt View of Development

Heinz Werner (1890-1964) brought gestalt view-point in developmental psychology. In contrast to Berlin school of Gestalt Psychology which concentrated upon perception, Werner adhered to Leipzig school which was more holistic and emphasized the whole, acting and feeling organism. Werner tied development to both an organismic and a comparative orientation. He describes development as an increasing differenciation and heirarchic integration. Differenciation occurs when a global whole seperates into parts with different forms and functions. Heirarchic integration takes place when behaviours come under the control of a higher regulating centre. Self-object differenciation is the major theme of of development and impersonal objective view of the world only becomes possible when it is raised to the conceptual level of thought. Development intrinsically directs itself to mature stages.

Werner was basically a theoretician and wrote very little on practical application of his work. That is why mention of his work is seldom found in the field of child development and education.

Development as a Learning Process

Learning theory, as expounded by Pavlov, Watson and Skinner greatly influenced thinking about childhood during the first half of 20th century. As learning theories emphasize the process by which *all* behaviour is formed by the mechanisms of external environment, there is no specific need for a child development theory. Pavlov (1849-1936) laid the foundation of a science of learning. He transformed Locke's idea of association into an experimental paradigm of conditioning a natural animal behaviour to an unrelated stimulus. John Watson (1878-1958) laid foundation of school of behaviourism in psychology. He proposed that psychologists should study only observable behaviour and their theoretical goal should simply be the prediction and control of behaviour. Behaviour can be controlled by systematic arrangements of learning schedules. Largely because of Watson's efforts, classical conditioning became cornerstone of psychological theory. Many gaps left by Watson were later on filled by Skinner. After realising limitations of classical conditioning Skinner explored the nature of operant behaviour, where the organism, instead of externally being scheduled, acts freely and is controlled by the consequences of its actions. As Skinner is primarily talking about learning his contribution in the educational practices is significant. He basically rejects a self governed process of development. Social learning theory of Bendura provides a framework for understanding the emergence of social behaviour in children. He emphasized the role of modelling in child rearing and education (Crain, 1980).

Selection of a Theoretical Framework

Selection of a theoretical framework for psychological research on children and their education will imply an explicit or implicit conception of human beings. In the history of human thought, whether clearly enunciated or not, some model of man has always been there. Significance of reflecting upon such model has been succinctly described by Jahoda, who said, "In science the universe did not change when Einstein thought of relativity but man did change a little after Freud" (Kay & Connally, 1980, p. xiii).

Psychologists' models of man can be very broadly categorized into two positions. The psychology which followed the paradigm of natural sciences, (which most of the main stream psychology did,) essentially thought of man as an object. The followers of this model have a rather distinct identity as the champions of mechanism. Whether accepted by themselves or not, most of the work of behaviourists and learning theorists fall into this category. The followers of the other category cannot be identified so clearly. They have been variously called adherents of existentialism and humanism. This division has also been called as rivalry between *plastic* and *autonomous* man (Hollis, 1977). At a different plane, the model of man is dependent upon the nature of driving forces which are assumed to sustain most of the human behaviour. For instance Freudian model lays all the stress upon instinctual forces while Maslow emphasises on a less clearly understood need of self actualization.

In the context of Muslim world, the most significant sources of evolving a model of man can be the Holy Quran. There are sufficiently clear indications about the distinguishing nature of human beings in Quran. While indicating that human beings have a special position in the universe, the differences between them and other creatures have been referred in various verses. However, the more relevant verses to infer a model of man are 2:30-33.

> (30) AND LO! Thy Sustainer said unto the angels: "Behold, I am about to establish upon earth one who shall inherit it."
>
> They said: "Wilt Thou place on it such as will spread corruption thereon and shed blood – whereas it is we who extol Thy limitless glory, and praise Thee, and hallow Thy name?"
>
> [God] answered: "Verily, I know that which you do not know."
>
> (31) And he imparted unto Adam the names of all things, then He brought them within the ken of the angels and said: "Declare unto me the names of these [things], if what you say is true."
>
> (32) They replied: "Limitless art Though in Thy glory! No knowledge have we save that which Though hast imparted unto us. Verily, Thou alone art all-knowing truly wise."
>
> (33) Said He, "O Adam, convey unto them the names of these [things]."
>
> And soon as [Adam] had conveyed unto them their names, [God] said: "Did I not say unto you. 'Verily, I

alone know the hidden reality of heavens and the earth, and know all that you bring into the open and all that you would conceal' ?"

There are two important points in these verses which need some interpretation. (a) Adam's superiority over angels cannot be established unless it is assumed that he was able to convey the names of things *by himself*. It essentially means that while the angels knew only what God told them, Adam was able to know the names of things by himself. God gave him the ability to know by the virtue of which he was able to *convey the names*. (b) "The term *ism* ("name") implies according to all philologists, an expression "conveying the knowledge [of a thing]...applied to denote a substance or an accident or an attribute, for the purpose of distinction" (Lane IV, 1435): in philosophical terminology, a "concept". From this it may legitimately be inferred that the "knowledge of all the names" denotes here man's faculty of logical definition and, thus of conceptual thinking...." (Muhammad Asad, 1980, pp.8-9). This basically indicates a model of man, whose most distinguishing characteristic is his ability to acquire knowledge – the epistemic man.

If primary school education is not an isolated phenomenon then, in order to understand its problems, a theoretical frame work is required which does not isolate education from the developmental process of children. Children themselves cannot be isolated from human beings and one significant model of man is epistemic man. Childhood is the foundation of that wonderful process of nature which culminates into the development of its most fantastic creatures, called human being. Development of human species is linked with the life process itself which keeps on striving for better and better forms, capable of more efficient adaptation in their environment. Therefore, rather then picking up narrow and limited views, a theoretical framework capable of adopting a holistic perspective about education and children may be preferable. Instead of falling into confined and un-ending grooves of nature versus nurture, a viewpoint is required which is capable of transcending such controversies. Such a view has to be multidisciplinary. It should encompass such philosophical questions as purpose of development as well as mundane details such as selection of specific teaching strategies in a class room. In the competing theoretical view points in psychology, Piaget provides a comprehensive framework. Therefore, selection of cognitive development theory of Jean Piaget is a better choice for looking at Pakistani children and their education. This viewpoint places the required stress on taking childhood seriously. It gives enough theoretical support to integrate education in the total context of development - not only the development of children but development of human intellect as the most significant factor in the ascent of man in the scheme of universe. Piagetian theory is based on solid scientific grounds but at the same time is not entrapped in a narrow and mechanical interpretation of science.

The Making of Jean Piaget

In order to review work of a theoretician, a glance on his life is always a good starting point. However, in the case of Jean Piaget it is significantly more important to consider his work in the perspective of his life. There would hardly be any other example in the history of science where such a close integration exists between life of a person, his methodology and his contribution. This, in itself, reflects upon a major themes of Piaget's theory – creative interaction between organism and environment and between theory and practice. Many sources, at many levels of detail and analysis, are available to look at Piaget's life (Bybee & Sund, 1982, Ginsberg & Opper, 1988, Inhelder & Chapman,1976, Munari, 1985, Piaget, 1952, 1971a).

Jean Piaget died on 16th September, 1980 at the age of 84. Just before his death he was intellectually as active as ever. Just the volume of his contribution is reflected in the fact that he was author of more than forty full-length books and more than a hundred articles in the field of child psychology alone. He was recognized for his contribution in the field of biology, psychology, philosophy, sociology, education and even literature. However, a few years before his death, while making a statement about his "work" he said (Inhelder & Chapman, 1976a):

> "Piaget's theory" in not yet completed at this date and the author of these pages [that is, Piaget himself,] has always considered himself one of the chief "revisionists of Piaget."

Piaget was born on 9th August, 1896 at a place which can be called a symbol of the European intellectual tradition. It was a small university town of Switzerland called Neuchatel. Piaget's father was a historian who specialized in medieval literature. His mother was an energetic, intelligent and religious person. She was, however, quite neurotic. Both of Piaget's parents had significant impact on his intellectual development. From the father he got the habit of serious scholarship and from mother's neuroticism he resolved to remain very rational, which he did throughout his life. His mother's psychological conditions were also one reason of his later interest in psychopathology and psychoanalysis.

Biological Beginnings

With an academic atmosphere at home, Piaget grew up into a boy who was keenly interested in observing fish, birds and other animals in their natural habitat. However, this was not just a childhood inquisitiveness. At the age of ten he wrote description of a bird which he spotted in his village. This description was published in a natural history magazine. This was his debut into a very long and productive professional career. Soon he started collecting molluscs from lakes around Neuchatel. When he noticed that molluscs found at different depths have differences in their forms he started thinking about reasons for these variations. When Piaget was 15, he published an article in a magazine about molluscs. This publication resulted into an offer of a post as curator of collection of molluscs at the natural history museum of Geneva. However, Piaget had to decline this offer in order to complete his school education. On the insistence of his mother he took a short course on religious instructions. This lead to new type of problems for Piaget to ponder about. How to reconcile Christian dogma with biological principles? This type of questions developed a new interest in Piaget – philosophy. His orientation in biology and religion soon took him to evolutionary philosophy of Bergson which presented God as the life force. The concept of *elan vital*, a life force carried from one generation to the next appealed to Piaget. Bergson's ideas appeared to him as a reconciliation between biology and religion. Now he turned more and more towards philosophy and soon found out that his next passion is epistemology, that is, study of knowledge. Piaget's interest in knowledge was in the perspective of biological evolution. What is knowledge? How it is acquired? To what degree it is subjective or objective? These were the questions which were occupying Piaget's mind but he did not abandon biology and science. He studied biology for his undergraduate degree, did his graduation from University of Neuchatel at the age of 18 and when he was 21 he submitted a thesis on molluscs and received his doctorate in science. During this period, when he was trying to determine an academic path for him, he wrote a philosophical novel, appropriately entitled, *The Researcher*. While studying for his degree in biology, Piaget was also being tutored by a philosopher, Arnold Reymond. Being aware of Piaget's quest, Reymond chalked out a very demanding course of studies for him: history of philosophy, general philosophy, philosophy of science, psychology and sociology. And all of this while doing his biology.

From Biology to Psychology

In between the pulls of philosophy and science, psychology emerged as a natural choice for Piaget. After receiving his doctorate from Neuchatel, he left for Zurich to work in some psychological laboratories. Along with attaining some experience of working in psychological laboratories, he joined Bleuler's psychiatric clinic. After his forays into experimental psychology and psychopathology, he, for a while, turned back to molluscs. Later on he turned up at Paris and joined Sorbonne to study psychology, logic and philosophy of science. While at Sorbonne he joined a course on pathological psychology and obtained some experience of clinical interviewing of mental patients. During this period he was referred to Theodore Simon, who with Alfred Binet had developed intelligence tests. Simon was working on standardization of some intelligence tests. He invited Piaget to join in some of his work. This turned out to be a major landmark in Piaget's intellectual journey. While looking at children's responses to standard questions, he found children's incorrect answers more interesting than the correct ones. He saw a pattern in the children's errors. He also realized that the older children were not just more "brighter" than the younger ones, the younger children's thinking was qualitatively different from the older children. During his two years' stay in Paris, Piaget was able to explore many of his interests. He was able to establish for himself some relation between biology and epistemology. He noted that logic in children is not inborn – it develops in certain incremental stages. He found out that standardized test are not very useful tools for understanding children. He published results of some of his investigations in *Archives de Psychologie* which was edited by Edouard Claparede, a well known psychologist at Geneva at that time. In 1922, realizing Piaget's genius from his contributions in his journal, Claparede offered Piaget post of director of research at Jean-Jacques Rousseau Institute of which Claparede was the director. This institute was already famous for its excellence in educational research.

The Middle Childhood

Piaget employed his biological background of naturalistic observations and started study of language and thinking of young children. This resulted into his first book on child psychology, *Language and Thought of the Child* (Piaget, 1959)* . Piaget joined Jean-Jacques Rousseau Institute with a plan to study emergence of intelligence in children for two years and then move on to the problem of thought in general and then proceed on to construct a psychological and biological epistemology. However, it took him good forty years before he could return back to epistemology proper and that also was not a complete come-back.

From this point on, Piaget's career of research on children can be divided into three decades, twenties, thirties and forties. During the first half of twenties he concentrated upon middle childhood. His major themes for investigation were change in reasoning patterns, perception of reality, cause-effect, and developmental difference between younger and older children. He published five books during this period (Piaget, 1959, 1970, 1971c, 1972c, 1975). One can see the influence of psychoanalysis in Piaget's work in this period. He not only employed primarily a clinical method but also used psychoanalytical terminology. He saw language and interaction with parents as significant social factors in the development of intelligence. During this period some of his

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* A wide gap of period between the original publication of Piaget's books and the reference of their year of publication is mainly due to generally very late publication of their English translated versions.

basic theoretical ideas started emerging. He was seeing children's thinking qualitatively different from that of adults. He was convinced of necessity of seeing intellectual development in terms of an evolution through characteristically different stages of thought. His own opinion of his first five books was very modest. However, lot of notice was taken of his work, specially by child psychologists. He started receiving invitations from various places to deliver lectures on his research, a pattern which continued throughout his life.

When Piaget was conducting a great deal of research at Jean-Jacques Rousseau Institute, he was also teaching various courses in psychology, philosophy, sociology and scientific thought at Geneva and Neuchatel. Along with being director of research at Jean-Jacques Rousseau Institute, Piaget also took up the position of his intellectual mentor, Arnold Raymond, as professor of philosophy at Neuchatel.

The Origin of Intelligence

During middle twenties Piaget got married. Piaget and his wife, who was a former student, became close observers of their three children. These children were born in 1925, 1927 and 1931 and are famous as very distinguished subjects in the study of young children. The result of Piaget's study of his own children resulted into a description and analysis of sensori-motor period of development. This study was very significant from methodological as well as theoretical perspective. Piaget shifted from his method of verbal inquiry to non-verbal observations. Instead of depending entirely on naturalistic observation he found it essential to intervene in the child's activity at certain critical points. Rather than considering social interaction and language as the source of development of thinking, he realized that thought is derived from child's own actions. Study of his own children produced three more books in late twenties (Piaget,1960, 1972a, 1976b). In 1929 Piaget became assistant director of Jean-Jacques Rousseau Institute and professor of history of scientific thought. In the same year he accepted directorship of International Bureau of Education. This was significant not only in making Piaget a cosmopolitan scholar but also provided a background of practical educational issues to his work.

The Expansion

The next decade, that is, thirties, brought more administrative responsibilities for Piaget. However, he utilized these as opportunities for expanding his research horizon. He used the course on history of scientific thought for deeper study of scientific and mathematical concepts which he was able to use later in his work on children. From being assistant director, he became co-director of Jean-Jacques Rousseau Institute. This allowed him to undertake research at a much larger scale. He was also able to involve two important collaborators, Barbel Inhelder and Alina Szeminska, in his research. Now he became interested in discovering development of scientific and mathematical thinking in children. The importance of this period lies in differentiation between children who could think logically (concrete operational) and children who could not think logically (pre-operational). With the help of concept of conservation, he was able to explain stability and change in the intellectual structures. His collaboration with Inhelder and Szeminska produced two books on children's concept of quantities and numbers (Piaget, 1969a, Piaget & Inhelder, 1974). Piaget's involvement with International Bureau of Education made him think that more effective education can be provided by better understanding of children's thinking. By the end of thirties Piaget had collected sufficient evidence to formulate idea of invariant sequence of cognitive development stages, each of which was qualitatively different. Now he knew that the sequence of development moves toward more complex levels of thinking, culminating into logical thought and formal patterns of reasoning.

By the beginning of forties Piaget had laid down the basic framework of his theory. He felt it important at this point of time to make a synthesis of his work on intellectual development. It initially came in form of some lectures at Paris but was later on elaborated in a book, *The Psychology of Intelligence* (Piaget, 1971b). When Claparede died in 1940, Piaget succeeded him as chairman of Experimental Psychology and Director of Psychological Laboratory at University of Geneva, a position which he held until he retired at the age of seventy-five. During the forties, one of his earlier interest in the problem of the structure of whole lead him to the work of Gestalt psychologists. This resulted into a long series of investigation into perception. Piaget's interest in the problems of perception resulted into his conclusion that perception is also related to the development of intelligence. This line of research was published as *The Mechanism of Perception* (Piaget, 1969c). Later on work on perception was extended into child's conception of space and geometry (Piaget, 1966,1971c). Another area of research during this period was suggested to Piaget by Albert Einstein. It proceeded into study of concept of time, speed and movement in children (Piaget,1969b).

Genetic Epistemology

Towards the end of forties, Piaget was able to redirect his attention towards his primary interest - epistemology. With sufficient empirical data to support his conception of psychological processes underlying logico-mathematical and physical operation, he was ready to present his synthesis of biology and epistemology. This synthesis is reflected in the term of Genetic Epistemology, which Piaget subsequently used to describe his theoretical contributions (Piaget, 1972d).

It would be appropriate to explain the term *genetic* at this point as it occurs frequently in the context of Piaget's contributions. *Genetic* is a translation of French word *genetique*, which has its root in *genesis*, – not in genes as it may be generally construed. Genesis means creation, origin, source, etc. Therefore, genetic epistemology means the knowledge of the genesis or the source of knowledge. Piaget also uses a term *genetic psychology* which is not a familiar term for English speaking psychologists. It not only means child psychology or developmental psychology but also something more than that.

For the subsequent three decades (1950-1980), just like first three decades, Piaget's life remained very busy in research and writing. This period can be characterized as being spent on consolidating his theoretical position and trying to fill various empirical gaps in different aspects of his theory. This was done by including many new topics for investigation in his research activities. However, the most important accomplishment for Piaget was establishment of the Centre for Genetic Epistemology within the Faculty of Science at the University of Geneva in 1956. Due to his very broad interests in such diverse areas as zoology, biology, science, philosophy, epistemology, psychology, logic and mathematics, Piaget always thought of approaching problems of cognition from a truly multidisciplinary perspective. The purpose of this Centre continues to be to encourage outstanding scholars, representing diverse disciplines and coming from different parts of the world, to conduct collaborative research on problems related to development of human intellect and knowledge.

The fifties also saw Piagetian research move on from childhood to adolescence. In his studies of the twenties, thirties and forties, Piaget had concentrated on infancy through childhood years. Now he completed the empirical picture of child development by studying patterns of reasoning in adolescent years (Inhelder & Piaget, 1972). His method of research now incorporated use of quasi science material for invoking cognitive responses of children. However critical verbal interview remained the main-stay of his method. Now he was using scientific notions to analyse formal operational thinking in adolescents.

Some Other Lines of Research

One can see that through most of his career Piaget took rather a narrow view of intelligence – logical patterns of reasoning and problem solving. However, in sixties and seventies Piaget and his colleagues started a new line of research. They introduced investigation of relation of intelligence to such aspects as memory, imagery and learning. *Learning and development of cognition* (Inhelder, B., Sinclair, H., & Bovet, M., 1974) and *Memory and intelligence* (Piaget, J. & Inhelder, B., 1968) are examples of work on these lines. In 1969, Piaget again felt a need to consolidate his work in a general statement. This was done at a more general level and appeared in a volume entitled *The Psychology of the Child* (Piaget & Inhelder, 1966). On more theoretical level, he presented he views of developmental process in 1977 which appeared in the form of a new book *The Development of Thought: Equilibrium of Cognitive Structures* (Piaget, 1978).

Once again, in the later years of his life, Piaget returned to his basic philosophical questions. *Insights and Illusion of Philosophy* (Piaget,1971a) is discussion of relation of science and philosophy. In *Biology and Knowledge* he addressed his early concern of integrating biological factors with epistemological problems. He later completed another book on biology, *Behaviour and Evolution*. *Structuralism* (Piaget,1972b) was an application of his philosophical views to several different disciplines, including development of intelligence.

The Accomplishment

If one wishes to do so, he can discern a circle being completed towards the last years of Piaget's life: Starting with biological problems giving rise to philosophical questions, undertaking a long empirical journey into studies of child development, reaching to certain conclusions based upon empirical research and then applying this research to reflect upon the original questions in a style which may appear as a sort of parting statement. However, it was far from the truth. During the last years of his life, Piaget was not only keenly embarking upon new areas of research, he was also showing willingness to reconsider some of his earlier positions on certain issues in his theory of child development.

Piaget's contribution in the field of child psychology can be properly appreciated by looking at his life which was *not* devoted to study of children. He had a much larger canvas to paint. Children emerged just as more appropriate props.

Piaget in the Perspective of his Institutions

One interesting viewpoint to look at Piaget can be from the perspective of those institutions where Piaget grew up and spent most of his highly productive life. In the Pakistani context, where we teach a class 8 child either *science* or *arts*, it would be quite intriguing to see how various discipline merged and submerged at Geneva University. Piaget's model of interaction between organism and environment beautifully applies to his own development in the perspective of his institutions.

Faculty of Psychology and Educational Sciences from where Piaget retired as its head had its roots way back in 1892 when Theodore Fournoy founded a Laboratory of Experimental Psychology at the Faculty of Science of Geneva University. Just after three years of Wilhelm Wundt's historial beginning in 1879, this was the second laboratory in the history of experimental psychology. It is important to note that it was established in the Faculty of Science rather than in the faculty of Arts or Humanities. The theme of liberating psychology from the *imperialism* of philosophy, which was one major motive for establishing psychological laboratory, can also be seen in Piaget even about 70 years later (Piaget,1977). In 1901, Flourney also founded *Archives de Psychologie*, a prestigious scientific journal which is published even now.

Integration of science and psychology at Geneva is highlighted by the fact that when Piaget came to this University in 1921, its department of psychology and physics was being headed by one person, Edouard Claparede. Claparede was not only head of the department of physics, psychology and the Director of Laboratory of Experimental Psychology but was also a keen educationist. In 1921, Claparede established Jean-Jacques Rousseau Institute as a private school for professional training of elementary school teachers. The selection of Rousseau's name indicates the fundamental attitude of Claparede and his associates towards children and their education. Pierre Bovet, from Nauchatel, who had a doctorate in philosophy and was teaching psychology at the University of Geneva was named as its first director. One year after the establishment of the Institute, a preprimary experimental school, Maison des Petits, was also founded. The reputation of this small private school rapidly spread all over the world. When Piaget joined Jean-Jacques Rousseau Institute as its director of research, it was already known for its high quality educational research. During this period the Institute was accepted by the University and attached to the Faculty of Science. The relationship between Maison de Petit and Jean-Jacques Rousseau Institute indicates the tradition of linkages between theory, research and practice at one end and applied and pure research on the other. Such linkages are also reflected in Piaget's basic theoretical framework.

In 1929, Claparede, Bovet, Piaget and Rosselo established International Bureau of Education. This was an obvious attempt to look at education in a global perspective. However, in Piaget's context this was looking at child at universal level. The importance of this Bureau can be discerned from the fact that in 1970 it was adopted by UNESCO.

In the early twenties Jean-Jacques Rousseau Institute had become so important that Laboratory of Experimental Psychology under Faculty of Science was transfered to this Institute. Only four year after joining the Institute, Piaget's work at the Institute was regarded so highly that, at the age of 29, he was appointed professor at the Faculty of Sciences. In 1930, Jean-Jacques Rousseau Institute changed its name to Institute of Sciences of Education. Realizing the growing importance of Piaget and his work the name of this Institute was once again changed in 1964 to School of Psychology and Sciences of Education. In 1973, along with the retirement of Jean Piaget, this school became Faculty of Psychology and Sciences of Education. This was one mode of acknowledging and honouring the work of Jean Piaget by the University of Geneva. The relation between psychology and education at this school and emphasis on *sciences* of education, rather than *science* of education is simultaneously a cause and effect of the dynamic approach of Piaget to his theoretical as well as research work.

A Theory of Cognitive Development

Although *theory of cognitive development* is a generic expression, it has almost become synonymous with Piaget's theory of cognitive development. A theory encompassing such a wide spectrum as biology, epistemology and child psychology is extremely difficult to describe in an outline. This very difficulty has resulted into a large number of books which have been written to introduce Piaget at a relatively general level of understanding. However, this task is so complex that one can see specialization even in these introductory accounts. Beside being a chapter devoted to his work in almost all the books on child development, developmental psychology, educational psychology, Pedagogy, teaching of science and teaching of mathematics, Piaget's work is now also included in many books on learning theories and personality development. Hilgard and Bower (1975) is one such example.

Most of introductory books on Piaget are addressed to psychologists. Ginsberg & Opper (1988) is a good general but partly critical presentation of Piaget's major contributions. Furth (1968) presents a theoretical and critical study. One set of introductory books are geared up for use of advance readers of Piaget. These, rather than introducing Piaget's work in any detail, provide guidance for approaching this difficult venture (Bearley & Hitchfield, 1966, Droz & Rahmy, 1972). Some books have been written by authors with specific orientation of disciplines other than psychology, such as biology, mathematics or epistemology. *Making Sense of Piaget: The Philosophical Roots*, (Atkinson, 1983) and *Piaget's Theory of Knowledge: Genetic Epistemology and Scientific Reason* (Kitchner, 1986) are two such examples. A large number of books have also been written for the more enthusiastic *users* of Piaget's work, that is, teachers and educationists (Baybee & Sund, 1982, Floyd (Ed), 1979, Phillips, 1969, Richmond, 1970).

A number of strategies can be adopted to present Piaget's contributions but none of these can be very satisfactory. There are too many levels and too many dimensions of Piaget's contributions. At a conceptual level, he has philosophical questions which he is trying to answer at a biological plane. In this pursuit he finds psychology a useful tool. He basic question is about the nature of life which in evolutionary perspective is in a continuous process of adaptation to its environment. At the level of human species he considers acquisition – rather construction – of knowledge to be the ultimate tool in the successful adaptation of human beings in their environment. Development of human intellect is the process through which ability to construct knowledge is attained. This development is related to development of biological and psychological structures through a dynamic interaction of body and mind with its environment. Development of these structure is a function of the processes of childhood. He is trying to develop a new conception of philosophy and science – a philosophy which could accept scientific evidence and a science which could deal with philosophical issues. At a different level of contribution he is providing a new direction to the science of psychology – making philosophical questions, such as origin of knowledge, proper subject matters of research in psychology. During this process he is also charting out a fully developed conception of developmental psychology along with a new method of experimentation in psychology suitable to the type of research required in the field of cognition. "Piaget's contributions to our knowledge of cognitive development have been nothing short of stupendous, both quantitatively and qualitatively. Moreover his ideas about cognitive growth are often very complex and difficult to grasp, even when presented as an integrated whole, at length and in full detail. They are particularly prone to distortion, over simplification, and general misunderstanding when one tries to integrate brief summaries of Piaget's of ideas within more general narrative about the filed..." (Flavell, 1977, p. 5-6).

The complexity of Piaget's contribution can be seen in his attempt to understand interactions between various fields of knowledge. This is illustrated in Figure 1.1 which is based upon Droz and Rahmy (1972, p.142).

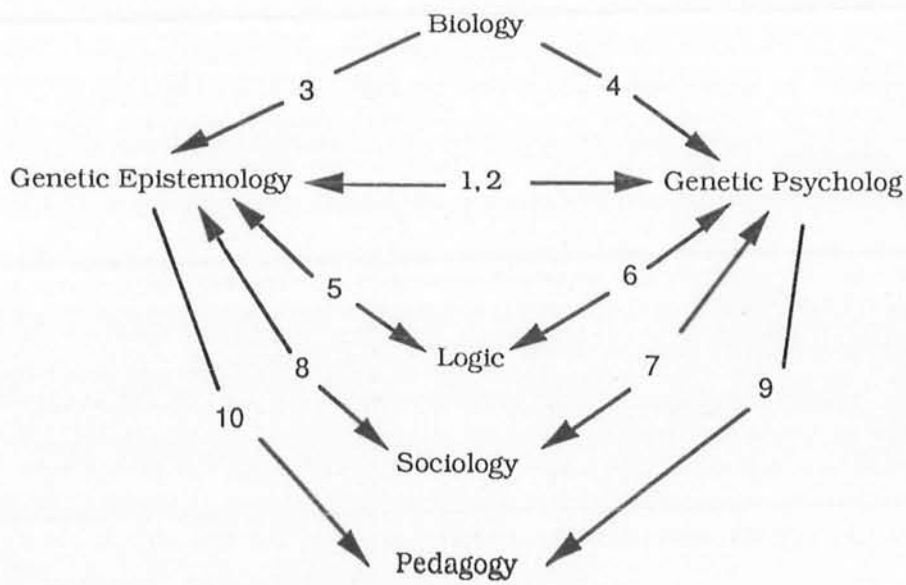

Figure 1.1 Interaction between the major fields of Piagetian endeavor

With this situation, one strategy can be to use Piaget's own description of his theory (Piaget, 1976a). This source is important because it comes from the later part of Piaget's life and can be taken as an account of his theory as he saw it at that point of time.

Piaget's Theory

Piaget's theory is based upon biological suppositions and leads to epistemological consequences. It postulates that same problems and same types of explanations can be found in the processes of (a) the adaptation of an organism to its environment during its growth, (b) the adaptation of intelligence in the course of construction of an organism's own structures, and (c) the establishment of cognitive relations which involve a set of structures progressively constructed by continuous interaction between subject and the external world.

Piaget rejects the common view that the external world is completely separate from the subject. He does not agree with Hull that the knowledge of objects is their *functional copies*. He does not accept this passive interpretation of knowledge. He thinks that such an interpretation is contradicted at all levels of development – from sensori-motor actions to most sophisticated intellectual operations. In order to know objects, the subject must act upon them and therefore transform them. Knowledge is constantly linked with actions or operations, operations being interiorized actions carried out mentally. Every operation upon an object results into transformation of that object. Therefore, the relation between subject and object is dynamic. In every action subject and object are fused. Knowledge, at its origin, neither arises from an object nor from a subject. It emerges from the interactions between the two.

The natural consequence of the interaction between subject and object is *construction*. Since knowledge originates in such interaction it implies two types of activity: (a) coordination of actions, and (b) introduction of interrelations between objects. These two activities are interdependent because it is only through action that these relations emerge. Therefore, objective knowledge is always subordinate to certain structures of action. But these structures are result of *construction* and are not given in the objects. The structures are dependent neither upon actions, nor on the subject. These are result of coordination of actions.

A psychological research on development of cognition is not possible without evolving an implicit epistemology. Such an epistemology has to be essentially an epistemology of the developmental process. Development of cognitive structures not only involve physical experience and empirical information but are also controlled by maturation and voluntary exercise and what is more important by continuous and active auto-regulation. The main point in Piaget's theory of development is to consider activities of subject in epistemological sense which has a deep biological meaning. The living organism is not a mere image of properties of its environment. It evolves a structure which is constructed step by step during the process of its development.

The process through which earliest structures are developed continues throughout the process of development. Therefore, there is no theoretical discontinuity in the thinking as it appears in children and in the highly abstract and scientific thinking of adults. The genesis of development is the genesis of knowledge.

Assimilation and Accommodation

Development cannot be reduced to empirical associations. It consists of biological as well as intellectual assimilation. At biological level assimilation is integration of external elements into an evolving or completed structure of an organism. The process of digestion and assimilation of food in an organism is a good example. Assimilation assumes an organism (or digestive system in the above example) to be there. This general concept of assimilation also applies to behaviour. No behaviour, even if it is new to the individual constitute a beginning. It is always built upon previous schemes and therefore amounts to assimilating new elements to the already constructed structures such as innate reflexes or previously acquired structures. The process of assimilation can be represented in the following symbolic form:

$$(T+I) \longrightarrow AT+E$$

T is the organism. I is substance or energy which is assimilated into the organism. This process of assimilation results into AT which is the organism and something more, and this is signified by A which is a coefficient greater than 1 and it indicates addition of material or energy or efficiency of an operation. E is eliminated substance or energy.

This conceptualzation is quite different from the famous

$$S \rightarrow R$$

theory of behaviourists. Piaget insists on

$$S \leftrightarrow R$$

or to be more elaborate

$$S \rightarrow (AT) \rightarrow R$$

where AT is assimilation of S to the structure T.

Assimilation is never present without its counterpart, that is, accommodation. Accommodation is modification of assimilatory structure by the elements it assimilates. In the above example of digestive process, a change in the chemical structure of a specific food prior to its being assimilated into an organism would be an example of accommodation. An infant who assimilates his thumb into his sucking scheme, when sucking his thumb, will make different movements from those he uses when sucking his mother's breast. Thus thumb is accommodated into his assimilatory scheme.

Accommodation needs assimilation and assimilation requires accommodation. At biological level, for instance during embryologic development, a phenotype assimilates the elements which are necessary for the conservation of its structure as specified by its genotype. Cognitive adaptation, just like adaptation at biological level, is an equilibrium between assimilation and accommodation.

There is no assimilation without accommodation and similarly accommodation does not exist without simultaneous assimilation.

Although assimilation and accommodation are present in all the activities, their ratio may vary. Only a more or less stable equilibrium between the two characterizes a complete act of intelligence. In the development of intelligence in children there are different types of equilibrium between assimilation and accommodation. The equilibrium varies with the levels of development and the problems to be solved. In the initial sensory-motor stage of development, there is too much assimilation without adequate accommodation. This results into subjects remaining centred into his own actions and viewpoints. However, with increasing capacity to accommodate assimilations, a successive equilibrium leads to decentration which makes it possible for the child to take viewpoints of others and that of objects. The progressive equilibrium between assimilation and accommodation is the fundamental explanation of the process of cognitive development.

With the above account of Piaget's theory, one can discern that it primarily deals with with structure rather than content. Piaget is interested with *how* the minds works rather than with *what* it does. It is concerned more with understanding than with prediction and control of behaviour. Piaget conceives intellectual development as a continued process of organization and reorganization of structure. Every new organization is based upon the existing organization and therefore contains certain elements of previous organization. Although this process is continuous it goes through certain characteristic structure which attain a relatively stable equilibrium at a particular sequences of development. Bybee and Sund (1982, p.36) has summarised basic Piagetian concepts into the following:

- Intelligence is the ability to organize and adapt to the environment.

- Cognitive functions of organization and adaptation contribute to the development of the cognitive structure.

- Cognitive functions do not vary with the development.

- A set of cognitive structures at a relative equilibrium is a stage.

- Each stage integrates the cognitive structures from the previous stage into a new higher order structure.

The Concept of Stages

Piaget's concept of cognitive development stages is an integral part of his theory. This concept implies several strong positions on the nature of development. (a) Stage sequence is invariant; (b) Growth is divided into qualitatively different periods; (c) Stages refer to certain general characteristics; (d) All stages represent hierarchic integrations; and (e) Stages unfold in the same sequence irrespective of cultural variations.

According to Piaget the culmination of development of human intellect is its ability of logico-mathematical thinking which emerges at the final stage of development called formal operational thinking. However, the structures required for this mature thinking depend upon many structures developed in earlier periods of development. The development of cognition is primarily distributed into three stages: sensori-motor, concrete operational and formal operational. However, there are many periods which characterize preparation, attainment and maturity of these stages. Concrete operational stage particularly goes through a longer period of preparation which is generally called pre-operational period.

Stages of Cognitive Development

Before attempting a short description of cognitive development stages it would be pertinent to point out that although Piaget followed a convention of quoting exact age of children, association of an age with a stage is always approximate and on the average. The question of *ages and stages*, which remained a misconception in the literature on Paiget for a long time, will be taken up later. As pointed out above, since all stages represent hierarchical integration, description of any stage is not complete without refering to its preceding stage. However, for the sake of brevity, as far as possible this has been avoided.

Sensory-Motor Stage

This stage is called sensory-motor because at this stage child interacts with his environment through her* senses and motor

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* In order to create some balance between sexes, a child is being assumed to be a girl child.

movements. Certain structures in a new born human child are already there. At the behavioural level, reflexes are example of these innate structures. Those structures which are characteristic of sensori-motor period are built upon reflexes. As a child encounters the environment, she slowly begins assimilation-accommodation process. She attends senses stimuli (sensori reactions) and responds to them by moving her muscles (motor actions). A typical example is organization of grasping ability. For instance, a child of two months may see a rattle and become aware of its existence. She tries to reach it but without much success. However, with repeated efforts her muscular coordination is improved and she is able to reach to the object. With the grasping reflex being already there, she grasps the rattle. With repeated interaction with this physical object in her environment she adapts techniques to better organise her muscular actions so that she is able to grasp any physical object in her surroundings with first attempt. In this way she slowly begins to organize her grasping abilities. Now she has built a basic schemata for her mind. This is development of intelligence through physical activity. Sensori-motor development stage is divided into six periods (Piaget,1961, 1972a, 1976b).

Stage 1 (0-1 month). Innate reflexes begin to function. Initially these reflexes are purely functional but soon these start being used for non-functional purposes, that is, exercising of reflexes. For instance sucking objects other than nipples provide an environmental experience to the child which are not directly related to her biological survival. In this experience the oral cavity is able to adapt a non-nipple object. This exercise of reflexes strengthens the initial schemes and prepare these schemes for later consolidation. At this stage the child does not differentiate between self and objects.

Stage 2 (1-4 months). Primary circular (repetitive) reactions which are related to child's body develop during this period. Such reaction are non-purpose and are repeated for their own sake. Although repetitive reactions lead to habit formation but these are ends in themselves. Since these reactions are not aimed at some goal these are not complete acts of intelligence.

Stage 3 (4-8 months). This is the period for development of secondary circular reactions. Now, since the scheme of reaching and grasping is there, the child starts to pull objects towards her. These are secondary reactions because instead of depending upon innate reflexes, these depend upon coordination of earlier schemes. Now the action are not repeated for their own sake, these are aimed at creating something interesting. For instance, a rattle is hit again and again to hear it sound. There is a greater input from the environment during this period. In certain situation the child uses old actions to achieve new ends. Hitting an object, which is not a rattle, to hear its sound is one such example. Such behaviour indicates that the child is about to show an intelligent behaviour.

Stage 4 (8-12 months). This period is characterized by practical intelligence. In order to achieve a goal, new coordination of schemes are established. Problems are solved by application of existing schemes to new situations. An object continues to exist for a child even when it is hidden from his sight.

Stage 5 (12-18 months). The child starts exploring the environment by making directed movement toward certain object with apparent aim of reaching out for these objects. These are called tertiary circular reactions because these allow the child to create new behaviour patterns in order to resolve new problems. Now, since child's behaviour is intentional it can be called intelligent behaviour. The child is systematically able to adapt schemes of actions in order to achieve some purpose. An object continues to be there even when it appears different due to its distance from the child. Towards the end of this period the child is beginning to represent objects mentally. However, even roots of representation are sensori-motor because child can imitate certain actions before availability of any linguistic tools for representation.

Stage 6 (18-24 months). The child can now use words to refer to objects which are not present in the immediate surroundings. She can also refer to her actions which are not taking place here and now. On confronting a problem, instead of physically acting out she can internalize the problem, that is, think about it before embarking upon a physical solution. She achieves the concept of permanence of objects. Now the objects exist separately from the self and their physical presence need not be there for their existence.

Pre-Operational Stage

As the nomenclature of this stage indicates, it is described negatively. Since child is not yet capable of completing mental operations, it is a pre-operational stage. As mental action – operation – is a central idea in Piaget's theory of intellectual development, prior to the ability of mental operations, the stages of sensori-motor and pre-operational thinking are preparations for an operational stage. Pre-operational stage is generally divided into two periods: pre-conceptual period and intuitive period.

Pre-conceptual Stage. This period approximately corresponds to two to four years of age. The most important aspect of this period is very rapid development of language which plays very significant role in the mediated thought. Child's actions are now mediated by representational thought such as signs, symbols and mental images. She can symbolize and imagine the world. With the use of language she can recall actions and then can imitate these actions, defer them and explain them. In contrast to mature thinking, the child in pre-conceptual stage is incapable of reasoning inductivly or deductivly. Rather she reasons *transductivly*, that is, from *particular to particular*. The child believes that objects or incidences which are togather are causally related. Use of transductive reasoning may sometime lead the child to a correct solution but it is not an indication of logical thinking. The pre-operational child has neither developed the idea of logical necessity nor physical causality. Lack of reversibility in the thought procees is an important distinguishing charactersitic of pre-operational child. Egocentrism continues to be an important aspect of the majority of children at this stage. They assume that all others see things as they do. Objects now have a conserved identity. Child is aware of past, present, and future.

Intuitive Stage. Four to seven years' age is associated with intuitive children. Nevertheless, there is a great deal of overlap between pre-conceptual and intuitive periods. The important difference is this that intuitive child gets more and more intereted in exploring reasons. There are lot of *whys* in this period. She may appear to use logic but in fact her thinking is *infralogical.* She can concentrate upon more than one aspect of a situation but is not yet capable of coordinating the role of these aspects to arrive at a correct solution. Her intuitive answers indicate a partial coordination of actions or patterns of thought that are incomplete mental actions. However these very incomplete operations are precursors of logical explanations expected in the near future. Intuitive children are often not able to diffrenciate between truth, phantasy and realism in their explanations. This is typically the period when most of children in Pakistan start their education in primary schools.

Concrete Operational Stage

This stage of cognitive development of children begins around seven years of age and continues till the age of about eleven years. A majority of Pakistan's primary school children can be expected to be in this stage of their mental development. That is the reason that this stage is being described in a more detail.

The child is not pre-operational any more. She is operational but concrete operational. It is called concrete because children's thinking is restircted to what they encounter through direct experience. They can think about *existing* objects and their properties. They can think about actions which they can perform on and about these objects. This is the stage in which children start distinguishing between the perception and the property of an object. Though not dependent upon perception of an object, their thinking remains limited to the concrete properties of objects. During this period children slowly develop a set of reasoning strategies which signify their ability to perform operations upon concrete objects. The following are some of the important strategies which develop during this period:

One to one correspondence of two sets of objects;

Reversibilty of an operation;

Classification into different ways;

Grouping things into classes and subclasses;

Ordering things in space and time;

Mathematical operations of adding, subtracting, multiplying, dividing, and substituting.

Concrete operational stage is an operational stage albeit concrete operations. At this stage Piaget's emphasis shifts to examining the relations between thinking and symboloic logic. He uses rules of mathematic and logic as models of mental functionong of children. He is convinced that the rules of logic have developed out of interactions of humans – interactions which emerge in the practical day to day living in a law abiding universe. This stage is characterized by the properties of *groupings* of *concrete operations*. The actions which were originaly overt (sensori-motor stage), and then interalized (pre-operational stage) now begin to form a tightly organized system of action.

A grouping combines attributes of both the *group* and the *lattice*. A group is a system that consists of a set of elements and an operation on these elements such as identity, reversibility, composition, or associativity. In the terminology of logic, it is called INRC group: I for indentity, N for negation, R for reciprocity, and C for correlativity.

Lattice is a structure consisting of a set of elements and a relation that encompass two or more of these elements. This relation must be specifically such that two elements have one least upper bound and one greatest lower bound.

Groupings include both groups and lattices. There are nine distinct groupings which appear during concrete operational stage of development.

Attainment of conservation, seriation and classification are the developmental hallmark of concrete operational stage. It gives the child an understanding that quantitative relationships between material remain the same even though the material has undergone a perceptual alteration. This consevation evolves relatively slowly.

Seriation is child's ability to order a group of objects using a property common to all the objects. Although a pre-operational child can classify objects into one dimensitional categories but it is not true classification. A concrete operational child develops capability not only to manage muti-dimensional classification but also can handle class inclusion, which is, ability to understand that a class can exist within another more comprehensive class.

Formal Operational Stage

The final stage of cognitive development is characterized by the attainment of intellectual accomplishment of an intelligent human adult by an adolescent (Bybee & Sund, 1982, Ginsberg & Opper, 1988, Inhelder & Piaget, 1972, Piaget & Inhelder, 1969, Phillips, 1989). This stage starts at about eleven years of age but the achievement of its high point is one of the controversies in Piagetian literature. Nevertheless, Piaget thought that adolescents at about fifteen years of age become formal operational thinkers.

Piaget invoked logic to describe the maturity of human thinking because he believed that logic is the mirror of thought and not the vice versa. The word *formal* comes from *formal logic* which deals with the *form* of an argument, which is the constituent or the essence of that argument, rather than its content or matter. This stage is called formal because the child is not any more dependent upon the content of an operation, she can now handle its *form*. The beginning of this stage is built upon the mastery of those problems with which the child was struggling during her concrete operational period, such as, conservation and proportionality. In this stage an adolescent frees herself from the concrete and succeeds in locating reality within a group of possible transformations. This transformation of thought permits handling of hypotheses and reasoning with regard to propositions removed from concrete and present observations. Formal operational structures constitute a natural culmination of sensori-motor structures and of the groupings of the concrete operations. In formal operational thinking a person, by the means of differentiation of the form and content becomes capable of reasoning correctly about those propositions she herself does not believe. She considers these propositions as hypotheses until these are proved or disproved. Such a thinking exhibited by an adolescent at this stage is comparable to propositional logic. Piaget describe these patterns as sixteen binary operations. Formal operational thinker becomes capable of drawing the necessary conclusions from those truths which are merely possible. This constitute the beginning of hypothetico-deductive or formal thought.

With the liberation from the content, it becomes possible to establish any relations or classes that are required. This generalization of the operations of classification and relations of order (seriation) culminates in a combinatorial system. This is also called operations upon operations.

Critique of Paiget's Theory and Research

One significant contribution of a scientific theory can be generation of scientific research. Piagetian theory has been exceedingly successful on this account. In the contemporary psychological research on child development, educational psychology and developmental psychology, most of the work, directly or indirectly, refers to Piaget. However, as pointed out by Pinard and Laurendeau (1969) the nature of Piaget's system is such that it invites one to take up extreme attitude of acceptance or rejection. The magnitude and the dimensions of Piaget's work are so overwhelming that one either tends to totally concede to it or repudiate it. In order to undertake a critique of Piaget, the first question is, "Critique of what?" Critique of Piaget the biologist, Piaget the psychologist, or Piaget the philosopher. Piaget himself preferred to be treated as a genetic epistemologist. Nevertheless, genetic epistemology itself, a hybrid discipline which Piaget tried to establish, defies a proper categorisation among the established systems of knowledge. Therefore, one problem is selection of a paradigm for making a critical evaluation of Piaget. In the context of criticism on Piaget's contribution, Vuyk (1981) talks about intra-paradigm critique and inter-paradigm critique. While a meaningful intra-paradigm debate is possible, inter-paradigm dialogue continues to be a difficult proposition. Nevertheless, a part of Piaget's critique comes from, for instance, logicians criticising his theory of child development and psychologists finding faults on his position about theories of evolution. One important review of Piaget's work (Modgil & Modgil, 1982) is divided into ten "disciplines", and psychology is just one of these. While Piaget has been called *a one-man interdisciplinary team* (Vuyk, 1981), his criticism comes from perspectives of distinct disciplines and not essentially from an interdisciplinary or multidisciplinary stand point.

One problem in evaluating Piaget's theory is his own attitude towards his theory.

> "Piaget himself has modestly claimed that he has "...laid bare a more or less evident general skeleton which remains full of gaps so that when these will be filled the articulation will have to be differentiated, but the general lines of the system will not be changed. (Sinclaire de Zwart, 1977,p.1)"... That the theory will be open-ended and tentative and subject to revisions, is, in part, a validation of it as a developmental theory which is developing" (Modgil & Modgil, 1982. p.1).

"Piaget is often said to be the most criticized author of our time and considering his output, his long life and the scarcity of psychological theories this in not astonishing" (Vuyk, 1981, p. 276).

