THE CHARACTERISTICS OF THE COLORED PROGRESSIVE MATRICES (CPM) AND THE ADVANCED PROGRESSIVE MATRICES (APM) IN THAI STUDENTS AGE 6-18 YEARS OLD: THE NORTHERN REGION

SIREE UDOMPHOL

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ABSTRACT

The purpose of this research was to study the characteristics of the Colored Progressive Matrices (CPM) and the Advanced Progressive Matrices (APM) and constructed norms for Thai students aged 6-18 years in Northern region. The sample was 1,388 students of which 614 were 6-11 years old, and 774 were 12-18 years old.

Results revealed that the CPM was rather easy for students aged 6-11 years ($\bar{p}$ = 0.74), mean of discriminating power was 0.50 and high reliability (r_{tt}= 0.92). A principal component analysis, followed by a series of varimax rotations of principal components, was performed. The 7-factor solution provided the most interpretable factor structure. Name of factor I was Creation. Factor II was Balance. Factor III was Category. Factor IV was Continuity. Factor V was Distinguish. Factor VI was Connection and factor VII was Assembly. The difficulty of the APM was of a moderately easy level ($\bar{p}$ = 0.60), mean of discriminating power was 0.49 and of high reliability (r_{tt}= 0.88). The principal component analysis, followed by a series of varimax rotations of principal components, was performed. The 9-factor solution provided the most interpretable factor structure. Name of factor I was Organization. Factor II was Relation. Factor III was Combination. Factor IV was Summation. Factor V was Creation. Factor VI was Subtraction. Factor VII was Transformation. Factor VIII was Increase. Factor IX was Category.

The results above found that the CPM and the APM were fair quality tests due to those characteristics. It could be used for constructed IQ score norm. In addition, the comparison of mean difference between sex, age, and educational level found a significant difference of mean in age and educational level. Therefore, the IQ score norm of the CPM and the APM classified by age and educational level were constructed. To use IQ score norm, age and educational level should be considered.

KEY WORDS: INTELLIGENCE / COLORED PROGRESSIVE MATRICES / ADVANCED PROGRESSIVE MATRICES /AGE 6-18 YEARS OLD

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การศึกษาคุณภาพของแบบทดสอบเชาวน์ปัญญา Colored Progressive Matrices (CPM) และ Advanced Progressive Matrices (APM) ในนักเรียนไทยอายุ 6-18 ปี: ภาคเหนือ (THE CHARACTERISTICS OF THE COLORED PROGRESSIVE MATRICES (CPM) AND THE ADVANCED PROGRESSIVE MATRICES (APM) IN THAI STUDENTS AGE 6-18 YEARS OLD: THE NORTHERN REGION)

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บทคัดย่อ

การวิจัยครั้งนี้มีวัตถุประสงค์เพื่อศึกษาคุณภาพของแบบทดสอบ และสร้างตารางเกณฑ์ปกติของแบบทดสอบ Colored Progressive Matrices (CPM) และ Advanced Progressive Matrices (APM) ในนักเรียนที่มีอายุ 6-18 ปี เขตภาคเหนือของประเทศไทย กลุ่มตัวอย่างจำนวนทั้งสิ้น 1,388 คน แบ่งเป็นนักเรียนอายุ 6-11 ปี จำนวน 614 คน และนักเรียนอายุ 12-18 ปี จำนวน 774 คน