Rita Vuyk's (1981) two volume overview and critique of Piaget's work is a bold attempt to assemble a presentation and critique of almost all aspects of Piaget's contribution. The nature of this effort can be judged from Paiget's comment to Vuyk about it: "I admire your courage." Many aspects of criticism of Piaget has been presented in form of curt statement. Although many of these statements have not been substantiated by the theoretical argument or an empirical evidence, these represent general lines of discussion. Therefore, these statements can be considered as a good overview of critique of Piaget's work.

At the highest conceptual level, Piaget's assertion that speculative philosophy, without active interaction with science cannot lead to truth has been criticised on the ground that Piaget's view of philosophy is rather outdated and narrow. For instance, he has not considered the position of dialectical materialism which, by adhering to rational abstraction, does not remain just speculative. Piaget has also been criticized that, despite his disdain for speculative philosophy, many of his biological concerns touches upon *abstract* philosophical questions. Despite calling epistemology genetic, it remains an epistemology. His attempt to bridge the gap between psychology of learning and philosophy of epistemology is not tenable. At the epistemological level Piaget's theory is so general that it is not falsifiable. For those questions which falls within the classical domain of philosophy Piaget has tried to invoke biology, which cannot answer *philosophical* questions.

Mathematicians and physicists believe that the child's cognitive development has no relevance for the understanding of development of mathematics and scientific thinking and vice versa. Similarly Piaget's attempt to use logic in his effort to understand children's thinking is misguided. There are basic differences between logic and natural thinking. Piaget's position that the origin of concept of number develops from classification and seriation has been challenged. Psycholingiustic have severely reacted to Piaget's undermining of the role of language in the development of thinking. They say that thinking is more strongly influenced by language and social and cultural frame within which it takes place than what Piaget's *logic* claims.

It is often criticised that while considering behaviourism and associationism, Piaget has adopted a negatively idealized conception of these schools of psychology which truly do not exist, at least not any more. Piaget appears to be if not ignorant, at least unmindful of recent developments in learning theory and more so in cognitive psychology, information processing and psychology of thinking.

About the use of logic for explaining cognitive development, logicians often insist that Piaget developed his own *psycho-logic*, which is not good logic. Groupings are poor and inelegant structures, these are trivial and probably contradictory.

The most of above lines of criticism can be called inter-paradigm. Within the field of psychology, Piaget's critics seems to adopt three basic attitudes. One attitude is total rejection of Piaget's theory and research. However, this rejection is based upon contradictory research findings on certain specific aspects of Piaget's work. For instance, lot of evidence appears to assert that certain cognitive structure emerge in children at an age different than what Piaget assumed or quoted. The order of appearance of certain concepts is another favourite topic. Many workers have found this order different from what Piaget reported. This line of work, often tend to ignore that Piaget was primarily interested in what are the common and general features of development. He never addressed the problem of individual differences in the development of children. A host of critique comes from methodological point of view. The main-stream psychometric tradition has obvious objections to the critical method of Piaget, which in their opinion is neither *objective* nor standardised. Piaget's insistence on a good reason rather than a correct answer is not tenable for most of the adherents of *objective* psychological testing and measurement. The overall argument of these *anti*-Piagetian workers is this that since there are so many shortcomings in different aspects of Paiget's theory and research, there is sufficient reason to reject it in total.

The second attitude in psychological research can be ascribed to what is now being called neo-Piagetian work. This group of workers, while agreeing to fundamental framework of Piaget, tend to either extend it or fill certain gaps gound in it.

The third type of attitude in criticism comes from the *Piagetians*, the hard core of which is represented by what is called Genevans or Piagetian School of Geneva. These *loyalists*, while agreeing with Piaget that his theory is neither complete nor final, are continuing to undertake further research in various areas of Piaget's concerns. Piaget has left a long agenda of work at the Faculty of Psychology and Sciences of Education, University of Geneva and at the International Centre of Genetic Epistemology to keep researchers busy for many decades.

At the present state of research and synthesis of knowledge, it is not possible to pass a categorical judgment about Piaget's contributions. Nevertheless, one thing is certain: Piaget has been successful not only in asking right questions but has also pointed out new avenues of psychological research.

The specific problems in Piagetian theory and research related to present line of work will be discussed in a later section.

Statement of the Problem

The present situation of Pakistani child, as described in the introductory sections, is detrimental for the future of Pakistan. Children need better nutrition, better health care, better living conditions, and better attitudes of parents and society. All of these exigencies need fundamental social and economic change. Psychology can play some role in almost every aspect of social and economic change. However, one area in which the science of psychology can contribute more effectively is education of children. Where ever there is a school, with the support of their parents, a large number of children do go to schools. Their own and their parents' desire for education is evident from the fact that in almost all schools of Pakistan class one is inflated with children. However, within the first year of child's stay in the school something goes wrong and a large number of them drop out from the school. Who are these children? What do they do in schools? What do teachers do to them in schools?

Primary school going age is a very important phase in the emotional and mental development of a child. School has every potential to provide stimulating psychological experiences which can be very conducive for healthy growth of a child. Pakistani schools are waiting for the arrival of Pakistani psychologists who could see these schools and these children and make some contribution towards their betterment.

Many parents who, despite their meagre financial resources and not being certain about the utility of education, send their children to schools, expect that their child will become literate (*parh likh ja'i ga*). The conception of minimum education for a child is *passing* the primary school. Then what happens to the children that more than 50% of these leave school without passing five classes of primary schools. This required a psychological investigation. Many studies on drop-outs tend to associate economic and cultural factors with this problem. These factors are important in their own right. Nevertheless, a psychological investigation on drop out needs to adopt a different viewpoint. It was felt that selection of cognitive development model for understanding primary education in Pakistan is a sound strategy. This model essentially focused upon child as the central character in the process of education. Piagetian psychology provided a fairly good framework for looking into primary school education because (a) it considered the child to be an active agent in the process of education, (b) education is viewed within the context of overall development of the child.

Therefore, the first task was a careful look at the primary school children. As the most distinguishing feature of human child is development of cognition, a psychological study of Pakistani child was planned as a study of his cognitive abilities. This required a comprehensive survey of cognitive development of Pakistani children. Schools are significant part of child's environment. An understanding of mental development of children and its relevance to the school can be very helpful in comprehending the role which a school can play in creating a harmony between the child and his educational experience. Only such a harmony can make the school education useful and interesting for the child and thus make him stay in the school.

Piagetian tradition of research is characterised by critical method, consisting of detailed individual interviews aimed at discovering cognitive structures in thinking of children. This method proved very suitable for the purpose for which it was evolved. However, a larger survey required a method which, while keeping all the advantages of critical method intact, was able to collect data on a large sample by a team of field investigators.

In the light of Piagetian literature about *age and stages*, it was assumed that majority of primary school children in Pakistan would be in the concrete operational stage of thinking. However, some children in earlier classes were expected to be pre-operational and it was also anticipated that some children on the higher end of ages and abilities would be formal operational thinkers. Therefore, a set of Piagetian interview protocols, called *tasks* were required that could assess children at all these levels of cognitive development.

With Pakistani children being the focus of attention, it was decided to select a sample which could be representative of Pakistani children: girls and boys, rural and urban children and children representing all the provinces of Pakistan. Primary schools also meant various classes in these schools. A coverage of all of these categories of children required a sample of a size which is generally not attempted in Piagetian research.

The large developmental survey of primary school children of Pakistan lead to investigations into some theoretical aspects of

Piagetian psychology. While the existing state of Piagetian theory warranted a survey of the type planned, the data collected from it was used to address two issues in Piagetian theory: (a) an investigation of psychometric characteristics of tasks used for assessment of developmental levels of children and, (b) an evaluation of the status of concrete operational thought as a psychological construct in the light of empirical data collected in the survey.

Although there has been a vigorous non-theoretical, even anti-theoretical trend in psychology, realization for need of a theory has also not been lacking. Pure empiricism has its own place in scientific pursuits but facts often do not yield to meaningful relations unless they are seen in some inferentially derived propositions or theories. Theories, on their own right are among the most elegant products of human mind but they also play a useful function of being an aid in directing empirical research. All theories assume specific meanings for certain ideas, processes or objects. Theories cannot adopt meaningfulness unless they are using their own concepts. Concepts within theoretical frameworks perform more specific function and are called constructs. A construct is name of a class which refers to certain abstracted properties of the class. It is a generalized term because it is intended to apply to all cases showing the referant properties. It is a symbol because it stands for and represent something else than what is assumed by the common meaning of it. (Marx, 1964). Concrete operational thought is a construct because Piaget has used it in a specific meaning to refer to a specific quality of thought process in a particular stage of cognitive development of children.

The assessment of the structure of concrete operational though relates to some aspects of "pure" research in the theory of cognitive development. This was, in fact, in line with the Piagetian tradition of reducing the barrier between pure and applied research.

With a knowledge about tenability of Piagetian tasks for assessment of cognitive levels of primary school children, and credibility of concrete operational thought as a psychological construct, the results of cognitive development levels of Pakistani primary school children provided sufficient ground to look at the educational processes in the the schools. This demanded further investigations into the cognitive levels of school children as an independent variable resulting into drop out. It was also found promising to look into the classrooms and textbooks to relate these with the cognitive levels of children and search for a possible lack of concordance between the mental levels of children and what is being provided to them as educational experiences.

History of a Research Project

A research project sponsored by the Federal Ministry of Education with an international assistance component of the United Nations Development Programme provided basic financial support to the survey of cognitive development levels of primary school children of Pakistan. The history of this project provides an important background for understanding the problems of social sciences research in Pakistan.

When the proposal of this project was presented to the government, it was only an act of faith in Piagetian theory that such a work would be useful. There was no background or technical know-how of Piagetian research in Pakistan at that time. The normal and logical sequence should have been to acquire education and training in this area of psychology, get a team of workers trained in critical method, develop and test psychological instruments, prepare a well thought-out research design and then embark upon the study. However, this rational sequence would have not made the present work possible. In the main stream education of psychology in Pakistan, cognitive development or Piagetian psychology is at the best just mentioned. Familiarity of Pakistani psychologists with Piaget is expressed in as a joke that in some workshops conducted by National Institute of Psychology about cognitive development, many psychologists are surprised to know that *Jean* (rhymed as *seen*) Piaget is not a woman. Despite this situation the first decision was to to go ahead – without much know-how and without any training in critical method. The steps undertaken were: talking to children in schools and thus having some inklings of Piagetian notions; assembling of a task battery; self training of the research team; two pilot studies which indicated some coherence of the method and the task battery; pilot studies leading to a decision on a the sampling design and final selection of tasks; developmental survey; analysis of the task battery as a psychometric instrument; analysis of the construct of concrete operational thought; selection of a sub sample on the basis of its cognitive levels and investigation of their drop out status; and analysis of classroom practices and textbooks. This sequence would not appear as a good practice in planning a research study. However, as the things continue to be in Pakistan the only planning possible is trying to keep on correcting the course while drifting right in the middle of a stream. Nevertheless, one can hope that better research traditions will emerge after some starts are taken – how ever shaky or false these starts may be. The only other possibility is to just wait for a miracle which may bring better times.

As this study did not follow a conventional sequence of planning and work, which is generally expected in most of research studies, this section has been limited to just mentioning the problems. These problems will be stated in greater detail in the following sections.

Chapter 2

METHOD

Selection of Piaget's theory of cognitive development as a model for research on primary school children of Pakistan preempted many choices of sampling design, methodology and reserach procedures. As pointed out earlier, Piaget's contributions have such an element of integration that his theory and method cannot be seperated.

Sampling Design

Piaget the biologist was primarily interested in a good specimen. He was selecting children to study the process of intellectual development. He was not interested in comparing children for finding out differences among them. Therefore, sampling was not an issue in the original Piagetian research. Whenever the size of the sample is mentioned in Piagetian literature it is generally very small. This small size of sample was justified because Piaget's major research concern was cognitive development in an *epistemic child*. He was not interested in finding out developmental *norms* of children. His critical method with a small sample suited his research postulates very well. However, while assuming the basic tenants of Paiget's theory correct, a survey was planned to determine cognitive development levels of primary school children of Pakistan.

A very large survey of cognitive abilities of adolescent was attempted in British middle and secondary schools (Shayer &

Kuchemann, 1976). *Group tasks* were used for this survey. Administration of these tasks proved successful because (a) British teachers were more educated and trained than Pakistani teachers, (b) student were familiar with *science work*, and (c) age group of students was higher than children in Pakistani primary schools. Despite economy in data collection and some claim of semi-standardization, cognitive group tasks were not selected for Pakistani survey because (a) these were not suitable for primary school children and (b) as it was first exploration of Piagetian methodology at this level in Pakistan, it was felt that remaining close to the original method would be more useful. Therefore, the classical critical method of individual interviewing was adopted. This method places a strong limit on the size of sample within the given resources.

After the selection of critical method two choices were available: (a) Select a smaller number of tasks and collect data from a comparatively larger sample of children, or (b) Select more tasks so that a larger amount of cognitive developmental behaviour could be sampled. A compromise was made between the two choices. The final decision resulted into fourteen cognitive development tasks with a sample of 360 children.

Testing of each child on the average took more than two hours of intensive interviewing. This interviewing required so much attention on the part of the experimenter as well as the subject that often it was broken down into several sessions. Even with these constraints of method, the sampling size was determined with the following considerations:

1. The smallest size of a sample cell is large enough to compare children of two cells. Therefore the cell size was determined to be ten children.

2. The sample covers all the four provinces of Pakistan.

3. Selected schools in the provinces are representative of the largest segment of population in that province.

4. One important dichotomy in Pakistani population, i.e., urban and rural, is taken into account.

5. The sample includes boys and girls.

6. The selection of children from a school is representative of children in that school.

7. There are matching sized cells for comparison of boys and girls and urban and rural children. Similarly, three provinces could be compared in rural population and three could be compared in urban population.

The selection of a sample was also based upon findings of a pilot study (Pervez, 1980) which indicated that differences between cognitive levels of children in all the five classes of primary schools were not large enough to justify inclusion of all these in the sample. The results of the pilot study were not categorical about gender and urban and rural differences in cognitive abilities of children. However, social, economic, cultural and ecological differences in these variables seemed so important in Pakistani society that it was decided to include equal number of boys and girls and urban and rural children in the sample.

Table 2.1 shows the sample.

Table 2.1
Sampling Design for Study of Cognitive Development in Primary School Children in Pakistan

Province	*Rural/Urban*	*Gender*	*Classes*			*Total*
			I	*III*	*V*	
Punjab	Rural	Girls	10	10	10	30
		Boys	10	10	10	30
	Urban	Girls	10	10	10	30
		Boys	10	10	10	30
NWFP	Rural	Girls	10	10	10	30
		Boys	10	10	10	30
	Urban	Girls	10	10	10	30
		Boys	10	10	10	30
Sindh	Urban	Girls	10	10	10	30
		Boys	10	10	10	30
Balochistan	Rural	Girls	10	10	10	30
		Boys	10	10	10	30
			120	120	120	360

Selection of Communities

Six communities from four provinces of Pakistan were selected for the survey of cognitive development levels of primary school children. It was decided to select rural as well as urban communities from the provinces of Punjab and North Western Frontier Province (NWFP). While, as Sindh has a heavy concentration of urban population, it was decided to select only an urban community from this province. On the other hand only a rural community was selected from Balochistan as this province has a very high ratio of rural population. In Punjab, a village in Faisalabad district was selected to represent rural Punjab. Gujranwala city was selected to represent urban Punjab. In NWFP, the choice of city fell to Peshawar while a village in Charsada district represented rural NWFP. In Sindh, Hyderabad city was selected to represent urban Sindh and a village near Quetta was selected to represent rural Balochistan. These decesions were made on the consideration of representative character of each community in its own province.

Selection of Schools

In order to select schools from various communities in different provinces the following considerations were observed:

1. Girls' and boys' schools were selected from the same community.

2. Very large cities (Karachi, Lahore) were avoided because they presented peculiar cosmopolitan

characteristics of life, and these characteristics were not typical of the majority of cities of Pakistan.

3. Rural area was defined as a village, characterized by a dominant majority of *kacha* (made of mud walls) houses. Its population's economic subsistence was on agricultural activity, its was unconnected to a highway and had no electricity.

4. From each community (a city or a village), a school was selected which was considered a representative of majority of schools in that community.

However, in some cases all the above conditions could not be fulfilled. For instance, for rural sample in Balochistan, no village school was large enough to obtain a sample of ten class 5 girls. Therefore, class 5 girls' sample was drawn from schools of two villages.

Selection of Children in Schools

It was decided to select children from class 1, 3, and 5 randomly. In some schools there were more than one sections in each class. Therefore, first, one section was randomly selected from more than one sections. In all the classes the class attendance registers were used for sampling purposes. Total number of names in a register of each section were divided by ten and the resultant number was used as the sample number. For example, in a class of sixty students the sample number was six so each sixth student was chosen for the sample.

Description of Sample Characteristics

In order to obtain some background information about those primary school children whose cognitive development abilities were investigated, some additional data was also collected. Some of this data, which pertains to socio-cultural and educational variables can lead to a different line of research. Some information which is related to this study is described below.

Ages of Children

Determining correct ages of Pakistani primary school children is full of difficulties (Pervez, 1980). These difficulties were verified during the survey of cognitive abilities. In the village Kang-Kalan of the Faisalabad district, records of the village record-keeper were extensively probed. The record-keeper is basically the *chowkidar* (guard) of the village, and is traditionally responsible for keeping record of deaths and births in the village. The *chowkidar* of this village was totally illiterate and said that though he was supposed to keep the record but was unable to do so because he had no *register* for making such entries. Moreover, whenever *register* was provided he had to ask someone else to put entries in the register because he himself could not read or write.

It was assumed that in the city schools, records of children's dates of birth will be better. In order to check this assumption, records of a boys' school in Gujranwala city were scrutinized. On the first instance, the headmaster said that each child coming for admission was asked to provide a Date of Birth Certificate. This certificate is issued by Municipal authorities on the basis of their records of births and deaths. However, in those cases, where due to one reason or other, the parents are not able to provide a certificate, they are asked to produce an affidavit about the accuracy of the date of birth of their child. This affidavit is nothing but statement of the parents that to the best of their knowledge such and such is the correct date of birth. In real practice the affidavit does not carry any authenticity but merely costs about ten rupees which includes the fee of *Oath Commissioner.*

The headmaster of Gujranwala boys' school claimed that they did not admit any child in the school without a Birth Certificate. However, when the school record was checked, in a file containing 86 cases of admissions, there were only 14 birth certificates issued by municipal authorities. All the rest of the admissions were based upon affidavits.

Age Records

Taking the first day of visit to the school as the base, ages in years and months were determined from the recorded dates of births.

Table 2.2
Recorded Ages of Children in Sample (N:360).

	Number of Children in Classes		
Age in Years	1	3	5
5	2	0	0
6	15	0	0
7	41	0	0
8	30	12	0
9	22	35	0
10	8	27	17
11	2	26	29
12	0	20	31
13	0	5	23
14	0	0	12
15	0	0	8

As it is obvious from Table 2.2, age-ranges in all the three classes are fairly wide and average or modal age is not a good estimate. Figure 2.1 presents the situation of ages in graphic form and shows the extent of overlap of ages in three classes of primary schools.

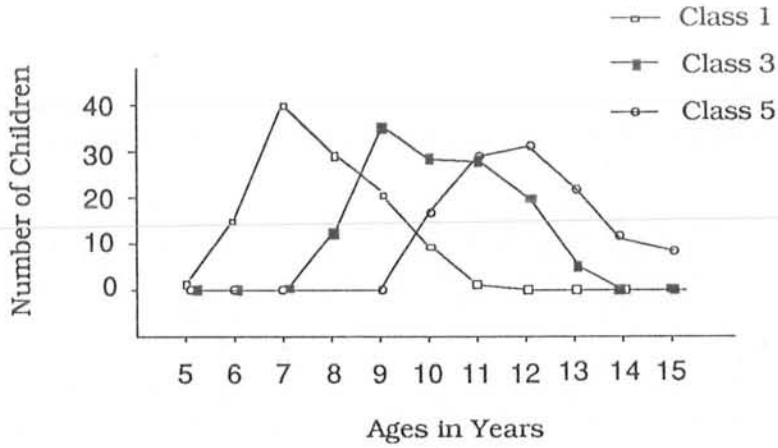


Figure 2.1. Ages of children in Class 1, 3, and 5.

Description of the Communities and the Schools*

In all the six communities selected for cognitive survey a stay for about ten days was made in each community. During this stay the the community centres were visited for interacting with the people. These interaction sessions were usually arranged in the evening. These sessions generally provided an opportunity to have a close look at the customs and habits of the people. The following descriptions are based upon direct observations. These are included to provide a socio-economic and cultural background to the sample of children.

Punjab Rural: Kang-Kalan

Situated at about 18 Kilometres from the city of Faisalabad, the village of Kang Kalan was selected to represent rural children of Punjab. The main reason for picking this village was that it was even

* I acknowledge the assistance of Mohammad Israr, a member of research team, who partly prepared these description.

without electricity, metalled roads, or much of what perhaps can be called as the effects of urbanization. Since the objective was to assess the difference (if any) in cognitive abilities of rural and urban Pakistani children, this place considered to be a typical village, was by every means one of the most desirable localities to attempt any such evaluation.

Kang-Kalan population had a variety of occupations in its population. One could find here the agriculturalists, potters, blacksmiths, small shop keepers, barbers, etc. A full spectrum of socio-economic and cultural life of a Punjabi rural area could be seen in Kang-Kalan.

The school going children had a good mix of socio-economic background of the village. They played, mixed up and developed friendships without any apparent socio-economic barrier.

Literacy rate of Kang Kalan (having only two primary schools - one for boys and the other for girls) appeared to be low. This low literacy rate was mainly due to the fact that the village was far from the city and did not have many facilities. It was told that the people in village usually put children to work the moment they grew old enough to help in cultivation. Poverty was thought to be one of the major causes of low literacy rate in the village.

Government Primary School for Boys, Kang-Kalan. The school was situated near the village on the side of an irrigation canal. The building comprised of four rooms and a big enclosure. The school building was surrounded by tall trees. In summer, classes were held in the shades of these trees.

The teachers (four in number) were highly cooperative to each other and had great awareness of their social and educational problems. When interviewed, they put forth valuable suggestions. The teachers were under-matriculate and only one had P.T.C. training.

The teachers knew all their students by name and their socio-economic background as well. They helped to a great extent in obtaining the basic information about children. The teachers and children looked like good friends and such a cordial atmosphere in the school was not experienced in any other school visited during the entire field work. Children played different games during the recess. Most of the children worked in the field after school time. Children were absorbed in the economy of the village, which added in the rate of dropout in that area. There were about 175 pupils in the school.

Government Primary School for Girls, Kang-Kalan. The Girls' school in the village Kang-Kalan consisted of two small rooms, which were in a depleted conditions, a veranda like place and a big enclosure. During winter, children sat under the sun while in summer the veranda was used to sit. The building for school was provided by Government. There was no furniture for the children. Moreover, they had no electricity and water facilities. The total number of pupils was about ninety, the maximum being in class 1, i.e., twenty-five. In class 5, this number came to ten. Teaching staff consisted of two teachers, one of them also acted as headmistress. Classes were evenly distributed between these two teachers. Academic qualification of teachers was matriculation with P.T.C. training. One teacher belonged to the same village while the other came from a neighbouring village. As compared with other places visited, teachers here were hardworking and seemed concerned with academic affairs of students, e.g., they, on their own had prepared alphabet and a number of other cards for class 1 and regularly used this material. They were friendly with the children. Children had games daily. They also had games competition with schools of neighbouring villages. Majority of children belonged to the families of peasants and ordinary labourers working on daily wages. Some mothers and girls were engaged in rug weaving. On the whole, they belonged to lower middle class.

Punjab Urban: Gujranwala

Urban children in Punjab were selected from Gujranwala. It is among the main cities of Pakistan. Because of nearness to Lahore there is not much attraction in this city. Most of the people seek their employment in Lahore. Gujranwala is linked with Lahore by a newly constructed highway which takes just one hour or so to one city from the other. Roughly the city can be divided into four parts; old city, new city, Model Town , and Cantonment.

Railway Station, bus stops and business centres are located in the old city. This area is very congested. No proper sanitary system is maintained. There are a few old hotels and restaurants. The new city lies to the left of the main road and is mostly occupied by residential quarters and bungalows. The school for the study was selected from this locality.

Government Primary School for Boys, Gujranwala. The school was situated in the new city, rather away from the noise of business centres and traffic. The school building was a hired private house. The building comprised of two stories. There were seven small rooms with electric fans but no furniture. The headmaster and other five teachers were under-matriculation with P.T.C. training. The headmaster was an old gentleman, who took very little interest in the school affairs. The rest of the teachers were hardworking and cooperative.

There was no play-ground in the school and children played in the streets. Outside the school premises was a small old shop, from where children bought eatables of very low quality. Number of the students was about 250.

Government Primary School for Girls, Gujranwala. The school was located slightly away from the main city, in a less congested area of Gujranwala. Building was provided by the Government. The building consisted of five rooms, a veranda and a big lawn. Even then the rooms were not sufficient for the number of pupils. Therefore, some classes used veranda as classroom. School had no seating furniture for the children. The number of students was approximately more than three hundred. The staff consisted of seven teachers. Academic qualification of teachers was Matric and Middle with P.T.C. and J.V.C. The teachers were typical of the majority of teachers in our schools. Tense relationship between the headmistress and teachers was a prominent feature of this school. Majority of children belonged to the families of office workers (clerks, etc.), petty shopkeepers, drivers, labourers and mechanics.

NWFP Rural: Utmanzai

This village is situated 22 miles away from Peshawar at the banks of river Jindey. It is one of the eight villages, which are collectively called *Hashth Nagar*. This part of NWFP is known for its greenery and advanced agriculture system.

Education was common among men and women in this village. Sending girls to schools is considered a shameful act in many parts of rural NWFP. This village was an exception in this regard. Along with schools there was a big *deeny madrassa*, where enrollment of students was very high. The Union Council of the village had constructed many grounds for different games. In the evening the educated people were seen on these grounds, playing foot-ball, volley-ball and other games, while the non-educated people played kabadi for trying their power and muscles. The kabadi matches were usually held between different communities of the village.

There were a few landlords while the rest of the population comprised of ordinary labourers, who worked in the local farms on daily wages. A minor portion of the people were absorbed in different government services. There were two high schools, one for boys and one for girls, two middle schools and three primary schools. Around this village there was a large number of small localities, which sent their children to these schools. That was the reason why these schools were highly populated.

Government Primary School for Boys, Utmanzai. The school was situated on the road side in the main bazar. A private building was hired for the school. There were two big halls, which were divided into two portions with half raised walls. The noises of one class was heard in the next class, making it impossible to teach or learn anything. There were no chairs or desks in the class room for children. In each class room one old, shaky chair was seen, which was used by the teacher. There was no office for headmaster. The headmaster and his five teachers had very low academic qualifications. They were all J.V.C. Teachers. They had no interest in education, most of them had side business and spent most of their time in their personal businesses.

There were no grounds for children to play. In intervals children were seen in the main bazar playing on the roads.

Water and electricity system in the school was not satisfactory. There were no electric fans in the school. And it was a pity to see these small kids studying in the scorching heat of summer and airy cold weather of winter. Water was brought from outside by children. Total strength of students was about 175. Most of the parents of these children were ordinary workers. They worked on daily wages in local farms. Most of the parents of these children were not educated or very low-educated. They had no awareness of children's educational problems. None of them had ever visited the school to ask about their child's performance.

Government Primary School for Girls, Utmanzai. The school was situated outside the village, in a newly constructed building, near Town Committee. The school was surrounded by walls. There were two gates of the school attended by *chowkidars*. Male entrance in the school was strictly forbidden. Wearing *chadars* was compulsory for all girls and even small babies of class I were seen hiding their faces in *chadars*, while coming to schools.

There were five rooms with a small room for headmistress office. All rooms were airy and furnished with glass windows and electric fans. The rooms of class III and class V were provided with benches and desks. In each room there was a blackboard and shelf for keeping registers, records, etc. The school had a big lawn and during recess children played in this lawn. The school had proper water and sanitary system which was properly maintained.

There were four teachers with low academic qualification. The headmistress was F.A. and was a senior teacher. She belonged to a respectable family of the village and therefore, tried to keep proper discipline in the school. There were two peons in the school, one of them was a female. Strength of the students was about 175. Most of the students came from respectable middle class of the village. Higher class of the village sent their children to city's English Medium Schools while lower class could not afford to send their children and especially daughters to schools. Above all, many people had conviction that schooling would spoil the habits of their daughters.

NWFP Urban: Peshawar

The urban community which was selected in NWFP was a newly constructed colony in Peshawar city. The colony was named Gulbahar. This colony was situated in less congested corner of the city. Streets were quite open and cleanliness was properly maintained in the area. There was no main shopping centres around and one felt calm and comfortable in doing one's work. Most of the children spoke Pashto and Hindko. There were parks and play ground for entertainment and games. Most of the people had their own houses. Here lived a business community. They were not old inhabitants but were new comers in the city. Many of them belonged to tribal areas around the city, who had established their business here.

Government Primary School for Boys, Gulbahar. The school was newly constructed and was situated far away from the main road. The school was highly populated and some classes were held outside the rooms. There were only few rooms for students and one office room for headmaster. The teaching staff was low educated and the headmaster was an S.V. teacher. The headmaster was an old man who had been to jails for various reasons. He was a strict person, having very bad relations with the rest of the teachers. He was highly non-cooperative and had to be forced for doing minor things.

Students in the rooms sat on earth, no benches or desks were available to the students. The school had a big playground for children. The rooms were airy and provided with fans. The school had a tube-well for supplying water.

School strength was between 300– 400.

Government Primary School for Girls, Gulbahar. This school was located in a less congested area of the city in a hired private building. Building of the school had little accommodation for the number of pupils enrolled. it comprised of five small rooms and courtyard with no play ground. Students had the facility of water and electricity. Children had rugs to sit on.

Staff consisted of ten teachers. Most of them were Matriculate, P.T.C. and Middle J.V. while one was F.A. The staff had ideally good and healthy relationship among themselves. They, on the whole, seemed to be conscientious and responsible as regards their duties. Number of the students was approximately 175.

Most children belonged to families of office-workers (clerks, dispensers, etc.,) ordinary shop-keepers, and skilled workers.

Sindh Urban: Hyderabad

Hyderabad is the second biggest and highly populated city in Sindh. Since urban and rural populations are almost equal in Sindh, only urban part of the province was selected for data collection.

Government Primary School for Boys, Hyderabad. Ghulam Mohammad Bharghari Government Primary School was situated in Sirrey Ghat, which was a locality quite in the centre of the city. Headed by an experienced teacher, the school staff included a couple of teachers with qualifications not usually found in primary schools of Pakistan. One of these two was an M.A., while the other had a degree in law. The total strength of the teaching staff was fifteen.

About seven hundred students were studying in the five classes of the school. There were ten rooms in the building and one class was taken in the headmaster's office. Students of two sections of two different classes (class 3 and class 5) were taught in one room. Considering factors like these plus the size of the rooms, it was felt that the school was too congested to accommodate such a large number of students adequately. Moreover, there was no play ground of the school and the kids had to go out and roam about during the recess. Since the school building itself was surrounded by other buildings and very narrow and busy roads with a lot of traffic running, the children could not play even out side the school. The school was, however, provided with electricity and a satisfactory system of water supply. They also had desks and benches to sit on in the classrooms.

Regarding the socio-economic background of the students, it could be said that most of them belonged to the middle class families. Two-thirds of them belonged to families with some adequate business of their own or were small shop keepers.

Government Primary School for Girls, Hyderabad. The girls' school selected was located in a highly congested area of Hyderabad in a hired, private building. The building was too small for the large number of students. It comprised of five or six small rooms and a court yard. School was so over-crowded that every inch of ground was occupied by children. Most of the rooms were shared by two sections (so much so that the research team was not able to get any place for testing and had to request the neighbouring school for some room for the purpose). As is apparent, school had no play-ground. The school had the facility of water and electricity. Children had seating benches. Each class was sub-divided in Urdu and Sindhi sections. Total strength of pupils was about three hundred. Staff comprised of ten or eleven teachers. Most of them were Matriculate while few were F.A., and M.A. Majority of children belonged to the families of skilled workers, petty businessmen, labourers and mechanics.

Balochistan Rural: Kechi-Beg and Saryab

These were two small villages, situated a few miles away from the Quetta city. Two villages were selected, because the number of students in each school was less than required for the sample.

Kechi-Beg lied at a distance of eight kilometres from Quetta. All the houses were made of mud, no electricity and water system was there in the village. There were no proper streets, rather narrow and dirty lanes. The village was surrounded by barrani lands and mountains. There was no greenery around and life in the village seemed very dull. There were no apparent activities in the evening. People were, perhaps, taking rest and soothing their weary and tired muscles after the hard work of the day. People were very poor and almost all people of the village consisted of ordinary labourers. Very little contacts were made with the people because of their non-availability.

The other village was called Saryab. Sometime before, there was a huge textile industry here. A small colony was established for the workers of the mill. This industry shifted to somewhere else and the colony was abandoned. A small community now resided in the area. Most of the people were semi-skilled or non-skilled workers.

*Government Primary School for Girls, Kechi-Beg.*A few girl students were selected from the school of this village. There were only two teachers in the school. The school consisted of only two small rooms. The total number of students ranged between fifteen and twenty. There was no water and electricity system in the school. The second village selected was Saryab.

Government Primary School for Boys , Saryab. The school was located on the side of the main road in the open atmosphere. It had six rooms, all with electric fans. Around the school were open fields with no greenery or beauty.

Staff of the school comprised of one headmaster and five teachers. The teachers belonged to different communities: Pathan, Baluchi and Baruhi. Strength of the students was less than 200.

Methodology

The significance of a methodology in research is no less than that of a theory. As a theory determines direction of empirical investigations, methodology also plays a significant role in indicating parameters which become part of an investigation.

Selection of a Methodology

After determining a theoretical framework for this study, the selection of critical method was an obvious choice. The critical method as developed by Piaget over a longer period of time is so significant in his total theoretical framework that it requires a detailed description. In the discussion on sampling design, justification for digressing from the classical mode of critical method was briefly mentioned. However, before pointing out the difference in the classical mode of critical method and the method adopted for this study, a description of critical method would be appropriate.

Critical Method

Piaget's critical method is firmly based upon his conception of the subject matter he is dealing with – human beings, or to be more specific a developing human child. This child is *not* a *subject* in the sense of natural sciences or that tradition of psychology which mechanically followed the methodology of natural science. In this mechanistic psychology, although an individual is called a subject in an experiment, he is in fact treated as an *object*. Piaget's child is not an *object*. He is an *active* child. Child's *activity* is a basic component of Piaget's conception of child. This activity is also called *experience*, physical as well as mental experience. Physical experience consists of actions on objects to discover their properties. Mental experience consists of not only action on objects, but also drawing information, not from the objects themselves but, and that is the significant difference, from the actions applied to them and transforming them. With this conception of child, the child cannot yield to mechanistic model of experimentation. Piaget has a different notion of experiment. Piaget's experiment is a technique of provoking an observation with the intention to study certain phenomenon, *or checking or suggesting an idea.* Critical method was evolved as a result of a need of a method particularly suited to evocation of psychological data. In this scheme of things what is observed as *behaviour* is not a psychological data. This entailed experiments in which the subject participates at least as much as the observer (or experimenter) though in a different way (Pauli, Nathan, & Droz, 1977).

Critical method is means of investigation which consists of a dialogue or conversation, carried out between two persons, the interviewer, generally an adult, and the respondent, usually a child, with the purpose of exploring the child's thinking processes in relationship to certain themes or topics. Since it is a dialogue, it can only be carried out in a dyadic situation and *individual sessions.* The purpose of this conversation is to follow, as far as possible, the child's thoughts in order to determine what sort of mental processes are occurring or what sort of thinking underlie the different responses of the child.

To a great extent the dialogue consists of questions from the interviewer and answers from the child, which are then followed by further probes, designed to clarify the child's responses. Every next question of the interviewer is determined by the answer of the child. This process of question-answer continues until the interviewer feels that he has explored the child's thinking, to the best of his satisfaction, in relation with certain situation or topic being investigated.

Critical method is a synthesis of clinical and experimental method. It is similar to clinical method in the respect that experimenter has an open ended interview – rather discussion – with the child to explore his thought processes but critical method has the merit of going further than the analysis of purely individual cases in order to reach something which has general application. Moreover, it is not verbal activity between two individuals. Rather, using a concrete situation contrived by the experimenter as a starting point, a clinical interview is conducted in which every next question of the experimenter is formulated in the light of the response of the child. Unlike the typical experiment, here the subject is as much active as the experimenter. Hence the experimenter is able to go further than the method of pure observation and attains the main advantages of experimentation (Pauli, Nathan, & Droz, 1977).

The interview situation in the critical method constitutes an "hypothesis-testing" situation. The interviewer has in his mind a certain theme or topic that he would like to explore. He also has a general idea about how children might respond or think about this theme. He then sets up his experimental situation to look into this hypothesis. The difference with regular experimental hypothesis testing situation is that in critical method there is instant feed back and the possibility of altering or changing the hypothesis or even replacing it with another one, in the course of actual interview. The interviewer, in the critical method, starts the session with a guiding hypothesis about the types of thinking a child will engage in. He presents to the child a situation, or a number of situations, and asks a number of questions relating to that particular problem and probes further. The purpose of these probes is to lead the child to observe and explain the various situations presented to him, and it is these observations and explanations that provide information on the particular concept that the interviewer is trying to explore.

Briefly, it can be said that the critical method involves a "discovery approach". The interviewer tries to explore and discover the child's thinking and is allowed a great deal of flexibility in this discovery.

The various features of the critical method, that help the interviewer in exploring the thought processes of the child, are described below. Some pertain to the attitude of the interviewer while others relate to the techniques or strategies of interviewing.

Establishing Rapport. Before starting the actual interview, it is essential that the interviewer makes sure that the child feels at ease and is psychologically prepared for the dialogue.

Keeping in view the authoritarian relationship between teachers and children in Pakistani schools, it was very important for the interviewers to come to children's level. One significant manifestation of it was sitting at the level of children, which, more or less as a rule, is never done by teachers. In most of the cases, it involved sitting on ground and providing a small floor cushion to the child identical to the one used by the interviewer.

To start with, the interviewer may talk with the child about his name, interests, family members, friends, games he plays, favourite subjects in school, etc. The interviewer should not go into any deep probing during this initial contact. If the child is shy, he can be given some toys to play with, or coloured pencils for drawing if he shows an interest.

In the setting of Pakistani schools, giving a candy to the child for eating and also eating one by the interviewer proved extremely useful in establishing rapport.

Depending on the child, every interviewer can set the situation to develop good rapport with the child.

This initial personal questioning or playing with some game material can then be followed by introducing 'task material' and asking general questions about the material to be used during interview, e.g.. "Do you know, what is this?", "Have you seen it before?", etc.

Having put the child at ease it is important to maintain a relaxed atmosphere throughout the interviewing situation.

Tone of the questions is very important. If the interviewer talks in a harsh tone, dismisses what the child says as irrelevant, interrupts the child if the child seems not to follow his question, this may have disastrous effect on the subsequent interviewing. The child may feel stupid, insecure and will not be willing to talk freely and elaborate his responses. If, on the other hand, the interviewer seems to be interested in whatever the child says, the child will feel relaxed, encouraged in giving more explanations and willing to continue with the interview.

Awareness of the Child's Level of Motivation. The critical interview is an interaction between two individuals. Where the interviewer with his own personality, habits, needs, likes and dislikes, fears and anxieties, is faced with another human being, who also has his needs, fears, anxieties, personality and habits. So, the interviewer must recognize that this aspect will have an effect on the child's level of motivation and subsequently on his interest in interview situation. If the child is anxious, or feels threatened about the interview, his level of motivation will be lowered. He will not talk freely, may just reply in 'yes' or 'no' or give random answers and will not be willing to respond. In such situation, it is meaningless to continue the interviewing situation.

Therefore, the interviewer must be constantly aware of the child's level of motivation throughout the interview and he should also be sensitive to the fluctuations in this level. The child may start with great excitement and interest but may get bored after some time or vice versa. So, the interviewer must be aware of these changes, decrease or increase in child's interest, etc. If the level of child's motivation is high it should be maintained and if it is low, he must try to increase it.

He should try that the child doesn't take the interview as a testing situation where his performance is being judged. The child should be encouraged to talk freely as this is an indication of high level of motivation. If he is unable to create the child's interest and motivation, it is better to cut down the session and continue at some later appropriate time. Similarly, if the session is long and the child seems to get bored and exhausted, the interview should be conducted in more than one session, especially with younger children.

Understanding Child's Language. As far as the 'language used by the interviewer' is concerned, it should not be complex, abstract and sophisticated for the child. Both the words and the ideas expressed through these words should not be beyond the child's level of understanding. This may discourage the child and lower his level of motivation. This will become apparent not only in the quality of the child's responses but also from non-verbal cues. The child will look embarrassed or uncomfortable. Such cues should serve as a signal for the interviewer. The sentences should be simple, easy and not too long.

Regarding the language of the child, his responses must be followed by the interviewer within the child's frame of reference.

The interviewer must try to see things from the child's point of view and understand the meaning of what he is saying. For example, in the Class Inclusion task, he should see what does the child mean when he says that there are more flowers in our country than roses, because there are different types of flowers and rose is only one of them. Whether in this response the child is including roses in different types or comparing roses with non-roses.

Understanding Child's Perception. Child's reference point is not only important in psychological and linguistic terms but also in physical terms. The interviewer should also be careful to place the experimental material directly in front of the child, so that the latter does not have to turn his head sideways to see it properly and has a clear view of the situation.

Retaining a Critical Sense. The interviewer must try to distinguish between what he believes to be an authentic expression of the child's own thinking and what is not. Children sometimes repeat parrot-like responses, learned from parents, teachers or older children and may not really understand what they are saying. The interviewer must retain a critical sense in this respect and probe and go further than these apparent responses.

Similarly, the interviewer must try to avoid any comment or judgement upon the child's performance. Though there are no 'incorrect' or even 'correct' answers in critical method. But a response may be incorrect with reference to the thinking of a mature person. Therefore, the interviewer must refrain from trying to elicit what he believes to be the correct answer, and also from passing judgements on the accuracy or inaccuracy of the child's answer. He should avoid saying "No, that's not what I asked you", when the child gives unexpected reply. This is an implicit criticism of the child. Rather he should try to analyze why the child answered the way he did and why he understood the question the way he did.

Tempo of the Interview. The pace or the tempo of the interview must be adopted to the speed of response of the child. Younger children, in particular, take more time to grasp the idea being asked and to think and organize their answer. The interviewer must be aware of it and not try to hurry the child beyond his normal speed. Similarly, it is also important not to go too slowly so that the child gets bored and loses motivation to respond. So, the interviewer must determine the pace at which each child feels at ease and continue it throughout the interview.

Sequence of Items and Variation in Order of Alternatives. Through experience, the interviewer comes to know which tasks are difficult one and these can be put towards the end of the session because difficult questions may lower child's level of motivation.

When several alternatives are being offered to the child in a question, the order should be varied. For example, in conservation of liquid the child is asked, "Is there same amount to drink in the two beakers or less or more in any one", so in the next inquiry this order of three alternatives should be changed because sometimes children have the tendency to choose the last alternative.

Probes. As we have seen, critical interview is more than simple questioning and answering. Of course there are major questions set earlier but since the interviewer is trying to explore the thinking process of the child, the additional questions and probes are needed. The real skill of an interviewer is shown in his ability to elicit the required information by the use of subtle yet penetrating probes. The types of probes will depend upon the previous answer of the child and secondly on the type of information the interviewer is looking for.

There can be many ways of going deeper in the child's thinking process. The interviewer can provide simple encouraging requests for more details, e.g., "Can you tell me more about this?", "Is there anything else?", "Can you explain?", etc.

He can use non-verbal encouragements or partially verbal. He can smile encouragingly, or can say "Yes" and nod his head with a questioning tone. He can also use a well-timed pause.

Another way of eliciting information is to repeat the last statement of the child with a questioning intonation.

Inquiry into Reasons. In the critical method, the child is asked to justify his answer and give reasons. This may simply be done by asking 'why' question. But each time a 'why' may upset the child, he may feel that his answers are inappropriate and may change or contradict his own responses. So, care must be taken that 'why' questions are asked in other forms, e.g., it can be said, "Can you tell me what makes you say that", "Why do you think that"?, "How do you know that?", etc.

Counter-suggestions. One characteristic feature of the critical method is the use of counter-arguments. These are put in cases where the child is not providing reasons for his judgement or does not seem to be sure of his answer. It involves asking questions or presenting situations to the child which contradict his own responses, and then asking him what he thinks of these contradictory points of view. For example, in conservation of liquid, the child says that the water in two containers is equal but doesn't give reason for his judgement, the interviewer may say, "the other day a little boy or girl who played this game said that water was more here because it was long. What do you think, was he/she right or wrong?". If the child agrees with the counter-suggestion, he is then asked for the reasons.

The arguments are always presented as those of children younger than the one being interviewed and not as views of the adults since the child may not challenge the adult point of view.

The counter-suggestions are not put to all children. When the child seems to grasp the notion and is very clear in his responses and reasoning, then there is no need for contradicting his argument.

So, in critical method, the role of the interviewer is very crucial and sensitive one and the true spirit of this method depends upon the skill of the interviewer. The interviewer must be aware of the factors influencing the interviewing situation, adapt to the child's level and maintain a balanced and relaxed atmosphere throughout the interviewing situation.

Piagetian Tasks. Before going into the details of the steps involved in development of cognitive task battery, it is important to make a distinction between a 'test' and a 'task'. In Piagetian research, the experimental situation is conceived of as an attempt to explore the child's thinking processes, rather than as a situation to estimate his level of ability. Here the emphasis is on the process rather than the end product. In a test of ability our main interest is in finding out if a respondent can answer a set of questions correctly or not. As against this, in a research on cognitive development, our interest is not so much in the correctness or incorrectness of answer given, but in the process, by which we decide about the child's developmental stage. Therefore, a child may give a 'correct' response, but after investigation it may be found that his line of reasoning belongs to a lower level, he may be assigned a lower developmental stage than a child giving a correct response with higher level of reasoning. This is one of reasons for preferring the term 'task' to that of 'test'.

Procedure

The critical method as practiced by Jean Piaget and his associate was most suitable at their level of work which was primarily aimed at presenting a theory of development of knowledge in children. However, in order to determine cognitive development abilities of primary school children some variations in the critical method were essential. While Piaget, during most of his work with children was concentrating on understanding specific cognitive structure, this study was aimed at determining a general level of cognitive development in children. Therefore, instead of selecting a specific task suitable to invoke a specific mental structure, a battery of tasks was required which could cover all the cognitive structures which are generally expected to be present in primary school age children. Moreover, in order to collect data from a number of primary schools in various parts of the country, it was essential to develop a team of associate investigators. In order to create a uniformity of procedure of individual interviewing of children by different workers, two contradictory demands were being made. While, keeping the spirit of critical method intact, it was essential to keep it open and unstructured but at the same time it was also required that different workers are basically following the same procedures in administering the task battery. This was achieved by (a) intense training of the team of workers, (b) writing down basic steps of tasks in precise detail with a clear mandate to digress from the agreed and written procedures whenever required, and (c) recording on a semi-structured format children's responses, verbal as well as physical or gestural, in graphic detail.

Development of Task Battery

Unlike researches following psychometric tradition, search for a standardized test or instrument was out of question because in the cognitive development research tradition, structured and standardized test are negation of the overall theoretical framework. Therefore, development of a cognitive task battery went through a long cycle of work. One important aspect of this style of work was an educational process for the researcher and his associates, where, while developing research instruments, they were also training themselves on this methodology and gaining an insight into basic Piagetian notions.

In the initial stages of exploration, beside going through whatever printed material was available, Piagetian concepts were tried out by bringing children in the Institute and by going into village and interviewing children in highly unstructured situations. A village near Islamabad was selected for the purpose. After this experience some regular material was developed to interview children on various Piagetian concepts. For this purpose primary school children form Islamabad schools were brought to the Institute.

This phase not only gave basic understanding of interplay between the material of tasks and child's thinking strategies, it was also the beginning of training of the technique where one person's interview with the child was recorded on cassette and later on discussed in detail. By going through this process, basic tasks for class I were drawn up.

Tasks in the following areas were planned to be included in the task battery: One to one correspondence; seriation; conservation of length and classification. These tasks were mostly of concrete operational thinking, suitable for the primary school age children. It was also assumed that these areas cover the thinking strategies employed in understanding the elementary school curriculum.

These tasks were again administered on children at the Institute in order to lay down somewhat standard procedures with full scope for recording child's original responses.

One issue confronted during development of tasks was that of level of familiarity of material used for tasks. At the present level of knowledge, it is not possible to say categorically that the nature of task material does not have any effect on manifestation of cognitive abilities in children. Basic patterns of cognitive structures seem to be universal. However, these structures are *pulled out* by various socio-cultural experiences. It is natural to assume that a child's familiarity with task material will effect her performance. After a long drawn discussion on culture-free tests in psychometry, the consensus seem to be that culture-free tests are not possible. Now the aim is culture-fairness. However discussion in psychometry cannot be directly applied to cognitive tasks. Here, one is not interested in *performance*. The purpose is to understand cognitive structure which children invoke to respond to experimenter's inquiry.

The problem of familiarity of tasks' material has been handled at various levels on cross-cultural studies of cognitive development. Some studies insisted to used exactly the same material used by Piaget and his associates. In another line of investigations there has been emphasis on use of highly indigenous material. Okonji (1971) directly reflected upon this issue and indicated that familiarity to material provided an edge to subject only in use of subordinate concepts in verbalizations of bases of their groupings. It did not give them any advantage in their coordination of the the *intensions* of their grouping with their *extensions*.

As cognitive development survey of Pakistani children was envisaged to cover various parts of country with substantial socio-cultural differences, it was not possible to assume any material having equal familiarity for all the children in sample. Therefore, the basis of selection of material was child's perceptual and loco-motor considerations rather than cultural familiarity. Material was selected with bright colours and of a size which primary school children could handle with ease. The material used for 14 tasks is listed with description of the tasks battery, enclosed as Appendix A. Following Okonji's (1971) conclusion that what familiarity does is to provide appropriate verbal templates, a very careful position was adopted. Before start of administration of tasks, instead of telling children what the material being use is called, they were asked to name it, which they did in their own cultural context. Once the child used a label, that very label was subsequently used by the experimenter. For instance, when a small wooden block was called *manka* or *dana* by a child, the experimenter carefully called it *manka* or *dana* throughout the task administration. In this way familiarity effect was reduced to the minimum

Initially the verbal activity during the testing process was used to be tape-recorded but it was soon felt that by this method some significant details of the process were being missed, because the child was interacting not only on verbal level but was also communicating through behavioural gestures. So, from then onwards it was decided to record each and every response of the child on paper. Some general guide lines were also established though adaptable to the individual interviewing situation.

Thus, the instructions for the administration of each task were formulated whereas for the recording of responses of the children, it was decided to record each and every response, verbal as well as behavioural.

With these instructions and administration procedures, data was collected on 50 urban children. These children belonged to an average school of Islamabad and were brought to the Institute in groups of 5 to 6 at a time. The battery at that time consisted of the following tasks:

1. One to one correspondence
2. Seriation
3. Conservation of length
4. Classification

Beside collecting data on 50 children from class 1, it was decided to run the entire battery to 5 children from each class, 1 through 5. It was hoped that this administration would provide us some understanding of (a) achievement of optimum level of each task on a particular age/class level, and (b) possibility of using the same battery for class 5.

After administering this initial battery to the sample of 50 urban and 50 rural children, it was put to a psychometric analysis following the model of discrimination-level analysis (Shayer, 1980). The analysis was done to check the performance of the battery for the purpose for which it was designed, i.e., to estimate cognitive stages of development.

Initial satisfaction of the working of the battery on class 1 children lead to expansion of the battery from four tasks to fourteen tasks so that the entire range of the cognitive levels in primary school children could be covered. In yet another pilot study the 14 tasks' battery was tried out on a sample of 50 urban and 50 rural children. The urban sample was taken from a school in Islamabad and the rural sample was drawn from a rural school, around Murree.

During this phase of pilot study (Pervez, 1980) the tasks, the basic steps and the instructions for the administration were finalized. For recording purposes, it was decided to note each and every response of the child, verbal as well as behavioural. Regarding the recording procedure, the arrangements of one person interviewing and the second person recording the child's responses was tried in this pilot study. This arrangement is desirable so that the interviewer can concentrate fully on presenting the task to the child and making all the necessary inquiry without diverting his attention towards recording the child's behaviour and responses. On the other hand, the recorder can record in greater detail and objectivity. So the working in pairs was tried and compared with the same person interviewing as well as recording. It was found that working in pairs does not significantly improve the quality of interviewing, details in recording or level of objectivity. Instead, in case of working in pairs, researchers' time required for data collection would have been almost doubled, therefore, it was decided to interview and record the child's responses by the same person.

Order of presentation of tests, with the consideration of learning effects of one upon the other, is an important issue in psychological research. However, as there are indications of minimal generalizations across tasks (Brainerd & Allen, 1971) the order of presentation was not considered to be important. However a more or less fixed order was determined with the purpose of keeping child's interest alive in administration of all the tasks.

All the 14 tasks of the battery were not administered to all the three classes of children. These tasks, though primarily addressed to concrete operational thinking, also included low-point and high-point markers, that is, containing something for pre-operational as well as formal operational thinkers. Results of pilot study (Pervez, 1980) had indicated that on some of the tasks children of higher primary school classes have almost complete facility while on some other tasks children of early classes have almost no facility. Therefore, such tasks were omitted for these classes.

Table 2.3 shows the list of tasks in the battery and the classes of primary schools to whom different tasks were given. A tally mark (√) shows that a task was administered to children of that class.

Table 2.3

Tasks of Cognitive Development Battery as Administered to Various Classes.

	Tasks	*1*	*3*	*5*
1.	Correspondence	√		
2.	Liquid	√	√	
3.	Weight	√	√	
4.	Seriation	√	√	√
5.	Water Level	√	√	√
6.	Volume	√	√	√
7.	Area	√	√	√
8.	Length	√	√	√
9.	Classification	√	√	√
10.	Time	√	√	√
11.	Mountain		√	√
12.	Plumb Line		√	√
13.	Class Inclusion		√	√
14.	Perspective			√

A detailed description of the task battery along with rules for assessment of cognitive levels is enclosed at Appendix A.

Survey of Cognitive Development

Before going into field for the final data collection, the research team spent a considerable time in preparing for this venture. As the same team was also associated with the development of the task battery, they gained a considerable insight in the application of critical method. In the initial stage of training role playing method of clinical psychology was used for training in critical method. In a dyadic situation, one investigator played role of a child and other became an interviewer. After administration of a task, the role was reversed. While two members were engaged in this activity, the rest of the member of the team observed it carefully and later on made comments on any deficiencies in the method. Lot of finer points of critical method used to emerge in the discussions which usually followed these session.

The team travelled together to all the communities and stayed there for eight to ten days. After selection of sample on the first day in the school, children in sample were assigned to various investigators without any specific considerations. However, due to gender segregation of schools, all the girl were interviewed by women members of the research team. In few cases women team members were allowed to interview boys. This was done in few cases when due to certain factors work load in boys' school could not be covered by men members of the team. All the visits to communities were interceded by coming back to Islamabad for rest and arrangement for visit to the next community.

Analysis of the Task Battery

The cognitive development task battery consisted of 14 tasks, levels of tasks ranging from pre-conceptual to formal operational stages. These tasks contained 32 items. The battery was administered to 360 children of class 1, 3 and 5 of primary schools of Pakistan. Children were equal number of boys and girls and represented various provinces of Pakistan and urban and rural areas. The results based upon this survey generated data which in the cognitive development research tradition was a substantially large data base.

Interpretation and Analysis of Task Protocols

Individual interviews with children, based upon tradition of critical method, were recorded on blank task protocols developed for this purpose. The protocols contained spaces for step-wise recording of children's behavioural and verbal responses resulting from actions/demonstrations and experimenter's verbal enquiry during administration of the tasks.

The first important step in the interpretation of the protocols was to reduce child's responses into specific cognitive categories. By invoking familiarity with Piagetian theory, response-categories were developed for each of the 14 tasks. With comments and discussions by other members of the research team, these categories were made more explicit and inclusive. After achieving a satisfactory level these categories were put to test by interpreting 20 sets of protocols, which were randomly selected from the total of 360 protocols. Some of the responses recorded on the protocols did not fit neatly into any of these categories. Therefore, more categories were added and/or amended and again reviewed in consultation with other members of the team. The second version of categories was again tested on 20 protocols, randomly selected for this purpose. Whenever any category presented some theoretical difficulty, Piagetian literature was consulted for help which on most occasions proved useful. However, at times Piagetian literature only added to the confusion. These response categories along with decisions to assign them cognitive levels were called "rules for assessment of cognitive levels." These rules are included in the description of the task battery enclosed at Appendix A.

Interpretation of 'Performance" Versus 'Process"

While interpreting task protocols there was a choice of drawing conclusion from sheer success of the child in producing the 'correct' answer on one hand and demanding from the child a 'good' reason for his correct answer on the other hand. The Piagetian tradition insists upon 'process' rather than 'response.' However some neo-Piagetians, either under the influence of behaviourism in U.S.A. or mainly for the sake of economy in data-collection, started being content with 'response' assuming that it is based upon the process. Some researchers have discussed in details the problems relating to characteristics of response criterion in

Piagetian research and the difficulties involved in it (Brainard, 1973). There are some indications that demanding reason for a correct response is a more severe criterion than merely accepting a correct response. In order to maintain the spirit of critical method many workers prefer to demand reasons.

Beside a theoretical preference of demanding reason as response criterion, a special consideration also favoured this choice. During the pilot study, although a care was taken that children are not conveyed 'correct' responses by their teachers or helpful friends, in certain cases it was felt that children are trying to produce 'correct' responses without ever arriving on these. Therefore, it was essential to elicit their reasons for their correct responses. By application of proper probing it is not difficult to make out that a child's correct response is fake. A child cannot support a fake response by reason. Therefore, during interpretation of protocols care was taken to differentiate between child's response with reason or without reason. In order to qualify for a specific cognitive structure, it was demanded that the child's correct response should be supported with a 'good' reason for that specific structure.

After being satisfied that all the response categories on all the 14 tasks are explicit and conclusive, these categories were given numerical signs, starting with 1 and going up to 6 in some of the tasks. Ascending order of the numerical signs were indications of developmental continuum. 1, representing the lowest order of development while 6 the highest.

Categories and Scores

Response categories of the Cognitive Tasks were named as rules for assessment of cognitive levels. At one point there was a strong temptation to call these 'scoring rules.' However, it is clear that the response categories are not 'scores'. These represent rather discrete developmental stages in the development of specific cognitive structures. Nevertheless these do indicate degrees of development. Although response categories were designated with numerals 1,2,3, sometimes followed by alphabets A,B, etc., it was not related to Piagetian tradition of designating cognitive development stages; pre-operational, concrete operational & formal operational as 1,2, & 3, respectively and an A and B for an early and late phase of development of a particular stage. Although some parallels were obvious, but the response categories at this level were not based upon Piagetian developmental stages.

Interpreting Protocols into Response Categories

Up to this phase of the work a reliance was made on *clinical insight*. Before starting the final assessment of the protocols, a detailed discussion on the assessment rules was done and a number of trial runs were made to understand and clarify the proper application of the assessment rules for interpreting the protocols. In order to assess task protocols it was decided to keep a check on reliability of assessment procedure. It was decided that two researchers, having more acquaintance with the theory and technique of critical method, will interpret and assess all the task protocols of all the subjects independently. The results of these two assessments were compared. In all those cases where there was difference between two assessments, a third researcher was asked to assess these protocols. In these cases all the three assessments were compared and two similar assessments were taken as the final. However if in some cases, which were very few, three different assessments emerged from three different researchers. In such situations the protocol was discussed between the three researchers and a final decision was made with consensus.

Uniformity in the assessments of two original assessors was of a fairly high degree (95% of the total assessment points obtained the same assessments from the two assessors). In all those cases where there were different assessments, the difference was within the contiguous categories. Most of the differences in the assessments were related to specific problems regarding interpretation of task protocols. Permissible variation of the angle of 90 degree for a line to be accepted as a vertical is one such example. In some cases differences occurred merely because the assessor had overlooked a particular sentence or point. In very few cases all the three assessors disagreed on a finer theoretical point in assigning a particular assessment to a particular response. Such differences were ironed-out through discussion.

Response Categories and Cognitive Stages

The cognitive developmental task battery was laid down to sample a child's behaviour in order to discover his cognitive structures, which he invokes to solve epistemological problems. It is expected that presence or absence of certain cognitive structures are indicative of a specific cognitive developmental stage in a child. Each response category in the task battery was to be indicative of a specific developmental stage in the development of a specific cognitive structure.

For a person unfamiliar with Piaget's work, this would look like a straight forward procedure. After all Piaget did devise tasks to uncover developmental stage of cognitive structures. In his discussions of the results of his interviews, he did describe specific stages in the development of structures. However Piaget's work is so voluminous and his level of inquiry is so varied that it is very difficult to pull out a definite scheme for imposing cognitive stages on response categories. Beside the difficulties inherent in the critical method, as practiced by Piaget, (open-ended unstructured interviews with highly selective reporting) his interests often penetrated deep into the finer details of the nature of cognitive structures. Such a depth makes it difficult to understand broader aspects of the structure.

Table 2.4

Cognitive Development Stages of Response Categories

Task	Items	Piagetian Stages
1. Correspondence	2	Pre Conceptual
	3	Early Concrete Operational
2. Liquid	2	Pre-Conceptual
	3	Early Concrete Operational
3. Weight	2	Early Concrete Operational
	3	Middle Concrete Operational
4. Seriation	2A	Intuitive
	2B	Pre-conceptual
	3	Early Concrete Operational
5. Water-Level	2	Middle Concrete Operational
	3	Early Formal Operational
6. Volume	2A & 2B	Middle Concrete Operational
	3	Late Concrete Operational
	4	Early Formal Operational
7. Area	2	Early Concrete Operational
	3	Middle Concrete Operational
8. Length	2	Pre-Operational
	3	Early Concrete Operational
9. Classification	2A,2B&2C	Early Concrete Operational
	3	Early Formal Operational
10. Time	2	Early Concrete Operational
	3	Middle Concrete Operational
11. Mountain	2	Early Concrete Operational
	3	Late Concrete Operational
12. Plumb-Line	2	Middle Concrete Operational
	3	Early Formal Operational
13. Class-inclusion	2	Middle Concrete Operational
	3	Early Formal Operational
14. Perspective	2A & 2B	Middle Concrete Operational
	3	Early Formal Operational

It is like comprehending a tree from a microscopic slide of a section of a leaf. In spite of these difficulties, developmental stages were imposed upon each of the response category in all the different 14 tasks. Whenever possible Piaget's works were consulted for this purpose. However, this effort became frustrating at many points. It was difficult to identify clear parallels between response categories of present task battery and Piaget's descriptions. During this process it was realized that in case of certain response categories, two adjacent categories do not discriminate between two different developmental stages. In such cases, two categories were merged into one. The results of this effort are shown in Table 2.4.

Most of these decisions are based upon Piagetian descriptions. However in some cases these are conjectures rather than being taken exactly from Piaget. It was not possible to take this line of analysis any further. It was possible to reports results of the cognitive development survey from the above categorisations but it was not shedding any light upon one major issue in Piagetian research, that is, relationship of specific response to an overall stage of cognitive development.

Each response category in each task was aimed at finding out if that particular response has been elicited by the child or not. Therefore, each category needed a present/absent or a pass/fail decision. If the task is a 'test' to discriminate between absence or presence of a particular cognitive structure in a child then each response category can be called a test 'item'. However as the tasks are not tests, the response categories can be called 'task items' rather than test items.

As the cognitive development is a continuum with a definite order of various stages, it can be assumed that various task items will present various levels of difficulty for children in various developmental stages. Therefore, a given universe of items, if plotted on the 'Y' axis of a graph will give item facilities. In order to work out item facilities, percentage of children passing a particular item in the total sample of 360 children was calculated. In this manner pass percentages of all the items of all the Tasks were derived and plotted on the ordinate of a graph, spreading from 0 to 100 percent. Considering the approximate ages of children in the sample, it was assumed that in the Piagetian continuum of cognitive development, these children will be in the pre-operational stage to early formal operational stage. The following six stages were assumed (in ascending order.)

1. Pre-conceptual stage	90 to 100%
2. Intuitive stage	80 to 90%
3. Early concrete-operational stage	60 to 80%
4. Middle concrete-operational stage	40 to 60%
5. Late concrete-operational stage	20 to 40%
6. Early formal-operational stage	0 to 20%

The Y axis of the plot was distributed in the six sections according to the above listed six stages.

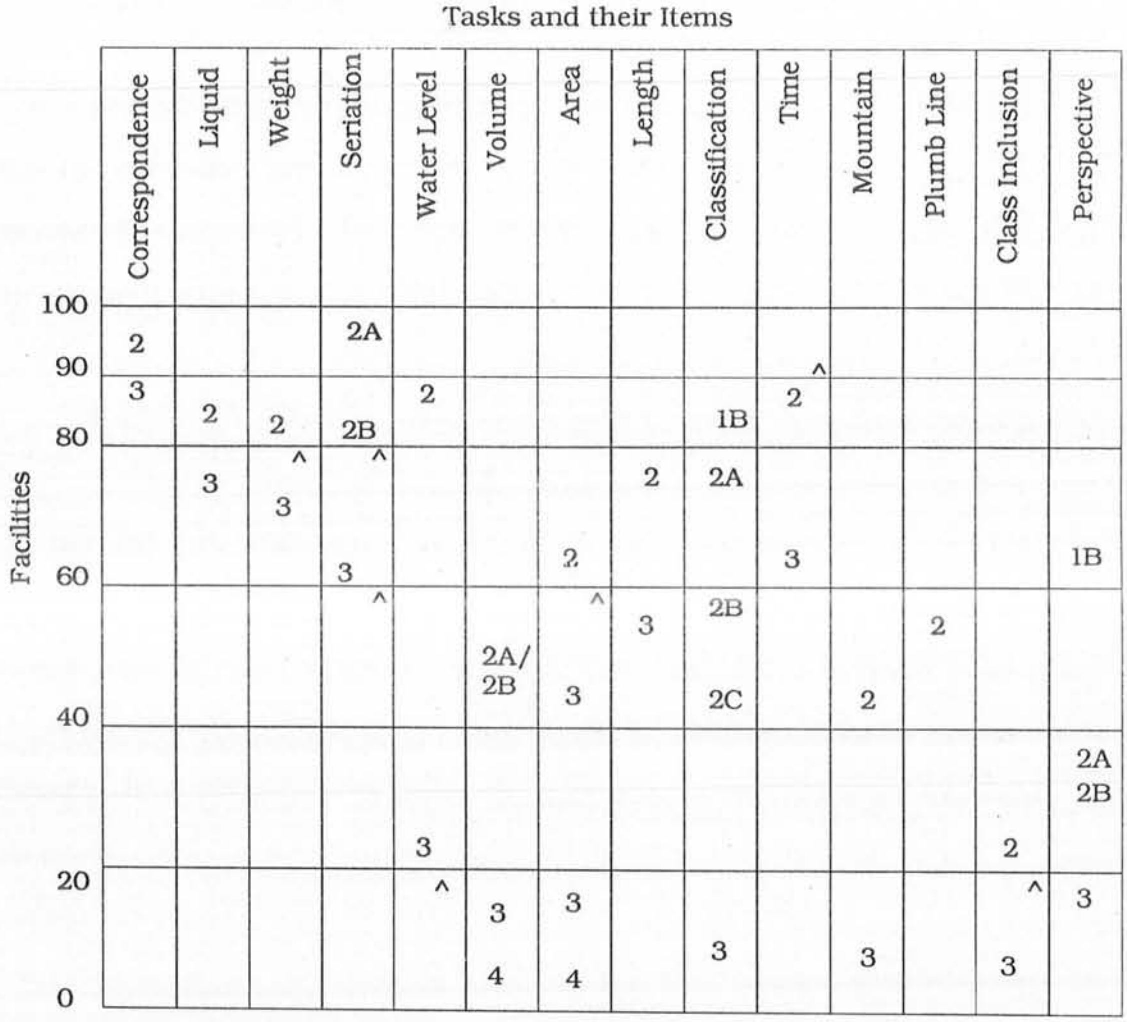


Figure 2.2. Item Facilities of 14 Cognitive Development Tasks

As derivation of stages by analyzing facilities of items in cognitive development tasks, was yet an unexplored attempt, it was decided not to strictly associate the six levels of facilities of items with Piagetian stages. Therefore, facility levels were designated as 'a', 'b', 'c', 'd', 'e' and 'f', assuming that 'a' is the lowest level of cognitive development in our sample of children while the 'f' is the highest level.

Distribution of facility range into six sections, representing six developmental stages was an arbitrary decision but it did provide an empirical basis for further analysis of the Task items in the Task Battery.

Stages 'c', 'd', 'e' and 'f' were given equal facility intervals, i.e. 20% each. However, stages 'a' and 'b' were basically one stage, i.e. pre-operational stage. In some of Piaget's works, where detailed analysis of pre-operational thinking is attempted, pre-operational stage has been further divided into Intuitive stage and pre-conceptual stage. Therefore, 'a' and 'b' together were given 20% facility interval while 'a' and 'b' separately were given intervals of 10 each.

As can be seen from the Figure 2.2, there are some items which fall on the border or very close to the border of the facility lines. On the other hand some pairs of items are in the same facility section. On the basis of a tentative and arbitrary decision, it was decided to: (a) pull any item on a facility line into a facility section; and (b) in case of a pair of items in the same facility section if one of it is near the boundary of a facility section, pull it into the next section.

Table 2.5
Key for Imposing Stages on Task Items

Task	Item	Stage
1. Correspondence	2	a
	3	b
2. Liquid	2	b
	3	c
3. Weight	2	b
	3	c
4. Seriation	2A	a
	2B	b
	3	c
5.Water Level	2	b
	3	e
6. Volume	2A/2B	d
	3 & 4	f
7. Area	1	c
	3	d
8. Length	2	c
	3	d
9. Classification	1B	b
	2A	c
	2B & 2C	d
	3	f
10. Time	2	b
	3	c
11. Mountain	2	d
	3	f
12. Plumb Line	2	d
	3	f
13. Class Inclusion	2	e
	3	f
14. Perspective	1B	c
	2A & 2B	e
	3	f

With this manipulation, six items, i.e. 2 of Weight 2B of Seriation, 3 of Water-Level, 2 of Area, 2 of Time and 2 of Class-inclusion were shifted from their original places. This shift is indicated in Figure 2.2 with an uppersand mark (^) at the original place of the item.

On the basis of the above analysis of item facilities a Key was obtained, so that the cognitive development stages could be imposed on task items. This 'key' is shown in Table 2.5.

Discrimination-Level Analysis of Task Items

The distinguishing features of Piaget's theoretical framework was outlined above. This framework has distinct implications, not only upon research methodology evolved by Piaget and his associates but also upon the tradition of reporting results. It is so different from psychometric tradition of highly structured, standardized and norm-referenced tests that psychometry appeared an anathema to Piagetian research and also vice versa. When the data on cognitive development stages of primary school children of Pakistan became available, it appeared that its reporting would be akin to a quasi norm of cognitive developmental abilities in this group of children. At this point need of a fresh data analytical approach was acutely felt. Facing a, more or less, similar situation Shayer (1980) evolved a psychometric solution for analysis of *Piagetian type* data.

In a Piagetian task, child's response is assumed to be dependent upon availability of a cognitive structure. Such a structure is needed to handle the cognitive demand made by that task. However, a child's inability to respond appropriately can be due to (a) higher level of the cognitive demand of the task, or (b) low level of child's cognitive development. This needs a clarification. Such a clarification is possible only if there is a scale on which a child's cognitive level and levels of difficulties of a large number of tasks could be placed. This method of data analysis has its origin in the scaling method developed by Loevinger (1954). So that a Pigetian task battery could yield to a scale, it is essential that it contains tasks of a wide range of difficulties and there is a moderate level of correlation among tasks. The range of difficulties in the tasks was expected to be a built-in feature because tasks were selected to cover class 1 to class 5 cognitive abilities. Such a range was also obvious from facility level analysis. Inter-task correlation was a theoretical assumption because the tasks addressing concrete operational structures were expected to invoke the same category of abilities. The results of the total task battery are expected to assign a cognitive level to each child. Then each task in the battery demands a particular level of cognitive ability from a child. Therefore, a child's levels and task's levels were on the same scale.

A psychometric assessment of task battery was suggested and helped by Shayer (1982a) for this data. The starting point of the above approach to analysis was to check if the cognitive stages imposed on the response categories of the task are appropriate or not. As mentioned above response categories are taken as task items. Therefore, the first step was a discrimination-level analysis of items. Imposed stage-levels were used for this purpose. Task items were listed according to the given levels in Table 2.5 and each subject was given an overall level by applying 2/3 success principle to the number of items passed at each level. The overall level was the maximum at which the subject passed this criterion. This procedure is explained below.

Table 2.6 is a 'class sheet' which shows performance of twenty class I children, ten girls and ten boys, of a Gujranwala (urban) primary school.* Each child's performance on each item of each task is indicated as '0' for 'fail' and '1' for 'pass'. For class I, there are 9 tasks and 21 items. There are 3 'a' level, 6 'b' level, 8 'c' level, 3 'd' level, and 1 'e' level items. As there are 3 'd' level items in the battery (for class I) in order to be at the overall 'D' level (if not at a higher level) a subject must pass at least two out of three (2/3 success criterion) of these items. However, if a subject failed at a lower level but had passed in other tasks at a higher level, lower level scores from his higher level passed tasks were added to his lower level.

* In this and some subsequent tables the following convention of abbreviations, which is obvious, was used. One to one correspondence:COR; Liquid:LIQ; Weight:WIG; Seriation:SER; Water level:WLV; Volume:VOL; Area:ARE; Length:LEN; Classification:CLF; Time:TIM; Mountain:MON; Plumb line:PLN; Class inclusion:CIN; Perspective:PER.

Table 2.6
Class Sheet Showing Performance of Class I Children on Each Item of the Battery

	COR	LIQ	WIG	SER	WLV	VOL	ARE	LEN	CLF	Number of Items passed on Each Level	Overall Cognitive Levels
	a a	b b	b c	a b c	b d	c d	c d	c c	b c c c	a b c d e	
1	1 1	1 1	1 1	1 1 1	1 0	1 0	1 0	1 0	1 1 1 0	3 6 7 0 0	C
2	1 0	0 0	0 0	1 1 1	1 0	0 0	1 1	1 0	1 1 1 0	2 3 5 1 0	C
3	1 1	1 1	1 1	1 1 1	0 0	0 0	1 1	1 1	1 0 0 0	3 5 4 1 0	C
4	1 1	1 1	0 0	1 1 1	0 0	0 0	0 0	1 0	0 0 0 0	3 3 2 0 0	B
5	1 1	1 1	0 0	1 1 1	1 0	0 0	1 1	0 0	0 0 0 0	3 4 2 1 0	B
6	1 1	1 1	1 1	1 1 1	1 0	0 0	1 1	1 0	1 1 1 0	3 6 6 1 0	C
7	1 1	0 0	0 0	1 1 0	0 0	0 0	0 0	0 0	0 0 0 0	3 1 0 0 0	A
8	1 1	1 1	0 0	1 1 1	1 0	0 0	0 0	0 0	1 1 1 0	3 5 3 0 0	B
9	1 1	1 1	1 1	1 1 1	1 0	1 0	0 0	1 0	1 1 0 0	3 6 5 0 0	C
10	1 1	1 1	1 1	1 1 1	0 0	1 0	0 0	1 0	1 1 1 0	3 5 6 0 0	C
11	1 1	1 1	1 1	1 1 1	0 0	1 0	1 0	0 0	1 0 0 0	3 5 3 0 0	B
12	1 1	1 1	1 1	1 1 0	1 0	1 0	0 0	1 1	0 0 0 0	3 5 4 0 0	B
13	1 1	0 0	0 0	1 1 0	1 0	0 0	1 1	0 0	0 0 0 0	3 2 1 1 0	B
14	1 1	1 1	1 1	1 1 0	1 0	0 0	0 0	1 1	0 0 0 0	3 5 3 0 0	B
15	1 1	1 0	0 0	1 0 0	0 0	0 0	0 0	0 0	0 0 0 0	3 1 0 0 0	A
16	1 1	1 1	1 1	1 1 1	1 0	1 0	1 0	1 0	0 0 0 0	3 5 5 0 0	C
17	1 1	0 0	1 0	1 0 0	1 0	0 0	0 0	0 0	1 1 1 0	3 3 2 0 0	B
18	1 1	1 1	0 0	1 0 0	1 0	0 0	1 1	1 0	1 0 0 0	3 5 2 1 0	B
19	1 1	1 1	1 1	1 1 1	1 0	1 1	1 1	1 1	0 0 0 0	3 5 6 2 0	D
20	1 1	1 1	1 1	1 0 0	1 0	1 0	1 1	1 1	0 0 0 0	3 4 5 1 0	C

Children at Each Overall Cognitive Level Passing Number of Items of the Battery

	COR	LIQ	WIG	SER	WLV	VOL	ARE	LEN	CLF
	a a	b b	b c	a b c	b d	c d	c d	c c	b c c e
D	1 1	1 1	1 1	1 1 1	1 0	1 1	1 1	1 1	0 0 0 0
C	8 7	7 7	7 7	8 7 6	6 0	5 0	6 4	8 2	6 5 4 0
B	9 9	7 7	4 3	9 8 3	7 0	2 0	4 3	4 2	4 2 2 0
A	2 2	1 0	0 0	2 1 0	0 0	0 0	0 0	0 0	0 0 0 0

In order to illustrate the above procedure from Table 2.6, let us have a look at the performance of first child in it. This child passed three 'a' level, six 'b' level, seven 'c' level, and none of 'd' and 'e' level items. Following a descending order, she cannot be placed at 'e' or 'd' level because she could not pass any 'e' or 'd' level items. She passed seven 'c' level items out of total eight 'c' level items thus passing 2/3 criterion. Therefore she got 'C' overall cognitive level. Now let us look at performance of a boy at serial number 13. He passed no 'e' level item, one 'd' level item, one 'c', two 'b' and three 'a' level items. Keeping 2/3 criterion in view, he cannot be placed in 'D', 'C' or 'B' overall level. However his one 'd' level and one 'c' level passed items can be added into his two 'b' level items. This addition (by adding higher level passed items into lower level items) makes his 'b' level items to be four. Thus he passes 2/3 criterion at 'b' level items and obtains 'B' overall cognitive level.

This next step of the discrimination analysis involved collecting for each separate class the number of subjects, classed overall at each level, who passed the item. This process was made possible by cutting a strip of graph-paper for each class marked with overall level of each pupil (using colour code for overall cognitive levels) in the each class of twenty children (ten girls and ten boys) and placing it alongside each items column in turn.* In

* In order to do this work on computer, and especially using SPSS, a very tedious programming was required. However, now using Mirosoft Excell on Macintosh, an algorithm has been developed through which, while remaining in the same file (data as well as programme file), this analysis can be done painlessly.

this manner it became convenient to make count of number of pupils, at the various cognitive levels turn by turn, who passed the item. Lower part of Table 2.6 shows results of one class obtained through this procedure.

The next step, like the previous step is also illustrated for class 1 only. There were six groups of 20 children (of each class) in the sample. For each item of the battery, children at each overall cognitive level passing that item were collected from six sheets similar to the class sheet in Table 2.6. Table 2.7 illustrates this for class 1.

As the last step of the discrimination level analysis, the 25 percent, 67 percent and 75 percent discrimination levels were calculated by linear interpolation in the scale of percentages in each class. However 0.5 level was added to each value because each of the percentages applying to the whole sample of subjects categorized at a level covers the range of subjects who just passed the criterion (i.e. obtaining 2/3 of the level) to those who just failed the criterion for the next level. This is shown in lower part of Table 2.7.

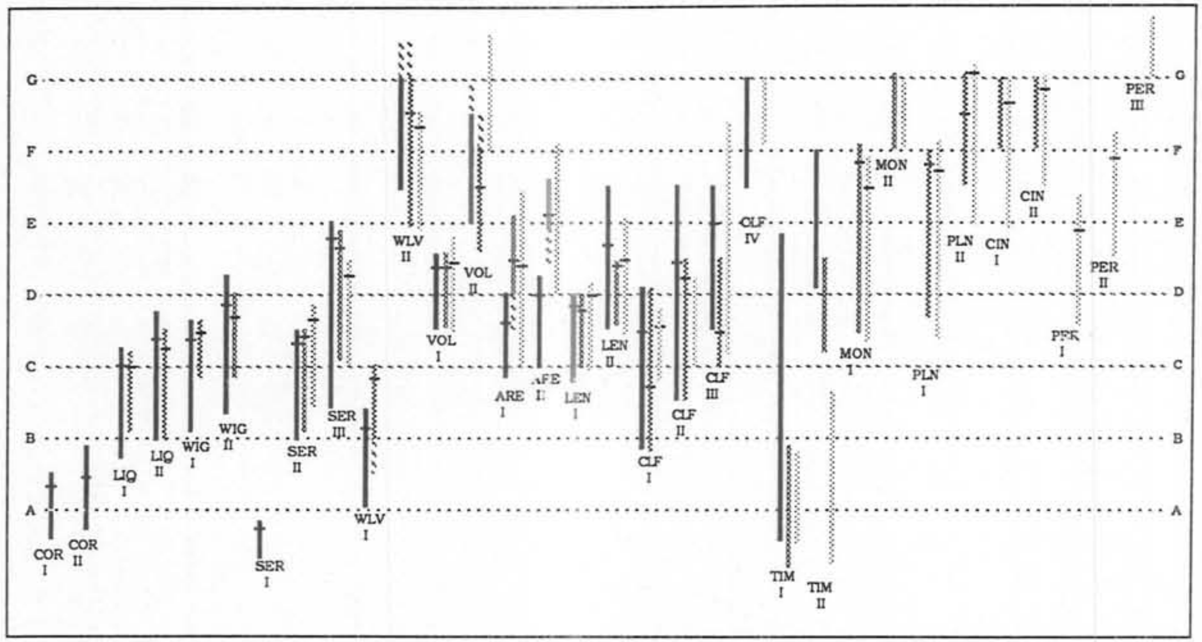
Table 2.7

Class I Sheet for Discrimination Analysis of Items *Class I Shee Discrimination Analysis of Task Items*

Overall Level	No. of Children at Level	COR		LIQ		VOL		SER			WLV		VOL		ARE		LEN		CLF				TIM	
		a	b	b	b	b	c	a	b	c	b	d	c	d	c	d	c	c	b	c	c	c	b	c
E	**4**	**4**	**4**	**3**	**3**	**4**	**4**	**4**	**4**	**2**	**4**	**1**	**4**	**2**	**4**	**3**	**3**	**3**	**3**	**3**	**3**	**1**	**4**	**1**
		100	100	75	75	100	100	100	100	50	100	25	100	50	100	75	75	75	75	75	75	25	100	25
D	**19**	**19**	**18**	**18**	**18**	**17**	**16**	**19**	**14**	**12**	**14**	**2**	**14**	**0**	**18**	**16**	**17**	**12**	**15**	**13**	**11**	**0**	**13**	**7**
		100	95	95	95	89	84	100	74	63	74	11	74	0	95	84	89	63	79	68	58	0	68	37
C	**53**	**53**	**52**	**42**	**37**	**39**	**32**	**52**	**42**	**18**	**44**	**0**	**10**	**0**	**31**	**25**	**28**	**12**	**36**	**28**	**11**	**0**	**44**	**17**
		100	98	79	70	74	60	98	79	34	83	0	19	0	58	47	53	23	68	53	21	0	83	32
B	**21**	**20**	**18**	**12**	**10**	**8**	**6**	**16**	**9**	**5**	**18**	**0**	**1**	**0**	**2**	**1**	**2**	**0**	**12**	**4**	**4**	**0**	**10**	**2**
		95	86	57	48	38	29	76	43	24	86	0	5	0	10	5	10	0	57	19	19	0	48	10
A	**15**	**12**	**11**	**2**	**0**	**0**	**0**	**11**	**1**	**0**	**5**	**0**	**2**	**0**	**2**	**1**	**1**	**1**	**2**	**0**	**0**	**0**	**8**	**0**
		80	73	13	0	0	0	73	7	0	33	0	13	0	13	7	7	7	13	0	0	0	53	0
A-	**8**	**1**	**0**	**0**	**0**	**0**	**0**	**6**	**1**	**0**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**2**	**0**
		13	0	0	0	0	0	75	13	0	13	0	0	0	0	0	0	0	0	0	0	0	25	0

Discri mi-	25%	1.68	1.80	2.80	3.00	3.20	3.40	0.83	2.00	3.60	2.10	6.50	4.60	6.00	3.80	4.00	3.80	4.60	2.80	3.70	4.60	6.50	1.50	4.20
nation	67%	2.30	2.40	4.00	4.40	4.30	4.80	1.40	4.20	5.70	3.10		5.40		4.70	5.00	4.80	5.70	4.40	5.40	6.00		4.00	?
Levels	75%	2.40	2.70	4.30	4.70	4.60	5.10	1.50	4.40	?	3.30		5.50		5.00	5.30	5.00	6.50	5.10	6.50	6.50		5.70	

Note: Number of children at each level are shown in bold and below it are their percentages.



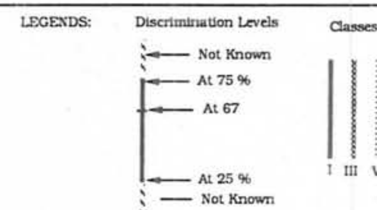


Figure 2.3
Discrimination Levels of Task Items

Discrimination level analysis, thus obtained, was checked in two ways. First the item discrimination lines were plotted vertically against the scale of levels from A to F (the bottom being 25 percent level, the top 75 percent and a dash cutting the line at 67 percent, the assumed discrimination-level). This was done separately for each Class to check for the consistency of relative scaling from class to class. It is shown in Figure 2.3.

The first casualty was the Time Task. Items of this Task were unstable from class to class while comparing to the other Task items. Weakness of this Task and problems relating to the concept of Time are reported in the Piagetian literature (Siegler & Richards, 1979). It was, therefore, decided to eliminate this task from the further analysis of the battery.

Contrary to the problem noted in the Time item, the discrimination levels of other items remained fairly stable from class to class. It was an initial confirmation that the Cognitive Development Task Battery is measuring a developmental construct. Nevertheless it did not confirm the item response categories. The level of number of items was at variance with the levels assumed for this analysis. Therefore, new categorisation of items were used and the whole process was repeated. A check was made on a sample of items to see that the new item categorisation was stable against 2/3 approximate success criteria. They had remained stable and no further re-categorisation was required at this stage.

Up to this stage, stage-levels imposed upon response categories, though based upon a background in Piagetian stage-conceptions, were not carefully aligned with specific Piagetian descriptions and nomenclatures of stages. Levels A to G were assumed cognitive developmental stages but so far not identified with Piaget's description of stages at empirical level. This work was undertaken now. By invoking the familiarity of researchers with the Piagetian literature, level A was identified with intuitive stage, which in most of Piagetian literature is designated as 1B. Our levels B & C were collapsed together and identified as Early Concrete Operational level which is designated 2A in Piagetian terminology. Level D & E were collapsed as Middle Concrete Operational stage, 2A/B. F was identified as Mature or Late Concrete, 2B, stage. G was a stage higher than Late Concrete but not a proper Formal-Operational stage. Therefore, it was considered a transitional stage between Late-Concrete and Early Formal Operational period. This was designated as 2B/3A.

The above identifications were checked in a new cycle of data-analysis. Fresh discrimination levels were computed from new re-categorisation. These discriminations were plotted again in a diagram similar to Figure 2.3. It appeared that the items are neatly grouped into five groups, at 1B, 2A, 2A/B, 2B, 2B/3A respectively. 2A items barley overlapped with 2B items. However 2A/B items seemed not to be very useful in discrimination from 2A & 2B level.

There was a considerable overlapping between the 2A/B discrimination ranges and those of both the 2A & 2B items.

In order to clarify the status of 2A/2B items, it was decided to reconsider the decision of collapsing D & E into 2A/B stage level. The 67% discrimination levels were grouped for F, E & D items, first for each class separately and then by best mean value. It now appeared that four of the E items were early 2B items, and that two were indistinguishable from the levels of D items. It indicated that the previous criteria were too severe for 2B and produced too few children at 2B level in each class. Therefore another cycle of re-assessment was undertaken, recording only D, E and F items which resulted into discriminations-levels which appeared satisfactory.

As all the tasks were not administered to all classes, discrimination-level analysis of items was undertaken on the scores of maximum possible number of children. For instance, Correspondence (two items), being the low end task, was only administered to class 1 only while on the other end, Perspective (three items), being the high end task, was administered to class 5 only. Discrimination-level analysis and percentage of success assessed at each level are reported in results. The levels of items of the task battery determined as a result of these cycles of analyses were used for reporting cognitive development stages in primary school children of Pakistan.

Reliability of the Task Battery

As different classes were given different sets of tasks of the task battery, the battery was considered as three sub task batteries. By using Kuder-Richardson formula, KR-20, (Guilford, 1971) reliabilities of all the three groups were calculated. Later on in order to consider all the subsets of the battery as one test, scores of those tasks which were not given to a particular class were added on the assumption that if these tasks were given to that class what they would have scored. The same scores were added to a particular cognitive stage of children of, say, 2A/B of class 1 which were scored, say 2A/B children of class 3. In this way it was possible to calculate KR-20 of total battery. Factor analysis by the method of Alpha Factoring, to be discussed later, also calculated reliabilities of the task battery which are called alpha reliabilities which in fact are same as KR-20. Therefore, in the results, alpha reliabilities of the task battery are reported.

Analysis of Concrete Operational Thought as a Construct

Piaget's explanation of operational thinking, concrete as well as formal, has been called *psycho-logic.* Piaget himself called it genetic epistemology, and that is what appears to be his explanatory level. However, the contemporary science of psychology is interested in these concepts as psychological constructs. One clear evidence of psychology's interest in Piagetian constructs is the amount of research produced in the efforts to conform or reject Piaget's theory. Even those psychologists who were not working within Piagetian context were striving to build theories of cognitive development which followed the Piagetian stage criteria of structures, constant succession and integration.

Piaget's view of cognition is that of a complex adaptive process which emerges over the years of development of children as more and more equilibirated mental structures. These structures provides a child (and later to a mature adult) the ability to intelligently and effectively represent and manipulate his environment. New structures are build upon previous structures through the process of assimilation and accommodation. However, at various stages of development one set of structures are relatively equilibirated till such a time that assimilation of new experiences creates dis-equilibrium and thus giving rise to need for a set of new structures. This is the Piagetian concept of stages in cognitive development. Such a notion of cognition was lacking in psychology. In the discipline of psychology which is characterised by lack of many powerful theories, the significance of Piaget's theory can be judged by the amount of discussion it has generated (Brainerd, 1978, Flavell, 1971, 1972, Flavell & Wohlwill, 1969, Halford, 1989, 1990, Wohlwill, 1973). Not only the inferential discussion of Piagetian concept of stages, the amount of empirical evidence produced for and against the concept of stages is also substantial (Case, 1985, Halford, 1989, Seigler, 1981).

However, the sort of synthesis which is so apparent in Piaget's theory is extremely difficult to handle, specially in a research tradition where small segments of problems are addressed from narrow angles. Within the given state of knowledge and research techniques, perhaps this was the only possibility. Nevertheless, this level of work has created more confusion about Piaget's theory than shedding any light on it. In about last thirty years lot of work has been undertake to clarify the position of stage concept. Whatever was done on sensory-motor stage, more or less, confirmed Piaget's position. Almost the same is true about formal operational thinking except that a much fewer adolescents appear to be formal operational thinkers than what was reported by Piaget and his associates. In the cross-cultural context, possibility of many adults not ever becoming formal thinkers has also emerged as a serious view. However, the most controversial stage has been concrete operational. Most of research about this stage of development is characterized by disagreement, incongruity and conflict. In early 1960s, Lovell, Mitchell, and Everett (1962) claimed that four basic concrete operational groupings, that is, seriation, class inclusion, multiplication of classes and multiplication of relations are simultaneously acquired around eight years of age. Dodwell (1960, 1961, 1962) presented low correlations between tasks as an argument against justification of the concept of concrete operational stage. Smedslund (1964) on the basis of strict tests of the Piagetian claim that concrete operational tasks should be solved at equivalent levels, argued that there is no empirical evidence for supporting the concept of stage.

If one looks for strict empirical evidence, Piaget's concept of stages appears to be paradoxical. If development is a constant process, which Piaget insisted that it is, then there cannot be any *stable* stage. A continuous process of assimilation and accommodation will make equilibrium only a theoretical possibility, incapable of being verified empirically. Piaget, in fact, towards the later period of his life, some what shifted his position on stages. This was indicated by his preference for use of word *equilibiration* instead of *equilibrium*. This signifies that equilibrium is not a state, it is a constantly continuing process. However, stages being one of the central concept in Piaget's framework, the stress appears to be on the sequence of stages rather than simultaneous acquisition of certain structures at certain stages. The concept of *decalage* appeared in Piagetian literature. Decalage "is a term (or phenomenon) which means inability of the child to solve another problem of the same nature at the same level of mental development which he had solved earlier. The underlying scheme of thought or the mental structure in both cases is more or less the same. It is called horizontal decalage. For example all the problems relating to the scheme of conservation, say, that of mass, at the same level of mental development, cannot be solved. Here varied achievement at the same level of mental development on the conservation of mass across other situations is involved. In the case of vertical decalage , there is a shift in the passage of one plane of activity to another.. Here, it is not possible for a child to solve a problem, say that of conservation of angular momentum or volume or weight when he has so far mastered conservation of mass" (Vaidya, 1991, p.432). If the accumulated evidence for horizontal decalage being a rule rather than exception (as Piaget thought) would have been conclusive, the emphasis of cognitive development theory would also had been shifted from the concept of horizontal to the concept of vertical structure. This situation would have not been totally disastrous for this theory. Knowledge of timetable of acquisition of various concrete operational abilities would have powerful theoretical as well as educational implications. Nevertheless, the evidence for horizontal decalage being a permanent aspect of stages is not without contradictions.

Studies addressed to establishing sequence rather than synchronicy of stages are also not without disagreements. Younnis (1971) found that seriation and multiplication of classes are acquired first and simultaneously and these are then followed by multiplication of relation and then class inclusion. However, Smedslund (1964) reported contrary evidence that emphatically supported that class inclusion is acquired before multiplication of classes and multiplication of relations. This confusion became more acute when evidence presented by other researchers (Dimitrovsky & Almy, 1975, Jamison, 1977) showed that seriation is acquired at least two years before class-inclusion. Lack of consistency in the acquisition order of multiplication of classes and multiplication of relations was reported by Shantz (1967).