ผลการวิจัยพบว่า แบบทดสอบ CPM ค่อนข้างง่ายสำหรับนักเรียนอายุ 6-11 ปี โดยค่าเฉลี่ยความยากง่ายเท่ากับ .74 ค่าเฉลี่ยของค่าอำนาจจำแนกเท่ากับ .50 แบบทดสอบชุดนี้มีค่าความเที่ยงอยู่ในระดับสูง (r_{tt}= 0.92) จากการวิเคราะห์องค์ประกอบพบว่าสามารถวัดองค์ประกอบร่วมได้ 7 องค์ประกอบ องค์ประกอบที่ 1 เกี่ยวกับการดัดแปลงรูปภาพ (Creation) องค์ประกอบที่ 2 เกี่ยวกับการรับรู้ความสมมาตรและทิศทางของส่วนที่หายไป (Balance) องค์ประกอบที่ 3 เกี่ยวกับการรับรู้ความเหมือน ความต่างและลักษณะเฉพาะของภาพ (Category) องค์ประกอบที่ 4 เกี่ยวกับการแยกส่วนของภาพที่ต่อเนื่องกัน (Continuity) องค์ประกอบที่ 5 เกี่ยวกับการรับรู้ลักษณะเฉพาะของภาพ (Distinguish) องค์ประกอบที่ 6 เกี่ยวกับการรับรู้ลักษณะเฉพาะของภาพที่มีความต่อเนื่องกัน (Connection) องค์ประกอบที่ 7 เกี่ยวกับการรับรู้ความเหมือนและความต่างเพื่อจะทำให้ภาพสมบูรณ์ (Assembly) แบบทดสอบ APM มีความยากปานกลาง โดยค่าเฉลี่ยความยากง่ายเท่ากับ .60 ค่าเฉลี่ยของค่าอำนาจจำแนกเท่ากับ .49 และมีความเที่ยงอยู่ในระดับสูง (r_{tt}= 0.88) จากการวิเคราะห์องค์ประกอบพบว่าสามารถวัดองค์ประกอบร่วมได้ 9 องค์ประกอบ องค์ประกอบที่ 1 เกี่ยวกับการรวม การแยก การเปลี่ยนตำแหน่งและการจัดกลุ่ม (Organization) องค์ประกอบที่ 2 เกี่ยวกับการรับรู้ความต่อเนื่องของภาพ (Relation) องค์ประกอบที่ 3 เกี่ยวกับการรวมภาพ (Combination) องค์ประกอบที่ 4 เกี่ยวกับการรวมลักษณะเฉพาะของภาพเพื่อทำให้ภาพสมบูรณ์ (Summation) องค์ประกอบที่ 5 เกี่ยวกับการดัดแปลงรูปภาพ (Creation) องค์ประกอบที่ 6 เกี่ยวกับการซ้อนทับและนำลักษณะบางอย่างของภาพออกไป (Subtraction) องค์ประกอบที่ 7 เกี่ยวกับการจัดกลุ่มรูปภาพที่มีความต่อเนื่องกัน (Transformation) องค์ประกอบที่ 8 เกี่ยวกับการเพิ่มลักษณะเฉพาะบางอย่างในภาพ (Increase) องค์ประกอบที่ 9 เกี่ยวกับการรับรู้ความเหมือนและทิศทาง (Category)

จากผลการวิจัยพบว่าแบบทดสอบ CPM และ APM มีคุณภาพเพียงพอที่จะสร้างเกณฑ์ปกติได้ จึงสร้างเกณฑ์ปกติโดยจำแนกตามอายุ และระดับชั้น ดังนั้นในการนำแบบทดสอบ CPM และ APM ไปใช้จึงควรคำนึงถึงอายุและระดับชั้นของผู้รับการทดสอบด้วย