These results present contradictory evidence even for different aspects of the same concepts. Some studies showed that ordinal numbers are acquired before cardinal numbers (Seigel, 1974). However Williams (1977) and Dodwell (1960) said absolutely reverse of it. The situation about acquisition of number concept and conservations is also not much different. Dimitrovsky & Almy (1975) found that conservation of quantity is acquired before seriation while Tomilson-Keasey, Eisert, Kahle, Hardy-Brown, & Kaesey (1979) found seriation appearing before conservation of quantity. Slowly and gradually it was becoming apparent that results being presented on various aspects of concrete operational thought were based upon studies which were narrow either because the sample was too small and lacked variation of an appropriate range of abilities or was based upon too narrow band of concepts, inappropriate to handle the overall structure of concrete operational thought.

One misconception which played a role in confounding the confusion in Piagetian research is the problem of relation between ages and stages. Although Piaget always quoted ages of his subjects, he never assumed development to be maturation, that is, depending upon physical age. For him development was based upon *development* – the total resultant of the interaction between the organism and the environment, and that too being a reciprocal interaction. However, lot of effort was made to show that certain abilities are not acquired at the age which Piaget *claimed* children acquire or vice versa. Many studies, for instance, Elkind (1961) and

Lovell & Ogilvie (1961) fall into the category of ages and stages controversy.

The construct of concrete operational thought also requires clarification. The first prerequisite for such a clarification is a large data base covering a wider range of children's abilities as well as difficulty range of items of a task battery. The cognitive development survey of primary school children of Pakistan provided such a data base. Analysis of psychometric characteristics of the task battery used in this survey provided evidence of its ability not only of discriminating children at various levels of their development but also items being discriminated at various levels of a scale developed to tab the continuum of cognitive development.

As indicated in the section on sample, ages of Pakistani children in primary schools is a moot issue. This may be problematic for many educational considerations but in the clarification of one significant aspect of concrete operational thought, this appeared as a positive aspect of the data. By really not knowing ages of children, one need not bother about ages and stages. If the question of age is eliminated we are left only with development.

Piaget's construct of concrete operations is based upon his notion of equilibrium. A stage is relatively stable state of equilibrium. It essentially means that when a child is at a specific stage of development, variation in his cognitive abilities would be minimum. The assessment of concrete operational thought as a construct is only possible if (a) internal consistency of those developmental tasks which are supposed to tab concrete operational thinking is determined, and (b) individual differences of children on those tasks which are characteristic of concrete operational thought have been determined. The data of cognitive development survey was found to be fulfilling the both of these requirements. Therefore, assessment of the construct of concrete operational was a promising prospect.

The period of concrete operational thinking spans about four years of age. During this period concrete operational structures start emerging in various content areas, are stabilized, matured and then start being de-stabilized for giving way to the next stage of development. When *is* a child at concrete operational stage of thinking? Theoretically it should be a point where the child has achieved maximum level of equilibrium within these structures, a manifestation of which should be minimum variation on performance of various concrete operational tasks. Flavell and Wohlwill (1969) and Wohlwill (1973) argued that the maximum inconsistency of children's performance on cognitive tasks should be expected at the beginning of concrete operational period. This inconsistency then should be followed by a process of cognitive integration which should culminate with disappearance of individual differences on concrete operational tasks. Longeot (1978), taking Flavell and Wohlwill position as a starting point made a more detailed prediction and developed a plausible argument for horizontal decalage. He argued that in the the intermediate steps of development towards more mature concrete thinking, some children may achieve operational thinking quicker in verbal/logical tasks, while others in spatial tasks and others in conservation. Longeot argued that variation in a child's performance on cognitive tasks relating to the same levels of development can be ascribed to those differences in mental abilities which are described in psychometric literature on mental abilities such as Catell (1971).

In the factor analysis of performance of a large sample of subjects on a battery of psychometric tests, only the fact that a substantial minority of individuals perform above the average for their age in spatial tests, and others perform below the average, allow a spatial factor to emerge from the analysis. Logeot proposed that those children who are *spatially* above average will show operational thinking in spatial tasks more readily at each stage of their overall cognitive development. In addition, Longeot adds to the the Wohlwill model at least two intermediate nodes within the concrete operational period at which the performance of different individuals converge and then diverge again on the way to the next convergence. This is moving towards a marriage of Piagetian and psychometric tradition. A *Piagetian type* data base being explained with psychometric models.

As the analysis of the the psychometric characteristics of the task battery confirmed it to be a scale, it was feasible to test the data for developmental model of Flavell & Wohlwill (1969) which claimed a node around 2B (mature concrete operational thinking) or 2B/3A (an intermediate stage between concrete operational thinking and formal operational thinking) where inter subject variation on the tasks is at the minimum. This was checked against the model of Longeot (1978) which says that that there are more than one intermediate nodes in the development of concrete operational thinking.

One way to check these models is to to make sub-groups of children by their overall level of cognitive development as determined by the task battery and then see their relative success on different tasks. If the Longeot model is correct, subjects assessed at a level beyond a node must succeed on all tasks prior to to that node.

Finally, the concept of concrete operational thought as a unitary construct also needs a verification. If it is a unitary construct, it needs to be shown that variation of children's performance is primarily due to their levels of cognitive development and not due to the psychometric model of mental abilities. Such a verification was tested by application of various types of factor analyses. The alpha factor analysis treats the tasks as a sample typical of psychological domain or domains and asks the quantitative question: In terms of test reliability, how the first factor compares with any subsequent factors? From the *eigen* values produced, the alpha reliabilities were estimated. The results of this analysis are shown and discussed in the relevant section.

Cognitive Development Level as a Factor for Drop outs

The results of survey of cognitive development in primary school children, which will be discussed in the next chapter, indicated that while the dispersion of cognitive abilities in class 1, more or less, followed a normal curve, which is generally expected from dispersion of an naturally occuring phenomenon, in class 3 and 5, children expected to be at the lower end of cognitive abilities were missing from the sample. This lead to the exploration of a possibility that those children in class 1, who are at lowe level og cognitive development stages and cannot keep up with the higher cognitive demands of school education are the children who drops out from the school. This can be an interesting hypothesis and requires a longitudinal research project.

Longitudinal research is generally considered a preferable methodology in developmental psychology. However, it requires a well established social and academic tradition of research and a long term commitment on the part of researchers as well as sponsors of such a research. Establishment of causal relation between cognitive development levels and drop out from primary schools needs a longitudinal research. However, as in the present context such a research was not possible, a strategy was adopted where children with known cognitive levels were traced after a period of about three years to find out their dropout status.

The dropout problem is talked about a great deal in Pakistan's educational circles. However, a great amount of ambiguity continues to exist about this concept. Just like literacy, its definition keeps on shifting from context to context and from situation to situation.

One way to look at the concept of drop out is from the perspective of the objectives of primary school education. Leaving aside the very important aspects of mental, emotional and social development of children through primary school education, the most obvious objective of primary education appears to be making a child literate within five years of schooling. Therefore, a failure to achieve this objective within the stipulated period of time can be called a drop out. Nevertheless such a definition will depend upon a stringent definition of literacy which, for any practical purpose, does not exist at the present.

A child enters into a primary school to complete her primary education in five years. This is what is generally expected by the child, by parents and by teachers. Completion of primary education is essentially passing of class five annual examination. Is a child who has not been able to do that a dropout? Is a child, who fails in examinations in various classe of primary school, also a case of drop out?

The word drop out appears to refer to a physical presence of child in the school. Therefore, as long as a child keeps on attending the school, he is not a drop out. But what about a child who, let us say, spend ten years in the primary school and yet does not pass his class five examination. Is he a drop out or not.

As discussed in the introduction, one category of research studies on dropout have been undertaken at the Institute of Education and Research, Punjab University by student for their M.Ed. research thesis. These studies typically lacked depth and did not make any effort to delineate upon the concept of drop out. A large educational research project of Bureau of Educational Planning and Management (1976) also dealt with the problem of drop outs. This project used secondary sources for data collection, which is generally considered unreliable in Pakistani situation. The only study (Asberg, 1972) which has tried to build a model of the phenomenon of drop outs has undertaken the issue of class wise movement of children in primary schools in a greater detail. However, Asberg, rather than collecting data by himself, relied upon official data. Instead of following children year by year, he built his model from data of an educational region, that is, Lahore for a number of successive year. All of these studies do not help in clarifying the concept of drop outs.

Chowdhri (1983) tried to create a model for study of the phenomenon of drop outs. Her emphasis was not upon collection of data for finding out rate of drop out in Pakistan. She was specifically interested in clarifying the concept of drop outs. Her major contribution is defining four categories of children in primary schools who are rather vaguely called drop outs in contrast to children for whom Chowdhri used a label: "present."

The following are Chowdhri's definitions:

1. Drop out (D): A pupil who leaves school for any reason except death before completing his primary school programme and without transfering to any other school.

2. Failure (F): A pupil who does not go to the successive class in the successive year being declared "failed" in the final examination and is still attending the school.

3. Migration-out (MO). A pupil who leaves the school with a migration certificate.

4, Unknown (U). A pupil who is not in the school and his whereabouts are untraceable.

5. Present (P). A pupil who has continued to study in the successive classes in the successive years and has passed fifth class.

Such elaborate categories are required for a study directly dealing with epidimeology of drop outs.

Chowdhri's data, although based upon just two villages, more or less confirms the situation of drop outs as discussed in chapter 1. However, the more significant gain of Chowdhri's work was possibility of an explicit definition of drop outs. Taking passing out five classes in five year as a condition for non-drop out according to Chowdhri, out of the total enrollement for class in the year 1977 and 1978 only 20% from the first cohort group and 17% from the second cohort group passed class V at the end of five year period.

There are certain indications that the content and style of education being offered to primary school children, requires at least concrete-operational thinking. For those children who have as yet not developed this level of thinking, education will be more or less meaningless, leading to frustration and resulting ultimately to drop out. Therefore it was decided to test this hypothesis on a limited number of children.

There is a general agreement that within the primary school maximum drop out takes place during transition from class 1 to class 2. UNESCO (1982, 1984) figures also indicated that maximum drop out occured in transition from class 1 to 2, that is, 40%.

First few years in the primary school are crucial for a child. Therefore, there is a good reason to concentrate upon class 1 children for investigating any relationship between cognitive abilities and the phenomenon of drop outs. As investigation of primary school children from this angle was an attempt of secondary analysis, it was decided to study only class 1 children in urban and rural localities of Punjab. There were 40 children in this sub-group.

As there are indications that concrete operational thinking is unstable till the middle of this period, it was decided to bifurcate class 1 children of Punjab into two categories, that is, (1) Children who are non-concrete operational thinkers, and (2) children who are concrete operation thinkers. 2A was taken as the high mark of non operational children while 1A and 1B were included into it. Concrete operational thinkers were children at 2A/B and 2B.

Punjab primary schools were revisited and records of the children of the sample who were in class 1 at time of cognitive development survey were were followed till the end of class 2, that is, appearing in class 2 examination, passing it, and entering into class 3. These 40 children were assigned into five categories as established by Chowdhri (1983). The results of this investigation are reported in the next chapter.

Classroom Observations in the Primary Schools

After establishing that the construct of concrete operational thought as a valid psychological concept for describing cognitive development abilities of children and having some indications of relationship of cognitive development with drop out in class 1, it was decided to undertake some observations of classrooms in a selected number of schools. It was decided to concentrate on class 1 for two reasons: (a) the largest amount of drop outs takes place within this class, and (b) the anlysis of cognitive development level as a factor in the drop outs pheneomenon in class 1 indicated this class to be a problematic group.

With a sufficient familiarity of characteristic of cognitive functioning of children at various levels of their cognitive development, it was decided to look carefully at what takes place within the classroom.

According to the findings of cognitive development survey, which will be presented in the next chapter, class 1 children are distributed into five sub-stages of cognitive development. There are few children at pre-conceptual level (8.3%) and yet fewer children at mature concrete operational thinking (3.33%). The rest of children are at intuitive to middle concrete operational thinking. The largest group is at early to middle concrete operational thinking. Therefore, class 1 teacher is dealing with a critical stage of mental development of children which is taking them from being pre-operational to concrete operational. Bybee & Sund (1982) has called the child in this stage practical student. The objective of classroom observation was to see what opportunities are provided to pupils in class 1 for exploring reality at a concrete level.

Three schools were selected near Islamabad. From the previous experience of spending considerable amount of time in primary schools in connection with cognitive development survey, it was known that classroom is rarely a room, it is a class-place. It was very obvious that for a teachers the concept of primary school education was nothing but the famous three R's.

It was decided to observe five *periods* of each class 1 teacher, two on language, two on arithmetic and one on science. However, it turned out that class 1 teachers think nothing about science. The administration of only one school admitted presence of a science textbook and the class 1 teacher of that school reluctantly agreed to *teach* science in one class. In this way, fifteen planned observations were reduced to thirteen.

The concept of period was taken seriously by one of the three schools only to the extent of striking bell regularly after every 35 minutes. However, even in this school the class 1 teacher followed his own rhythm. For the sake of observations, a duration of 35 minutes was fixed. Following Bybee & Sund's recommendations to the teachers of *practical child*, just two characteristics of teaching and learning processes in class 1 were probed during these observation. (a) How far concrete experiences are used as bases for educational strategies, and (b) How much references are made to objects, events, or situations familiar to students.

Repeated visits to these schools in various connection was responsible for creating a candidness in teachers. Nevertheless, when the intention to observe a class became known to teachers, they did one very important thing – they *took* class. However, rural schools in Pakistan provide excellent opportunity for non-intrusive classroom observations. All the five classes, especially in winter are sitting in five groups of children in an open court yard. This provided a situation where while for the teacher X of class 2, he and his class was being observed, in fact an observation was being made of teacher Y and class 1. Decision to observe a particular class at a particular time was done without prior planning with teachers. Only early and late hours of the school were avoided. If after an intention to observe a particular subject being taught in a particular class, it conspired that a particular subject is not being taught at that particular time, the observation was left for another time.

Assessment of Class 1 Textbook

In the absence of any things else as teaching material, textbooks play crucial role in the school education of Pakistan. A content analysis of class 1 textbook was undertaken to explore that to what extent a textbook provides concrete experience to pupils and to what extent a teacher can take a lead from the textbook to plan concrete experiences for children.

Chapter 3

RESULTS

Presentation of results of this study requires some explanation. The scientific objective of this study was assessment of concrete operational thought as a construct. However, this assessment required a large data base on cognitive development of children with the conditions that (a) this data contains a sufficient spread of variations of the levels of difficulties of items, (b) it represents results of fairly large number of structures associated with concrete operational thinking, and (c) it is based upon subjects having enough variations in their abilities. The survey of cognitive abilities in primary school children met these conditions for the data and hence proved useful for assessment of the construct of concrete operational thought. However, this study was not undertaken purely for scientific considerations. Its real motivation was desire to improve conditions of Pakistani children and specially their education. Therefore, the survey of cognitive abilities had a primary purpose of providing some psychological inputs for improvement of primary education – basically an applied consideration for a research. However, this applied consideration required some pure scientific work so that the construct which was being assumed to be relevant is assessed for its scientific worth. This required a detailed analysis of the instrument which was being used for the survey. Therefore the results of the survey, which provided its own justification, were also used for assessment of the task battery and assessment of the concrete operational thought. The results of survey also lead to an exploratory study of drop outs of children with specific levels of cognitive abilities. This indication of link between cognitive level and drop outs provoked two more explorations – one into classroom processes and other into content analysis of textbooks.

By the way of research operations things happened in the following order: cognitive survey, analysis of task battery, analysis of the construct of concrete operational thinking, and then work on drop outs, classroom observations and textbook analysis. However the following results will be presented in a more logical and conventional order of a research study, that is, analysis of task battery, analysis of the construct, results of survey and then results of on drop outs, classroom observations and textbook analysis.

Psychometric Characteristics of the Task Battery

The analysis of the cognitive development task battery which was not assembled as a psychometric instrument, showed that that it came up to the expectations for which it was used. It was assumed that its tasks will cover the entire range of concrete operational thinking. From the familiarity with Piagetian literature, it was assumed that one to one correspondence is the lowest level task in the battery. Some aspects of volume, classification, perspective and class inclusion were expected to be that of mature concrete operational levels. The analysis of this task battery showed that the above assumptions were correct. However, now it was important to determine the fine details of relations of other items to the lower and upper markers of the scale. It was also to be seen that the performance of those children who were given a particular overall cognitive level was consistent irrespective of the fact that they are in class 1, 3, or 5. If so this would be the only justification of separating class or age from cognitive development. In other words if a child of class 1 is, for instance, at the middle of concrete operational stage (2A/B), his performance on various tasks will be identical to a child of class 3 or 5 if that child is also at 2A/B.

The results of discrimination-level analysis of the battery is shown in Table 3.1. As pointed out earlier, all tasks were not given to all classes.

Table 3.1
67% Discrimination-Levels and Percentage of Children Passing an Item at Each Level

	Overall Cognitive Level of Assessment							Discrimination-Level			
Task	Pre-operationa	1B	2A	2A/2B	2B	2B/3A	Total Sample	Class 1	Class 3	Class 5	Total Sample
Class 1	**10**	**17**	**30**	**59**	**4**	**0**	**360**				
1:1 Correspondenc	10	88.2	100	100	100		96.9	2.2			2.2
1:1 Correspondence	0	82.3	93.3	96.6	100		91.9	2.3			2.3
Class 1 and 3	**10**	**17**	**36**	**104**	**68**	**5**	**360**				
Liquid I	0	23.5	72.2	87.5	98.5	100	83.9	3.1	?		3.39
Liquid II	0	5.9	58.3	86.5	98.5	100	81.9	3.8	3.5		3.8
Weight I	0	5.9	41.7	89.4	98.5	100	81.7	4	4.1		4.02
Weight II	0	5.9	22.2	82.7	95.6	100	72.2	4.3	4.2		4.24
Class 1, 3 and 5	**10**	**17**	**42**	**144**	**131**	**16**	**360**				
Seriation I	20	70.6	90.5	99.3	100	100	95	2.4	?	?	2.42
Seriation II	0	5.9	59.5	86.1	96.2	100	80.6	4	3.5	4.1	3.77
Seriation III	0	0	33.3	55.6	77.1	100	60.3	5.3	5.2	4.3	5.02
Water Level I	40	47.1	85.7	88.2	95.4	100	86.9	3.1	?	?	3.01
Water Level II	0	0	9.5	7.6	26	81.3	17.2	?	6.2	6.3	6.24
Volume I	10	0	7.1	49.3	82.4	100	53.1	5.2	4.9	5.1	5.03
Volume II	0	0	0	1	16.8	68.8	9.4	?	6.1	6.8	6.46
Area I	0	23.5	28.5	59.7	77.1	87.5	58.6	4.5	5.1	4.5	4.9
Area II	0	5.9	28.5	44.5	68.7	87.5	48.9	4.8	5.3	6.7	5.42
Time I								3.5	<1	<1	
Time II								>5	4.4	<1.5	
Length I	0	0	21.4	78.5	95.4	93.8	70.8	4.3	4.3	4.3	4.29
Length II	0	0	9.5	46.5	91.6	87.5	51.7	5.2	4.9	5	4.95
Classification I	0	17.6	61.9	84.7	97.7	100	78.9	3.8	3.5	4	3.71
Classification II	0	0	28.6	71.5	93.9	100	69.7	4.6	4	4.5	4.39
Classification III	0	0	21.4	51.4	74	100	55.3	5.3	4.6	5.5	5.18
Class 3 and 5	**0**	**0**	**12**	**85**	**127**	**16**	**360**				
Mountain I			25	23.5	52.8	56.3	31.9		6.1	?	>6
Mountain II			0	0	4.1	18.8	2.8		>7	>7	>7
Plumb Line I			25	23.5	66.9	87.5	36.7		5.5	5.5	5.56
Class Inclusion I			8.3	12.9	20.5	18.8	13.6		>7	>7	>7
Class Inclusion II			0	2.4	11	18.8	5.6		>7	>7	>7
Class 5	**0**	**0**	**6**	**40**	**63**	**11**	**360**				
Perspective I			16.7	40	77.8	90.9	29.2			5.2	5.21
Perspective II			0	15	47.6	63.6	18.1			6.7	6.7
Perspective III			0	2.5	12.7	18.2	4.7			>7	>7

The number of subjects at each level are shown in bold. The question mark indicate that due to too few children at this level, estimate was not posible.

A central core of seven tasks were given to all classes. Initially class 1, 3, and 5 samples were seperately analysed to check if the task levels relative to each other varied with respect to ages. Here three classes were taken as representative of three age groups. The tasks given to different classes had a large variation of difficulty levels for various classes. Therefore, it was a strong test. The results showed that in most cases the difference in task levels between classes were satisfactorily small, and there was no trend with class/age. In order to point out significance of discrimination-level differences, with each class containing 120 children, two standard errors of a percentage in the middle of the scale is 9% which, linearly transformed onto the discrimination-level scale of 7 units, is 0.6 of a unit. None of the values was this far from the mean with one pronounced exception of Time I item, and to a small extent, Area II. For this reason Time was omitted from the scoring decisions on which the data analysis was based. Area had a fairly wide discrimination range within the battery. Any trend with the age is though opposite to what one might expect. All the three classes were then amalgamated, and discrimination levels were calculated. These are shown in the last column of Table 3.1. The column giving difficulty values contain some tasks which were not given to all the children. To compute these difficulties it was assumed that a child who was not given a task would show the same proportion of success which a child of a different class but the same overall cognitive level showed at a particular task. This step is justified as it has already been shown that age has not effect on the task level.

Reliability of the Task Battery

One significant check on the task battery was its reliability. The estimates of reliability were available from the alpha factor analysis. In alpha factor analysis one seeks to define factors which have maximum genralizibility, the measure of which is known as *Kuder-Richardson reliability coefficient* or *Cronbach's Alpha* (Kim, 1975).

The first factor, significance of which will be discussed later, estimated reliability of 0.97 for class 1, 0.93 for class 3 and 0.91 for class 5. However, when tasks of Mountain and Plumb Line were omitted from the analysis of class 3 so this class becomes comparable with class 1, the alpha reliability improved to 0.95. Even from psychometric standards this is considered as a fairly high reliability.

Results of Analysis of Concrete Operational Thought

The first assessment of the construct of concrete operational thought was determining a level, if any, at which a child's thinking is equilibirated. This should shows in dis-appearance or substantial reduction in variations of his performance in various tasks of concrete operational levels. This followed Flavell and Wohwill (1969), Wohwill (1973) and Longeot (1978). The results of this analysis are shown in Table 3.2.

Table 3.2

Test of Lengeot Model: Percentage of Success Assessment at Each Level.

	Level of Assessment						
Task	*1A*	*1B*	*2A*	*2A/B*	*2B*	*2B/3A*	*Location of nodes*
Seriation I	20	71	91	100	100	100	
1: Correspondence	10	82	93	97	100		
							Node 1
Classification I	0	18	62	85	98	100	
Liquid II	o	6	58	89	99	100	2A range
Seriation II	0	6	60	86	96	100	
Classification II	6	29	72	94	100		
Weight II	0	6	22	83	96	100	2A/B range
Length I	0	0	21	79	95	94	
							Node 2
Length II	0	0	10	47	92	88	
Seriation 3	0	0	33	56	77	100	
Classification 3	0	0	21	51	74	100	2B range
Volume 3	0	0	7	49	82	100	
Area II	0	6	29	44	69	88	
							Node 3
Mountain I			7	14	51	56	
Plumb Line I			7	14	65	88	2B/3A
range							
Water Level II	0	0	10	8	26	81	
Volume 3	0	0	0	1	17	81	

The results shown in Table 3.2 do not fit into a model of development as proposed by Flavell and Wohwill (1969), Wohwill (1973). These also do not completely fit either with Longeot (1978) but appear to be closer to that.

Table 3.3
Factor Analysis of Cognitive Development Task Battery

Type of Analysis	Factor	Class1	Class3*	Class3	Class5
		Principal component analysis (% of variance)			
Estimate of mean signal/ noise ratio for each task	1	37.5	33.5	28.4	21.2
	2	14.6	16.5	14.2	14.0
	3	-	-	11.3	13.2
Total		52.1	49.4	53.9	48.4
		Factor analysis – SPSS PA-2 (% variance)			
Estimate of proportion of signal attributed to each factor	1	78.6	73.0	60.6	57.7
	2	21.4	27.0	24.0	24.1
	3	-	-	15.0	18.2
		Alpha factor analysis (alpha reliabilities)			
Estimate of relative significance of each factor	1	.97	.95	.93	.91
	2	.54	.61	.66	.61
	3	-	-	.37	.44

Note: These analyses omitted the Mountain and Plumb Line tasks for comparison with class 1.

These results support presence of horizontal decalage in the development of concrete operational thought. There is divergence and convergence at more than one point, hence three nodes rather than one at the beginning of 2A.

The other important test applied to the task battery data was factor analysis. The results of this analysis are shown in Table 3.3.

These results show that if a single Piagetian task is used as an estimate of cognitive level, the signal/noise ratio is about 50/50. However, the use of task battery, which is assumed to be measuring a unitary ability, has improved this ratio to 90/10. In terms of validity, the results show that only 20% of the common factor variance requires another one or two more factors for a complete description of cognitive abilities, but the reliability of these factors is low and can be neglected as the first approximation. The same was done by Cattell (1971) in describing a general fluid intelligence factor. Because extra factors are strongly correlated with the first factor, the results give a strong support to considering the concrete operational thought a unitary construct.

In order to determine factor structure of the construct of concrete operational thought all the three class were analyzed separately. Table 3.4 shows the results.

Table 3.3

Factor Structure of Each Class and Class 3 and 5 Combined (After Varimax Rotation)

	Cla ss 1		Class 3			Class 5			Class 3 and 5 combined				
	1	2	1	2	3	1	2	3	1	2	3	4	h2
Task													
Correspondence	0.31	0.5	*	*	*	*	*	*	*	*	*	*	*
Liquid	0.63	0.32	0.35	0.54	*	*	*	*	*	*	*	*	
Weight	0.58	0.31	0.54	0.37	*	*	*	*	*	*	*		
Volume	0.55		0.42					0.54	0.54				0.34
Area	0.39	0.26	0.52					0.39	0.26		0.27		0.14
Length	0.75		0.64			0.39			0.66	0.36			0.58
Seriation	0.26	0.69		0.43				0.54		0.33			0.15
Classification		0.61	0.48			0.57			0.32				0.13
Class Inclusion	*	*	*	*	*	*	*	*					0.07
Water Level		0.43		0.57	0.25	0.37				0.63			0.41
Mountain	*	*			0.44		0.26					0.49	0.25
Plumb Line	*	*		0.27	0.5		0.73			0.38		0.35	0.29
Perspective	*	*		*	*	0.38	0.32			*	*	*	*
Time	*	*	*	*	*	*	*	*			0.73		0.57

Note: * indicates that a task was omitted from analysis. Loading below 0.25 are omitted.

Table 3.4 indicates that Class 1 gives a two factor solution. While there was only one spatial task in class 1, data of two more spatial tasks were available in Class 3. These have substantial correlation with other task but the factor structure is not as clear as in class 1. This may be explained by the lack of good spread of sample in class 3 and 5, a fact which will be discussed in the results of survey. This characteristic of sample of class 3 and 5 may have made inter-task correlation low and have increased the tendency of data matrix to split into small factors. Class 5 again show spatiality as a factor but nothing else seems to be clear. A sub sample was created by combining class 3 and 5 (n=240) to look into the relation of tasks omitted earlier in the analysis to those retained. Again there is a spatial factor, 4, but two spatial tasks, Water Level and Plumb Line also appear in Factor 2 showing their correlation with other tasks. Time, as expected from the earliest explorations of the data continues to be odd entity, appearing almost as a factor on its own.

The above analysis shows that as long as spatial tasks do not enter to spoil the picture, factor analysis yield to two clean factors picture – conservation and what the other can be called logico-verbal tasks, represented by correspondence, seriation and classification. This may provide a support to Lengeot (1978) that some mental abilities other than cognitive may explain horizontal decalage.

Cognitive Development Stages of Primary School Children

After establishing the validity of cognitive development task battery as an instrument which discriminates children at various stages of their cognitive development and also establishing the status of concrete operational though as a valid construct, the results of cognitive development survey can be presented with a degree of confidence.

Figure 3.1 and Table 3.4 gives an overall picture of cognitive development stages of primary school children in Pakistan. It may be noted that it is a merged data of class I, 3 and 5 (N=360), which includes boys, girls, rural, urban children of all the four provinces.

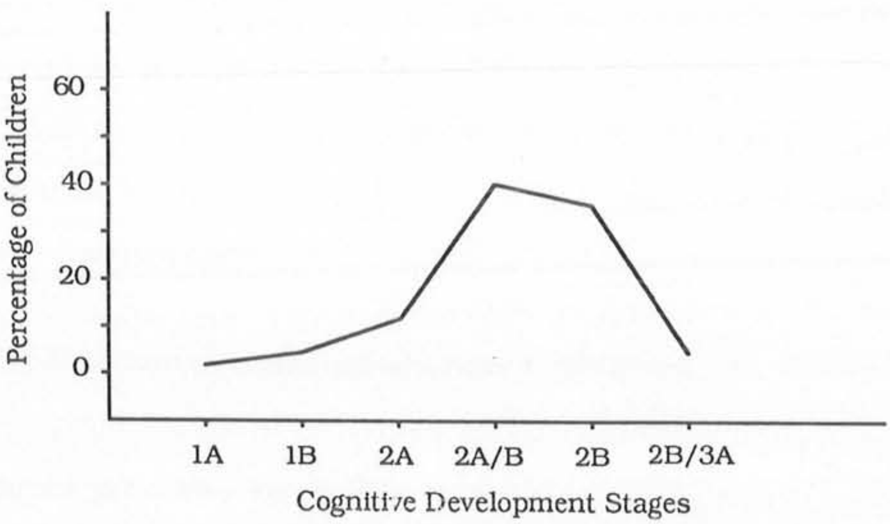


Figure 3.1. Cognitive Develoment Stages of Primary School Children

Table 3.4

Cognitive Development Stages of Primary School Children. (N=360)

Stages	*No.*	*%*
1A	10	2.70
1B	17	4.72
2A	42	11.66
2A/2B	144	40.00
2B	131	36.10
2B/3A	16	4.44

One assumption with which this study was undertaken was proved in Table 3.4. Primary school age is the period of concrete operational thinking. With the exception of 7.42 %, all children were at various levels of concrete operational stage. The largest group was right in the middle of this stage, 2A/B. Just a marginal number of children (4.44%) crossed this stage but were not yet at formal operational level. They were at a transition between concrete operational thinking and formal operational thinking of cognitive development.

Cognitive Development Stages of Class I Children

Figure 3.2 and Table 3.5 shows the developmental stages in Class I children.

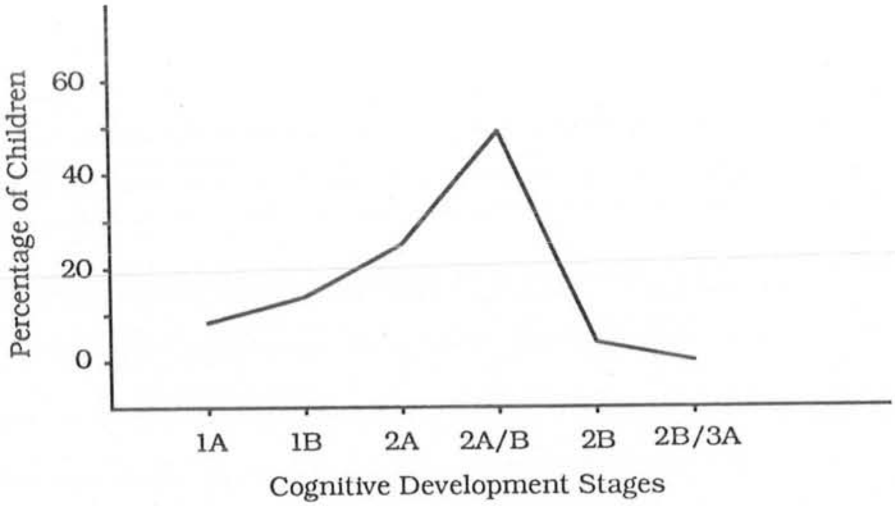


Figure 3.2. Cognitive Develoment Stages of Class 1 Children

Table 3.5

Cognitive Development Stages of Class 1 Children. (N=120)

Stages	*No.*	%
1A	10	8.30
1B	17	14.16
2A	30	25.00
2A/2B	59	49.16
2B	4	3.33
2B/3A	0	0.00

There is always a strong temptation to mention ages of children while discussing their developmental stages. As discussed above, there was sufficient reason not to confuses ages with stages. However, it is a well established fact that classes in Pakistan schools have children of mixed ages and this situation is likely to continue for a long time. Therefore, mentioning classes rather than ages was a sound strategy. Educational practices will continue to depend upon the school classes - whatever may be the ages of children. Despite mixed ages, cognitive abilities of Class I children as a group remain very important. Development of mental operations is an important qualitative change in the intellectual abilities of children. For 22.46 % of children who are at 1A & 1B stage, this change takes place in Class I. These children use distinctively different mental strategies than rest of about 78 % who are at various levels of the concrete level thinking. The majority of Class I children can handle concrete operations at elementary level. An important segment (49.16%) have reached to a middle point of development towards concrete operational thinking. There are negligible number of children (3.33%) who can use mature concrete operational strategies for dealing with educational experiences. These findings suggest an educational strategy where children's transition from pre-operational level to concrete-operational level need to be helped and consolidated. About 74% of children can handle or can try to consolidate elementary notions of concrete operational thought.

Dispersion of Cognitive Stages in Class I Children

Figure 3.2 and Table 3.5 indicate that the spread of number of children on different stages, more or less follows a normal distribution.

Keeping in mind the social, cultural and economic diversity of Pakistani society and realising the fact that only about 50 % of the school going age children go the schools,, one cannot expect that the distribution of any parameter of mental abilities of children in Class 1 would follow distribution of a normal curve. One can make an assumption that children with better mental abilities are enroled in the school while children with lesser abilities have a lesser chance of being in school. However this assumption is not being proved in the case of cognitive development abilities. Despite social, cultural and economic disparity in children's background, Class I children in the schools indicate normal distribution of cognitive abilities.

Cognitive Development Stages of Class 3 Children

Figure 3.3 and Table 3.6 show the findings on cognitive development stages of Class 3 children.

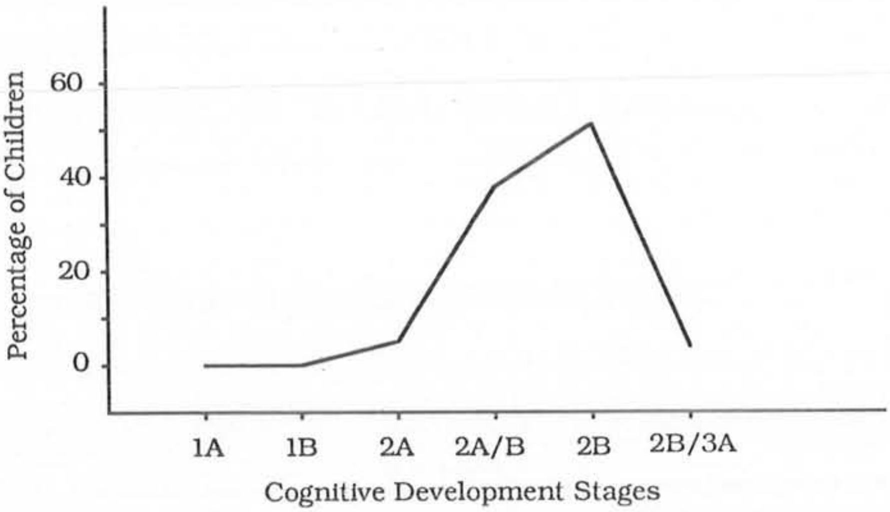


Figure 3.3. Cognitive Develoment Stages of Class 3 Children

Table 3.6
Cognitive Development Stages of Class 3 Children. (N=120)

Stages	*No.*	*%*
1A	0	0.00
1B	0	0.00
2A	6	5.00
2A/2B	45	37.50
2B	64	53.30
2B/3A	5	4.16

A majority of children in Class 3 (53.3 %) are clustered at the middle of concrete operational stage of cognitive development. There are some children (5%) still at the early stage of concrete operational thinking, some have reached to its mature level while just a negligible number (4.16%) have crossed this stage and have just started approaching some form of formal operational thinking. As discussed earlier 2B/3A is not a proper formal operational stage. Rather it is a transition between the mature concrete operational and early formal operational thinking.

Dispersion of Cognitive Stages in Class 3 Children

Figure 3.3 indicates that there is lesser dispersion in the cognitive abilities of Class 3 children. Comparing with expected normal distribution, there is a clustering at 2B stage in Class 3 children. Moreover, there are more children towards higher cognitive levels than towards the lower levels. There are only 5% children at the first three stages in comparison to 95% at the higher three stages. Implication of this lack of a better dispersion will be discussed later on but it may be noted here that the sort of distribution we noticed in Class I is not there any more in Class 3 children.

Cognitive Development Stages of Class 5 Children

Figure 3.4 and Table 3.7 shows the cognitive levels of Class 5 children.

The majority of children (52.5%) continues to stay at the middle of concrete operational thinking even in Class 5 . However, the ratio of children who have crossed the limit of mature concrete operational thinking has increased from 4,16 % in class 3 to 9.16 % in class 5. This shift is small but indicate the general developmental trend.

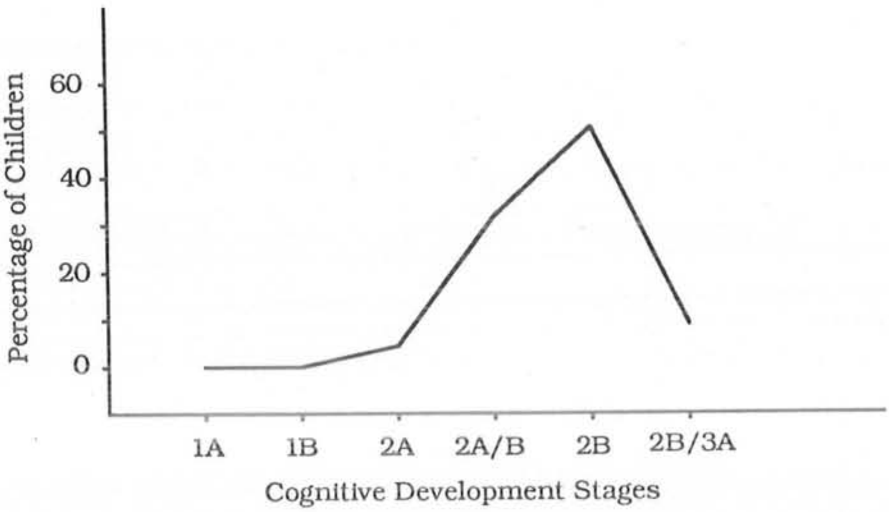


Figure 3.4. Cognitive Develoment Stages of Class 5 Children

Table 3.7
Cognitive Development Stages of Class 5 Children. (N=120)

Stages	*No.*	*%*
1A	0	0.00
1B	0	0.00
2A	6	5.00
2A/2B	40	33.33
2B	63	52.50
2B/3A	11	9.16

The results in Table 3.7 shows that 38.3% of Class 5 children are still at early or middle stages of concrete operations. The development of cognitive abilities from class 3 to class 5 appears to be marginal.

Dispersion of Cognitive Stages in Class 5 Children

Figure 3.4, by and large, repeats the pattern obtained in Figure 3.3 showing cognitive stages of Class 3 children.

The majority, just like class 3 is at 2B. At the lower end, again just like class 3, 5% children are at early concrete operational level. As expected one finds more children on the higher side of middle level of concrete operations but as far as the expectations of a normal distribution are concerned, the lower side of this curve also continues to remain lopsided.

Comparison of Development Stages in Class 1, 3, and 5 Children

Fundamentally being a developmental study it was an obvious assumption that cognitive development over the Class, 1, 3 & 5 should be there. Figure 3.5 and Table 3.8 clearly show that cognitive development is taking place from Class 1 to Class 3 and from Class 3 to Class 5.

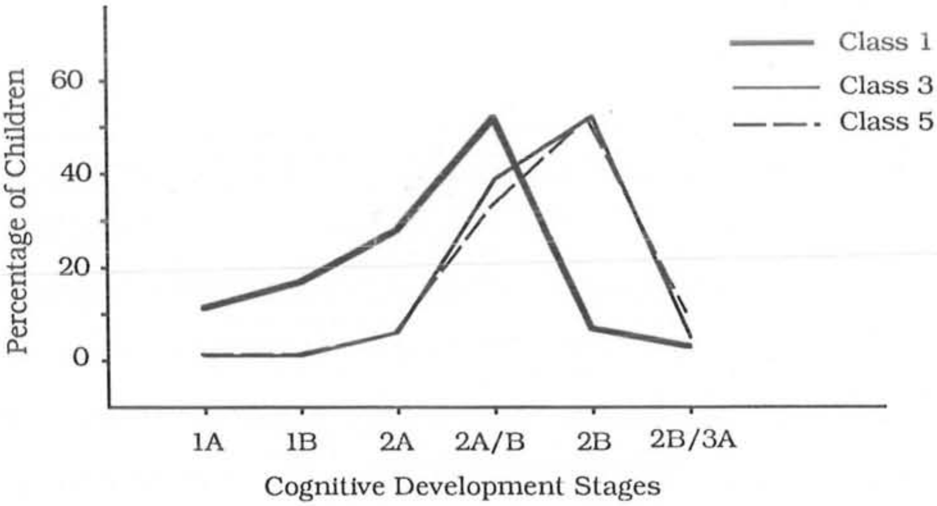


Figure 3.5. Cognitive Develoment Stages of Class 1, 3 and 5 Children

Table 3.8

Cognitive Development Stages in Class 1, 3 & Children. (N=360)

	Classes					
	1		3		5	
Stages	No.	%	No.	%	No.	%
1A	10	8.30	0	0.00	0	0.00
1B	17	14.16	0	0.00	0	0.00
2A	30	25.00	6	5.00	6	5.00
2A/B	59	49.16	45	37.50	40	33.30
2B	4	3.33	64	53.3	63	52.50
2B/3A	0	0.00	5	4.16	11	9.16

As can be seen in Table 3.8, as the children go into the higher classes (from class 1 to class 5) their number at the lower cognitive stages keeps on reducing and in contrast to this, their number keeps on increasing at the higher stages. Figure 3.5 shows the difference in cognitive abilities of children in different classes. It is imposition of stages of three classes on one diagram. Cognitive developmental trend in the transition from class 1 to class 3 is marked. However, at the same time, a great deal of overlaps of cognitive abilities between class 1 and class 3 and even between class 1 and class 5 cannot be ignored. The dispersion in class 1 is wide and covers four developmental stages, that is, 1A, 1B, 2A/B and 2B.

Considering the wide spread of ages, as discussed above, it was not an unexpected result. Class 1 is a mixed cognitive ability group. Some of these are at a very early stage of cognitive development, called pre-conceptual stage (1A), while some others have gone as far as late concrete operational (2B) stage. As far as addressing to specific cognitive structures of children is concerned, it is difficult to communicate with both types of children. However, for about 74% of Class 1 children, it is being at early or late concrete operational stage, two contingent stages involving basically same strategies of varying complexity. Educational implications of this situation will be discussed later but it may be noted here that beside more or less following expected normal distribution, these findings are generally expected in the sort of group (Class 1) we are dealing with. Comparison of cognitive abilities of Pakistani children with children of anywhere else, is likely to invoke a highly legitimate interest.

However, although such comparisons are very common, these require task batteries with comparable scales.

Class 3 is clearly distinguishable from Class 1. There are only 5% of children at 2A stage while in Class 1, 47.46% of children were at 2A or lower than 2A stages. In Class 1, 49.16% reached at middle of concrete operational thought while in Class 3 as many as 95% were at middle or higher than middle concrete operational level. Similarly there are obvious differences of the higher cognitive abilities between Class 1 & 3. There are just 3.3% of Class 1 children at mature concrete operational thinking while in Class 3, the percentage at this stage is 53.3. Not a single child of Class 1 has gone beyond late concrete operational stage while there are few (4.16%) children in Class 3 who reached this level.

The difference between Class 3 and Class 5 are not as marked as between Class 1 and 3. However, except 2A level, where there are same 5% of children in Class 3 and 5, the developmental trend, although not very marked, is consistent at all development levels. Higher the class, more children at the higher levels, lower the class more children at lower levels. Despite this trend Class 3 and Class 5 are not very different from each other. We find majority of children in both classes at the middle of concrete operational level. However, there are more children in Class 5 who can use late concrete operations (2B) and can go even somewhat beyond that to 2B/3A. Both the children of Class 3 and 5 can employ same operational strategies but with varying levels of ease. It can also be said that although the Class 3 and Class 5 children have more or less same cognitive structures available to them, the effective use of these structures will differ: Class 5 will use these with greater facility and flexibility while Class 3 will be a little restrained in fully employing the available structures.

Dispersion of Cognitive Stages in Class 1, 3, and 5

If one keeps in mind the expectations of a normal distribution, the trend of curves in Figure 3.5 becomes very striking. The curve of Class 1 seems to follow more or less a normal distribution. While the curves of Class 3 and and Class 5 present a different picture. Here we see a spike at 2B level followed by a sharp drop towards 2B/3A. However, on the left side of these curves we see just 5% of cases at 2A and nothing before that. These are positively skewed curves with a concentration of cases in the middle and mature concrete operational thinking.

In all those variables which are assumed to be related to the development, it is expected that with the increase in age the net quantity of that particular variable will also increase. Physical attribute in children such as height and weight are clear examples. The same is also expected in the psychological variables dependent upon development or age. As the age of children increases, the range of variation will also increase. Those children who have higher rate of development will develop further ahead. On the other hand children with slower development will lag further behind and will give a long "tail" to the distribution. With this assumption, it would have been expected that distribution of cognitive abilities in Class 3 and Class 5 children will be even more widely spread out than that of Class 1 children. However the above evidence is contrary to this expectation. The spread of distribution in Class 3 and Class 5 is much less than in Class 1. Not only the lesser dispersion is peculiar, the lower ends of the class 3 and class 5 curves seem to have been chopped off. Following the normally distributed trend in Class 1, more cases of lower cognitive abilities were expected in class 3 and class 5 children.

Sex Differences in Cognitive Stages

Considering the marked differences in sex roles in Pakistani society, one can expect differences between boys and girls of primary school of Pakistan. Table 3.9 is a comparison of cognitive stages in boys and girls in all the three classes of primary schools.

As can be seen from Table 3.8 the difference between cognitive stage of girls and boys are not significant. It becomes obvious if we look at it carefully that if there are differences in one direction at one stage, these are cancelled out at another stage with a reverse direction of differences. For instance, at 2B level there are fewer girls (43.3 %) than boys (63.3 %). However, in class 5 at the same 2B level now there are fewer boys (48.3 %) and more girls (56.7 %).

Table 3.9
Sex Differences in Cognitive Development Stages in Primary Schools of Pakistan.