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CHAPTER I
INTRODUCTION

Background and Rationale

Most psychologists developed test to measure intelligence based on intelligence theory e.g. Alfred Binet and Theodore Simon, David Wechsler, Alan S. Kaufman and Nadeen L. Kaufman, and J.C. Raven. They try to efficiently and trustworthily measure intelligence, and the way to do this is to measure intelligence by use standardize test (1). In 1905, Alfred Binet and Theodore Simon introduced "Binet-Simon Intelligence Scale" and Lewis Terman revised to "Stanford-Binet Intelligence Scale" and still in use. In 1939, David Wechsler, American psychologist, developed intelligence test that appropriately measure in each age group and created the norm that can compare with other similar group(2). In 1983, Alan S. Kaufman and Nadeen L. Kaufman developed "Kaufman Assessment for Children (K-ABC)" consists of Mental Processing Composite, Achievement Scale, and Nonverbal Scale (3, 4).The importance and value of test are reliability, validity, usability, and predictability. These characteristic is represented standardize of each test. Therefore, the standardize tests, that use in different culture, have to verify the quality of test, which are reliability and validity, to ensure that test is appropriate to use (5). The most popular test such as Standford-Binet Intelligence Scale, David Wechsler's Intelligence Test, and Kaufman Assessment for Children was developed base on western culture that the item of tests selected much more from the typical experiential background of certain groups than from that of other group. The typical experiences involving the acquisition of knowledge and skill were different for various subpopulations (6). The alternative tests when measured in the cross culture that to use the culture-fair test which usually is a nonverbal test. The nonverbal test was without language bias and the acquisition of experience involve picture, which particularly those who is English is the second language or had problem

of language in reading or writing. The nonverbal test such as the Davis-Ells Test, the Cattell Culture Fair Intelligence Test, and the Raven's Progressive Matrices Test can use for the one who had these problem. However, the Davis-Ells Test and the Cattell Culture Fair Intelligence Test still have bias between sub-cultures. The Davis-Ells Test has presented by pictures of man in many situations, it may have the cultural bias. The Cattell Culture Fair Intelligence Test has some content related to language, and it is not popular in used (6). While, The Raven's Progressive Matrices Test use geometric shapes for questioned, and by using these shapes, although subjects live in different cultures but they could have the same results, that was the qualifications of cultured fair test. In addition, this test can define observation ability, visual perception, thinking and controversial ability (1). Moreover, it is convenient, easy, take only short time to do, and can used as both individual and group (7). In 1938, the Raven's Progressive Matrices (RPM) Test was created to measure g-factor (General Factor) based on Spearman, and consists of three forms. The first one called "The Colored Progressive Matrices (CPM)" which is appropriate for children aged 5-11 and elderly, consist of 3 set, A, Ab, B, presented in 36 item. The second one named "The Standard Progressive Matrices (SPM)" which is suitable for general adults, consist of 5 set of twelve items (set A, B, C, D, E), but it can not discriminated person that has intelligence in above average from average. The last one is "The Advanced Progressive Matrices (APM)" constructed for adults, university students, genius persons or any person who used to get high score from SPM. It consists of 2 set, set I has 12 items and set II has 36 items. Set I is generally used to establish a field of thought for respondents and provide them with training in the method of working (8). Set II can divided person that has above average intelligence from average intelligence. After finish testing, convert raw score to percentile or IQ score for compare with the other similar group.

Even RPM is culture fair test but by the concept of cognitive development, Piaget believed that it composed of two processes, assimilation and accommodation, involved difference of individual's experience and cognitive structure. Therefore, it was not fair to compare the score from test with norm of different culture that had difference cognitive structure oriented. These may cause no real efficiency measured (9).

Because the culture of northern region was integrated the culture of neighboring countries with local culture and inherit until now. This research aim to identify the

intelligence of Thai students ages between 6-18 years in the Northern region of Thailand. There are other research about the characteristic of the CPM and APM in other region of Thailand that consists of North-East, Central, East, West, South, and Bangkok.

Research Objectives

1. To study the characteristic of the Colored Progressive Matrices (CPM) and the Advanced Progressive Matrices (APM) in consideration of validity, reliability, discriminating power, and difficulty index.

2. To construct norm of the Colored Progressive Matrices (CPM) and the Advanced Progressive Matrices (APM) for student ages between 6-18 years in the Northern region.

Scope of the study

Characteristics of Test

The characteristics of test in this study were item discrimination, item difficulty, reliability, and validity.

Population

Population for this study was students who study in primary school and secondary school aged between 6-18 years in the Northern region.

Variables

Independent variables: demographic data such as sex, age, and educational level

Dependent variables: the score of intelligence from the Colored Progressive Matrices (CPM) and the Advanced Progressive Matrices (APM)

Research Instruments

Raven's Progressive Matrices: the Colored Progressive Matrices (CPM) and the Advanced Progressive Matrices (APM)

Benefits and Expected Outcomes

1. Obtain the characteristics of the Colored Progressive Matrices (CPM) and the Advanced Progressive Matrices (APM) in Thai students aged between 6-18 years in the Northern region led to have the quality of test in the issue of reliable and standardization.

2. Define the intellectual characteristics and exploit the results in the process of education as placement for student and for suitable learning preparation, academic prediction, and appropriate medical diagnosis and treatment.

Definition of Terms

Intelligence refers to abstract thinking, learning from experience, solving problems through insight, adjusting to new situation, focusing and sustaining one's abilities to achieve a desired goal. As this research means observation ability, visual perception, thinking, and controversial ability. The number, which shows intellectual ability, which we can get from measuring with intelligence test in that time has been tested, called "Intelligence Quotient (IQ)". To know the level, compare with the other same age or educational level.

Norms refer to standard score obtained from the test which are conducted to the standard samples. A test score converted to equivalent standard score in normal distribution and transformed to percentile and IQ score.

CHAPTER II
LITERATURE REVIEW

This research is to find the characteristics of the Colored Progressive Matrices (CPM) and the Advanced Progressive Matrices (APM) for student age between 6 – 18 years who studied in the Northern region of Thailand. These reviews of literatures related to the study are as follow:

1. Intelligence
   1.1 Intelligence Theories
   1.2 The influential factors of Intelligence
   1.3 Intelligence Measurement and Evaluation
2. Culture fair intelligence tests
   2.1 Raven's Progressive Matrices
      2.1.1 The Colored Progressive Matrices (CPM)
      2.1.2 The Advanced Progressive Matrices (APM)

Intelligence

Intelligence Theories

There are many psychologists who focused on this issue with different concepts, which used as basis knowledge for build psychological tests. Currently, intelligence theories divided into 4 theories (10) as follow:

1. Psychometric Approaches

This approach was studied first in France by Binet & Simon in 1905 and defined intelligence was to understand and could solved problem creativity and discretionary (11).

Binet & Simon presented Uni-factor theory that intellectual ability united in to one call general ability and was be developed by maturity. Intelligence test based on this theory measured about the global ability.

Charles Spearman (12), English psychologist, explained about persons' intelligence variables and differentials by using factor analysis method, which based on statistic analysis of test score basis, beyond hypothesis that is scores of every intelligence test tended to relate in positively aspect. From mathematical approach it been found correlation of tests, all tests have same component which we call 'General Intelligence'. About this, Spearman presented Two-Factors Theory in 1904. This theory explained that human's intelligence combined with two factors i.e.

1) General Factor (g-factor) refers to general abilities was used in every activity of brain function and each person had this ability in difference. Spearman emphasize this factor was the mental energy and believed that these abilities depend on genetics. This factor consisted of logical ability, mechanical ability and spatial ability and difference in each person that made intelligence ability in difference.

2) Specific Factor (s-factor) refers to a group of abilities in which each person use for each activity and also affected by environment, education background and gender. By this s-factor, it causes individual differentials e.g. musical ability, sports ability, etc. and determined level of achievement in each activity.

To evaluate intelligence according to Spearman's concept, this will measure more of g-factor than s-factor because of g-factor involves with all of brain functioning. He also suggested that intelligence test, which use for measure g-factor, should contained abstract relations test, which contained seeking abilities in term of pertaining, prudent relations, and justifications based on Spearman's Neogenesis concept (13). This concept explains human's cognitive concept in three aspects: apprehension experience, education of relations, and education of correlations.

Questions to test for pertaining seeking abilities and prudent relations seeking abilities, they could be created based on concept stated above. They could be used as guideline to create intelligence test, especially test for g-factor, e.g. Raven's Progressive Matrices and Cattell's Culture Fair Intelligence Test (14).