	No. of Children at Stages					
	1A	1B	2A	2A/B	2B	2B/3A
Class 1, 3, and 5						
Girls	4	11	21	75	62	7
	(2.2)	(6.1)	(11.7)	(41.7)	(34.4)	(3.9)
Boys	6	6	22	68	59	9
	(3.30	(3.3)	(12.2)	(37.8)	(32.8)	(5.0)
Class 1						
Girls	4	11	14	29	2	0
	(6.7)	(18.3)	(23.3)	(48.3)	(3.3)	(0.0)
Boys	6	6	16	30	2	0
	(10.0)	(10.0)	(26.7)	(50.0)	(3.3)	(0.0)
Class 3						
Girls	0	0	4	28	26	2
	(0.0)	(0.0)	(6.7)	(46.7)	(43.3)	(3.3)
Boys	0	0	2	17	38	3
	(0.0)	(0.0)	(3.3)	(28.3)	(63.3)	(5.0)
Class 5						
Girls	0	0	3	18	34	5
	(0.0)	(0.0)	(5.0)	(28.3)	(56.7)	(8.3)
Boys	0	0	4	21	29	6
	(0.0)	(0.0)	(6.7)	(35.0)	(48.3)	(10.0)

Note: Percentages are given in parentheses.

Differences in Cognitive Stages of Urban and Rural Children

Table 3.10 indicates that differences between rural and urban children are also insignificant in all the three classes.

Table 3.10

Differences in Cognitive Development Stages of Rural and Urban Children.

	No. of Children at Stages					
	1A	1B	2A	2A/B	2B	2B/3A
Class 1, 3, and 5						
Girls	5	9	20	70	69	7
	(2.8)	(5.0)	(11.1)	(38.9)	(38.3)	(3.9)
Boys	5	8	22	74	62	9
	(3.8)	(4.4)	(12.2)	(41.1)	(34.4)	(5.0)
Class 1						
Girls	5	9	15	28	3	0
	(8.3)	(15.0)	(25.0)	(46.7)	(5.0)	(0.0)
Boys	5	8	15	31	1	0
	(8.3)	(13.3)	(25.0)	(51.7)	(1.7)	(0.0)
Class 3						
Girls	0	0	2	24	31	3
	(0.0)	(0.0)	(3.3)	(40.0)	(51.7)	(5.0)
Boys	0	0	4	21	33	2
	(0.0)	(0.0)	(6.7)	(35.0)	(55.0)	(3.3)
Class 5						
Girls	0	0	3	18	35	4
	(0.0)	(0.0)	(5.0)	(30.0)	(58.3)	(6.7)
Boys	0	0	3	22	38	7
	(0.0)	(0.0)	(5.0)	(36.7)	(46.7)	(11.7)

Note: Percentages are given in parentheses.

Development of Cognitive Structures in Primary School Children

The data of the task battery in its original form was behavioural descriptions of primary school children. These descriptions were translated into levels of development in specific stage characteristics of concrete operational thinking. These behavioural descriptions, as recorded in the task protocols, according to Piagetian theory of cognitive development, are manifestations of mental structures of children. For educational point of view assessment of a child's development on these structure is very significant. Therefore, it is also important to look into performance of children in individual tasks. It may be noted here that these results are being discussed in terms of all the items representing response categories of tasks. The following description are more in the spirit of clinical method rather than psychometric characteristics of these item. The figures and percentages of success on various items of different tasks refer to the analysis of original task protocols. The main purpose of this section is description of children as they respond while invoking cognitive structures to situations demanding a particular level of mental development. Therefore, it is important to refer to the description of cognitive development task battery which is enclosed at Appendix A. The item numbers here refer to the items numbers in the task battery and are not related to the convention of designating developmental stages in Piagetian literature.

One to One Correspondence. Assessment of children in one to one correspondence task is based upon two items. The first item identifies children who have some elementary notion of correspondence while the second item discriminates those children who have mastered one to one correspondence. As correspondence is a structure which develops just towards the culmination of pre-operational stage, this task was administered to only class 1 children.

Table 3.11

Results of One to One Correspondence in Class 1 Children (N=120)

Item	No.	%
2	17	14
3	103	86

Table 3.11 indicates that with the exception of 14% children, all the remaining 86% children in Class 1 have mastered the concept of One to One Correspondence.

Almost all the tasks on various aspects of conservation distribute children into three categories: (1) Children lacking a cognitive structure to conserve; (2) Children on transitional stage who are able to elicit some indication of the development of structure. However the structure is neither stable nor the child is able to apply it in various situations; (3) Children with clear evidence of a fully developed cognitive structure which is highly stable and the child is able to apply it in various situations.

Conservation of Liquid. This task is also called conservation of continuous quantities. Children are distributed in three categories on this task. Item 1 identifies children who are clearly non-conservers. While children on item 2 are in transition and children on item 3 have definite cognitive structure to conserve liquid. In Class 1 about half of the children (58%) have cognitive scheme to conserve liquid while as many as 35% are clearly non-conservers and have no idea of conservation of continuous quantities. For these children it is not possible to separate the contents from the container.

Table 3.12
Results of Conservation of Liquid in Class 1 & 3 .(N: 240)

	Class 1		Class 3	
Item	No.	%	No.	%
1	42	35	6	5
2	8	7	2	2
3	70	58	112	93

In Class 3 the situation changes dramatically. Now almost all (93%) children have complete mastery of this concept.

Conservation of Weight. Conservation of weight is also achieved in Class 3 by 89% children while in Class 1 there are almost half the children who have a fully stabilized notion of conservation of weight.

Table 3.13
Results of Conservation of Weight in Class 1 and 3. (N=240)

	Class 1		Class 3	
Item	No.	%	No.	%
1	52	43	8	7
2	11	19	5	4
3	57	48	107	89

Seriation. As can be seen from the Table 3.14, seriation is a structure which develops rather gradually over Class 1, 3 and 5. Even in Class 5, 68% of children lack complete mastery of this notion. On the other hand, 10% of Class 1 children have already attained this concept.

Table 3.14
Results of Seriation in Class 1, 3 and 5. (N=360)

	Class 1		Class 3		Class 5	
Item	No.	%	No.	%	No.	%
1	32	27	10	8	1	1
2	76	63	89	74	80	68
3	12	10	21	18	39	32

Water Level. Majority of children even in Class 5 continue to lack a cognitive structure to understand and apply the concept of horizontality in the context of water-level. However, in all the

Table 3,14

Result of Water Level in Class 1 , 3 and 5. (N=360)

	Class 1		Class 3		Class 5	
Items	No.	%	No.	%	No.	%
1	17	14	2	9	0	0
2A	34	28	9	8	8	7
2B	32	27	29	24	17	14
3	37	31	80	67	95	79

three classes most of the children are in a transitional phase where they start to be unstable at a situation where water always stays parallel with the bottom line of a vessel. However, they are not able to dissociate the water level from the position of the container completely.

Conservation of Volume. Acquisition of conservation of volume is very low in the primary school children. However, it is not unexpected as the task set up for understanding the concept of volume refers to displaced volume which is a fairly high order notion. It is expected to develop with the onset of formal operational thinking.

Table 3.15

Results of Conservation of Volume in Class 1, 3 and 5. *(N=360)*

	Class 1		Class 3		Class 5	
Items	No.	%	No.	%	No.	%
1	90	75	36	30	39	33
2A	27	23	57	48	67	56
2B	4	1	5	4	4	3
3	2	2	14	12	7	6
4	0	0	8	7	3	3

Conservation of Area. Development of conservation of area is also gradual in the primary schools. Even in Class 5 only half of the children have mastery of this notion and as many as 33% are almost incapable to handle it.

Table 3.16

Results of Conservation of Area in Class 1, 3 and 5. (N=360)

	Class 1		Class 3		Class 5	
Items	No.	%	No.	%	No.	%
1A	11	9	0	0	0	0
1B	51	43	43	36	39	33
2	12	10	8	7	18	15
3	46	38	69	58	63	53

Conservation of Length. A very large number of children in Class 3 (73%) have a fully stable structure to understand the notions involved in conservation of length. Even in Class 1, 37% have attained conservation of length.

Table 3.17

Results of Conservation of Length in Class 1, 3, and 5. (N=360)

	Class 1		Class 3		Class 3	
Items	No.	%	No.	%	No.	%
1	64	53	14	12	19	16
2	24	20	18	15	17	14
3	32	37	88	73	84	70

Classification. Classification as a cognitive structure covers a spectrum of abilities. The task set up to understand the developmental stages of children elicits many behavioural possibilities. Therefore, in contrast to other tasks, it contains seven items.

Table 3.18

Results of Classification in Class 1, 3 and 5. (N= 360)

	Class 1		Class 3		Class 5	
Items	No.	%	No.	%	No.	%
0	9	8	1	1	6	5
1A	41	34	4	3	6	5
1B	21	18	11	9	8	7
2A	19	16	15	13	23	19
2B	15	13	4	3	18	15
2C	14	12	81	68	48	40
3	1	1	4	3	11	9

As can be seen, true logical concept of classification is rather negligible (9%) in even class 5. However 40% of class 3 & 5 children are very close to achieving this concept.

Time. As discussed earlier, the task of time has proved to be a poor task. The results on items of this task are being reproduced in Table 3.19. However, it is not appropriate to give much meaning to these results except that these describe children's responses on these items.

Table 3.19

Results of Time, in Class 1, 3 and 5. (N=360)

	Class 1		Class 3		Class 5	
Items	No.	%	No.	%	No.	%
1	21	18	0	0	0	0
2	70	58	30	25	9	8
3	29	24	90	75	111	93

Mountain. Majority of children in Class 3 & 5 continue to lack any notion of horizontality as evoked in the context of the mountain problem. Only 3% in class 3 and 5% in class 5 attained mastery in it.

Table 3.20

Results of Mountain in Class 3 and 5. (N=240)

	Class 3		Class 5	
Items	No.	%	No.	%
1A	9	8	10	8
1B	66	55	56	47
2	42	35	48	40
3	3	3	6	5

Plumb Line. Cognitive scheme to solve the problem of plumb line is available only in 13% of Class 3 children and 21% of Class 5 children. Majority of children in both of these classes are at the lowest item of the task.

Table 3.21

Results of Plumb-Line in Class 3 and 5. (N=240)

Item	Class 3		Class 5	
	No.	%	No.	%
1	61	51	57	48
2	44	37	38	32
3	15	13	25	21

Class Inclusion. Class inclusion task and the concept as treated in Piagetian research has raised many controversies. Results of this task should be considered carefully as it also involves linguistic intervention. According to the results obtained a very large majority of children in Class 3 & 5 (92 % & 72 % respectively) are far away from achieving any clarity in this concept. Only 2% of Class 3 and 14% of Class 5 children have been able to evoke a cognitive structure where differentiation between class and sub-class could be understood.

Table 3.22

Results of Class Inclusion in Class 1, 3 and 5. (N=240)

	Class 3		Class 5	
Item	No.	%	No.	%
1	110	92	86	72
2	8	7	17	14
3	2	2	17	14

Perspective. As it was not expected that class 3 children would have cognitive structures to attempt this task, only class 5 were given perspective. Only 9% of these children were found to possess the required cognitive structure. This was not an unexpected result as coordination of all the elements required to understand proper notions involved in perspective cannot be expected without some help from formal operational thinking.

Table 3.23

Results on Perspective in Class 1. (N=120)

	Class 5	
Item	No.	%
1A	43	36
1B	35	29
2A	3	3
2B	28	23
3	11	9

Drop outs in Class 1 Children

With the availability of the results of the task battery and the analysis of its psychometric characteristics, it was possible to divide class 1 children into two categories. These categories were called cognitive status of children. The cut point was decided to be a stage prior to the middle of concrete operational thinking, that is, 2A/B. All the class 1 children in four schools of Punjab (Girls' and boys'; and rural and urban) were divided into two categories, (a) Pre-concrete operation thinkers, and (b) concrete operational thinkers. Table 3.24 show the number of children in these two categories.

Table 3.24

Cognitive Status of Class 1 Children of Punjab

Pre-concrete operational	14
Concrete operational	26
Total	40

Punjab primary schools were re-visited and the records of the children of the sample, who were in class 1 at the time of cognitive development survey, were were followed till the completion of class 2, that is, going to class 3 after class 2 examinations. These 40 children were assigned into five categories as established by Chowdhri (1983). It has been called drop out status here. Table

3.25 show the drop out status and cognitive status of these children.

If following Chowdhri (1983) children are distributed into present and not-present categories, then percentage of not-present in the pre-concrete operational group is 58 while this percentage in the concrete operational children is 42.3. This difference indicates a significant trend. The cognitive status of pre-conceptual children was clearly associated with their being non-present in the drop out status. Although this data is too small for any categorical decision but it clearly support the assumption that cognitive developmental levels can be explored as a factor in drop outs.

Table 3.25
Drop outs and Cognitive Status of Class 1 Punjab Children

	Cognitive Status			
	Pre- concrete		Concrete	
	No.	%	No.	%
Total	14		26	
Drop-out Status				
Drop-out	3	21.4	4	15.3
Failure	4	28.0	4	15.3
Migration-out	1	7.1	2	7.7
Unknown	0	0.0	1	3.8
Present	6	42.8	15	57.7

It may be pointed out here that being in class 1 and being pre-operational thinker is absolutely natural. This finding does not indicate in any way that the cognitive development of class 1 children is retarded. It only shows that with their given cognitive abilities they find it difficult to cope with what is primary education in Pakistan.

Classroom Observations in the Primary Schools

Although it was not a surprising finding, one gets disturbed by putting in writing that out of five classes which were observed without their teachers knowing about it, in three classes teacher was not *taking* the class. In these classes the observation was limited to what children do in the absence of a teacher.

What goes into primary school classrooms is rather well known and was discussed in chapter 1. These observations were made to find out that (a) to what extents concrete experiences are used as bases for educational strategies, and (b) how much references are made to objects, events, or situations familiar to students. The flat answer to these questions is none. There was no indication that primary school teacher has any notion of providing any *experiences* to pupils. A look at an attempt to categorize the activities which take place in the classroom will readily show that what experiences are possible for children and within the context of these activities what role a teacher can play in providing such experiences.

1. A teacher, or a senior pupil, recites something and the rest of the class repeats it.
2. Pupils at their own are busy in making some noises which are initiated by teachers instruction to memorize their *lesson*, ("*Apna sabaq yad karo*"). This is supposed to be recitation at their own but after some careful concentration, at appeared that if not very strictly watched by teacher, these pupil fall beck to either talking or some apparently unrelated activity.
3. Active teaching which mostly means writing on blackboard and occasionally looking into pupils' *takhtis* or notebooks and rarely marking pupils mistakes.
4. Teacher's talking to children.
5. Pupils reciting their lesson when the teachers is listening. This is typically initiated by teacher's command, "Recite your lesson." [*Apna sabaq sunao.*]
6. Children making verbal responses on teachers questioning.
7.. Pupils doing writing work at their own.
8. Teacher helping individual pupils in their writing.

Table 3.26

Percentage of Time Spent in Various Categories of Classroom Activities.

Category	Time Spent
1	32
2	24
3	8
4	4
5	8
6	2
7	14
8	8

Not for once during these 13 observations of 35 minutes each any teacher brought any material object in the classroom, except of course chalks and often a ruler to administer physical punishment. Even at verbal level there is a possibility of invoking concrete experiences but surprisingly, despite lot of emphasis one verbal content of education very little *talking* took place in classrooms. Category 4, which could have been utilized for such interaction is not utilized for this purpose. Most of teachers' talk consisted upon admonishing children on their undesirable behaviour and some sort of sermonizing.

The above observations clearly show that the present primary education is not geared up for either supporting mental development of children nor responsive to mental levels of children. While often talking to teachers their concept of a child's mental level is (a) short memory, (b) lack of attention, and (c) limited vocabulary.

Evaluation of Textbook. in the Context of Cognitive Development of Children

The schools selected for observations were located within the federal territory of Islamabad. Therefore, textbooks used in these schools are supposed to be prepared, printed and prescribed by the Federal Government. However, as mentioned in chapter 1, due to lack of integration in the system, the situation was not very clear. Some teachers in some schools, not being happy with the government books, were using some textbooks published by private publishers.

The Federal Government, under a major policy initiative decided to make primary school curriculum *integrated*. A laudable objective but its only manifestation so far is a set of two textbooks for class 1 which are supposed to teach Urdu, natural sciences, social sciences, mathematics, etc., etc., all in one.

The first booklet is entitled as *Nia Qaida* [New Primer] (Kazmi,1991). It contain one page of notes on teaching method for teacher and *parents*. Among about ten teachers of Islamabad schools only one said that he has read this page but he too could not make anything out of it. The most important innovation in this primer are nine pages of pictures. According to teaching method notes, these are there to help teacher in providing opportunities of seeing, recognising, thinking and talking to children.

The insensitivity of writers and illustrators of the textbook to the mental levels of class 1 children was obvious from page one where within an illustration of a classroom an outline of Pakistan's map has been shown on a wall, as if, perhaps, painted on the wall. The concept of map or Pakistan's representation in this form is absolutely beyond the mantle capacity of class 1 child. The quality of pictures were generally so dull that the intuitive child of class 1 can hardly be attracted towards these. On two pages two stories were illustrated in time sequence in four and five boxes within the same page. Small arrows were drawn to direct child's attention from one box to the next. One can see a lack of comprehension about child's attention and his ability to abstract four or five different incidences in a time sequence from one page. The next five pages had about nine pictures on each page addressing highly varied concepts and also at highly varied levels. The most intriguing was picture of an extracted tooth. A needle was seen along with a hockey stick, the size of needle appeared to be just the same as that of the hockey stick.

The most significant aspect of this new primer is first lesson in reading and writing Urdu which starts on page 10. One word *Aam* was broken in shape (and perhaps intended to be broken down into in sounds as well) of *Aa* and *mem*. This was the beginning of a highly abstract process which can be a significant challenge for cognitive psychologists in Pakistan – how to teach Urdu reading and writing to class 1 children. This textbook was absolutely confusing in its teaching method. Teaching method notes clearly say that children should be taught to recognise composite words but throughout the text words are broken into units *[Jor kay tor]*. Bottom line of each page was a *workbook*. How the manual dexterity of a first time entrant into a school can manage to write one it. This appeared as not of any concern to the designers of this textbook. The all pervasive concept on most of these pages is breaking down of words into various syllables. A poor way to start educating class 1 children. All the words and sentences with their implied meanings were sacrificed for introducing broken down shapes of words. If there is something interesting for the child it is only coincidental. The child of this age, who can manage language quite elegantly for his expression, is bound to be disturbed by this eerie concept of language from this primer as a tool of communication. With a definite consistency all lessons were started with an array of unconnected words. The only consideration appeared to be similarity in some parts of the shapes of letters of these words, which of course signified various letters of Urdu alphabet. There appeared to be an assumption that a child's attempt at reading need not to be linked with meaningful communication. Reading can be started by an analysis of words into their component letters, wheather they make any meaningful segment of communication or not.

A very detailed analysis is needed for this and all other books produced to start reading and writing of Urdu. As there seems to be no concern with concepts in this book an analysis has not attempted at that level.

Chapter 4

DISCUSSION

This study was started as an initiative to take psychology to schools. A major objective was to concentrate upon children and develop a role for psychology to participate in the process of understanding problems of Pakistani children and their education. This objective was achieved is indicated by the mere fact that a team of psychologists spent lot of time in schools, and communicated with children at their mental levels. This opportunity was provided by the application of critical method in Pakistani schools. This group of psychologist developed so much understanding about working of children's mind that when the World Bank was looking for a team of educationists to develop prototype of learning modules for primary schools, after a search all over Pakistan, it was the *cognitive development research group*, which came up with an acceptable model of learning modules. This is one major gain. Psychologist are interested in the educational process in Pakistan and psychology is not only clinical psychology any more. A serious interest in problems of children and school education continues to persist, at least at the National Institute of Psychology.

There are two aspects of cognitive development survey of primary school children. At the level of critical method, which in fact was the foundation of this survey, this survey provided a description of cognitive functioning of children's mind. If the child is the central character of educational process, these description can play important role in developing primary education for the child in primary schools. However, this is not an easy task. There continues to be a wide gap between what psychologists have discovered as mental structures in school children and what educationist can apply to education from psychologists' discoveries.

Cognitive development stages of Class 1, 3 and 5 children in primary schools have provided a definite bench-mark for rational planning of curriculum and classroom activities in Pakistani schools. Development of cognitive abilities in primary school children is obvious from the results. However the trend is not very smooth.

These developmental curves indicate a jump from class 1 to class 3 and then the pace slows down considerably. This would be explained in Piagetian literature in terms of stabilization of concrete operations in Class 3 and 5 before further development towards formal operational stage. However, possibilities of alternative hypotheses should not be ignored. One obvious and interesting area can be investigation of educational practices in primary schools – specially earlier years – with a view of its effect on cognitive development of children.

While looking at stage-curves of all the three classes, it strikes out that while class 1 seems to follow a normal distribution, distribution in class 3 and 5 is positively skewed. As the sample in all the three classes was randomly selected, this cannot be ascribed to any apparent sampling error. The only plausible explanation is that children of relatively lower cognitive abilities who were there in class 1 are just not there in class 3 and class 5. This is an indirect confirmation of the one of the original hypotheses of the project that cognitive development may be one important factor in drop out phenomenon in primary schools. The evidence of relationship between cognitive development status and drop out status of a selected number of class 1 children tend to support this assumption. However, further research work is required in this direction. The analysis of class 1 textbook also indicated a mismatch between children's cognitive levels and the teaching practice implied in this textbook. Class 1 curriculum seems to demand some operativity from children while 22% of class 1 children are clearly on pre operational level, and 42% just start to approach concrete operations. This mismatch can be one explanation of a high drop out rate in class 1, where children on being unable to cope with class room teaching, get discouraged and frustrated and transfer the same to their parents and teachers which eventually results into a dropping out decision. This cannot be the only explanation of drop out but there is sufficient evidence to seriously consider it as an important factor.

There is a lot of over lapping of cognitive stages in class 1, 3 and 5 children. although, at present there does not exist an explicit theoretical model to explain individual difference in the cognitive development of children, these differences do exist. In our sample, mixed ages is a substantial factor to explain these differences. Not only practically it is very difficult to reduce age-range in the primary schools of Pakistan, a definite view-point will rather support presence of children of various ages in the same class.

A large majority of children in Class 1 operate at the earlier phase of concrete operational thinking. However for about 23% of children, operativity at any level is not possible and they are at pre-conceptual or intuitive stage. Mature level mental operations, even at concrete level, are beyond the reach of the majority of class 1 children. A very large segment of class 3 children are just in the middle or mature concrete operational stage. All of them can use mental operations at concrete level. The profile of class 5 is not much different from class 3. Majority is still at middle to mature level of concrete operations . However, the number of children approaching the next stage of development has` increased from 4 to 9%. With the exception of 14% children, Class 1 has mastery of One to One Correspondence. Only half of Class 1 children can handle conservations in the field of liquid and weight. Majority cannot handle the concept of area. Similarly majority of children cannot seriate. They are unable to classify. The only thing they can do by the way of classification is sorting. They are far away from any notion of horizontality and conservation of volume. A large majority will confuse time with distance and speed.

The development of class 3 children in the significant area of conservation appears to be complete. The only exception is volume They are specially very strong on liquid, weight and length while relatively not so strong on area. Majority has also attained mastery in seriation. Conservation of volume continues to be a rarity but there is definite improvement over class 1. Majority is able to distinguish time from distance and speed. Horizontality in all the three tasks of water level, plumb line and mountain continues to be a problem for a large majority. There are just 2 children (out of 120) who are able to coordinate the relation between class and sub classes in the task of class- inclusion. There is a little improvement in classification but not of much consequence.

In comparison to development from class 1 to class 3, the pace of development from class 3 to class 5 has slowed down. But it is consistent in all the areas. A large majority now has mastery in seriation. However all the remaining tasks continue to present problem for the majority (although less so than it was in class 3). Almost half have achieved mastery in area but still there are few who have attained conservation of volume. Only one third of children in class 5 can handle concept of horizontality in the water level. There are even fewer to understand horizontality in plumb line. There is very little improvement in Mountain but now many more are clear on class-inclusion and perspective. There is improvement in classification but the majority continues to classify at rather elementary level, by only evoking concrete-level thinking.

The above cognitive description of three classes have important educational implications. It is not possible in primary schools to teach children anything which is abstract or theoretical. More specific analysis and recommendations are possible in the light of cognitive demand analysis of primary school curriculum. However, it can be pointed out here that this study indicates a strong need to reconsider primary school curriculum in the light of cognitive abilities of primary school children.

Comparison of cognitive ability of Pakistani children with children of elsewhere requires a detailed and updated survey of latest research in this field. However there is sufficient ground to say that present findings do not indicate that cognitive abilities of

Pakistani children are in anyway inferior to children anywhere else. The only thing which Pakistani children are lacking are educational activities suitable to their level of cognitive development.

Lack of significant differences between boys and girls and urban and rural children in primary school not only support the Piagetian theory, where cognitive development is a natural result of a very broad interaction between organism and the environment it can facilitate application of these results. As far the cognitive abilities are concerned, boys and girls, children of villages and children of cities do not require separate sets of learning activities. Requirements of different cultural contents may be there, but as for as cognitive aspect is concerned boys and girls of villages and cities in all the different provinces of Pakistan, can handle educational activities with same facility (or difficulty in case of mis-matched curriculum). Therefore, there is a sufficient cognitive justification for curriculum planning at the national level.

From theoretical point of view the present research clearly supports the Piagetian model of cognitive development. The children are distributed on various developmental stages and they follow the same developmental sequence as has been described in Piagetian research. Development of various cognitive schemes, by and large, also support the evidence generated by other researches in various parts of the world. For instance in the field of conservation of various notions, the order follows, by and large, as reported by most of other researchers. The first to appear is conservation of liquid. It is followed by weight, then length and then area. Last of the conservation to appear is volume. As was expected one to one correspondence was the earliest cognitive structure (among the structures investigated in this present study) which appeared in full bloom even in class 1. On the other extreme, as the notions like horizontality in mountain task, perspective and class -inclusion, required some formal operational thinking, these appeared in the last. Further statistical analysis can provide theoretical clarity on the process of development in the context of these 14 tasks. However as far as requirements of applied research are concerned, it is sufficient to comment that Pakistani children seems to follow a natural course of cognitive development.

However, this does not provide any immediate respite to the educational situation of primary school children of Pakistan. In order to implement these findings in schools, a group of people, equally interested in psychology and education is needed. The cognitive profile of primary school children, as outlined above, can provide a basis for setting curriculum objectives from children's perspective, writing textbooks and planning classroom activities which are in consonance with children's mental level.

The other aspect of this survey is psychometric assessment of data collected by a distinctly non-psychometric strategy. The cognitive development task battery appears to fulfil two promises, the promise of qualitative research associated with critical method and promise of quantitative assessment as prefered by objective test of psychometric tradition The data and analysis of this survey further established its worth when this was included in an ambitious work of integrating three sets of data from four countries to test the construct of concrete operational thought. This work was published is Genetic, Social, and General Psychology Monographs and its copy is enclosed as Appendix B (Shayer, Demetriou, & Pervez., 1988).

The assessment of the construct of concrete operational thought, which was the major scientific interest of this study came up very well. By and large it supported a unitary structure with some indications of distribution of this structure into three types of mental abilities, conservation, logico-verbal and imaginal-spatial. The horizontal decalage appears to be an integral aspect of cognitive development, at least, at this stage of development. Nevertheless, assessment of its quantity has shown that its presence does not make the construct of concrete operational thought irrelevant. The decalage can be explained by variance in children's some non-cognitive developmental abilities which appear to influence their performance on cognitive tasks. This can be a useful hypothesis for further work in this area.

Investigation of drop out status of children with different level of cognitive development appears to support the initial hypothesis. However, this exploration was on such a small sample that the present findings should only be considered as a support for a major work in this area.

The nature of classroom observations were also exploratory and pointed out a strong need to investigate and quantify what happens in the classrooms of primary schools of Pakistan and how it relates to the cognitive development levels of children.

The analysis of textbook also appears to support the overall lack of sensitivity to child's cognitive structures in school education. It is much easier to point out faults in textbooks but it is much more difficult to write textbooks which are relatively free from problems. This would only be possible with a coordinated work by psychologists and educationists. Reading and writing, which appears to be the main stay of early years of primary education in Pakistan, is a complex cognitive process. It is a very active area of research in psychology and education. Its direct relevance to the process of education has been highlighted by calling it technology of reading and writing (Smith, Smith, & Brink, 1977). The title of an important work, *Stages of Reading Development* (Chall, 1983) indicates the influence of Piagetian psychology in this area. However, in the context of reading and writing of Urdu many issues, which are not relevant to reading and writing of English, need to be investigated. This is a very important area which need to be investigated. Without discovery of an appropriate and efficient methodology of teaching of reading and writing Urdu, any improvement in primary education is not possible. Development of such a method is an important challenge for psychologists and educationists.

Time has yet no come when educational decision making could listen to the voice of psychological research. There are problems on both sides. The psychologist have not produced any model of research inputs which could go directly into the educational process. On the other hand educational planning and management has also not been able to organise itself to a level where it could utilize findings of researches. Integration of research into practice at a large scale is not an easy task. One major obstacle in Pakistan is governments insistence on thinking big. There is a general tendency to ignore any research proposal which is not big. However, what is need most at the present situation in Pakistan is are small educational psychological research projects are highly desirable. Here small essentially means a physical size where various elements of educational process could be efficiently integrated and managed. Small does not mean small in ideas. Such a small project need to be very big in conceptualizations. The central theme of such a project should be integration. Integration of development and education, integration of learning and teaching. Research should be actively linked with practice. Applied and pure research need not be a dichotomy. As far as possible the role of teacher and researcher should be complementary.

Many attractive and workable models have ben evolved to integrate cognitive development theory and research into education of children. Copeland (1970), Furth and Wachs (1972), Good (1977) and Moore (1973) are few such examples. However, none of these models can be implemented in Pakistan. Pakistani situation demands development of its own model. Here, we are facing a reality of teachers with minimum education and even lesser training and schools with hardly any physical facilities. These conditions have their own dynamics and need their own solutions.

An excellent opportunity exists in a village school near the campus of Quaid-i-Azam University. National Institute of Psychology can adopt this schools as a base of their educational psychological research. This appears to be at least one hope of really meaningful psychological inputs in the school education of Pakistan.

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Appendix A

Description of Cognitive Development Task Battery

The battery consists of the following tasks:-

1. One to one correspondence.
2. Liquid.
3. Weight.
4. Seriation.
5. Water-Level.
6. Volume.
7. Area.
8. Length.
9. Classification.
10. Time.
11. Mountain.
12. Plumb-Line.
13. Class-Inclusion.
14. Perspective.

The first task, One to one correspondence, which is generally considered marker of beginning of concrete operations is also called a task on conservation of number. Liquid , Weight, Volume, Area and Length are series of tasks which address the problem of conservation of quantities. Seriation is related to the concept of cardinality. Three tasks, i.e., Water-Level, Mountain, and Plumb-Line probe the structure of horizontality and are sometime are also called spatial tasks. Perspective also deals with spatial relations. Classification and Class Inculsion deal with relations of classes. The task of of Time also covers concepts of speed and distance.

1. One to One Correspondence

Material

Twenty-four wooden blocks, 1/2 inch cubic each, 12 red and 12 green.

Procedure

The child is familiarized with the material. He is encouraged and helped to name the material and the two colors in the pile of mixed-up blocks. Whatever name is used by the child for the blocks and for the colours is followed by the experimenter throughout the interviewing situation. Then he is encouraged to separate the two colors and is asked to take the red pile.

Step I

Seven blocks from the green pile, i.e., the experimenter's pile, are taken up by the experimenter, one by one, and placed on the table in a line with a distance of one inch between the two blocks. The rest of the green blocks are removed from the table so as not to distract the child's attention.

The child is asked to take as many red blocks from pile as are green ones so that there are equal number of red and green blocks. Any reference to *counting* is to be carefully avoided.

When the child has placed his blocks in front of the experimenter's blocks, he is asked: "Are there as many green blocks as red ones or are there more green or red?" Whatever the child says, the reasoning of his response is explored. For example, he is asked, "How did you know?", "Why do you say so?", etc. The responses are noted down.

If the child faces difficulty in making the initial equality he is encouraged and helped to the extent that the equality is established because unless the child agrees that the red and green blocks are equal it is not possible to move on for the further steps.

Step II

After the child agrees that there are as many red blocks as are the green ones, the green row is piled up by the experimenter and again question about the equality of the two sets and also the reason for his response, whatever it may be, is asked.

Anticipation. In case the child says that any of the sets contains more blocks, he is asked whether these blocks would be equal in number or not if green ones are put back in the same formation as were before.

Then green blocks are spread out in a line as were before and questions about the equality of two lines and the child's reasoning are asked.

Step III

In the last step, the red blocks are bunched together and the child is again asked whether there are as many red blocks as are greens or are there more green or red? Whatever his response is, that is noted down and the reasoning underlying the response is explored.

Counter-suggestion. It is put in such cases where the subject says 'equal' in his response and does not give reason or the reasoning is not clear. At such occasions the experimenter may say that some other day he was playing the same game with another child of the same age as the subject is and that child said that the two sets were unequal. What does he think, was that child right or wrong and why did he say so? Important point is that this contradictory suggestion is put in such a way that the child does not feel threatened.

Rules for Assessment of Cognitive Levels

1.A. The child is not capable to put up the same number of blocks by himself, by placing one against one or by any other way, *and* does not qualify for any subsequent step. However, if the child does qualify for any subsequent step, his failure at this stage will be ruled out.

1.B. The child is able to place seven blocks and accepts the equality of the sets. If the child is not able to place the seven blocks by himself but once the experimenter has helped him to do so, he now by himself may accept the equality of the two sets. But cannot give any reason for the equality. No conservation of number when the 1:1 correspondence is destroyed.

2. Recognizes initial equality of the sets *and* gives logical reason *but* with the change in spatial configuration, the equality in number is destroyed. May maintain equality in some situations but not in all situations. May accept empirical reversibility (i.e., accepts the sets will become equal when placed in 1:1 correspondence).

3. Equality maintained in all situations supported with logical reasons.

2. Liquid

Material

1. Glassware consisting of one 250 ml, wide, beaker (C); one 100 ml , thin and tall, cylinder (A); two 100 ml, identical, beakers (Bl, B2); four 60 ml , small, beakers (4D).

2. One transparent plastic bottle filled with colored water.

Procedure

After familiarizing the child with the material, equal amount of water is poured into B1 and B2. If the child disagrees that the water is equal in the two containers, he himself is asked to make it equal.

Anticipation. Having equality of water in B1 & B2 established, the child is asked to anticipate the level of water in 'C', if water from 'B1' is poured into 'C'. The child's task is to tell whether the level in 'C' would be equal to 'B2' or lower/higher than B2.

Transformation I. B1, B2 & C : (Equal amount of water in B1 & B2). Water from B1 is poured into C and the child is asked whether the two beakers have the same amount of water or does any of these contain more than the other.

After making inquiry into the reason of subject's response, second question is asked that if the child were to drink water from B2 and the experimenter from C, would anyone of them have more or less water to drink, or would they have the same amount? The reasoning for the child's response is probed. Water from C is poured back into B1.

Transformation II. B1, B2 & A: Again equality of water in B1 & B2 is established and water from B1 or B2 is poured into A. Question about the equality of water in the two containers is asked and also the reasoning for the child's response.

Besides this, the child is also asked that who will have more/less/or equal water to drink if one has container A and the other has B1. Again reasoning is inquired.

Transformation III. B1, B2 & 4D: Equality of water in B1 & B2 is again established and water from B1 is poured into four small beakers. The child is asked if there is same amount of water in B1 and the four containers or one has more than the other. It is important that the child understands that water in four small bakers, i.e., 4D, is being compared with water in B1.

After making inquiry into the reason, the child is asked that if he has these four containers to drink and the experimenter has the other (B2), both of them will have more/less/or equal amount of water to drink or not. Reasoning underlying the child's response is probed.

Counter-suggestion is put, if necessary.

Rules for Assessment of Cognitive Levels

1. No conservation. Amount varies with the change of container. The verbal response is conserving but it is *not* supported with any logical reason.

2. Conserving in some situations and non-conserving in others. Conserving in 'drink' response and non-conserving in 'amount' response. Whenever the response is conserving, it is supported by some logical reason.

3. Conservation in all situations supported by logical reasons.

3. Weight

Material

1. One small brass weighing scale.
2. Two plasticine balls of the same size.

Procedure

The child is familiarized with the scale and its use. For example, he may be asked. "Do you know what is this?", "Have you seen it before?", "What is it for?", etc. The experimenter takes the two plasticine balls and the child is also made familiar with these balls. He then tells the child that they are going to weigh the balls to see whether these weigh the same or not. The balls are put on the scale. If the child does not agree about their same weight, he himself is asked to adjust the weight so that he is satisfied. The task is not proceeded unless the child has this satisfaction that the two balls are of the same weight.

Anticipation. Before making actual transformation, the child is asked to anticipate the weight of the ball which is going to be turned into a sausage.

Transformation I. One of the balls is rolled into a sausage and the child is asked whether the sausage and the ball weigh the same or does one weigh more than the other. Whatever he responds, he is asked to explain his answer and to provide reasons about how did he come to that answer.

Transformation II. Sausage is turned back into the ball and again equality of the two balls is established. One ball is changed into a pan-cake and the child is asked whether the pan-cake (any familiar name may be used, in actual administration, the word "Roti" was used) and the ball are of the same weight or has any of these more or less weight than the other?

Probing into the reasoning is done.

Transformation III. Pan-cake is changed back into the ball and equality in weight of the two balls is established. The child is told that now one ball is going to be turned into small pieces. The experimenter may ask the child to help him in making small balls out of one ball just to keep his interest in the process. That ball is converted into four or six balls.

The child is asked if these four or six balls are put in one pan of the scale and the other one big ball in the other pan, would they weigh the same or not. Inquiry in the reasoning of the child's response is made.

Counter-suggestion is put, if necessary.

Rules for Assessment of Cognitive Levels

1. No conservation. Weight changes with each transformation.

2. Conservation in some transformations and no conservation in some others. Logical reasons in conserving responses. Lack of logical support in conserving response will render it as nonconserving response.

3. Conservation in all situations with logical reasons.

4. Seriation

Material

Two sets of wooden sticks, all blue colored and 1/4 inches thick.

1. One set consisting of 10 sticks, starting with one inch length and going up to ten inches with one inch interval.

2. Second set consisting of 9 sticks, starting with 1 1/2 inch
length and going to 9 1/2 inches with one inch interval.

3. Screen.

Procedure

Step I

Without showing to the child the way of picking sticks and by starting with the smallest one, a model seriation, with steps apart having distance of about one inch, is created on the table with one set comprising of ten sticks. The child is encouraged and helped to label it 'staircase'.

Making sure that the child has observed the staircase, the seriation is broken down and the sticks are mixed-up. Now the child is asked to construct a series just like the one experimenter had made.

Two things are to be carefully noted about child's performance. The way of choosing each stick and putting on the table to make a series and the final order in which he has put the sticks. If the child has made the seriation without the base line or the order of sticks is not correct, he may be encouraged to correct it, not by clearly pointing out the mistake, instead it can be said whether he has finished, is the staircase all right, can he make it better?, etc.

When the child has finished with his construction, he is asked to explain the way of choosing each stick while making the staircase.

Step II

Seriation completed by the child or constructed by experimenter (if the child is not able to make it correctly) is presented to the child. The steps of the staircase are about one inch apart from each other. The experimenter holds the second set of sticks in his hand.

Child's attention is drawn to the empty spaces in between the sticks. He is told that this staircase is not complete and he has to fill in the gaps by the remaining sticks so as to make a nice complete staircase. The nine sticks of the second set are handed over to the child one by one randomly and he is asked to place each stick in its proper place.

How the child finds the place for each stick is carefully observed and noted. After the child has put all the sticks, he is asked to explain how did he find the place for each stick or how did he put the sticks in empty spaces.

Step III (If necessary)

If the child's ability to seriate is not clear upto this point, both of the sets are removed from the table. The experimenter holds up the screen and the sticks of the first set are handed over to the child and he is told that this time the staircase will be made behind the screen and the experimenter will place the sticks in the order in which the child gives them to him to make staircase.

The child gives the sticks one by one and the experimenter places them behind the screen. If the child makes mistakes, the experimenter stops after the first three sticks and the series behind the screen is shown to him and this step is started again.

Rules For Assessment of Cognitive Levels

1. Fails to construct a single series. Constructs two or more small series, e.g., long sticks versus short sticks. Ignores base line completely and considers only tops or vice versa, has difficulty in inserting additional sticks. Feels need to break previous series to insert new sticks.

2.A. Produces more or less correct series by trial and error. Can insert additional sticks by trial and error. Produces series without trial and error *but* cannot insert sticks correctly.

2.B. Can hand over sticks correctly in the last trial despite difficulty in one or both of the first two parts of the task.

3. Immediate success, starts with the smallest (or largest) and systematically goes up (or down). No problem in inserting additional sticks.

5. Water Level

Material

1. Reagent bottle.

2. Cloth mask for the bottles.

3. Two sets of five sketches of empty bottle on a table in the following positions: (1) upright (2) inverted (3) side-wise (4) upright, titled to the right and (5) inverted, titled to the left.

4. Coloured water.

5. Marker or colored pencil.

Procedure

Bottle is put on the table in front of the child and is half filled with colored water. He is familiarized with the material and is asked to show the level of water in the bottle by running his finger around the bottle at the water level.

Then he is shown a drawing of empty bottle (upright) placed on the table. Attention is drawn to the presence of table as the frame of reference. Then he is asked to show the water in the sketch of empty bottle by drawing a line and putting a cross where he perceives the water is.

Step I

One by one, the bottle on the table is moved to all the subsequent four positions and the child's task is to draw the water level, i.e., the top line of water in the corresponding sketches and also to make a cross in the drawing where he thinks the water is.

Step II

After the completion of the first set of five sketches, the bottle is covered with the cloth-mask.

The covered bottle is moved to five positions one by one. Corresponding drawing is shown with each position and the child has to draw the water-line in each position of the bottle. The child also places a cross in that part of each sketch where he guesses the water in each position of the bottle.

Rules for Assessment of Cognitive Levels

1. Water parallel to the base of bottle in all situations. No awareness of gravity. Base of bottle is the point of reference.

2. Some adjustment in the line of water with change in the position of the bottle.Water parallel to the

surface of the table in some situations but not in all situations.

3. Water line parallel to the table-surface in all situations.

6. Volume

Material

1. 2 beakers of 100 ml.
2. 2 rubber bands.
3. 2 plasticine balls of the same size.
4. 1 steel ball of same size as the plasticine ball.
5. Colored water.

Procedure

Equal amount of water is poured in the two identical beakers. Equality of plasticine balls is also established. As in the other tasks of conservation, if the child is not agreeing about the equality, he himself is asked to adjust the equality and be satisfied. The two rubber bands are wrapped around the beakers to indicate the present level of water.

The child is probed and helped to understand the process of displacement of water. He is asked, "What will happen if this ball is put in the water"? Then one ball is actually put in one beaker, it goes down and water level rises from the rubber band which indicates the previous level. The child is asked why the water has gone up by putting ball into it. Then the second ball is also put in the other beaker. The child is asked whether the water in the two beakers has risen to the same level or not? He is also asked the reason for the same water level in the two beakers. It is impossible to proceed for further steps unless the child agrees that the water has risen to the same level.

Anticipation. Two balls are with the experimenter and he says to the child that he is going to change one ball into a sausage and if he puts one ball in one beaker and the sausage in the second beaker, what does he think whether the water will rise to the same level in the two beakers or one will be higher than the other. Actual transformation is not made. Reason for the response is also noted.

Transformation I. One of the identical balls is turned into sausage and the child is told that the ball and the sausage are to be put in the two beakers, what does he think whether the water in the two containers will go up to the same level or one will go higher than the other. It is important that the child understands that the sausage will also be completely submerged in the water because some children say that because the sausage is long so some part of it will stay above the water level, and on this assumption their whole reasoning is then based, so it is necessary to make the point clear.

After asking the reason for the displacement response, second inquiry is about the space occupied by the sausage and the ball. The child is asked whether the two things will occupy same space when put in the water or will one of these occupy more/less space. Inquiry into the reason of the child's response is made.

It may be noted that ball and the sausage or whatever the transformed shape is, are never put in water through out all the steps.

Transformation II. Sausage is turned back into the ball and equality of the two balls established.

One ball is changed into a pan-cake and the experimenter says to the child that if the pan-cake is put in one beaker and the ball in the other beaker, will the water in the two will rise to the same level or not or which one will make water go much higher.

It is also asked that the space occupied by the two plasticine things will be same or not. Reasons for the responses are inquired.

Transformation III. Pan-cake is turned back into the ball and the equality of the balls is got established.

One ball is changed into four or six small balls. The child may be asked to help the experimenter in making small balls out of one ball just to create his interest (similarly, for the sake of getting child involved in the process, he may be asked after each step to roll the sausage or pan-cake, whatever it is, back into the ball). Then the experimenter says that he is going to put these four or six balls in one beaker and the other ball in the second beaker and so the water-rise in the two beakers will be the same or not. Similarly, the question about the space occupied by the two is also asked and probing into the reasons is done.

The two balls (plasticine and the steel one) which are of the same size are handed over to the child so that he can feel the relative difference of the weight. Equality in size of the two balls is got established.

Balls are taken back from the child so that he may not throw them into the beakers. Because children throughout are very keen to put the balls in the water and see what really happens.

The child is then asked if the steel ball is put in one beaker and the plasticine one in the other, will the water-rise be the same in the two beakers or one will go higher than the other. Reason is inquired and then is asked "Will the steel and the plasticine balls occupy the same space when put in the water or not"?. Probing into the reasoning of his responses is done.

Rules for Assessment of Cognitive Levels

1. No conservation in any situation.

2A. Conserving in some situations with logical support but non-conserving in some other situations (involving plasticine balls only).

2B. Consistently conserving responses with reasoning of weight.

3. Conservation in all situations regarding the plasticine balls but not in the metal ball.

4. Conservation in all plasticine situations and also in metal ball situation. Success in metal ball will not be treated as success unless it is preceded by success in all the plasticine situations.

7. Area

Material

1. 2, 12x14 inch green plywood boards (grass-fields).
2. 2 Toy cows.
3. 2 Toy persons.
4. 20 small toy houses.

Procedure

The two plywood boards ('A' and 'B') are placed in front of the child. He is told that these represent two grass fields. Then one cow is put in one field and the other in the second field. It is told that each cow has its own field and grass to eat. The child is asked whether the two fields are of the same size and the two cows have the same amount of grass to eat. It is asked so that the child has clear idea about the equality of the two fields.

One toy person is placed near field 'A' and the child is told that this man wants to build a house in his field, and one house is put in the corner of field 'A'.

The child is asked, "Do the two cows still have same amount of grass to eat or one has more than the other"?. Whatever is his response, next inquiry is "Why?"

If the child realizes that the building of a house has reduced grass in one field, it is alright but if the child insists that the grass is still the same, he is then helped to understand that the house has occupied some area and reduced the grass because unless the child understands this point, the administration of further steps is meaningless.

Step I

The second toy person or farmer is placed near field 'B' and it is explained that this farmer also wants to build a house in his farm and one house is placed in the center of field 'B'.

Question is put whether the two cows still have the same amount of grass to eat or any cow has more grass. The child is asked to explain his answer.

Step II

Now the child is told that the two farmers want to build some more houses in their fields. Another house is placed in the corner of field 'A' close to the previous house. Then a house is also put somewhere in field 'B' but not near the previously laid house. By this way five houses are placed in the two fields, i.e., one in 'A' and corresponding one in 'B'. In 'A' these five houses are in one side and are in a straight line touching each other, while in 'B' the five houses are in scattered form.

The child is again inquired about the equality of grass in the fields 'A' & 'B' and also asked to justify his response with reasons.

Step III

Five more houses are put in the two fields in the same fashion, i.e., every time building one house in each field correspondingly. Now there are ten houses in field 'A' in straight lines and ten houses in field 'B' scattered all over the field. Perceptually there seems to be wide open area in field 'A' in front of the houses, while in field 'B' the whole area seems to be occupied by the houses. Question about the equality or inequality of grass for the two cows is again asked and also the reasoning underlying the responses is probed.

Counter suggestion is put, if necessary, e.g., if the child says that the grass is equal but does not give reason, he may be told that the other day a child who played the same game said that 'A' had more grass than 'B' because there the houses were close together while in 'B' they had covered the entire field. Does he think that the child was right in saying this, or wrong and why?

Rules for Assessment of Cognitive Levels

1A. One house built does not affect the total area.

1B. No understanding of the concept.

2. Concept in some situations supported by reference to number and size of the houses but not carried to all situations.

3. Clear understanding of concept in all situations supported by logical reasons.

8 . Length

Material

1.2 Sticks of 1/2" square in cross-section & 12 inches in length.

2. 2 toy dolls.

Procedure

Both the sticks are placed in front of the child. Equality of the sticks is established. Child himself may be asked to match them in order to be sure of their same size.

Step I

Both sticks are placed before the child parallel to each other, ends coinciding, and with some distance between them. Top stick is moved about four inches to the right of the child and he is asked, "Are the two sticks of same length or one is longer than the other?" Reasons are probed.

Then, the two dolls are taken and child is asked to suppose the two sticks as roads. Both dolls are made to walk on the two sticks from right to left. The child is asked. "Did the dolls walk the same distance or one walked longer than the other?" Reasoning for the response is inquired. The dolls are made to walk back from left to right on the displaced sticks and question is repeated as which dolls travelled more or did they walk the same.

Step II

Top stick is brought back to the original position and again equality of the two sticks is established. The top stick is now moved about four inches to the left of the child and same questions are repeated. As earlier, two dolls are made to walk on the sticks from right to left (same direction) and question about the distance covered is inquired and also the reasoning.

Step III

Top stick is again brought back to the original position and equality of the two is established. Now the top stick is moved about two inches to the right of the child and the bottom stick about two inches to the left of the child. The child is asked the same questions as before. The dolls are made to walk on the sticks in the same direction and the child is again asked if the two dolls walked the same distance or not. Reasoning of the child's response is explored.

Rules for Assessment of Cognitive Levels

1. No conservation in length or walking distance. Length is equal only when both ends of the sticks coincide with each other.

2. Conservation in some situations supported with logical reasons but no conservation in some other situations (length and walking-distance).

3. Conservation in all situations supported by logical reason.

9. Classification

Material

1. 6 Circles (3 large, 3 small; red, green, blue)
2. 6 Squares (3 large, 3 small; red, green, blue)
3. 6 Triangles (3 large, 3 small; red, green, blue). All wooden.

Procedure

The child is familiarized with the material. Whatever name he uses for the pieces is used by the experimenter. In familiarization, any hint to the dimensions (size, shape or color) is carefully avoided.

All the pieces are mixed up in front of the child. He is asked to put together those pieces which are alike. If the child starts with any dimension, say color or shape, he is encouraged to make minimum possible piles (i.e., to put all alike pieces in one pile according to one criterion disregarding the other).

When the child has sorted the pieces in accordance with any criterion, he is asked to name the piles he has made. Number of piles made is also noted.

The pieces are again mixed-up and the child is asked to group them according to some other dimension different from the previous one. If he is able to switch to the other criterion, then he is asked to classify the objects with the third criterion. Each time the number of piles and the naming of piles by the child is noted.

If the child is not able to classify spontaneously, help is offered, e.g., helping for the dimension of shape, he may be shown one circle and one square of the same color and size and asked if the two pieces differ from each other and how they differ. He then is asked to make piles of alike objects according to that difference. Similarly, if the child fails to classify in terms of other dimensions, help for the other criteria is presented. It is noted whether the child was able to sort spontaneously or was he helped for any of the three dimensions.

Rules for Assessment of Cognitive Levels

0 Figurative collection. Just one dimension with help and no further progress.

1A Just one dimension without help. No further progress.

1B Second dimension with help. Inability to classify with a third dimension even after help.

2A Three dimensions with help at 1B (It means that one dimension without and two with help).

2B Two dimensions without help.

2C Three dimension with help at 2B.

3. Three dimensions spontaneously.

10. Time

Material

1. One plywood board with 2 roads; small road

inches long and parallel to the board, large road 13 inches long on the top of small road at 30 degree angle.

2. Two toy cars.

Procedure

The child is familiarized with the material, especially with lengths of two roads, i.e., their differences in size.

Step I

The child is told that the two cars will travel on the two roads. He is asked if the cars start simultaneously from the same point and with the same speed, will the two cars reach to the ends of their roads at the same time or will any one reach earlier to its destination (destination of each car is the end of its road). He is also asked to explain his answer.

Step II

One car is made to travel on the shorter road and while it travels, the child is asked if the two cars on their respective roads start simultaneously with same speed, at which point the car on longer road would be when the car on shorter road reaches the end of its road. Reasoning is inquired. Now the two cars travel on their respective roads, starting point and the speed is same. The car on shorter road reaches its end while the car on longer road is still on its way and stops at that point with the other car. The child is asked whether the two cars have reached the ends of their roads or not?

Step III

Without actual demonstration, the child is asked if the two cars start simultaneously on the longer and shorter roads and reach simultaneously to their respective destinations, would they have travelled with the same speed or any one have moved faster than the other. Reason is probed.

Now both cars move on the roads, they start and reach to the ends simultaneously, of course one moves faster to reach at the same time. The child is then asked whether the two cars have travelled with the same speed or not.

Rules for Assessment of Cognitive Levels

1. Confusion of time, speed and distance in all situations.
2. Clarity in some situations and confusion in some other situations.
3. Clarity in all situations.

11. Mountain

Material

1. A well-formed mountain sketch on a paper.

2. A marker or colored pencil.

Procedure

The mountain sketch and marker are given to the child. Before starting the task, it is made sure that the child identifies the mountain on the paper. Then the child is asked to draw a house and a few trees on the mountain sides. It is checked that the child can draw the house and trees. If he hesitates or says that he cannot draw, he is helped to draw on the back of paper by showing simplest form of a house and tree in drawing.

It is made clear that the house and trees are to be drawn at the mountain's outline not at the top or in front of the mountain. If horizontality is not clear enough in the first drawing, the child is asked to draw on the other side of the mountain.

Rules for Assessment of Cognitive Levels

1A. Drawing unrelated to the mountain.

1B. Houses and tress are vertical to the top-line of the mountain.

2. Houses and trees start shifting along the gravity. Some true vertical and some vertical to the top-line of the mountain.

3. All the houses and trees are true vertical.

12. Plumb Line

Material

1. Reagent bottle with a cork.
2. Black piece of cord with a lead plumb at its end. The plumb line is fixed in the centre of the cork.
3. Two sets of five sketches of empty bottle on a table in the following positions: (i) upright (ii) inverted (iii) side-wise (iv) upright, tilted to the right and (v) inverted, tilted to the left. The first sketch shows the plumb line in the bottle and the remaining sketches show empty bottles.
4. A marker or coloured pencil.

Procedure

The child is familiarized with the material and is told that here is a weight hanging at the end of the black cord. He is encouraged to shake the bottle with the cord, before starting the task, to make him aware that the cord and weight move with the movement of bottle. His attention is also directed towards the base-line of table in the sketches.

He is then shown the first sketch with the plumb-line already drawn in it and is told that the cord and weight are hanging in this position while the bottle is put upright on the table. Next sketch is shown, empty bottle with upside down on the table. The child is asked to imagine and draw the position of cord and weight in this position of the bottle, i.e., how the plumb-line would look like or in what position it would be if the bottle is moved to upside down position. Note that the child now is not allowed to touch or move the bottle. In all the steps the children have great temptation to actually manipulate the bottle and see what happens to the plumb-line when bottle is moved to different positions.

Like-wise all the subsequent sketches of the bottle in different positions are shown to the child and his task is to draw the cord and the weight hanging at its end in all the positions of the bottle.

Rules for Assessment of Cognitive Levels

1. The line parallel to the side walls of the bottle. No awareness of gravity.

2. Beginning of adjustment of movement of line with the position of the bottle. Awareness of gravity but lack of external reference in some situations. Line not lumped in the inverted bottle.

3. Line lumped in the inverted bottle. Line vertical to the table base in all situations. External system of reference.

13. Class-inclusion

Material

Bunch of Plastic flowers: 8 red 'roses', 2 yellow '*gaindas*' (a local strain of mari-gold flower).

Procedure

The child is shown the bunch and is asked to name the two kinds and colors of the flowers to find whether the child can differentiate the different kinds. Besides asking about the color/kinds of flowers, he is also asked as what are all these and whether roses are flowers and the *gaindas* are flowers. What name the child uses for the two types of flowers is followed by the experimenter.

Step I

While holding the bunch in his hand, the experimenter asks the child whether there are more roses in this bunch or more flowers. Whatever is the child's response, he is asked "Why do you says so?", or "How did you come to know it?"

Step II

Now the experimenter poses a situation before the child. He says that two little girls came to him when he had these flowers, both of them wanted to make a bunch of these. The first girl wanted to make a bunch with all the roses he had. So, she took all the roses from him and afterwards she handed back those roses to him and he had all the flowers again. Then, the second girl came to him and took all the flowers from him.

After presenting with this situation, the child is asked as which girl made the bigger bunch; the first one who took roses or second one who made bunch of flowers. Reasoning of the child's response is inquired.

Step III

The child is now asked what will be left with the experimenter if he, the child, is given all the flowers and what will be left if the experimenter gives him all the roses.

Step IV

The first step is repeated, that is, "Are there more flowers or more roses in the bunch"? If the child seems to have the concept in the preceding steps, then this question is omitted. The purpose of repeating this step is that the child may have developed the understanding of the phenomenon going through the earlier steps.

Step V

The experimenter hides the bunch and question is posed to the child, "Are there more flowers or more roses in Pakistan?" Depending upon the child's level of familiarity, the word Pakistan can be replaced by name of his village or city. Reasons for the response are asked. If the child says that there are more flowers, he is probed if he includes roses in flowers or not, because sometimes children may mean by flowers, flowers other than the roses.

Rules for Assessment of Cognitive Levels

1. No understanding of class-inclusion relations. Comparison between discrete sub-classes (Red versus Yellow) or horizontal comparison.

2. Beginning of inclusion-relations. Some vertical comparisons between class and sub-classes. Understanding of inclusion in some situations but not generalized to all situations.

3. Correct comparisons between sub-classes and class (vertical comparison) in all situations supported with logical reasons.

14. Perspective

Material

1. Sheet of a blank paper.
2. A marker or colored pencil.

Procedure

The child is asked to imagine a long straight road with trees on its sides while he himself standing at the commencement of the road, the road going far off in the distance.

The child is given blank paper and marker. He is asked to imagine himself standing at the bottom of the page (which means at the commencement of the road) and looking in front of himself on the road. A little sketch of the person is drawn at the bottom of the page by the experimenter to give definite frame of reference to the child. Then he is asked to draw the road the way it would look like. After the child has drawn two lines of the road, he is asked to draw trees on its both sides. The child is also asked to explain verbally how has he drawn the road and trees, how the road and trees look like with distance, to be more clear about the child's drawing.

Rules for Assessment of Cognitive Levels

1A. No concept of perspective. Lines of road parallel and trees vertical to the lines.

1B. Trees drawn upright but no perspective in the road or trees.

2A. Receding trees vertical to road.

2B. Perspective in the road but trees drawn of uniform size or receding upright trees but no perspective of road.

3. Full perspective; trees receding in size with distance and far-end bending together; inclination of edges of road into distance.

Appendix B

The Structure and Scaling of Concrete Operational Thought: Three Studies in Four Countries

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ABSTRACT. A method of scaling called discrimination analysis was applied to data collected independently by the three authors on the performance of large samples of children aged 6 to 12 on a variety of concrete operational tasks in England, Greece, Australia, and Pakistan. The same task was found to scale at the same level, regardless of the country or the age of the child. Décalage between different children's performances on the same tasks was found to be confined within the limits of the three nodes of development described by Longeot (1978). A factor-analytical study showed that the décalage could be explained in terms of a simple mental-abilities model, with the tasks representing three capacities: *quantitative-relational*, *qualitative-analytic*, and *imaginal-spatial*. The scaling method yielded a measure of the overall cognitive development of the child precise enough to be used in an intervention study, and a meta-analytical procedure was shown by which previously published studies may be scaled retrospectively. The results were discussed in relation to recent neo-Piagetian theories.

THE SUCCESS OF PIAGETIAN THEORY in generating a vast number of theoretical and empirical investigations should be ascribed to an important characteristic discriminating this theory from any other developmental theory. Namely, it viewed cognition as a complex adaptive process that evolved through the years by the construction of more and more equilibrated structures enabling the subject to effectively represent and intelligibly manipulate the environment through overt and mental action. Long before the advent of the computer, this theory managed to popularize the view that the developing structure of the intellect, to paraphrase Guilford (1967), should be considered as a system capable of being analyzed into logical rules governing its organization at various phases of its transformation from one phase to the next.

In other words, the promise of Piagetian theory in psychology was its stage descriptions of cognitive development (Inhelder, 1963; Piaget, 1960). According to Piagetian stage theory, cognitive abilities are structured in wholes obeying more or less easily specified laws of organization (e.g., concrete operational groupings or the lattice-INRC structure of formal thought), which are transformed during development in a constant order of succession, with the following ones integrating the preceding ones until an end-state is arrived at that ensures the equilibrated interaction of the intelligent human being with its complex environment.

That psychology needed such a theory has been evident by the great number of theoretical (Brainerd, 1978; Broughton, 1981; Flavell, 1971, 1972; Flavell & Wohlwill, 1969; Wohlwill, 1973) and empirical works (Case, 1985; Demetriou & Efklides, 1981, 1985, in press-b; Fischer, 1980; Halford, 1982; Pascual-Leone, 1970; Pascual-Leone & Goodman, 1979; Siegler, 1981) that were addressed to the problem of stages. But more important, current psychological theorizing is built on the same pattern. Specifically, theorists and researchers strive to build theories of cognitive development that follow the Piagetian stage criteria of structure, constant succession, integration, and so forth.

However, present research with regard to empirical findings is deplorable. During the past 25 years, the findings produced with the aim of testing the Piagetian stage-related assumptions are characterized by disagreement, incongruity, and conflict, particularly with regard to the stage of concrete operations, which is the primary concern of this monograph. For example, in the early 1960s, Lovell, Mitchell, and Everett (1962) claimed that seriation, class inclusion, multiplication of classes, and multiplication of relations—the four basic concrete operational groupings—are synchronously acquired at about the age of 8. Dodwell (1960, 1961, 1962) found, on the basis of low correlations between tasks (around .3), meagre evidence for the concept of structure. Smedslund (1964), on the basis of strict tests of the Piagetian claim that concrete tasks should be solved at equivalent levels, argued that there is no empirical evidence supporting the concept of stage.

It would not be particularly embarrassing to psychological theory in general if the abilities were not synchronously acquired, but followed, instead, a consistent sequence of acquisition. After all, Piagetian theory might be wrong

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in this regard, but the gain would still be significant if we knew the timetable of the acquisition of the various concrete abilities. In such a case, a new, more precise theory of cognitive development could be constructed. Such a theory would be more tolerant of the between-concepts inconsistency than Piaget's, but at the same time would build its descriptive and explanatory constructs on the consistent succession of the levels or steps along which this or that concept develops. The emphasis of cognitive developmental theory might be displaced from the concept of horizontal to the concept of vertical structure (Case, 1985; Fischer, Hand, & Russell, 1984).

Unfortunately, there is little agreement between studies even in this respect. For instance, Younnis (1971) found that seriation and multiplication of classes are acquired first and at the same time; then comes multiplication of relations, and finally class inclusion (see also Angelev & Kuhn, 1976; Bruner, Olver, & Greenfield, 1966). However, Smedslund (1964) reported, on the contrary, that class inclusion is *always* acquired *before* multiplication of classes and multiplication of relations. The results of other studies enhanced the confusion even more. That is, they showed that seriation is acquired *at least* two years before class inclusion (Dimitrovsky & Almy, 1975; Jamison, 1977; Tomlinson-Keasey, Eisert, Kahle, Hardy-Brown, & Keasey, 1979). Finally, Shantz (1967) found that there is no consistency in the acquisition order of multiplication of classes and multiplication of relations.

The results are conflicting even with regard to the acquisition order of the different aspects of the same concept. Specifically, some studies showed that the ordinal aspect of number is acquired before its cardinal aspect (Brainerd, 1973; Brainerd & Brainerd, 1972; Brainerd & Frazer, 1975; Siegel, 1974). However, other studies suggested that the cardinal aspect is acquired first (Williams, 1977) or at the same time (Dodwell, 1960).

The situation with regard to the relation between logical and number abilities on the one hand, and the conservations, on the other hand, is the same. Dimitrovsky & Almy (1975) and McManis (1970) found that conservation of quantity is acquired before seriation. Tomlinson-Keasey et al. (1979) and Wohlwill, Fusaro and Devoe (1969) found that seriation is acquired before conservation.

The same degree of confusion is found in the literature concerning the relations between operativity and figurativity. In line with Piagetian theory (Piaget & Inhelder, 1971), a number of studies have shown that transformational and anticipatory imagery is not acquired before the consolidation of concrete operational structures. Moreover, these studies found that mental images are patterned according to the characteristics of the operational structures themselves (Dean, 1976, 1979; De Lisi, Locker, & Younnis, 1976; Younnis & Dean, 1971; Younnis & Dennison, 1970; Younnis & Robertson, 1970). Some other studies found that dynamic mental images are acquired very early in development, at the age of 4 (Brondy, Mattson, & Zuckerwise, 1978; Marmor, 1975, 1977). Even worse, other studies appeared to show that no consistent synchronicity or priority relations exist between performance on Piagetian mental imagery tasks and concrete operational tasks (Anooshian & Carlson, 1973; Oppenheimer, 1976; Oppenheimer & Strauss, 1975).

By 1970, it was evident in the important book, *Measurement and Piaget*, that the empirical literature functioned poorly as a data base on which the objective evaluation of Piagetian theory could be effectively attempted (Green, Ford, & Flamer, 1971). One important source of confusion in the interpretation of Piagetian data has been the failure to distinguish between the variables of chronological age and cognitive development with a consequent false trail of "ages and stages." This problem was clearly evidenced by the great diversity between studies regarding the precise acquisition age of the same concept. For example, Beard (1963) found that 50% of her 5- to 6-year-old samples conserved quantity (solid). In contrast, Lovell and Ogilvie (1960) and Uzgiris (1964) reported that it is in the 8- to 9-year-old range that children conserve quantity. Elkind (1961) reported that 52% of 6-year-old children conserved weight, but Lovell and Ogilvie (1961) reported this percentage for 10-year-old children. Thus, data that merely give the proportion of a small sample of a given age at different Piagetian levels have provided no basis either for describing the child population as a whole or for testing the reliability and validity of a battery of different Piagetian tasks, bearing in mind the breadth of the developmental spectrum.

The two major issues we propose to address in this monograph are those of horizontal décalage—that is, the variation between subjects on different tasks—and the relationship between age and stage of development.

Age-Stage Relationship

In looking at the relationship between Piagetian concrete operational tasks and at the possibility of relating them all through an overall developmental model, it is necessary to remove the factor of age from the data analysis. Here clarification is needed. Before removing the age factor, one must first check that it is not a significant variable governing the relative difficulty of operational tasks. If five tasks spread over the developmental span between early concrete and mature concrete operational thinking, then one first must show that, for a sample of 10-year-olds with assessed individual levels covering this range, the tasks appear in the same order and have the same level within the range, as is the case for a sample of 7-year-olds.

If it turns out that the relative position of a task varies with the age of the subjects, then something other than the levels of cognitive development is governing the subjects' success, and it would be necessary to include age as an essential part of one's descriptive model. In the present studies, it was necessary in each case to show that age was not a variable before eliminating it in amalgamating data sets.

Again, clarification is needed. In saying that the age variable must first be eliminated, one is not asserting the absurdity that children (taken as a whole population) do not develop cognitively as they grow up. But unless the confounding of age with cognitive level, as assumed, is first removed from the data, it is not possible to bring it back as one major independent variable in relation to which the development of subsections of the total population can be viewed. In statistical language, the check is being made that there is no interaction between the variables of age and task. In this monograph, a modest beginning will be made on the life span description after the data base has been presented.

Such an approach could lead to the solution of a series of important problems that presently plague cognitive developmental theory. First, it could help tease out whether there are ages particularly favourable to cognitive development as contrasted to periods of relative quiescence (see Fischer, Pipp, & Bullock, 1984; Strauss, 1982). Second, it could show whether there are differences between individuals, such as those found between the sexes, both in the relative acquisition of different abilities and in any age-related spurts or plateaus in development (see Demetriou & Efklides, 1985; Shayer & Williams, 1984). Third, it could show in a straightforward way whether there are cultural differences with regard to various aspects of cognitive development and, if any, could specify their exact degree and nature (see Dasen, 1977). Thus, a developmental theory could be constructed that would be able to accommodate both the general patterns of development and the deviations from these patterns that might be due either to global differences between individuals or to intra-individual differences in abilities.

A basic condition must be satisfied if such a goal is to be attained. A method of analyzing cognitive developmental data is required that could serve the attainment of the following aims:

1. To reveal the structuring and sequencing of abilities without being detrimentally affected by small variations in the age of the subjects, the procedure of testing, and so forth;
2. To reveal the exact developmental status of each of the individuals tested with regard to the abilities that are the target of this study; and
3. To apply the results on previously published data so as to remove insofar as possible, the reported inconsistency between studies.

We need a method much more versatile than other alternatives that have been used by cognitive developmental researchers. For example, scalogram analysis, which was used quite widely (Koffsky, 1966; Nassefat, 1963; Versey, 1978) earlier, and recently in Fischer, Pipp, and Bullock (1984) can only achieve the first of the three aims. Prediction analysis, recently proposed by

Froman and Hubert (1980) can fully achieve the third aim, the first, in part, but the second not at all.

The purpose of this monograph is to achieve these aims for the concrete operations period, and at the same time describe both intercultural differences, and inter-individual differences on types of tasks. The method, *discrimination analysis*, will be described when the analysis of British data is presented.

Models of Intersubject Development

In discussing the décalage problem, Flavell and Wohlwill (1969) and Wohlwill (1973) argued that a period of maximum inconsistency of childrens' performance on different tasks is to be expected at the beginning of the concrete operations period, given the process of cognitive integration that Piaget described for each major stage. Toward the end of the period, individual differences on tasks characteristic of the stage should disappear. A test of this model is desirable.

Longeot (1978), who has worked consistently on these issues since the late 1960s, took the Flavell/Wohlwill model as valid, gave it a plausible explanation and made a more detailed prediction. In the intermediate steps of development toward mature concrete thinking, he argues that some children may achieve operational thinking quicker in verbal/logical tasks, others in spatial tasks, and still others in conservation tasks. In short, Longeot suggested that these individual differences in development are none other than those described in the psychometric literature (Cattell, 1971; Thurstone, 1938) as *mental abilities*.

In the factor analysis of the performance of a large sample of subjects on a battery of psychometric tests, only the fact that a substantial minority of individuals perform above the average for their age in spatial tests and others perform below the average allows a spatial factor to emerge from the analysis. The spatially above average will show operational thinking in spatial tasks more readily at each stage of their overall cognitive development. In addition, Longeot (1978) adds to the Wohlwill model at least two intermediate *nodes* within the concrete operational period at which the performance of different individuals converges and then diverges again en route to the next node.

Although the reader may be tempted to reject the yoking together of such different models of cognition as that of psychometric mental abilities and the Piagetian theory, such a complementary view has been successfully used over a number of years by Feuerstein (Feuerstein & Krasilowsky, 1972). His model has formed the basis both for the assessment of learning potential by individual interview (Feuerstein, Rand, & Hoffman, 1979) and for the designing of intervention materials for the development of cognition in disadvantaged adolescents (Feuerstein, Rand, Hoffman, & Miller, 1980). Elkind (1981) has also commended such a complementary approach.

Strategy of the Monograph

As a test of these two models, and to achieve the aims with regard to age-stage relationship, three different data sets were analyzed. They were collected in Britain, Greece, Australia, and Pakistan, and arguably represent two different cultures (that of Pakistan contrasted with the rest). Eight tasks were administered to the subjects in the British study, 18 tasks in the study of Greek and Australian children, and 14 tasks were used in Pakistan. There was sufficient overlap between the tasks in the three studies to find possible developmental inconsistencies, and it was clear that the attempt to impose the same developmental construct on each group constituted a strong test of the Genevan paradigm and its modification by subsequent workers.

Discrimination analysis was used first on the British data and then on the other two data sets to test the degree of décalage between tasks. The greater variety and number of tasks used both in Pakistan and on the Greek and Australian children made these studies a better test of the Wohlwill and Longeot models than the British study, so these models were then tested using discrimination analysis. Factor analysis was used as a further test both of the overall unitary construct and of the Longeot model.

Based on the results of these analyses, an integrated model was formulated, the aim of which was to unify cognitive development and psychometric theorizing into a single conceptual framework able to accomodate both general developmental patterning of abilities and intra- and interindividual variation vis-a-vis this patterning.

DATA ANALYSIS

British Data and Discrimination Analysis

Although the British data contained a less varied set of concrete tasks than either the Pakistani or the Greek-Australian batteries, it did contain, in addition, formal operational tasks. These assisted the calibration of the top end of the concrete scale.

Discrimination Analysis

This mode of data analysis was developed to overcome the difficulty, endemic in the Piagetian literature, of determining to what extent differences in task difficulties, as recorded empirically, are due to differences in abilities in the children sampled or to genuine differences in levels of cognition required by the tasks. Its origin in the scaling literature of Jane Loevinger has been described (Shayer, 1980). Two conditions are necessary for a battery of tasks to yield a scale: moderate but not too high correlation of tasks with each other, and a wide range of difficulty. If the tasks correlate perfectly with each other, then the subjects either succeed on all tasks or none. If the tasks do not correlate, then the subjects show a random pattern of success and failure on all tasks, and the subjects are not scaled at all (test reliability = zero). These are the conditions for avoiding the Attenuation Paradox (Loevinger, 1954).

Discrimination analysis has previously been used successfully as an item-analysis procedure in the development of Piagetian group tests of formal and concrete operational thinking (National Foundation for Educational Research [NFER] 1979), in the use of group testing procedures for describing detailed developmental relationships in formal and post-formal thought abilities (Demetriou & Efklides, 1985), and in the understanding of science concepts (Shayer & Wylam, 1981).

Its assumptions are very simple. For each *person,* there is a cognitive level that can be estimated from task-battery results, and for each *task* there is also a level of cognitive demand. The person levels and the task levels are on the same scale. This is the convention in which Piaget reported all his data from about 1938 onwards. Behavioural descriptions were instanced for each task and classified arbitrarily at, for example, Levels I, II, III and IV, using Roman numerals, and some of these levels were then identified with sublevels on his operational scale, for example, II = 2A and IV = 2B, so as to link research on one task context, such as spatial relations, with another such as classification. The same category, 2A, described both the task level and the performance level of the person whose behaviour on the task matched the corresponding behavioural description.

For these purposes, the term *task* was given a specific meaning: a behavioural description that specifies a success criterion. This may be the sole criterion for a problem context, for example, using Conservation of Mass (liquid quantity), wherein the person is said to conserve if he or she is not deceived by change in height and width, or the context may allow several criteria. For example, in the usual classification problem, Task 1 would be to sort the set of objects according to one salient variable. Task 3 would be to succeed in reclassifying the set according to colour, shape, or size, a higher level task, as Piaget described it.

To activate the process of differentiating person levels and task levels, one needs, as a starting point, a battery of tasks of sufficiently wide range of cognitive demand to represent several levels on the scale to be determined. One also needs a sample of subjects of sufficient range of ability that all tasks are solved by at least a few subjects, yet there are no tasks that are solved by everybody. The first step in the analysis is to coarse-group the tasks, using the initial ascription of task behaviour to a Piagetian stage, or by later replications. Suppose the tasks cover the range from intuitive (1B) to transitional formal (2B/3A). Then the groupings 1B, 2A, and 2B may suffice for the first iterative step. For the purposes of this monograph, an equal interval scale was used: pre-operational (1A) = 1, intuitive (1B) = 2, early concrete (2A) = 3, middle concrete (2A/2B) = 4, mature concrete (2B) = 5, concrete generalization (2B/3A) = 6, early formal (3A) = 7.

In the second step, an estimate is made of the scale level of each subject in the sample. Each subject's performance is grouped into the number of tasks at each level on which success was achieved. These numbers are then converted into percentages of the total number of tasks passed at each level. The person is then coarse-scaled at the highest level at which mastery is still shown. A mastery criterion of something less than 100% is used, usually around 67% of the tasks at a level. Any scale exceptions—a subject failing mastery criterion at a level lower than he is scaled—are recorded at this stage as part of the evidence. If the data analysis has been recorded on a microcomputer, the subjects are then regrouped in the matrix, with 2B/3A at the top, 2B next, and so on.

From a count of the subjects scaled at each level and for each task, one then computes the percentage of subjects at the 2B/3A level who succeeded on the task, the percentage of those at the 2B level who succeeded, and so forth. This allows Step 3, the first finer scaling of the tasks, to take place. By linear interpolation one looks for the level at which 67% of the subjects succeed on the task.

The next step is to find the number of sublevels the scale will take while still yielding discrimination between levels. One finds empirically how fine are the steps of measurement one's instrument will produce before the noise becomes greater than the signal. In Piaget's own reported work, the criterion was behavioural: An additional level was created when its characteristic behaviours could be differentiated from the levels preceding and succeeding it. In the present study, an additional person level was interpolated when there were enough tasks scaled at levels between those used in the first analysis to differentiate persons reliably.

The result of the analysis for one task from the British battery is shown in Figure 1. The intermediate level, 2A/2B, has remained, because there were sufficient tasks in the battery to differentiate this from the 2A or 2B levels, and the sampling variation around the 2A/2B level was not appreciably greater than around the 2A or 2B level. Also, scale exceptions did not appear. The final stage of the analysis is to take the finer scaling of the tasks as the criterion for person levels, and to use these person levels for the last iterative step. Thus the *discrimination level* for the Internal Volume task from Figure 1 was 5.1 (67% success level at 4.6, by interpolation, and 0.5 level continuity correction). Essentially one is looking for that part of the scale at which suc-

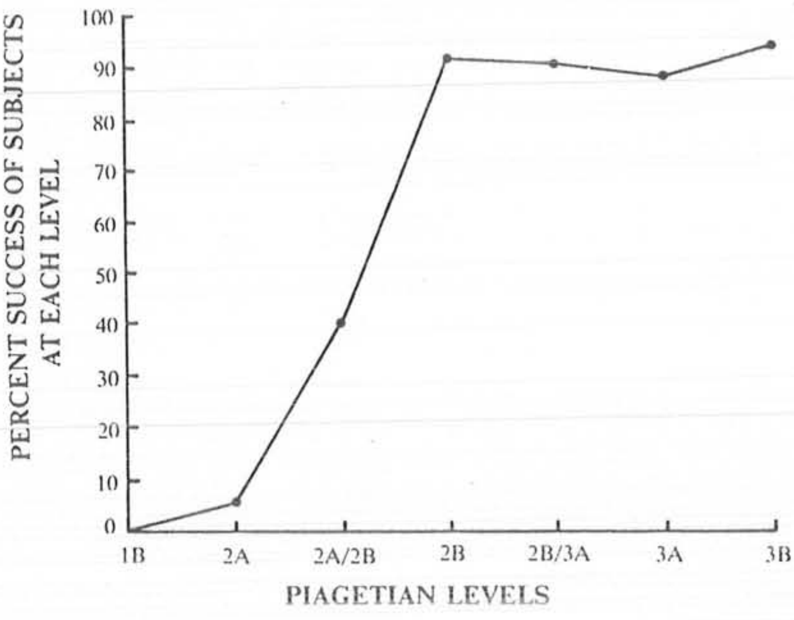


FIGURE 1. Discrimination level diagram for Internal Volume task.

cess on the task is contributing most information toward the scaling of persons.

As an additional check on the linearity of the interval scaling procedure, one can use the function derived from the difficulty parameter in Rasch scaling: namely, the logit transformation, ln $(p/1\text{-}p)$, where p is the task difficulty for the sample. This is used as an estimator for task level in the Rasch procedure to linearize values of percentages as p tends toward zero and 100% (Rasch, 1980; Wright & Masters, 1982). The check is made by plotting logit p against discrimination level.

The intention of this method of data analysis is to stay as close as possible to the observational and estimation procedures developed by Piaget, while translating them into quantitative form so as to shed additional light on two controversial aspects of the Genevan tradition. The first is the metatheory itself, which underpins the fairly coarse distinctions between preoperational and early concrete thinking and between early and mature concrete operational thinking as exemplified by tasks. Even among neo-

Piagetians like Case (1985) and Pascual-Leone (1983), there is the feeling that Piaget's logical model lacks explanatory power. At this stage, the appropriate step is to gather the more fine-grained empirical evidence on development that should better describe the phenomena requiring more powerful or additional models. Second, many psychologists have pointed to the décalage problems in the Piagetian literature to justify their own rejection of the Genevan work (e.g., Fischer, 1980; Flavell, 1971). There is no doubt that the problem exists, but we assert that the only way to purchase judgment on whether the problem is decisive is to estimate the size of the décalage problem. Our method has allowed us to do this.

British Sample

The subjects were a subset of a much larger representative sample covering the ages between 9 and 16, tested from 1974 to 1976 to characterize, in Piagetian terms, the developmental spectrum in pupils in middle and secondary (high) schools in Britain (Shayer, Küchemann & Wylam, 1976; Shayer & Wylam, 1978). This research was undertaken as part of the work of the British Social Science Research Council funded research program, Concepts in Secondary Mathematics and Science (CSMS), conducted at Chelsea College, University of London, from 1974 to 1980.

Although this sample was deliberately selected for the purpose of this monograph, the unit of sampling was a whole class of the three schools chosen. Data on a group of 271 children covering the age range of 9 and 10 through 12 and 13 were taken, using the results of previous data analysis, in order to adequately represent every level of thinking from pre-operational to early formal (3A). In comparison with the representative sample, this was a little above average and of slightly wider range.

Selected for analysis were four spatial tasks and four conservation tasks covering the whole range of concrete operations. These are described in the appendices. The CSMS survey was conducted using group-test versions of these tasks (NFER 1979) as well as three tasks on analytical density (early formal thinking) and a group-task version of the pendulum problem, giving estimates of person levels from 2B(5) to 3B(8). It was thus possible to group the subjects into levels ranging from 3B (mature formal) down to 1B, (intuitive). One purpose of this analysis was to anchor the top part of the concrete operational scale by using a sample whose mean was about mature concrete and whose range included the formal.

The data analysis was carried out as described, using the person levels from the previous survey as the starting point. No further sublevels were required and the analysis was completed in one step. In Table 1, in addition to the 67% discrimination levels, two other levels are recorded, as in the Rasch (1980) item-analysis procedure, to estimate the performance range of the task

TABLE 1
British Sample: Percentage of Success Assessed at Each Level and Discrimination Levels of Tasks

Task	Level of assessment							Total	Discrimination level		
	1B	2A	2A/2B	2B	2B/3A	3A	3B	sample	25%	67%	75%
Plumb Line	0	15	24.6	73.9	81.6	83.0	100	53.7	4.5	5.36	5.7
Mountain	30	23.0	28.0	60.3	67.0	82.5	84.0	49.4	3.9	6.17	6.7
Perspective	0	15	19.4	62.0	78.2	92.0	100	48.9	4.6	5.81	6.3
Water Level	10	7	13.3	47.3	67.0	79.8	100	39.0	4.8	6.50	7.1
Conservation of Mass	0	63.3	88.9	92.0	84.0	94.0	94.0	80.1	2.9	3.65	4.0
Weight/Volume differentiation	10	33.3	49.2	63.1	75.9	67.0	77.0	51.9	3.2	5.81	6.4
Internal Volume	0	6.7	39.7	92.2	91.0	88.0	94.0	64.9	4.0	5.02	5.2
Displacement Volume	0	6.0	13.6	35.1	62.2	75.8	78.0	35.1	5.0	6.85	7.4
Scale level	2	3	4	5	6	7	8				
n =	10	36	66	74	45	33	18	282			

in the context of the battery. A wide range indicated low correlation of the task with the battery, and a narrow range indicated high correlation and sharp discrimination. The Internal Volume task representation may be compared both in Figure 1 and Figure 2. In Figure 2, the discrimination levels and discrimination ranges were plotted against logit difficulty. It can be seen that the plot is essentially linear and that the technique of discrimination analysis facilitated disconfirmation of a tested model as well as confirmation. If 33% of the subjects assessed at the early formal level fail a task, whereas 33% of those assessed at the early concrete level succeed, as with the Weight/Volume differentiation task, then Piaget's model must have relatively little to do with children's performance on this task. In this case (the "pop-corn" version of the conservation of weight task) context factors clearly outweigh the signal.

Pakistani Data and Analyses

The Pakistan National Developmental Survey

This survey of primary school children from Grades 1, 3, and 5 was carried out in 1979 by a team from the National Institute of Psychology, Islamabad, Pakistan, with the purpose of shedding light on the school drop-out rate in Pakistan, with its consequences for literacy. Because nearly 40% of children in Pakistan drop out of school by the end of their first year of primary education, the sample should be considered as not representative of the total population of children in that country but only of those children still remaining in school.

Considerable care was taken to ensure that subsamples of the total sample tested were representative both of the different provinces and of the rural/urban contrast within each of those provinces. However, the urban sample is over-represented in the survey.

As no developmental inconsistencies were found between the different elements of the sample, all sample data were amalgamated to give 120 children from each of the three grades: 360 in all. The mean age of the Grade 1 subjects was 7 years, 3 months (SD = 15 months); for Grade 3 students it was 9 years, 6 months (SD = 16 months); and for Grade 5 students it was 11 years, 6 months (SD = 17 months).

Analysis of Pakistan National Development Survey Data

The results of this survey are the subject of a UNESCO consultant's report (Shayer, 1982). Only the Piagetian testing component of the survey is presented here.

The purpose for the cognitive element of the survey was to present as representative a picture as possible of the current cognitive level of operation

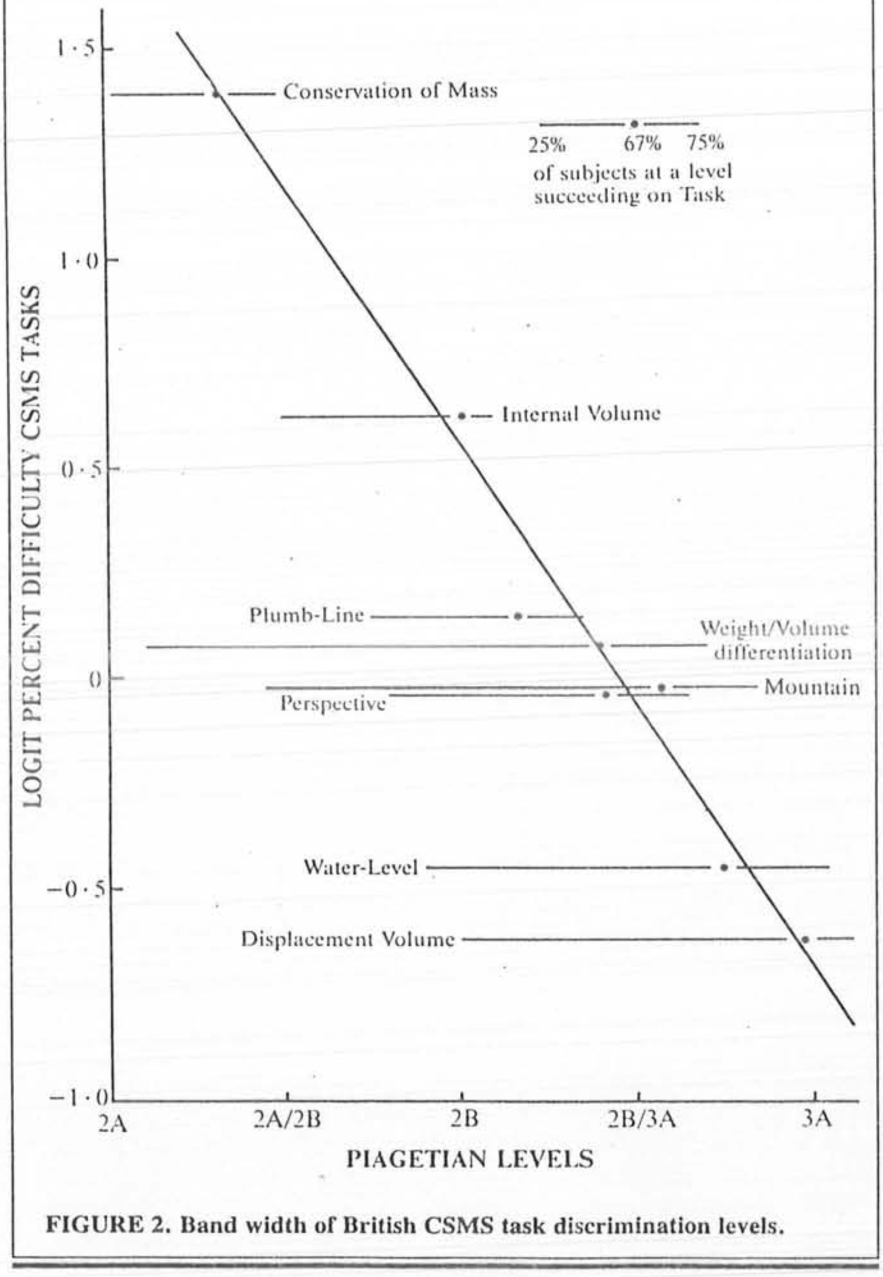


FIGURE 2. Band width of British CSMS task discrimination levels.

of pupils in the public primary schools in Pakistan, with a wider purpose of ascertaining the extent to which current teaching practices in Pakistani schools match the abilities of the pupils. The administration details of the 14 tasks used in the survey are given in Appendix B, together with the criteria adopted. The tasks are listed in Appendix A. The three seriation tasks and the three classification tasks use three different success criteria for the same task situations.

The analysis of this battery clearly shows the intentions announced earlier. From knowledge of the replication literature, the collection of tasks was chosen to represent both as wide a variety of task type and as well spaced a range of task difficulty as possible. Thus, the survey depended on an act of faith that the data, when collected, would scale, and that the scaling would not be rendered meaningless by variations in performances on task type (décalage). From Appendix A, it can be seen that the battery contained some tasks unequivocally showing different levels of concrete operational thinking. One-to-one correspondence (Conservation of Number) is cited by Piaget (Inhelder & Piaget, 1964) as the necessary condition for operational thinking and is thus a "marker" for the 1B (intuitive) 2A (early concrete) boundary. Classification I, Seriation I and Conservation of Mass are the three main types of early concrete tasks. Classification III, Seriation III, Internal Volume and Water Level II (Piaget & Inhelder, 1976) show the coordinations characteristic of mature concrete thinking. This degree of scaling is given by the Genevan literature. With this as a starting point, our questions were: What was the fine detail of the relation of the other tasks of these markers, and was the performance of individual children sufficiently consistent for an estimate of person level to be meaningful?

Initially the first-, third-, and fifth-grade samples were analyzed separately to check whether the task levels, relative to each other, varied with respect to age. Bearing in mind the great differences in difficulty levels on tasks between the different grade groups, this is a strong test. The discrimination levels of tasks produced by this analysis are shown in Table 2. Table 2 shows that all the tasks were not given to all subjects in all grades. A central core of seven tasks was given to all the children; the omissions and overlaps are obvious.

In most cases, the differences in task levels between grades were satisfactorily small, and there was no trend with age. As a guide to the statistical significance of the discrimination level differences, given that each sample contained 120 children, two standard errors of a percentage in the middle of the scale is 9% which, linearly transformed onto the discrimination level scale of 7 units, is 0.6 of a unit. None of the values was this far from the mean with the exception, glaringly, of the Time I task and, minimally, the Area II task. For this reason Time was early omitted from the scoring decisions on which the data analysis was based. It will be seen shortly that Area has a fairly wide

TABLE 2
Pakistani Sample: Percentage of Success Assessed at Each Level and 67% Discrimination Levels for Grades and Total Sample

	Piagetian level of assessment							Discrimination level			
Task	Pre-operational	1B	2A	2A/2B	2B	2B/3A	Total sample	Grade 1	Grade 3	Grade 5	Total sample
Grade 1	(10)	(17)	(30)	(59)	(4)	(0)	(360)				
1:1 Correspondence I	10	88.2	100	100	100		96.9	2.2			2.2
II	0	82.3	93.3	96.6	100		91.9	2.3			2.3
Grades 1 and 3	(10)	(17)	(36)	(104)	(68)	(5)	(360)				
Conservation of Mass I	0	23.5	72.2	87.5	98.5	100	83.9	3.1	?		3.39
Conservation of Mass II	0	5.9	58.3	86.5	98.5	100	81.9	3.8	3.5		3.80
Conservation of Weight I	0	5.9	41.7	89.4	98.5	100	81.7	4.0	4.1		4.02
Conservation of Weight II	0	5.9	22.2	82.7	95.6	100	72.2	4.3	4.2		4.24
Grades 1, 3, and 5	(10)	(17)	(42)	(144)	(131)	(16)	(360)				
Seriation I	20	70.6	90.5	99.3	100	100	95.0	2.4	?	?	2.42
Seriation II	0	5.9	59.5	86.1	96.2	100	80.6	4.0	3.5	4.1	3.77
Seriation III	0	0	33.3	55.6	77.1	100	60.3	5.3	5.2	4.3	5.02
Water Level I	40	47.1	85.7	88.2	95.4	100	86.9	3.1	?	?	3.01
Water Level II	0	0	9.5	7.6	26.0	81.3	17.2	?	6.2	6.3	6.24

Internal Volume	10	0	7.1	49.3	82.4	100	53.1	5.2	4.9	5.1	5.03
Displacement Volume	0	0	0	1.0	16.8	68.8	9.4	?	6.1	6.8	6.46
Conservation of Area I	0	23.5	28.5	59.7	77.1	87.5	58.6	4.5	5.1	4.5	4.90
Conservation of Area II	0	5.9	28.5	44.4	68.7	87.5	48.9	4.8	5.3	6.7	5.42
Time I								3.5	<1	<1	
Time II								>5	4.4	<1.5	
Conservation of Length I	0	0	21.4	78.5	95.4	93.8	70.8	4.3	4.3	4.3	4.29
Conservation of Length II	0	0	9.5	46.5	91.6	87.5	51.7	5.2	4.9	5.0	4.95
Classification I	0	17.6	61.9	84.7	97.7	100	78.9	3.8	3.5	4.0	3.71
Classification II	0	0	28.6	71.5	93.9	100	69.7	4.6	4.0	4.5	4.39
Classification III	0	0	21.4	51.4	74.0	100	55.3	5.3	4.6	5.5	5.18
Grades 3 and 5	(0)	(0)	(12)	(85)	(127)	(16)	(360)				
Mountain I			25.0	23.5	52.8	56.3	31.9		6.1	?	>6
Mountain II			0	0	4.1	18.8	2.8		>7	>7	>7
Plumb Line I			25.0	23.5	66.9	87.5	36.7		5.5	5.5	5.56
Class Inclusion I			8.3	12.9	20.5	18.8	13.6		>7	>7	>7
Class Inclusion II			0	2.4	11.0	18.8	5.6		>7	>7	>7
Grade 5	(0)	(0)	(6)	(40)	(63)	(11)	(360)				
Perspective I			16.7	40.0	77.8	90.9	29.2			5.2	5.21
Perspective II			0	15.0	47.6	63.6	18.1			6.7	6.7
Perspective III			0	2.5	12.7	18.2	4.7			>7	>7

Note. The numbers of subjects at each level in each sample are in parenthesis. A question mark indicates that there were too few subjects at that level to allow an estimate.

discrimination range within the battery: Any trend with age, though, is opposite to what one might expect.

In the case of Time, on the other hand, it was clear that age, rather than cognitive level, as assessed by the overall battery, was the major determinant of success. For the 7-year-olds, too few, even of those categorized at 2B on the battery as a whole, succeeded on the Time item to enable it to be placed on the top end of the scale. For the 10-year-olds, too many of those categorized at 2A succeeded to place this item on the bottom of the scale. The logical requirements for success on this item would appear to be merely the compensation argument required for success on Conservation of Mass.

This is consistent with the findings of Siegler and Richards (1979). The development of notions of time might be expected to be sensitive to the social constraints placed on children at different ages rather than to their absolute cognitive ability. This task was thus rejected from the battery for the purposes of further data analysis.

All three grade samples were then amalgamated, and discrimination levels were calculated. These are shown in the last column of Table 2. The column giving difficulty values contains some tasks that were not given to all the children. To compute these difficulties it was assumed that the untested children would have shown the same proportion of successes, for a given person level, say 2B, as those in the other grade groups. This step is justified by the age invariances of task levels shown earlier in the table.

From Table 2, Figure 3 was prepared, corresponding to Figure 2 for the British CSMS data. This figure clearly displays the limits and extent of the décalage problem. Longeot's approach to this problem will be shown after the analysis of the Greek/Australian battery. There was also a problem with the scaling of three spatial tasks—Perspective, Water Level, and Displacement Volume. This will be discussed later, when the three data scales are amalgamated.

Greek/Australian Data and Analyses

Greek/Australian Sample

A total of 180 children served as subjects of Demetriou's (1983) study. Sixty were Greek, 60 were Greek/Australian bilingual children born in Sydney of Greek immigrants, and 60 were Australian children of British origin. Each of the three cultural groups comprised 20 first-grade children (*M* age = 6 years, 6 months; range, 6 years to 7 years, 3 months); 20 second-grade children (*M* age = 7 years, 7 months; range, 7 years to 8 years, 4 months); and 20 third-grade children (*M* age = 8 years, 6 months; range, 8 years to 9 years, 2 months). Each age group comprised a subgroup of 10 high socioeconomic status (SES) children (children of professional and businessmen were over-

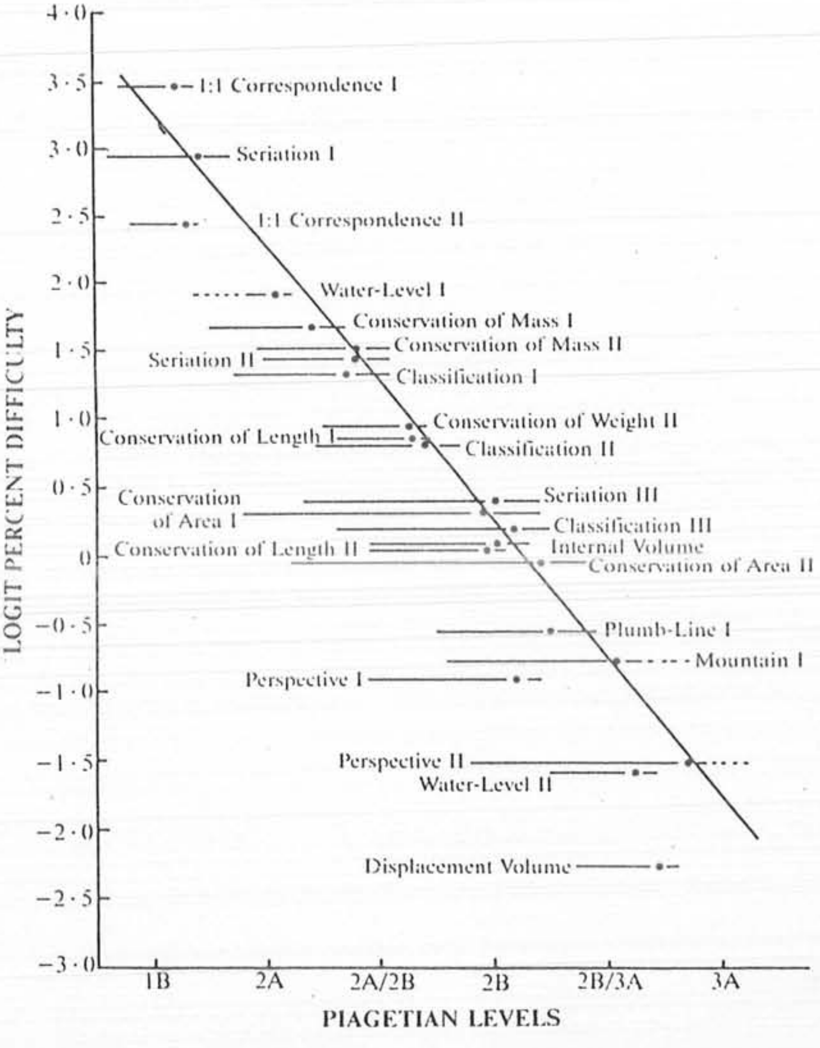


FIGURE 3. Relationship between Pakistani task discrimination levels and logit-transformed difficulties.

represented in this subgroup) and a subgroup of 10 low SES children (children of unskilled workers were over-represented in this subgroup) across all cultural groups. Each SES subgroup consisted of five boys and five girls across all age and cultural groups, so that every level of response to be expected in children of these ages and of different abilities was represented in the samples. The purpose of these studies was (a) to identify the developmental sequencing of the abilities tapped by the tasks used in the study; (b) to investigate, factor analytically, the unity of the concrete operational stage in relation to cognitive tasks of different subject matter and of different levels of cognitive demand; and (c) to determine whether there were any important cultural differences in the cognition to be described between the three different subcultures from which the children were drawn.

Analysis of Greek/Australian Survey Data

The results of this survey have not previously been reported in the literature and formed the substance of Demetriou's doctoral research. For the purposes of this monograph, the data were re-analyzed by discrimination analysis, and by further factor analyses.

There are obviously two ways of testing the consistency of the discrimination level: by age variation, by amalgamating the cultural samples; and, for crosscultural variation, by amalgamating the different age groups. The 18 tasks were analyzed both ways, resulting in no more variation between samples than was shown for the Pakistani children. The variation of discrimination levels by cultural groups is shown in Table 3, and in the last column, the discrimination levels for the total sample are shown. Details of administration and scoring criteria for the tasks are given in Appendix B.

In Figure 4, a plot is displayed of logit difficulty against discrimination level for the total sample for comparison with the previous figures. Task 2, Seriation, Task 6, Cardinal/Ordinal Integration, and Task 1 Class Inclusion have rather wide ranges. In the case of Seriation, the Greek sample had a discrimination level of 2.5; the Greek/Australian sample, 4.6, and the Australian sample lay on the overall linear plot. Task difficulty was the more consistent parameter. Otherwise, the characteristics of the battery appear to be quite satisfactory.

Application of the Longeot Model

Pakistani Sample

Given the rudiments of an overall scale fitting all three data sets, we examined whether the tasks fit a developmental model corresponding to Flavell and

TABLE 3
Greek/Australian Sample: Percentage of Success Assessed at Each Level and Discrimination Levels of Tasks

Task	Level of assessment						Discrimination levels			
	1A	1B	2A	2A/2B	2B	Total sample	Greek	Greek/ Australian	Australian	Total sample
1 Class Inclusion	0	0	2	30	50	18.9	5.4	?	?	6.35ex
2 Seriation	29	50	61	68	86	63.3	2.5	4.6	3.5	4.4
3 1:1 Correspondence	7	62	94	97	100	84.4	3.0	2.8	2.2	2.65
4 Multiplication of Classes	0	15	22	70	82	45.6	4.4	4.2	4.7	4.44
5 Multiplication of Relations	0	8	16	44	71	32.2	5.4	5.5	5.1	5.35
6 Cardinal/Ordinal Integration	0	12	33	59	78	43.3	4.9	4.7	5.5	4.92
7 Conservation of Mass (Liquid)	0	12	71	81	100	65.0	4.2	3.5	3.3	3.43
8 Conservation of Mass (Liquid)	0	8	71	76	100	62.8	4.2	3.7	3.3	3.44
9 Conservation of Mass (Solid)	0	4	67	81	100	62.8	3.5	3.9	3.4	3.50
10 Conservation of Length (displacement)	0	0	55	73	89	54.4	4.6	4.1	3.7	4.16
11 Conservation of Length (distortion)	0	0	20	51	89	32.2	5.0	5.0	4.7	4.92
12 Measurement of Mass	0	12	86	84	100	70.0	3.2	3.3	3.2	3.24
13 Anticipation of Mass Conservation	0	4	43	71	96	52.2	4.6	4.2	4.3	4.36
14 Anticipation of Mass Conservation	0	0	14	52	76	37.2	5.0	4.5	4.8	4.84
15 Kinetic Reproductive Imagery	0	4	6	32	75	25.0	5.1	?	5.1	5.31
16 Transformational Reproductive Imagery	0	12	8	33	50	23.3	?	6.4ex	6.3ex	6.1ex
17 Transformational Anticipatory Imagery	0	4	8	46	86	32.2	4.9	5.0	5.1	5.03
18 Anticipation of 2:0 Transformation	0	15	28	79	96	52.8	3.8	4.2	4.4	4.26
n =	(14)	(26)	(49)	(63)	(28)	(180)				

Note. A question mark indicates that there were too few subjects at this level to allow an estimate. Ex indicates value was estimated by extrapolation.

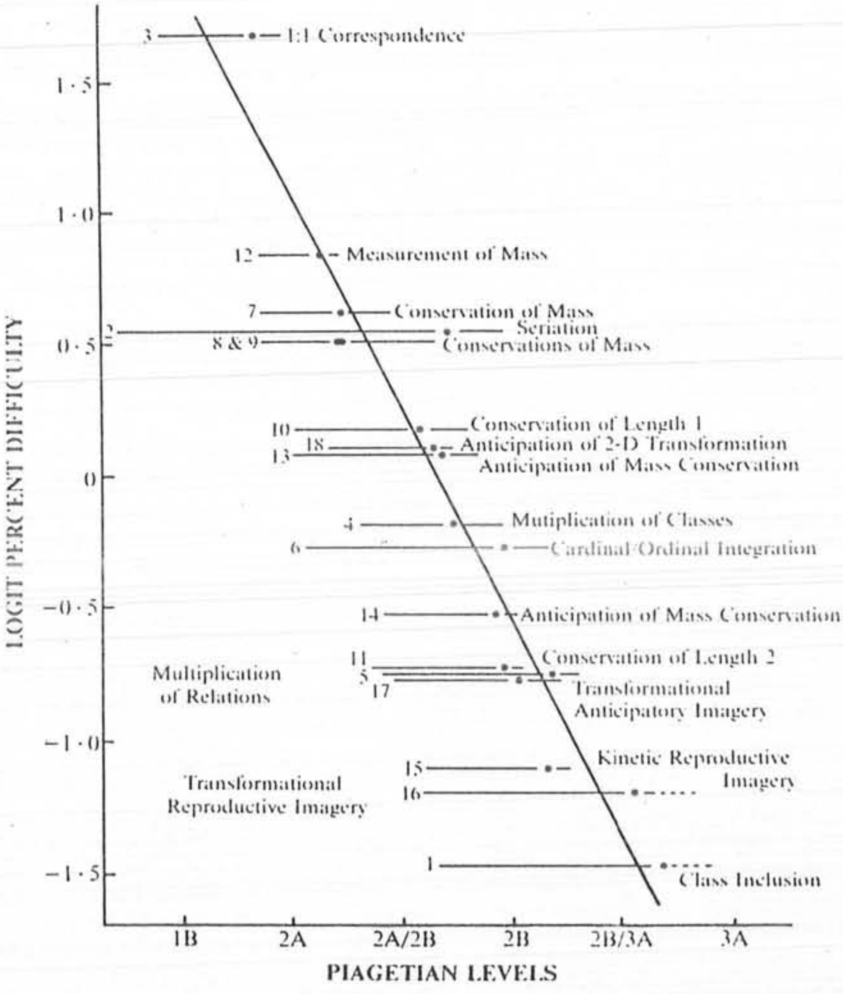


FIGURE 4. Relationship between Greek/Australian task discrimination levels and logit-transformed difficulties.

Wohlwill's (1969), approaching a node around 2B or 2B/3A where intersubject variation on tasks is at a minimum, or whether, as Longeot (1978) asserts, there are one or two such intermediate nodes in the development of concrete operational thinking.

The Longeot (1978) model requires that, at nodal points in development, subjects show the same level of operational performances on different types of task, but that as they develop further there is antinodal variation between children as to the type of task on which they show development. One way of testing this model is to group the subjects by their overall level as assessed by the task battery, and then inspect their relative successes on the different tasks. If the Longeot model is correct, subjects assessed at a level beyond a node must succeed on all tasks prior to that node. Table 4 gives the result of this test.

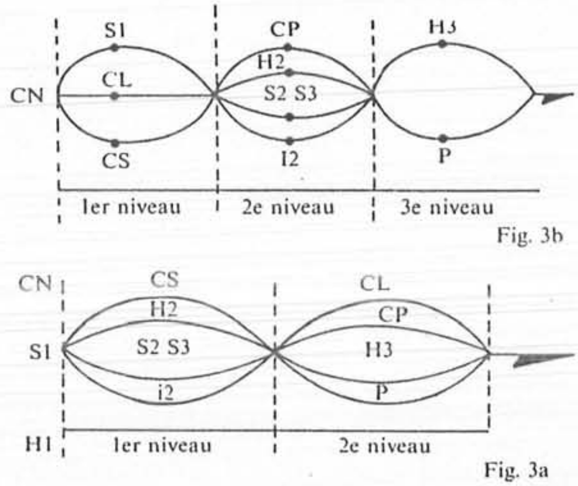
If a 90% success rate is taken as the criterion for virtual certainty, then it appears that there is a node just at the 2A boundary, another at the middle concrete level, and a third between 2B and 2B/2A. On tasks such as Length,

TABLE 4
Test of the Longeot Model on the Pakistani Sample: Percentage of Success Assessed at Each Level

Task	Level of assessment						Location of nodes
	1A	1B	2A	2A/2B	2B	2B/3A	
Seriation I	20	71	91	100	100	100	
1:1 Correspondence II	10	82	93	97	100		
							Node 1
Classification I	0	18	62	85	98	100	
Conservation of Mass II	0	6	58	89	99	100	2A range
Seriation II	0	6	60	86	96	100	
Classification II	0	0	29	72	94	100	
Conservation of Weight II	0	6	22	83	96	100	2A/2B range
Conservation of Length I	0	0	21	79	95	94	
							Node 2
Conservation of Length II	0	0	10	47	92	88	
Seriation III	0	0	33	56	77	100	
Classification III	0	0	21	51	74	100	2B range
Internal Volume	0	0	7	49	82	100	
Conservation of Area II	0	6	29	44	69	88	
							Node 3
Mountain I			7	14	51	56	
Plumb Line I			7	14	65	88	2B/3A
Water Level II	0	0	10	8	26	81	range
Displacement Volume	0	0	0	1	17	81	

Area, and Internal Volume, Conservation and developed Classification and Seriation, at the level at which subjects are achieving above a 67% success rate, success is above 90% on all previous tasks. In Longeot (1978), two different nodal models are given, fitting different of his data sets, as shown in Figure 5.

In Longeot's figures, the first and third nodes correspond to those found in the Pakistani data. Node 2 in Table 4 corresponds to Longeot's Node 2 in Figure 3b. There appears weaker evidence for Longeot's additional Node 2 represented in Figure 3a. The subjects assessed at 2A/2B who succeeded on the 2A/2B tasks, Classification II, Conservation of Weight II, and Seriation



CN = 1:1 Correspondence; S1 corresponds to Pakistan Seriation I; CL = Conservation of Length; CS = Conservation of Mass; CP = Conservation of Weight; S2 and S3 correspond to Pakistan Seriation II & III; I2 = Class-Inclusion; H2 = partial success on the Water-Level task; H3 corresponds to Pakistan Water-Level II, while P = "Point of (relative) View".

Reproduced from Longeot (1978).

FIGURE 5. Two possible nodes and antinodes of cognitive development during the concrete operations period.

II, above the 67% level also showed just under 90% success on the three 2A tasks shown in Table 4.

Longeot's success criterion for Conservation of Length is slightly more modest than in Length I (Table 2) or Task 10 (Table 3). And although in the Longeot study, 100 six-year-olds and 100 eight-year-olds were tested, the sample had to be broken down into groups of 25, and only four or five of the total small battery of eight tasks were given to any group. This meant that, for example, with the 8-year-olds, several of the tasks only appeared in two groups ($n = 50$). Thus, comparison of the tasks in terms of relative difficulties was subject to more uncontrolled variation than was the case either with the Pakistani or Greek/Australian studies, and a point by point comparison cannot be established. Given that three clear nodes—between 1B and 2A, between 2A/2B and 2B, and between the 2B and the 2B/3A tasks—appear confirmed, one must test the assumption that there is a further node somewhere in the middle of the concrete operational period.

Greek/Australian Sample

The corresponding test on the data from Greece and Australia is given in Table 5. Node 1 appears at the same place as in the Pakistani data. Those who were categorized at the 2B level almost fulfilled the 90% criterion on all preceding tasks (with Seriation giving some inconsistency, as mentioned previously), so Node 2 corresponds both to Longeot (1978) and the Pakistani data. There is also the suggestion of a Node 3 corresponding to that in the Pakistan table. Both the Pakistani and Greek/Australian data appear to fit the Longeot model as well as the Flavell/Wohlwill (1969) model. As to whether there is a further node corresponding to the second one in Longeot's 3b, the evidence was less convincing. On the Greek/Australian battery, those who succeeded on Tasks 13, 18, and 10 (2A/2B) had success rates between 68% and 84% on the 2A tasks, ranging between 12 and 9.

On both sets of data there was empirical confirmation of Flavell and Wohlwill's (1969) anti-nodes at the 2A and 2B/3A boundaries, and the strong node described by Longeot (1978) between the 2A/2B and 2B tasks was also found in both sets of data. With the additional weaker node between 2A and 2A/2B, it was clear that, although horizontal décalage existed, the limits within which it occurred were substantially circumscribed.

Alignment of all Three Data Sets

Before amalgamating the three data sets, problems raised earlier concerning the bottom and top of the scale must be analyzed. With any scaling procedure, there is always some arbitrariness about the values of the metric at the extremes. In the case of the Pakistani data, the extreme difficulty of some of the

TABLE 5
Test of the Longeot Model on the Greek/Australian Sample: Percentage of Success Assessed at Each Level

Task		Level of assessment 1A	1B	2A	2A/2B	2B	Location of nodes
3	1:1 Correspondence	7	62	94	97	100	
							Node 1
12	Measurement of Mass	0	12	86	84	100	
2	Seriation	9	50	61	68	86	
7	Conservation of Mass (Liquid)	4	12	71	81	100	2A range
8	Conservation of Mass (Liquid)	0	8	71	76	100	
9	Conservation of Mass (Solid)	0	4	67	81	100	
10	Conservation of Length (displacement)	0	0	55	73	89	
18	Anticipation of 2:D Transformation	0	15	28	79	96	2A/2B range
13	Anticipation of Mass Conservation	0	6	49	83	96	
							Node 2
4	Multiplication of Classes	0	15	22	70	82	
6	Cardinal/Ordinal Integration	0	12	33	59	78	
14	Anticipation of Mass Conservation	0	0	14	52	96	2B range
11	Conservation of Length (distortion)	0	0	20	51	89	
5	Multiplication of Relations	0	8	16	44	71	
17	Transformational Anticipatory Imagery	0	4	18	46	86	
							Node 3
15	Kinetic Reproductive Imagery	0	4	6	32	75	
16	Transformational Reproductive Imagery	0	12	8	33	50	2B/3A
1	Class Inclusion	0	0	2	30	50	range

2B/3A items and the presence of only 16 subjects at this level meant that the tasks of Displacement Volume and Water Level contributed a disproportionate influence on the scoring decisions, assigning a subject to the 2B/3A category and thereby lowering the assessed level of these tasks. In Figure 3, we see that these items are low on the difficulty/discrimination level plot. It was partly to deal with this indeterminacy that the British sample was selected. By setting these tasks in the context of other tasks discriminating in the range 2A to 3A, and by choosing a sample with 170 subjects in the range 2B to 3B it was possible to provide a far more reliable estimate of the discrimination levels of the tasks.

In fact, when a graph was prepared of the logit difficulty of the British sample tasks against the logit difficulty of the Pakistani sample tasks, a linear plot was obtained indicating that the discrimination level of the Water Level and Displacement Volume tasks should have been consistent to both samples. Accordingly, the following view was taken of the procedure to be adopted. Figure 2 was a good linear relationship, and the line of best fit went through the two points for Conservation of Mass (common to all three samples) and for Internal Volume (common to the British and Pakistani data) higher up the scale. Plots of discrimination levels of the three data sets, taken two at a time, showed no systematic difference in the scaling up to the 2B range. Thus interpolation on Figure 2 would utilize a common Piagetian scale and the extra range of scaling provided by the older British subjects. It would not only be convenient for purposes of comparison; it would also provide a linear transformation of the other two sets of logit difficulties onto the British sample for comparison with other reported data on the literature where difficulty values have been recorded.

Graphs of logit difficulty of the British tasks against the logits of both the Pakistani and the Greek/Australian tasks in common were prepared. For each task, the corresponding British logit was read from the linear plot, and the Piagetian level of the task estimated by interpolation on the line in Figure 2. In this way the comparisons shown in Table 6 were prepared. For consistency, the British logits were treated in the same way, accounting for the slight dif-

TABLE 6
Comparison Between Estimated Piagetian Levels of Tasks Common to British, Pakistani, and Greek/Australian Samples

Task	British	Pakistani	Greek/Australian
1:1 Correspondence (3)		2.90	2.65
Seriation II (2)		3.62	3.80
Conservation of Mass (7, 8, 9)	3.68	3.70	3.70, 3.82, 3.82
Conservation of Length I (10)		4.48	4.15
Classification II and Multiplication of Classes (4)		4.58	4.52
Conservation of Length II (11)		4.95	5.10
Internal Volume	4.90	4.90	
Plumb Line I	5.65	5.50	
Perspective I	5.95	5.80	
Mountain I	5.92	5.72	
Water Level II	6.63	6.42	
Displacement Volume	6.85	7.0	
Class Inclusion	—	6.65	5.80

Note. Numbers in parentheses are task numbers in the Greek/Australian battery.

ferences between the discrimination levels in Table 1 and the Piagetian levels reported in Table 6.

The values for Class Inclusion were inconsistent. Otherwise, agreement was sufficiently close to justify amalgamating the data sets by taking a mean value where there were tasks in common, and by simple interpolation of the estimated discrimination level value onto the diagonal where only one data set supplied the task. This was done in preparing Figure 6.

There were two problems. First, what is the precision of these estimates of scaling levels? For the Pakistani sample the internal consistency was calculated using the KR-20 formula. This gave an r_{tt} of .88, which, given a sample range of $\sigma = 1.037$ scale units, leads to an estimate of the error of person level of 0.35 scale units. It would appear that a Piagetian battery has measurement properties similar to many good psychometric tests. Second, there is a scaling problem apparent in Table 6. One-to-one Correspondence

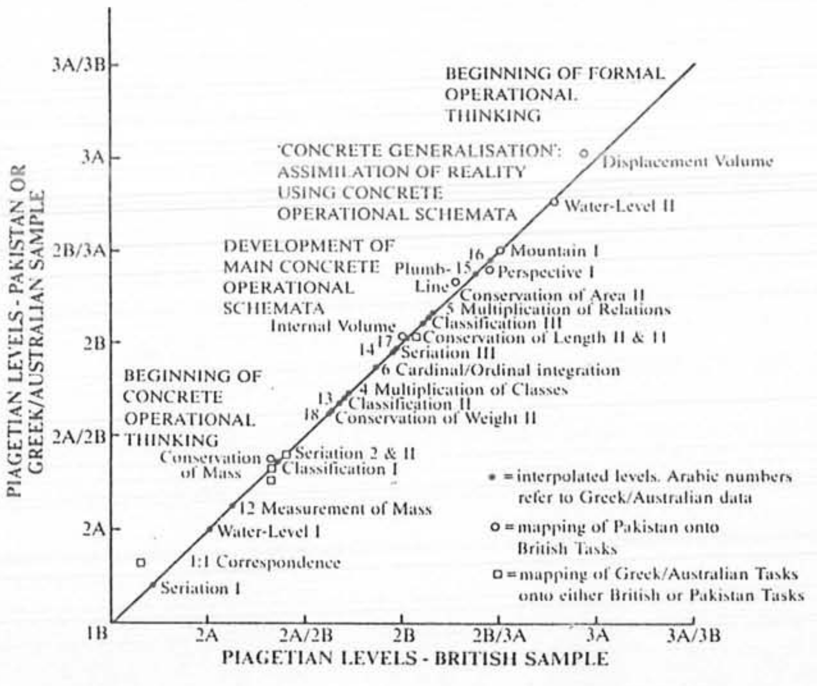


FIGURE 6. Amalgamated concrete operational scale with the main mappings of data sets.

lies at the bottom of the scale, and scales anywhere between 2.3 and 2.9, depending on whether discrimination level, or logit difficulty, or a weighting of the two, is taken. Given the arbitrariness of the scaling procedure at the extremity of the scale, the soundest procedure was thought to be to take a mean value of 2.6.

The quantitative treatment given in this monograph helps to clear the confusions mentioned at the outset. With the exception of Time, tasks have been found to scale consistently and independent of age. Tasks have also been found to scale consistently in relation to culture, with the Pakistani contrast being particularly striking. The problem of Class Inclusion, however, is one of task definition, and for this notorious task, an update of Koffsky (1966) is clearly overdue. Otherwise, it has been possible to scale the main steps in the development of concrete operational thinking with substantial clarity (Figure 6).

INTERPRETATION AND META-ANALYSIS

Concrete Operational Thinking and Mental Abilities

In this monograph, we used the view of psychometric test theory devised by Cattell (1971), in which he summarized the British and American traditions by an analysis that differentiates psychometric tests first into two broad categories of fluid and crystallised intelligence, g_f and g_c, and then subdivides each into the mental abilities first described by Thurstone (1938). Insofar as Piagetian tests have been included in test batteries, they factor with fluid rather than with crystallised intelligence (Pascual-Leone, 1983, p. 148; Vernon, 1969).

Piagetians have generally followed his lead in preferring to study the *reasons* both for success and partial failure on cognitive problems rather than to view children entirely in terms of their successes on test items. Historically, there is no doubt that this decision was profoundly fruitful for Piaget. But now that the traditions have defined themselves, it is possible to take a different view. It is now clear that it is a weakness of the psychometric tradition that, although there is a substantial correlation between test battery measures and academic achievement, there is no way of relating, say, an IQ measure of 107 of a 12-year-old with a description of what cognitive tasks that person can achieve and what one may expect him or her to fail on.

Piagetian tasks were always criterion-referenced even before that term was coined. Piagetian testing describes cognitive behaviour in terms of its degree of logical structure (the term *logical* being given the sense of *reasoning* rather than the sense with which a logician is happy), and abstracted from both its context and its position in the spectrum of abilities. But the development of the two arts of norm referencing and of factor analysis has led to the covert dropping of a description of different *levels* of thinking and to a qualitative discrimination, within the overall spectrum, of the different mental abilities. Thus, in the general investigation of intelligent activity, each tradition has developed complementary descriptions of the nature of intelligence, both of which are needed for a proper characterization of thinking.

If the above view is correct, it should be possible to analyze the test battery results by the mental abilities model and by the methods of factor analysis associated with it. We addressed two questions. To what extent is it reasonable to view concrete operational thinking as a unitary construct, and to what extent is it possible to account for some or all of horizontal décalage variation by the mental abilities model?

Reliability of Test Batteries and Factorial Unity

Both the Pakistani and the Greek/Australian batteries were given an alpha-factor analysis (Kaiser & Caffrey, 1965; SPSS: Alpha-factor). This mode of factoring treats the tasks as a sample typical of a psychological domain or domains, and asks the quantitative question: In terms of test reliability, how does the first factor compare with any subsequent factors? From the eigenvalues produced, the alpha reliabilities were estimated, and are shown in Table 7.

These figures speak for themselves: If a single Piagetian task is used as an estimate of cognitive level, the signal/noise ratio is about 50/50. Given a battery of tasks, we may improve that ratio to about 90/10, taking a unitary view of the test battery. This is certainly the reliability range—about .95—considered adequate in psychometric test construction. In terms of validity, the results show that only 20% of the common-factor variance requires another one or two factors for a complete description, but the reliability of these factors is low and may be neglected as a first approximation, as indeed did Cattell (1971) in describing a general fluid intelligence factor. Because the extra factors are strongly correlated with the first factor, we believe that the results amply justify regarding concrete operational thinking as a unitary construct.

Factor Analysis of Task Batteries and the Mental-Abilities Model

Both batteries were given the PA2 factor-analysis procedure of SPSS. Although the underlying model involves that of a sample of subjects whose behaviour typify the psychological domain analyzed, the factor loadings and structures were almost identical, within .02, of the alpha-factor analysis.

TABLE 7
Three Types of Factor Analysis on Pakistani and Greek/Australian Batteries

Type of analysis	Factor	Pakistani Grade 1	Grade 3*	Grade 3	Grade 5	Greek/Australian
		Principal components analysis (% variance)				
Estimate of mean signal/noise ratio for each task	1	37.5	33.5	28.4	21.2	41.1
	2	14.6	16.5	14.2	14.0	9.0
	3	—	—	11.3	13.2	6.0
Total		52.1	49.4	53.9	48.4	56.1
		Factor analysis—SPSS PA-2 (% variance)				
Estimate of proportion of signal attributed to each factor	1	78.6	73.0	60.6	57.7	81.1
	2	21.4	27.0	24.0	24.1	13.0
	3	—	—	15.0	18.2	5.9
		Alpha factor analysis (alpha reliabilities)				
Estimate of relative significance of each factor	1	.97	.95	.93	.91	.98
	2	.54	.61	.66	.61	.58
	3	—	—	.37	.44	.45

Note: *These analyses omitted the Mountain and Plumb Line tasks for comparison with Grade 1.

Greek/Australian sample. After a preliminary analysis, four of the tasks were omitted from the data to avoid producing small "doublet" factors. The omitted tasks were those differing only in slight detail from those left in the analysis, and which had been shown to have very similar first and second factor loadings to those left in. The analysis was first performed separately for the Greek, Greek/Australian, and Australian samples, and when no significant differences were found, it was repeated on the total sample. The factor loadings are shown in Table 8. It can be seen that there are two factors: the conservations, and the logico-verbal tasks (Class Inclusion, Multiplication of Classes and Relations, and Seriation). The tasks to do with number lie between the two factor clusters, when plotted in a two dimensional array, and the various imagery tasks factor with the logico-verbal tasks. Between the two clusters is an angle of approximately 40°, giving a correlation of the two clusters (cosine 40°) of .76.

TABLE 8
Factor Structure of the Greek/Australian Battery (After Varimax Rotation)

Task		Factor 1	Factor 2
1	Class Inclusion		.45
2	Seriation		.33
3	1:1 Correspondence	.49	.32
4	Multiplication of Classes	.25	.56
5	Multiplication of Relations	.25	.60
6	Cardinal/Ordinal Integration	.39	.46
7	Conservation of Mass (Liquid)	.83	
9	Conservation of Mass (Solid)	.79	
11	Conservation of Length (deformation)	.64	.33
12	Measurement of Mass	.78	.30
14	Anticipation of Mass Conservation	.40	.30
15	Kinetic Reproductive Imagery		.64
16	Transformational Reproductive Imagery	.26	.41
17	Transformational Anticipatory Imagery	.33	.55

Note. Loadings below .25 omitted.

Pakistani sample. Because not all tasks were given to all three grades, each grade was analyzed separately. In Table 9, it can be seen that the Grade 1 sample gives a two-factor solution very similar to that for the Greek/Australian study. For Grade 3, two extra spatial tasks were added to the Water Level task from the Grade 1 battery. These have a substantial correlation with the other tasks, but the factor structure is not so clear as in Grade 1. This is partly because the range of the subjects in the samples from Grades 3 and 5 is considerably narrower than that of Grade 1, making the intertask correlations lower and increasing the tendency of the data matrix to split into small factors. In the case of Grade 5, there is again a spatial task factor, but nothing is clear about the others. Finally, an analysis was run on subjects from both Grade 3 and Grade 5 combined ($n = 240$) to look at the relation of the tasks omitted earlier in the analysis to those that were retained. Again, there was a spatial factor (4), but two of the spatial tasks also appear in Factor 2, showing their correlation with the other tasks. Time, as to be expected, factors on its own, and Factors 1 and 2 are not clearly differentiated. Most of the communalities are low because of the narrower range of this sample compared with Grade 1—in particular that of Class Inclusion—which is why it was left out of the previous analyses.

Summary. Whereas there were many subjects in the 2A interval on the overall scale (between Nodes 1 and 2, see Table 5), as with the Greek/Australian sample, or with Grade 1 of the Pakistani sample (Table 4), the analysis then

TABLE 9
Factor Structure of Each Pakistani Age Group and of Grades 3 and 5 Combined (After Varimax Rotation)

	Grade 1		Grade 3			Grade 5			Grades 3 and 5				
Task	1	2	1	2	3	1	2	3	1	2	3	4	h^2
1:1 Correspondence	.31	.50	—	—	—	—	—	—	—	—	—	—	—
Conservation of Mass	.63	.32	.35	.54	—	—	—	—	—	—	—	—	
Conservation of Weight	.58	.31	.54	.37	—	—	—	—	—	—	—		
Internal Volume	.55		.42					.54	.54				.34
Conservation of Area	.39	.26	.52					.39	.26		.27		.14
Conservation of Length	.75		.64			.39			.66	.36			.58
Seriation	.26	.69		.43				.54		.33			.15
Classification		.61	.48			.57			.32				.13
Class Inclusion	—	—	—	—	—	—	—	—					.07
Water Level		.43		.57	.25	.37				.63			.41
Mountain and House	—	—			.44		.26					.49	.25
Plumb Line	—	—		.27	.50		.73			.38		.35	.29
Perspective	—	—	—	—	—	.38	.32			—	—	—	—
Time	—	—	—	—	—	—	—	—			.73		.57

Note. Loadings below .25 omitted. The symbol '—' indicates that a task was omitted from the analysis.

yields two factors, one being the conservations, and one being the logico-verbal tasks. This can be accounted for in Longeot's (1978) terms as indicating two different developmental paths to the middle part of the concrete operations stage. Beyond this point, the subjects' performance did not appear to diverge in the same way. We suggest that this is due to a "ceiling" effect on both the seriation and classification tasks, and subsequently only the spatial tasks indicate a separate developmental path as distinguished from the other types of tasks. Thus the intersubject variation on the tasks in these batteries, and the horizontal décalage, may at least be plausibly accounted for by their differential mental abilities, with other contrasts becoming salient in the successive internodal periods.

Problems and Applications

Intercultural differences. These differences might be of two kinds: *qualitative*, in which concrete operational thinking is achieved by different routes or varies at the end of the developmental period; and *quantitative*, in which children in different cultures develop on the tasks in the same order but at different rates. Apart from minor differences between the Greek and Australian children on seriation tasks, we have nothing to report on qualitative differences, strange as that might have seemed to, say, Heron & Dowel (1974). As to whether there are quantitative differences, this depends on whether one believes that previous studies have used samples carefully enough chosen to be representative of children of each age in a particular culture. Given the distinction between the factors of age and stage argued for earlier, we doubt whether there are many studies that may validly be compared. With this caution, one may compare the samples reported here. The percentages of the children assessed at each level in the three studies are listed in Table 10.

First, the comparison between the Greek/Australian and the Grade 1 Pakistani samples is between children of approximately the same age. The difference here, if any, is only between the proportion of mature concrete thinkers (2B) compared with those at the middle of that stage. One may also compare the Grade 5 Pakistani sample with the 10+ sample from the CSMS representative survey from 1974/1975. One notes the lower proportions of those at 2B/3A or above in the Pakistani compared with the British sample. It is possible that these would be found in the Pakistani fee-paying selective schools that were not sampled. Yet the proportion of those assessed at 2B or above was 61.7% in the Pakistani Grade 5 sample compared with only 42.9% in the British sample. Moreover, there are only 5% below 2A/2B in the Pakistani sample compared with 21.2% in the British!

We believe these figures should be looked at very carefully by anyone concerned with cross-cultural comparisons. Only the fact that the British CSMS survey was genuinely representative and of sufficiently large sample size to justify generalization allows an interpretation to be put on the Pakistani percentages. By the fifth grade, about 60% of the Pakistani children have left the educational system, if indeed they ever entered it. In the British system, on the other hand, they are a completely captive population that can be sampled. The Pakistani children who have left the system must be the low-ability children, leading to a higher average of children assessed at 2B among those who are left (40% have dropped out before the third grade).

A speculative interpretation of these findings is that the system of rote learning, almost universal in Pakistan, far from favouring the less able, in fact thrusts onto the child the whole burden of creating the relational understanding required to make sense of the reading, writing, and the number work covered in school. Only the mentally mature and robust can survive the system. Parents who can use their childrens' labour on the land will not keep them at school if they can see no resultant gain. In addition, this has led to current work in progress at the National Institute of Psychology on the feasibility of changing the education of teachers and their teaching style both to stimulate cognitive development in their pupils, and also to accommodate more flexibly to the differing development of the pupils.

Use of a Piagetian Task Battery as an Estimator of Cognitive Development

The feasibility of using a Piagetian individual interview battery as a psychometric instrument was demonstrated by Lunzer (1970), and such a battery was used (Lunzer, Wilkinson, & Dolan, 1976) in a study of the learning of reading and mathematics in 5-year-olds. But the battery was used only as a

TABLE 10
Percentage of 6- to 7-year-olds and 10- to 11-year-olds at Different Piagetian Levels Across Cultural Groups

	6- to 7-year-olds				10- to 11-year-olds	
Piagetian level	Greek	Greek/ Australian	Australian	Pakistani Grade 1	British 10+	Pakistani Grade 5
3A					5.6	0.0
2B/3A					10.1	9.2
2B	21.7	15.0	10.0	3.3	27.2	52.5
2A/2B	41.7	31.7	35.0	49.2	36.0	33.3
2A	20.0	25.0	36.6	25.0	13.8	5.0
1B	10.0	20.0	13.3	14.2	7.3	0.0
1A	10.0	8.3	5.0	8.3	0.0	0.0

Note. Empty cells indicate that the battery did not include tasks to estimate this level.

correlational measure in a multiple-regression analysis: The problem of assessing individual developmental levels by the battery was not attempted.

Part of the reason for this monograph was that Shayer required an instrument sensitive and sufficiently quantitative to assess the progress of early adolescent educationally subnormal students who were receiving Feuerstein's Instrumental Enrichment course (Feuerstein et al., 1980). The battery chosen for a pre- and posttest was the one used in the Pakistani survey, minus the tasks of Time and Class Inclusion, and Conservation of Area (the latter was omitted because that part of the scale was well populated with other tasks). It was administered as a pretest by individual interview to 20 twelve-year olds, of whom half were the experimental and the other half the control group. The posttest was given 20 months later. For scoring, a table was prepared from Figure 6, with the scoring points located at the discrimination levels of the tasks within the equal-interval scale used in this monograph. Each student was assessed as right or wrong on each task, and his level read off as the midpoint of the highest set of adjacent tasks at which two thirds success was still achieved.

The cut-offs were sharp, and there were no cases, either at pre- or posttest, where the student's success proportion dropped below two thirds at a position *below* that at which he was assessed (i.e., the décalage problem did not give ambiguity). With rather a narrow range (*SD* of 0.72 scale units, and range from 4.45 to 6.55 on pretest) the KR-20 reliability of the battery was a respectable .82, giving a standard error of test battery of 0.31 scale units. This mode of analysis allowed an effect size of 1.2 standard deviations between experimental and control subjects to be reported in Shayer and Beasley (1987).

Meta-Analysis of Previous Studies

None of the well-known difficulties in the Piagetian literature—for example, differing administration or scoring procedures being used by different authors, or the use of behaviour versus reason as success criteria—will disappear as a result of the adoption of the procedures outlined in this monograph. But it is suggested that a constructive meta-analytical review is called for, and that the technique of discrimination analysis can allow a better comparative description of data sets.

We have shown that the two parameters, discrimination level and logit-transformed difficulties, are linearly related when they relate to the same underlying construct. By using these transformations, three data sets have been mapped onto a common amalgamated scale ranging from intuitive (1B) to early formal (3A). How may we then relate another study, involving tasks not contained in any of the previous studies, to this scale?

Provided a previous study shares at least four tasks with any of the three studies presented here, and these tasks cover at least three intervals on the scale (i.e., 1B to 2A/2B, or 2A to 2B), then there are two possible procedures. Ideally the whole discrimination analysis procedure, starting from the raw data of subject successes and failures on the task battery, should be carried out. For these purposes, the categorical scale levels of the tasks given in this study can be taken as the starting point of the iterative procedure, giving preliminary estimates of the subject levels and hence the other task levels, and so on.

But in most cases only difficulty values will be available from the literature. The general procedure is to prepare a logit-difficulty/logit-difficulty graph with the study in this monograph that has the greatest number and range of overlapping tasks. The appropriate best straight line will satisfy a least-squares orthogonal distance from points to line, since neither of the two data sets can be taken as the criterion. Mapping the values of the new study onto Figure 6 will give the corresponding discrimination levels of the tasks not shared between the two studies. This procedure is illustrated in two examples.

Heron (Heron & Dowel, 1974), in questioning the unity of the concrete operations stage, quoted evidence taken from testing Yugoslavian immigrants in Australia. Figure 7 shows the mapping of the quoted difficulties onto the Pakistani data. It can be seen that Conservation of Mass lies off the line, but only by an amount equivalent to the 0.3 level on the amalgamated scale of Figure 6. For the sample number ($n = 49$), this is well within the sampling error. At the position of Class Inclusion one can only gasp. Finally, Multiplication of Classes, from the Greek/Australian data, can be computed by linear interpolation from Figure 7 to Figure 4. The comparison is: Demetriou discrimination level, 4.5; Heron discrimination level, 4.7. With the exception of Class Inclusion, these data are obviously compatible with those presented in this monograph. Bearing in mind that Conservation of Internal Volume lies just in the 2B interval of Figure 6, and that the sample difficulty for this group of children (M age = 10 years, 5 months) was 45%, one may differ from Heron's conclusion that they appear ". . . retarded by at least two years in comparison with the children tested in Geneva." The figure of 45% is quite close to that quoted for the British 10^+ sample: One may conclude that, as has been conceded before, the Genevan sample was above average.

Lunzer (1970; Lunzer et al., 1976) gives the number of successes achieved on his task battery by 75 children, aged 5 through 10. The battery contains six tasks in common with the Greek/Australian battery, although it is unclear from the description whether Lunzer's Nested Classes can be identified with Demetriou's Class Inclusion. A further figure corresponding to Figure 7 was prepared using logit difficulties of the tasks in common with the Lunzer and Demetriou batteries. Figure 8 gives the complete scaling of the Lunzer battery in relation to the scaling of the data shown in Figure 4:

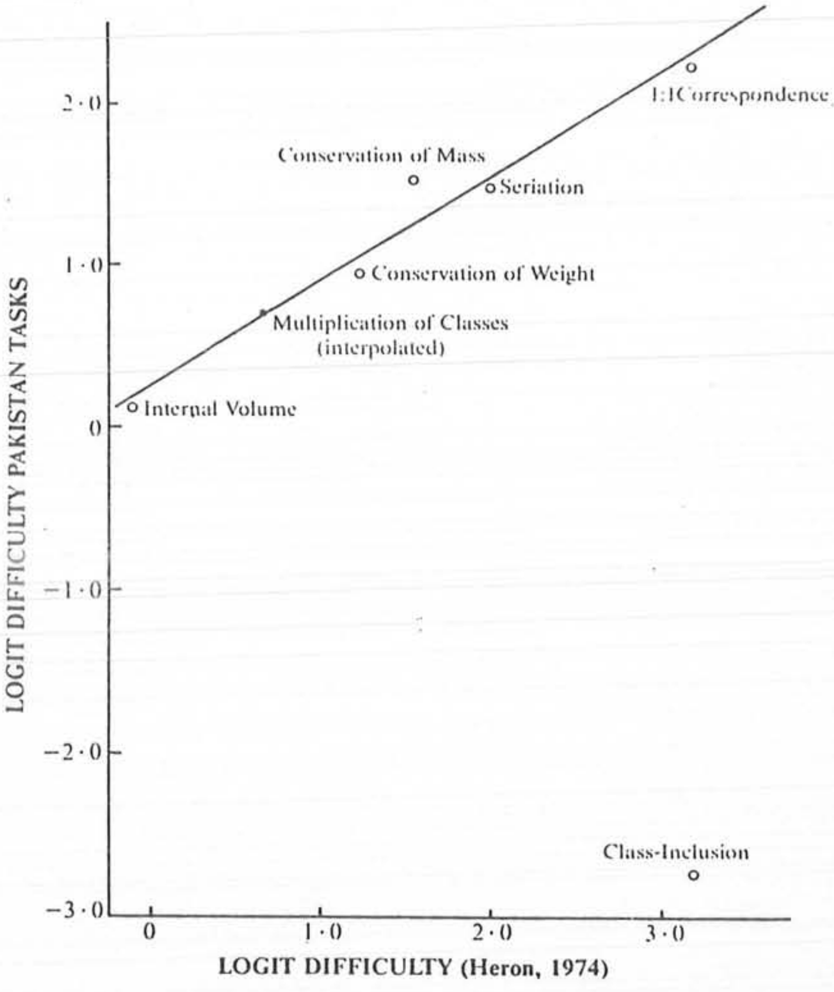


FIGURE 7. Mapping of tasks reported in Heron (1974) onto corresponding tasks in the Pakistani battery.

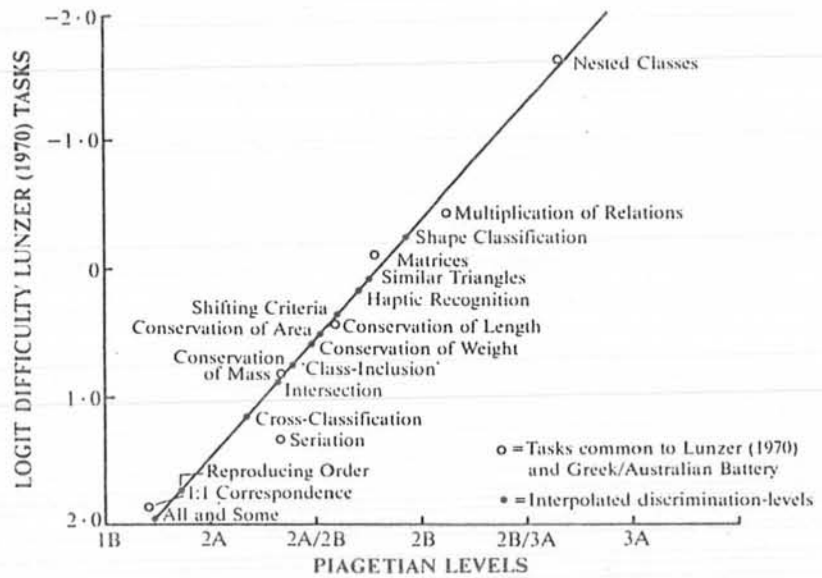


FIGURE 8. Scaling of the Lunzer (1970) task battery by reference to the Greek/Australian task battery.

The tasks unique to the Lunzer battery were scaled by interpolation. As before, the position of Class Inclusion is quite incompatible between the two batteries, and this task clearly needs close investigation as to the effect of different success criteria and the details of administration. This meta-analytical tool has the utility of comparing data sets of Piagetian tasks in such a way that their congruence can be seen and their areas of incompatibility highlighted for investigation.

DISCUSSION

The research presented in this monograph is directly related to three distinct but interdependent problems that have occupied developmental psychologists since the early days of Piaget. These are (a) *the problem of the method* to be used for uncovering the development of cognitive abilities; (b) *the problem of* *the horizontal structure* or organization of cognitive abilities in more general capacities; and (c) *the problem of the vertical structure* or the evolution of abilities as a function of age and/or experience. What are the implications of our research with regard to these problems, and how is our work related to that of current neo-Piagetian research?

The Problem of Method

In this monograph, we claim to have solved the issues that were so inconclusively presented and discussed in *Measurement and Piaget* (Green et al., 1971). With the exception of Goldschmid and Bentler's (1968) scaling of the earlier conservations, no previous researchers have presented anything but dismay at the psychometric problems involved. Yet we have seen that, even including the internodal décalage, the battery can be used as an estimate of individual development, with a standard error of 0.35 scale units, and that such measurements can be used to measure the effects of interventions. Why have we succeeded with such apparent ease where others have found only problems?

The psychometric tradition developed models of test reliability and factor analysis but, since the very early days of Binet, neglected to develop mathematical models for scaling. Insofar as scaling was addressed mathematically (e.g., Guttman's scalogram analysis), the underlying model fit attitudinal and feeling scales, where it is impossible to be at two parts of the scale at once, rather than relating the data to differential cognitive development.

Almost to a person, the Piagetians had no interest or expertise in psychometrics. Insofar as we have succeeded it has been because we have realised that the nature of the scale was one with a comparatively large amount of uncertainty in it (as estimated by the σ_e of 0.35), which is in the phenomena themselves and requires description rather than the imprecision of measurement. We asked the question: Does the data scale at *all?* And the data-analytical method chosen was one that would give a quantitative answer to the question. We found that not only does the data scale quite well, and that other studies can be retrospectively analyzed, but that much more developmental order existed than had been believed by most researchers in the field.

The new wave of neo-Piagetian psychologists (Case, 1985; Fischer, 1980; Halford, 1982; Pascual-Leone & Goodman, 1979) do believe that there is considerable order in the horizontal and vertical structure of abilities during development. However, with the exception of Fischer, none of these authors used a method that could directly reveal the horizontal and vertical interpatterning of cognitive abilities as presented in this monograph. Thus, these authors resorted to other measures, such as those related to the working memory of the subjects and the demands placed on working memory by tasks tapping different concepts in order to pinpoint their developmental equivalence.

As a number of authors (Demetriou & Efklides, in press-b; Dempster, 1985) have pointed out, this method is plagued with problems. It suffices to mention only two. First, once the measure of a subject's working memory has been obtained, it is difficult to interpret how much can be attributed to memory (or other cognitive) strategies and how much is indicative of the size of working memory capacity in terms of units or bits of information. Second, when one samples different domains of cognition, such as the domain of causal and the domain of quantitative relations, one cannot be sure that the "units of information" are really equivalent in terms of working memory or the mental energy they require to be held in an active state and effectively processed.

The basic research tool used by the neo-Piagetian researchers, if used on its own, is destined to arrive at a dead end. Specifically, whenever tasks sufficiently variable in content are used, it will show that no structure or low structure is present instead of the high structure expected on the basis of working memory measures (Case, Marini, McKeough, Dennis, & Goldberg, 1986). In other words, this line of research seems to regress to the impasse of the research conducted in the 1960s.

We believe that our method can inform and greatly enhance the scope of neo-Piagetian information processing, theorizing, and research. Specifically, we propose that the levels that can be uncovered by discrimination analysis, be they in correspondence to the Piagetian stages or not, can be considered as indices of increasing information processing capacity and/or expertise. A set of tasks found to discriminate at the same level may then be further analyzed in terms of information processing or mental power demand according to the procedures described by Case (1985), Halford (1982), or Pascual-Leone (1970; Pascual-Leone & Goodman, 1979). The aim would be to test whether same-level tasks also involve the same number of schemes or information units.

Such an analysis, provided that it is consistently applied across tasks, can result in one of two outcomes. Either same-level tasks *do* or *do not* involve the same number of schemes. Demetriou and Efklides (in press-b) showed that both outcomes can be true. They found that some same-level tasks *are* equivalent in their information processing demand whereas other same-level tasks are not equivalent. At least two methodological and theoretical issues are implied by this finding. Same-level and different-level memory-demand tasks may involve information units that are not equivalent in the mental energy they require for processing or the space of memory capacity they occupy; for example, one unit of Task A is equivalent to two units of Task B in this regard. The units comprising same-level and different-level memory-demand tasks are equivalent in regard to mental energy or space but they are approached through *different strategies;* that is, a strategy is applied on the informationally more loaded task that is able to reduce its information load to the level of the information load of the less-loaded task.

These alternative possibilities lead to testable predictions, which can stimulate experimental manipulations that could greatly enrich cognitive developmental methodology. Specifically, were the first possibility true, only subjects with a working memory capacity equal to the demand of the *most* demanding task would be able to solve both tasks. Were the second possibility the case, the subjects possessing the information-reducing strategy relevant to the processing of the more loaded task would be able to solve both of them even when their working memory capacity was found to fall short of the demands of the most demanding task. These manipulations can evidently be combined with cognitive acceleration (Shayer & Beasley, 1987) or scaffolding methods (Fischer, Pipp, & Bullock, 1984), with the aim of settling the dispute over whether strategies (Chi, 1978), structures (Fischer, 1980), or working memory (Pascual-Leone, 1970) are the most important factors governing cognitive development.

Last, but not least, the analysis of discrimination levels, by definition, is a tool to be used for the description of intra- and interindividual differences. It specifies the level of tasks in reference to the level of persons, and vice-versa. In this respect, discrimination analysis is complementary to Rasch analysis, which allows conditional probabilities of success to be calculated for any person for any item or group of items (Andrich & Constable, 1984; Shayer, 1987). Using the two methods jointly, one is able, at the same time, to state which tasks or items in a battery go together in the same psychometrically valid level or slice of the developmental scale, which or how many such levels exist in the battery, what is the position of each person on the scale and what are the probabilities of the subjects found at a given Level A to succeed also on the next level, A + 1. We think this is the evidence needed to specify and systematically vary the cognitive parameters instanced earlier. We propose that the method introduced in this monograph is a productive research approach that can be combined with other methods to settle unresolved issues and to open new ones in the study of cognitive development.

The Horizontal Structure of Concrete Thought

The consistent appearance of three factors across the various groups of this study strongly suggests that concrete thought should be considered a composite of three dimensions: (a) the *quantitative-relational,* (b) the *qualitative-analytic,* and (c) the *imaginal-spatial.* Two related problems require discussion. First, the capacities represented by these dimensions must be defined. Second, the reason for and the extent of their separateness have to be explained.

The quantitative-relational capacity. The factor representing this capacity has been defined by high loadings on the various conservation, measurement, and number tasks. Therefore, it may be defined as the capacity concerned with the representation and processing of quantifiable reality. As such, this capacity seems to be composed of three interrelated sets of component abilities.

First, *abilities of quantitative specification and representation* enable one to specify the quantitative character of the properties or elements processed and to encode what is specified into the terms of an arithmetic or metric system. This capacity seems to be symbolically biased (Gardner, 1983) toward the condensed, arbitrary, and unequivocal symbol system of mathematics. Second, *abilities of dimensional-directional construction* enable one to reduce the encoded reality properties to points or levels of a dimension, to define their scaling (e.g., arithmetic or geometric variation), and to capture the direction (e.g., increase or decrease) and shape of the dimension (e.g., linear or curvilinear). Third, *abilities of dimensional-directional coordination* enable one to interrelate dimensions so as to grasp and process their possible covariation. Overall, it may be said that this capacity is *synthetic* or *relational* in character. That is, given at least two elements, the application of quantitative processing "will result in their *reduction* to a relation that resolves them in a single mental product." (Demetriou & Efklides, 1981, p. 28, emphasis in the original).

The qualitative-analytic capacity. The factor representing this capacity has been defined by loadings on the various logico-verbal tasks of classification and ordering. Therefore, this capacity seems concerned with the representation and processing of the qualitative aspects of reality.

Despite its many similarities with the quantitative relational capacity, the qualitative-analytical capacity differs from it in an important way. Specifically, its processing operations are *analytical* or *disembedding* rather than synthetic or relational. That is, it is able to construct hierarchical (i.e., categorical), horizontal (i.e., matrix), or dimensional (i.e., serial) structures only after having analyzed or disentangled intermixed properties and having held them out of context as criteria that can subsequently be interpreted freely. Here the priority of analytical and relational operations is reversed compared with the quantitative-relational capacity. Thus the qualitative-analytic capacity seems to be biased toward the static declarative part of the verbal mode (e.g., nouns and adjectives). This enables the person to abstract properties and criteria and precisely encode them so as to operate on them efficiently.

The imaginal-spatial capacity. The factor representing this capacity has been defined by loadings on the various imagery, mental rotation, and coordination of perspectives tasks. We may assume that the imaginal-spatial capacity is directed to those aspects of reality that can be preserved and projected on a mental screen or buffer as integral wholes, visualized, so to speak, by the "mind's eye" (Kosslyn, 1978), and processed by the mind's scanner. Therefore, the imaginal mode of representation seems to be the symbolic medium that is peculiar to this capacity.

The component abilities used by this capacity are highly constrained by the imaginal medium. Only those related to the present study will be mentioned here. *Reformation and/or transformation abilities* enable one to rearrange the parts composing an image to make it consistent with corresponding changes in the reality represented. *Rotation abilities* enable one to reorient an image in three dimensional space to test whether it is similar to another image or scene. *Referential coordination abilities* enable one to effect one or more of the above transformations without distorting the relations of the image with the broader mental spatial layout in which it is embedded.

These capacities differ from each other in three important aspects. Each relates to a different reality domain, each is characterised by different operational mechanisms, and each is biased towards a different symbolic system of representation. Domain specificity, formal procedural specificity, and symbolic bias are proposed as being the organizational principles that govern the integration of specific abilities into more general processing systems. These systems may be considered a ". . . result of a higher-order interaction between a versatile self-cognized system and a systematically variegated pragmatic and symbolic environment" (Demetriou & Efklides, in press-b). These systems bear on functional autonomy capable of capturing the great variations that one observes in intra- and inter-individual cognitive functioning and development. It is precisely that variation that Piagetian theory failed to bring to light and explain because of its adherence to the notion of a logico-mathematical *structure d'ensemble*.

The Vertical Structure of Concrete Thought

Up to now, the discussion has focused on the separate aspects of concrete thought. Yet the results of both factor analysis and analysis of discrimination levels clearly indicate that the three separate capacities do share substantial common variance. Factor analysis showed that 80% of the common-factor variance is accounted for by the first factor. In addition, despite décalages, the batteries can be used for estimates of the overall level of development of the subject, with a standard error of estimate of .35 scale levels. We propose these two findings as a psychometric explanation of the fact that each developmental node, in Longeot's (1978) terms, comprises tasks of all three capacities (see Tables 4 and 5, and Figure 6).

The findings suggest that all three capacities are permeated by a common functional-processing core, despite their differences. This core, as it expands and becomes more complex during development, opens the possibilities for the construction of ever higher level abilities specific to each of the three capacities. Therefore, in Fischer's (1980) terms, the common core is a functional construct that controls the *optimum level of skills* a person can assemble along with growth. The general levels to be analyzed function as universal competencies characterizing all normal children. The implementation of these competencies into capacity-specific levels is a matter of person-specific biological and/or environmental contingencies that produce intra- and inter-individual differentiation (see Demetriou, 1987; Demetriou & Efklides, 1987a, in press-a).

Level 1: Incipient concrete operations (1B). Two tasks scaled below the first node: Conservation of Number (1:1 Correspondence) and the beginnings of seriation (Seriation I from the Pakistani battery). Both tasks are characterized by what might be called high perceptibility and representability of the relations involved.

In the 1:1 correspondence tasks, the number relation between the two counter series can be constructed by the 1:1 correspondence itself or by the association of both series to the same number name. In fact, 63% of the explanations given as a response to a conservation of number judgment in the Greek/Australian sample referred to the numerical equality of the sets (e.g., "They are still the same because each of them contains six counters." Demetriou, 1983). Likewise, the Measurement of Mass task (Task 12 of the Greek/Australian battery) scaled lower than the corresponding conservation of mass tasks because the subjects were able to formulate and explain their judgments on the basis of the fact that ". . . three little glasses of water were poured in each."

In the Seriation I task, there is a strong gestalt for the ordering of the sticks in a staircase. As a result, the child need only proceed iteratively in the placing of the sticks. In other words, he or she can translate into action the relations between adjacent sticks forming a real or imaginal gestalt only one at a time to construct a staircase. True, disordering may ensue, and it does, as a result of this approach, but the representational model is there to direct the child to approximate it by successive trial-and-error attempts.

Overall, then, the argument is made that at this level the child can adequately solve a task once its solution is clearly associated with some kind of perceptual and/or representational marker (e.g., a number, name, or a gestalt-like size relation). In this case, the child succeeds in the task the moment he or she understands that the marker is related to the solution sought.

Level 2: Early to middle concrete operations (2A to 2A/2B). At this level, the child becomes able to solve the tasks placed between the first and the second nodes. These include (a) the various simple conservation tasks, (b) the seriation tasks requiring the systematic application of transitivity on the selection of rods, (c) classification by one salient variable (Classification I of the Pakistani battery), (d) the simplest imaginal-spatial tasks such as the imaginal anticipation of the division of a ball of plasticine (Greek/Australian battery) and the Water Level I task (Pakistani battery). All of these apparently different tasks, which represent all three capacities, seem to share at least two characteristics.

First, all of them can be directly linked to some everyday scheme or model. This model is taken by the child at its face value, that is, as the logical framework from which their solution can be deduced straightforwardly. The application of the model, provided that it is directly associated to the task solution, results in the right response. If the model is not relevant to the task solution, or if an intervening transformation needs to be applied, its application will result in an incorrect response.

The responses given to the four tasks addressed to anticipation of conservation and anticipatory transformational imagery (i.e., Tasks 13, 14, 17 and 18 of the Greek/Australian battery) can illustrate this argument. It was unexpectedly found that the anticipation of conservation task elongation was easier than the corresponding anticipatory imagery task, which required the subjects to draw the results of the elongation transformation. In contrast, the anticipatory imagery task, which required the subjects to draw the results of the division transformation, proved to be easier than the corresponding anticipation of conservation task.

The explanations given by the subjects in response to these "Why?" questions highlighted this seemingly paradoxical pattern of results. The children anticipated that quantity would not change as a result of the elongation transformation because ". . . you roll *one* thing, it's the same thing, so its quantity will be the same." However, this same scheme acted negatively in the case of the imagery task: ". . . if it's going to have the same quantity it should have the same dimensions" as a result of the elongation transformation. The everyday scheme acted conversely in the case of the division tasks by prohibiting the anticipation of conservation (e.g., "You are going to have more pieces; if they are more, the quantity will be more because more pieces mean more quantity"), but it aided the formation of correct images (e.g., "When you cut something the pieces coming out are always smaller than the original one.").

Likewise, an extensive analysis of the explanations given by the subjects to the various conservation tasks revealed that almost half (49.2%) of the first grade children, who predominantly function at the 2A or 2A/2B levels (see Table 3) attained conservation on the basis of identity (i.e., quantity has to be the same because we use the same water) rather than on the basis of inversion (20.8%) or compensation (27.4%) operations (Demetriou, 1983). Yet, by the second grade, the proportion of inversion and compensation arguments had more than doubled. These findings indicate that, at the beginning, the use of global models is a predominant characteristic of cognitive functioning.

The Level 2 tasks share a second common characteristic. They all seem to require from the child that he or she apply the component processes of the capacities tapped by them with some systematicity. In the case of conservation tasks, tapping the quantitative relational capacity, an earlier state (e.g., they had the same quantity) needs to be integrated with a present state (e.g., it's still the same water) if a conservation judgment is to be produced. In the case of the classification or the seriation tasks, tapping the qualitative-analytical capacity, a criterion (classification) or a relation (transitivity) needs to be abstracted and consistently applied on the problem elements in order to build a categorical or a serial structure. In the case of the imagery tasks, tapping the imaginal-spatial capacity, a given property or dimension of the stimulus concerned (e.g., the water level or the diameter of a plasticine ball) needs to be systematically transformed in order to give a new mental object consistent with the operation assumed to be effected on an original real or mental object.

Practically, the activation of these inferential processes always results in the simultaneous processing of two dimensions or properties of those composing the reality domain concerned. For example, levels of height are related to levels of width (conservation), a class is related to another class through the presence or absence of the criterion applied (classification) and the size of the imaginally represented objects is related to their number (anticipatory imagery-division).

However, the processing capabilities acquired at this level need not be overestimated. It has already been stressed that they are dependent on the availability of everyday models. According to the evidence presented, these models may divert processing to irrelevant responses as readily as they lead to correct responses. The present level can be considered a direct extension of the earlier one, which was considered dependent on the availability of simple markers. But the present level, particularly in its more refined 2A/2B instantiation, opens the way for the next, as it enables the child to experiment mentally with rather complex everyday models instead of markers and to discover their strengths and limitations. The outcome of this process will be a step toward the use of content-free processing rules and operations.

Level 3: Mature concrete (2B). At this level, the child becomes able to solve the tasks placed between the second and the third nodes. These include (a) the more complex conservation tasks such as Conservation of Area, Internal Volume (Pakistani battery) and Length of Distorted Sticks (Greek/Australian battery), (b) the more complex classification and seriation tasks such as Classification III (Pakistani battery) and Multiplication of Classes and Relations

(Greek/Australian battery), and (c) the simple but counter-intuitive anticipation of conservation (division) or imaginal anticipation tasks (elongation) of the Greek/Australian battery.

Evidently, as Piaget has noted by invoking the notion of horizontal décalage, there is no operational difference between the tasks placed at Level 3 and those placed at Level 2. Piaget ascribed this décalage to increased resistance of the reality domains associated with the Level 3 tasks (Piaget & Inhelder, 1974). But this explanation simply begs the question of *how* the system does succeed in overcoming increased resistance at the present level. We propose that two interdependent factors are responsible for this success.

First, *emancipation of thought from everyday models* is clearly evident by the fact that at this level the child becomes able to solve the two counter-intuitive tasks by ignoring or even running counter to the illusory models evoked by the tasks. The result of this partial emancipation is that processing can now be directly focused on, encoding and processing the specific properties and dimensions that compose the task at hand. It is only at this level that compensatory arguments begin to systematically appear as justifications of judgments of conservation. As a result, the problem space of the task at hand may be painstakingly analyzed into its component elements (e.g., the properties or dimensions that define a matrix of classes or relations). Once these component elements can be identified, they can rather easily be operated on at a subsequent stage of processing, provided the operations needed were already functional at the previous level.

The second factor is concerned with the functioning of the processing operations themselves, and it may be considered as a derivative of the first factor. It has already been argued that the refocusing of processing from global models to the task problem space itself makes the processing operations explicit. Thus, the child is now able to monitor his or her on-line cognitive processing so as to tune it to the requirements of the task in hand. It is plausible to assume that monitoring ability, in its turn, causes the further elaboration and sharpening of processing operations (Demetriou & Efklides, 1985; 1987b; in press-b). Thus, on the one hand, tricky (e.g., Conservation of Internal Volume), unfamiliar (e.g., Conservation of Area), or quite complex (matrices) task structures may be deciphered. On the other hand, the operations, by having become elaborate, sharp, and differentiated from each other, are ready now to be coordinated with each other. This development takes place at the next level.

It is to be noted, however, that even before this coordination is attained, considerable consistency may be observed by the end of Level 3. This is clearly suggested by the results shown in Tables 4 and 5, which indicate that by Node 3, most of the classic concrete tasks are solved at a high level of consistency by all subjects. Indeed, if they were not all readily functional, children would not be able to proceed to coordinate them in everyday tasks as described in Level 4.

Level 4: Concrete generalization (2B/3A). At this level, the child becomes able to solve the tasks placed above the third node: the kinetic and transformational reproductive imagery tasks and the Class Inclusion task of the Greek/Australian battery, and the Plumb Line, Mountain, Water Level II, and Displacement Volume tasks of the Pakistani battery. Thus it appears that this is the level of the imaginal-spatial capacity par excellence. How is this to be explained?

All of the tasks referred to here share a common characteristic. They all require the coordination of both complementary perspectives and complementary operations if they are to be correctly solved. Displacement Volume, for example, requires that the changes in the shape of the object are mapped, point by point, onto the ensuing changes in the surrounding liquid, once the object sinks in it. This mapping, which is evidently an instance of spatial referential coordination, needs to be coordinated with the operation of dimensional coordination, which is a component of the quantitative-relational capacity. Were the spatial operations not mapped onto the relational ones, the assumption that changes in the object shape do not correspond to changes in the distribution of the containing liquid—that is, non-conservation—would be very likely.

Likewise, the Class Inclusion task necessitates the coordination of advanced analytic abilities (e.g., dissociation of the properties of "squareness" and "greenness" even though they are indissociable in the reality of the objects observed) with advanced quantitative-relational abilities (i.e., those enabling the subject to quantify the vertical and horizontal relations between classes) and, possibly, with abilities of imaginal representation that would assist the child in an attempt to disembed properties and quantify relations. Finally, the child would not be able to properly represent the gradual transformation of an arc into a straight rod, were he or she not able to dissociate (qualitative-analytic capacity) conservation of the rod's length (quantitative-relational capacity) from its possible shape transformations and map the latter onto a series of mental images (imaginal-spatial capacity), which preserve the curvature-end points relations resulting from the specific transformations to be effected.

A study by Demetriou (1983) is directly related to intercapacity coordination. In this study 7^{+}-year-old children were tested on three tasks. Three balls of different colours (identified by the subjects as equal in quantity) were used according to the standard procedure in transitivity tasks. First, Balls A and B were compared, and second, Balls B and C were compared. Afterwards, and without having seen the balls together, the subjects were able to make a judgment about the equality of balls A and C (Task 1). Then, again without Balls A and C being presented together, Ball A was transformed into a sausage and the subjects were asked to make a judgment concerning the quantities in Balls A and C (Task 2). That is, the subjects were tested for their ability to *conserve the transitivity argument* made before.

Thus the subjects had to coordinate conservation (quantitative-relational capacity) with transitivity (qualitative-analytic capacity). The subjects were also given the Conservation of Mass (elongation) task (Task 3). Respectively, 96.7%, 50.0%, and 33.3% of the subjects succeeded in solving Task 1, Task 3 and Task 2. In fact, Task 2, which was addressed to the conservation of transitivity, scaled with the most difficult of the mature concrete schemata, indicating that by the end of the previous and the beginning of the present level, capacities tend to be intercoordinated.

In conclusion, the changes that take place at the fourth level are important for two main reasons. On the one hand, they enable preadolescents to generalize basic concrete schemata already acquired over a variety of contexts until their application becomes habitual. It is in this sense that Collis (1975) used the term *concrete generalization* to describe those aspects of mathematical thinking attained by children immediately prior to their using formal operational thinking. Concrete generalization is evidently important by itself because it enables the person to cope with the many aspects of reality which, although descriptive rather than hypothetical, are complex and multifaceted.

On the other hand, capacity coordination and ensuing concrete generalization will sooner or later make the person realize that the world is more complex than it appears. According to Demetriou and Efklides (in press-a), the person will be made suspicious about the existence of nonobservable properties and interrelations. As a result, thought will change from descriptive to suppositional in its attempt to conceive the unobservable. By the time thought becomes suppositional, it has already entered into a new and long developmental track, which, by the end of adolescence, will lead to the establishment of formal thinking. But that is already another story (Demetriou & Efklides, 1981, 1985, in press-a; Shayer, 1979; Shayer et al., 1976; Shayer & Wylam, 1978). The fourth level may be considered the end point of one developmental cycle and the starting point of another. In Fischer's (1980) terms, this implies that the intercapacity coordination achieved at Level 4 results in the creation of a new mental unit that bears on properties that characterize all of the capacities already described.

CONCLUSION

In this monograph, we have systematically attempted to develop an integrated model of cognitive organization and growth, using analysis of discrimination levels and factor analysis, two methods that depend heavily on the long and powerful psychometric tradition. We hope these two methods have shed light on two of the most important aspects of the human cognitive system, its organization toward adaptively valid and psychologically meaningful capacities and its evolution toward ever more inclusive, powerful, and consequently errorless processing modes.

The organization of abilities toward more general capacities was shown not to agree with the Piagetian notion of *structure d'ensemble*. Indeed, instead of a single-structured whole of operations, three were identified: the quantitative-relational, the qualitative-analytic, and the imaginal-spatial. These capacity structures were shown to differ from each other in a number of respects, such as application domain, component abilities, and symbolic bias. They appear to function as autonomous systems, in virtual cooperation, despite the fact that they may have a common background.

This picture of cognitive organization is in general agreement with all dominant neo-Piagetian theories of cognitive development (Case, 1985; Fischer, 1980; Halford, 1982; Pascual-Leone & Goodman, 1979). As Case (1987) has noted, all theories either assume or are compatible with the assumption that domain-specific structures are independently assembled. At the same time, however, the present model supercedes all other neo-Piagetian models in one crucial respect. It analytically specifies *what* capacities seem to exist, *why* they exist, and *how* they come into existence, whereas all other theories go no further than making the assumption that distinct capacities may exist.

The model of growth proposed in this monograph is also in partial agreement with the other neo-Piagetian theories. It espouses the assumption made by all of them that cognitive growth is governed by changes that have to be located in a central pool of potential. This assumption, elegantly discussed by Fischer (1980; Fischer, et al., 1984) and Longeot (1978), states that the various abilities that belong to different capacities tend to converge around each major change in potential. This, in turn, implies that each level of central potential constrains the upper level of the complexity of cognitive skills that can be constructed by the subject. However, the attainment of a given central potential level does not imply that all distinct capacities will automatically be elevated to this level. On the contrary, the general potentialities afforded by the given level have to be worked out separately for each capacity in order to be actualized in capacity-specific competence *and* performance.

Provided that this does not ordinarily happen, large intra- and interindividual differences must be the rule in cognitive development. A second point of agreement between our theory and other neo-Piagetian theories, particularly those of Case (1985) and Fischer (1980), is related to the description of the developmental levels themselves. The four levels identified in the present monograph are fairly similar both in modal age of attainment and basic processing capabilities to the four levels comprising Case's dimensional stage and to the four levels comprising Fischer's representational tier. To make the argument clearer, it seems to us that Levels 1, 2, 3 and 4 are very similar to the levels of (a) single representational sets, (b) representational mappings, (c) representational systems, and (d) systems of representational systems, respectively, described by Fischer.

Yet this account has avoided the definition of the possible working memory capacity associated with the various levels as might have been expected from Case (1985), Halford (1982), and Pascual-Leone (1970). This is because we regard sceptically the assumption made by these theorists that (a) the growth in central potential is equivalent to the growth of working memory and (b) that the size, speed of processing, and deactivation rate of information units or schemes is the same across different domains of knowledge (see Baddeley, 1981; Demetriou & Efklides, in press-b; Dempster, 1985). Evidently, only future research can settle this dispute. We hope this monograph provides an empirical methodology and framework of theory in a fruitful combination that can further corroborate the points at which alternative theories converge and also resolve points of debate.

APPENDIX A
Tasks Used in the Three Developmental Surveys

British	Pakistani	Greek/Australian
	1:1 Correspondence	1:1 Correspondence
	Seriation I	
		Measurement of Mass
Conservation of Mass	Conservation of Mass	Conservation of Mass (Liquid) (7)
		Conservation of Mass (Liquid) (8)
		Conservation of Mass (Solid) (9)
		Anticipation of Mass Conservation (elongation)
		Anticipation of 2:D Transformation
	Seriation II	Seriation
	Classification I	
	Conservation of Weight	
		Anticipation of Mass Conservation (division)
	Classification II	Multiplication of Classes
		Cardinal/Ordinal Integration
	Seriation III	Multiplication of Relations
Internal Volume	Internal Volume	
	Conservation of Length	Conservation of Length (displacement)
		Conservation of Length (distortion)
	Conservation of Area	
Weight/Volume differentiation		

British	Pakistani	Greek/Australian
	Time	
		Kinetic Reproductive Imagery
		Transformational Reproductive Imagery
		Transformational Anticipatory Imagery
Plumb Line	Plumb Line	
Mountain/House/Trees	Mountain/House/Trees	
Perspective	Perspective	
Water Level	Water Level	
Displacement Volume	Displacement Volume	
	Class Inclusion	Class Inclusion

APPENDIX B
A Brief Description of the Administration and Success Criteria for Each Task

Task	Apparatus and procedure	Success criteria
	British sample	
Conservation of Mass	Water is poured from a 100-ml cylinder into a 250-ml beaker. The cylinder is refilled to the same mark. The subject is asked if the cylinder contains more, or less, or the same amount of water as the beaker.	Subject must affirm there is the same amount of water in each container
Internal Volume	A 60-ml cube of clay is lowered into a 1000-ml cylinder full of water, so that water overflows. The shape of the clay is changed twice. Given an initial water level of 500 ml, the question is, how do the rises in water level compare for the different shapes?	Volume of water overflowing is the same as volume of clay. Change of shape of the clay does not affect rise in water level.
Weight/Volume Differentiation	Corn is popped. Four unpopped and four popped grains are shown. After being asked how the amount of corn in the two sets compare, the subject is then asked whether the popped grains weigh more, less, or the same as the unpopped ones.	Weight of both sets is the same, despite larger volume of popped corn or the heavier feel of the unpopped grains.
Plumb Line	A jam jar and a cork with a lead weight hanging down on black thread are shown at different angles, then returned to the vertical with the weight hanging vertically. The subject is asked to draw how the jar, weight, and thread would look if the jar is tilted.	The drawing should show verticality of the thread independent of slope of sides of jar.

Task	Apparatus and procedure	Success criteria
Mountain/House/Trees	The subject is first asked to draw a hill; then to draw a house on one slope, three trees on the opposite slope, and in addition, being told the day is windless, to draw smoke coming from house chimney.	Trees, orientation of house, and direction of smoke should all relate to vertical rather than to the slope of the hillside.
Perspective (two-dimensional)	The subject is asked to imagine himself standing in the middle of a long straight tree-lined road, then to draw how the road and trees would look going into the far distance.	Trees should be drawn upright and there should be some sign that the far end of the road comes together.
Water Level	An empty jam jar is shown. The subject is asked to imagine it half full of water and to draw it (a) vertical, (b) tilted, and (c) lying on it's side.	Drawings should show the surface of the water related to horizontal.
Displacement Volume	A 1000-ml cylinder is filled with water. Subjects are asked to heft two blocks in their hands (a 60-ml block of clay, and a 60-ml block of brass, both of dimensions 5 × 4 × 3 cm). Subjects are then asked to predict how the volume of water overflowing would compare if blocks were lowered into the clyinder.	Subjects must resist the weight cue, and predict that both will displace the same volume of water

Pakistani sample

Task	Apparatus and procedure	Success criteria
1:1 Correspondence (Conservation of Number)	The child is shown 12 red and 12 green 1 cm-cubes. Seven red cubes are selected, one by one, and the subject is asked to match each red cube with a green one. After agreeing that both groups of cubes have the same number, the subject is shown the red set spread out, and is asked if each group still has the same number. The question is repeated after the red cubes are pushed close together, leaving the green cubes at the original spacing.	Level 1: Accepts initial equality, with a reason, but in some situations denies equality of sets. Level 2: Equality is maintained in all situations, with logical reasons.
Conservation of Mass	The child is shown a 500-ml beaker (C), two 250-ml beakers (B1 & B2), and four 50-ml beakers (4D). Equal levels of water are poured into B1 & B2. The child checks this. First, the child is asked to predict the level in C, and is then shown B1 poured into C, B1 refilled, and B2 poured among 4D equally. The child is asked about equality after each transformation.	Level 1: Conserves in some situations, but not all. If the response is conserving, a logical reason is given. Level 2: Conserves in all situations, with logical reasons.

Task	Apparatus and procedure	Success criteria
Seriation	The child is given two sets of ¼-inch thick sticks. Sticks in Set A are from 1 inch to 10 inches long, arranged at 1-inch intervals. Set B sticks range from 1½ inches to 9½ inches long, arranged at 1-inch intervals. The child is shown a "staircase," which is then destroyed. The child is asked to recreate it with Set A, then is handed Set B in random order and asked to find the right place for each stick. If seriation is not clear, the child is given Set A and asked to hand them over one by one so experimenter could make staircase behind a screen.	Level 1: Seriation is almost correct by trial and error; or a correct series is accomplished with A but the child cannot insert Set B. Level 2: Succeeds on the last trial, even if some difficulties arise in Parts 1, and 2. Level 3: Systematic success on all trials, starting with smallest or largest sticks. New sticks are readily inserted.
Conservation of Weight	The child is shown an equal-arm weighing scale and two plasticine balls of the same size. The child is asked to make the balls weigh the same by changing their shapes. One ball is transformed (a) into a sausage (b) into a pancake (c) into six pieces. The child is asked how they would now compare in weight (balls are remade to an equal size between each transformation).	Level 1: Conservation is not achieved in some responses, but a logical reason is given when conserving. Level 2: Conservation is achieved in all situations with logical reasons.
Classification	The child is given 18 wooden pieces of two sizes (large and small), three colors (red. green, and blue), and three shapes (circle, triangle, and square). The child is asked to put together like with like. If one classification is achieved, the set is randomized and the child is asked to group the pieces in a different way. If the child fails a new criterion, he is given an example using only a few pieces and is then asked to continue.	Level 1: Just one classification is achieved without help. Level 2: Two modes of classification are achieved, but help may be needed to achieve the second. Level 3: Three modes of classification are achieved, but help may be needed for the third (usually size)
Internal Volume	Water is poured into two 250-ml beakers, while the child assists to equalise levels, which are marked by rubber bands. Equality of displacement is established by placing two ¾-inch balls of plasticine in each beaker. One ball is given the same three transformations as in the Weight experiment. After each transformation, the child is asked about relative displacement by plasticine in each beaker.	Level 1: Conservation of displacement by plasticine is achieved in all transformations.

Task	Apparatus and procedure	Success criteria
Conservation of Length	The child is shown two sticks of a ½-inch cubic cross-section (12 inches long) and two toy dolls. The sticks are placed parallel and the child agrees they are of equal length. One stick is moved 4 inches to the right. Dolls are walked on the sticks from right to left, and the child is asked which doll walked further. The question is repeated after the dolls are walked back from left to right. After showing the equal length of the sticks again, the procedure is repeated with a 2-inch displacement of one stick.	Level 1: Conservation of walking distance is achieved in some situations with logical reasons, but not in others. Level 2: Conservation in all situations is supported by logical reasons.
Conservation of Area	Materials include two 12- × 14-inch green plywood boards (representing grass fields) 20 toy houses, 2 toy cattle, and 2 toy persons. The child agrees that placing one house in each field leaves the same amount of grass for the cattle. Five houses are placed in each field, in a line in one corner in first field and scattered all over the second. Then five more are added to each field. At each change, the child is asked about the grass remaining for cattle.	Level 1: Conservation is achieved in some situations, mentioning number and size of houses, but not in all situations. Level 2: There is a clear understanding of the concept of equal areas in all situations, supported by logical reasons.
Time	The child is shown a board with two roads on it—a small road 10 inches long, parallel to the side of the board and a large road 13 inches long at a 30° angle to first. Two toy cars are placed on the board with the same starting and finishing points relative to the side of the board. The child is told that both cars travel at the same speed and start from the same point. Prior to and after movement, the child is asked which car will get to end of road first, and when the car on the shorter road reaches the end, where will the car on the other road be? Last, two cars start together and reach the end of the roads together. Did they go at the same speed?	Level 1: There is clarity in some situations and confusion in others. Level 2: Clarity is achieved in all situations.
Plumb Line	Apparatus is the same as for British sample, but also includes four sketches of the jar in vertical, vertical inverted, tilted, and tilted inverted positions, without cord and weight, but showing the table base line. One sketch shows the plumb line in the	Level 1: The child makes some adjustments of the line to the position of the bottle, showing awareness of gravity, but not in all cases

Task	Apparatus and procedure	Success criteria
	bottle in a vertical position. The child is asked to draw the cord and weight in the first four sketches.	Level 2: The line is shown lumped in the inverted bottle. The line is vertical to the table base in all situations.
Mountain/House/Trees	Apparatus is as for British sample, but the hill is provided ready drawn.	Level 1: House and trees are sometimes related to the vertical and sometimes to the hillside. Level 2: All trees and house are related to true vertical.
Perspective	Apparatus is as for British sample, but a little sketch of a child is provided at bottom of the page to suggest a frame of reference. The child is asked to complete the sketch, showing the road going into the distance with trees on either side.	Level 1: Trees are drawn upright, but no perspective is shown in the road. Level 2: Either receding trees are vertical to the road but the road is uniformly wide, or the road is narrowing in the distance but vertical trees are uniform in size.
Water Level	Materials include a reagent bottle half filled with water, a cloth mask for the bottle, and two sets of sketches of an empty bottle on the table positioned upright, inverted, on its side, upright tilted to left, and inverted tilted to right. The child is asked to draw water in the first sketch, marking the water with a cross. The bottle is moved to the other four positions, and the child is asked to draw in the water. Then the bottle is masked with the cloth, and the child is asked to complete the second set of five sketches.	Level 1: Some adjustment of the water line is made with change in the position of the bottle, but not in all cases. Level 2: The water line is parallel to the base of the table in all situations.
Displacement Volume	Apparatus is the same as for Internal Volume (British sample), with the addition of a ¾-inch steel ball of the same size as the pieces of plasticine. The child is asked to feel both balls, and then to predict the relative water displacement of each ball.	Level 1: The child predicts the same displacement by each ball, and also shows conservation on the Internal Volume task.
Class Inclusion	The child is shown two yellow plastic flowers (giandas) and five red plastic roses. The child is asked to talk about whole sets of flowers and the subsets	Level 1: There is understanding of inclusion in some situations but not in all

Task	Apparatus and procedure	Success criteria
	of roses and giandas, while the experimenter holds the bunch of roses in his hand. But when questions are asked about the size of the whole class, (flowers) versus the subclass (roses), the giandas and roses are removed from the child's visual field.	Level 2: The child makes correct comparisons between subclasses and class (vertical comparison) in all situations.
	Greek-Australian sample	
Class Inclusion	Materials include 13 plastic squares (General Class B), of which 10 are green (Subclass A) and 3 are red (Subclass A′), and two cardboard boxes. The child is asked to compare green ones with square ones and (a) if put into the boxes, or (b) if made into necklaces, (c) who would have more.	The child must show a correct judgment (B > A), plus a logical reason, such as the greens are only some of the squares.
Seriation	Ten plastic rods from 4 cm to 40 cm in length, are initially in a random pile. The child is shown a seriation of the first three rods, with the comment that the second is twice as big as first, and so on. The child is asked to continue the staircase.	Deductive construction of a staircase is required. The child is allowed only one mistake in constructing a staircase, which he must correct.
Multiplication of Classes	Materials include 6 green and 6 red plastic circles with a diameter of 2 cm, 6 green and 6 red plastic equilateral triangles, with each side 2 cm, and 3 red squares, A white table, 22 × 22 cm, is divided into four cells with black lines. Cell A contains 3 green triangles; Cell B contains 3 green circles, Cell C, 3 red triangles, and Cell D is empty. The child is asked which of the remaining material ought to go into the empty cell, which might be put into the other cells, and if any other pieces might suit the empty cell.	The child must select the right class for Cell D (red circles), must answer *No* to the last question, and must point both to shape and color as criteria.
Multiplication of Relations	Materials include 3 plastic squares, dark, medium, and light green, 2.5 × 2.5 cm, 3 plastic squares, dark medium, and light green, 1.9 × 1.9 cm, 3 plastic squares, dark, medium, and light green, 1.3 × 1.3 cm. A white table, 10 × 30 cm is divided into three 10 × 10 cells. Cell A contains one light green big square; Cell B contains one medium green me-	The criteria are analogous to those required for multiplication of classes. The child must make the right choice and give the two grounds.

Task	Apparatus and procedure	Success criteria
	dium sized square. After seriating the squares by size and color separately, the child is asked whether he can find the square that fits the empty Cell C. Other questions replicate those in the multiplication of classes task.	
Conservation of Number (1:1 Correspondence)	Ten green and 10 red plastic squares (2.5 × 2.5 cm), and 6 green squares are laid out 2-cm intervals. The child is asked to match the 6 green squares with the red ones. The space between the green squares is doubled and the child is asked if there are now the same number of squares, more or less. A counter argument in terms of space occupied is given in case the answer is correct.	A conservation answer is required, together with a logical reason, which may be of identity reversibility, compensation, or transitivity.
Cardinal and Ordinal Integration	Rods are seriated and the child is asked of each, from the second to the tenth, how many like the first one would we have if we cut "this one" into pieces of equal size? At the fifth and eighth rod, the child is asked why? The procedure is repeated in reverse order. Then rods 5 and 8 are pointed to at random, and the same question is asked. Finally, the staircase is destroyed, the seventh rod is picked up, and the same questions are asked (rods differ by 4 cm at each step).	Correct responses are required at each part of the task, with ordinal number used as the criterion for deducing the cardinal.
Conservation of Mass (elongation)	Materials include two beakers 5-cm in diameter and 6 cm in height (A1 and A2), one beaker 4 cm in diameter and 10 cm high (B), and one beaker 2.5 cm in diameter and 20 cm high (c). There is a supply of water in a larger beaker. The child is asked to fill beakers A1 and A2 equally to about ⅔ rds full. Then water in A2 is transferred to B, and questions and counter-suggestions are asked as in the Conservation of Number task. Finally, water in B is transferred to C and the same questions are asked in relation to the water in A1.	Criteria are the same as for Conservation of Number.
Conservation of Mass (division)	Materials include beakers A1, A2 and a supply of water (as in the previous task) and also 4 little beakers, 2.5 cm in diameter and 3 cm high. Procedure is similar to the previous task, but	Criteria is the same as for Conservation of Number.

Task	Apparatus and procedure	Success criteria
	water in A2 is first divided into two of the little beakers, and finally into all four.	
Conservation of Mass (solid)	Materials include two balls of plasticine of different colors, 3 cm in diameter. One ball is transformed into a sausage, into a pancake, and into several small pieces. The usual conservation questions are asked.	Criteria is the same as for Conservation of Number.
Conservation of Length (displacement)	Materials include two black plastic rods 1.3 cm × 18 cm, and four black plastic V-shaped angles. The child agrees that the rods are of the same length; one rod is then displaced by 4 cm and the child is asked about their equality of length again. Countersuggestions are used after right answers. Last, the 4 angles are added to the two rods to create the Müller-Lyer illusion, and the same questions are asked.	Criteria is the same as for Conservation of Number.
Conservation of Length (distortion)	Apparatus includes two rods, A1 and A2 (0.8 × 0.8 × 13 cm) of flexible material and one long rod (0.8 × 0.8 × 30 cm) of same material (B). The child agrees that A1 and A2 are of the same length. Then A2 is distorted to an S shape, and the same questions are asked as used in the previous task. The child is then asked to imagine ants walking along A1 and A2, and asked which ant will have to walk the farthest. Finally the child is shown rod B and asked to point to where it should be cut to give the same length as A1, then where it should be cut to give the same length as the transformed A2.	The straight rod (A1) should be used as criterion for all questions, and the explanation should be given in transitivity of relations terms.
Measurement of Mass	Materials include beakers A1 and C from Conservation of Mass and a small beaker, E of 2.5 cm in diameter and 3 cm high with a red line 0.5 cm from top. Beaker E is filled with water to this line three times, and poured into A1. The same procedure is repeated with beaker C. The child agrees that 3 pourings occurred with each beaker. Questions and countersuggestions are then put, as in the Conservation of Number task.	Quantities in A1 and C are asserted to be the same, and an operational explanation is given.

Task	Apparatus and procedure	Success criteria
Anticipation of Conservation of Mass (elongation)	Balls of plasticine are used as for Conservation of Mass (solid). But in this version the balls remain untouched, and the child is asked to imagine one of them rolled into the form of a sausage, and then asked what difference it would make to the amount of plasticine. The same question is repeated after child is asked to imagine the sausage even longer.	Criteria is the same as for the previous analogous conservations.
Anticipation of Conservation of Mass (division)/ Kinetic Reproductive Imagery	Balls of plasticine are used as in the previous task. The child is instructed to imagine three successive divisions of one of the balls into 3, 6, and 9 little balls. The child is shown two glass squares (5 cm × 5 cm), with red lines around their perimeters, and is asked to draw how they would appear if lying directly above each other (one square with one red perimeter). The child is then asked to imagine how they would appear if one is displaced laterally by one half of its width. Five alternative drawings are presented, four representing typical errors, and the child has to choose the one showing four vertical red lines and two parallel horizontal ones.	The child must draw two overlapping squares, make the right choice, and justify by referring to the common and the different parts of the squares.
Transformational Reproductive Imagery	Flexible rods are used as in Conservation of Length (distortion): A, 0.8 cm × 13 cm; B, 0.8 × 16 cm. Rod A is curved to an arc with a radius of 3.5 cm; B is curved to an arc with a radius of 5 cm. Seven 18 × 18 cm white cards are shown, each with a drawing of A in the curved arc form, at the top, followed by two successive drawings showing possible appearances as A is transformed to a straight rod. The child is asked first to draw A in a curved form. Then he is shown B gradually straightened from its curved form. With B removed, the child is now asked to choose which set of drawings represent the straightening of A, and to justify his choice.	The child's drawing must show the gradual decrease in the curvature of the arc and the gradual increase of the distance between its endpoints. He or she must make the right choice and justify accordingly.
Transformational Anticipatory Imagery (elongation)	One ball of plasticine is used, as in Conservation of Mass (solid). On three 18 × 18-cm cards are drawn 3 successive transformations of the ball to a longer and longer sausage. On	The child's drawing must show the inverse covariation of length and perimeter of sausages, make the right

Task	Apparatus and procedure	Success criteria
	two of the cards, the width is not adequately compensated for by the change in length. The child is asked first to draw how he would expect the appearance to change, and then to choose the right card of drawings and justify his choice.	choice, and justify accordingly.
Transformational Anticipatory Imagery (division)	Materials used are the same as in previous task. Cards are shown, with drawings analogous to previous task, except here the transformation on each card is to 3, then 6, then 9 smaller balls. On first two cards diameters less than compensate for the increase in the number of balls. The child's procedure is as for previous task.	The child's drawing must show the inverse covariation of the number and size of balls, make the right choice and justify accordingly.

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