E. L. Thorndike, American psychologist and educationist, claimed that intelligence structure has many composites and were related to each other. As human have to collaborate those composites together in each activity, Thorndike had divided intelligence in three aspects as follow (15):

1) Abstract Intelligence; is ability to learn and understand abstract issues including religious principle, philosophy and symbols.

2) Mechanical Intelligence; is ability to learn mechanical usable skill, understand about mechanism of machine including able to modify, maintenance and repair machine.

3) Social Intelligence; is ability to adapt one's self to get along with others, interpersonal skills and able to do for public's interests.

Louise L. Thurstone (12, 16, 17) focused on intra-individual differences, which composed by all composites and were called Primary Mental Abilities. They can be divided into 7 composites (3, 11, 13, 14, 16) i.e. spatial abilities, perceptual speed, numerical reasoning, verbal meaning, word fluency, memory, and inductive reasoning. To measuring intelligence referring to Thurstone's concept needed to use intelligent test, which was called as battery test, composed by varied subtests. Each subtest is for measure each composite of intelligence.

J. Paul Guilford (3) opposed that there are 180 traits of intellectual abilities (5 traits of content, 6 traits of operation and 6 traits of product). So he believed that to measure intelligence shouldn't use only total score and he also believed that abilities could be changed by training and learning. He named the intelligence construct as 'Structure of Intellect Model' that has three dimensions (14, 16) as follow:

First Dimension was contents. Contents were to categorize information into four categories i.e. figural, symbolic, semantics and behavioral but in 1977, another one category, auditory (3), had been added.

Second Dimension was products. Products were results of process between contents and operations. These products can be divided into six groups i.e. unit, classes, relations, systems, transformations and implications.

Third Dimension was operations. Operations were to collect received information and try to understand meaning of them. Operations are consisting of cognition, memory – in 1988 had divided memory into two different types which are memory recording and memory retention, divergent production, convergent production and evaluation (3).

Vernon (17) presented his model- Hierarchical Model. This model explained referring to Spearman's concept, which on top is g-factor and another part is major group factor – in which divided in to verbal education and practical. In each factor also divided into minor group factor, which divided into specific factors depend on each activities needed which he ranked as the lowest level.

Raymond B. Cattell (11, 15) interested in human's intelligence, which divided into two groups – fluid intelligence and crystallized intelligence. The former type of intelligence was the reasoning ability, abstract thinking ability, problem solving although they never had skills for that problem before. They also believed that this kind of intelligence could be passed on by genetics. For the later – the crystallized intelligence was abilities that can get by learning or collect through direct and indirect experiences. To solve any problem, it really needed to use those two types, the fluid intelligence and the crystallized intelligence, together.

Arthur R. Jensen (11, 17), American psychologist had presented intelligence model that is two level of intellectual abilities. First level is Associative Ability, is the basic learning ability and basic memory of in-transformation and unordered received information. This is the ability of perception, record stimulus in our memory and ready for recall with accuracy. Second level is Conceptual Ability, is the ability for reasoning thinking, problem solving and abstract understanding, which will has transformation and ordered received information process. This level is congruence with g-factor by Spearman.

Although Jensen's model supported to g-factor model for several years until now, but his studies did not used the same approach as other, even though his analysis

based on statistical approach (18). Unlike Carroll, which his studies based on hierarchical factor analysis, who presented intelligence model that called Carroll's Three-Stratum Theory of Human Cognitive Abilities. This model divided human's intelligence into three segments. Firstly, was called narrow abilities. Secondly, was called broad abilities, which same as crystallized abilities and fluid abilities referring to Cattell's model. Thirdly, was called one-general ability. From this, it can imply that abilities in second and third hierarchy could be found in other model, which based on factor analysis.

2. Developmental Theories

One of the most recognizable is Piaget's Intellectual Development Theory (19, 20, 21). He explained that everybody born with readiness to interact with environment. Human, naturally, is ready to action to environment first and tended to born with two basic abilities. Firstly - Organization, this is a process of organizing internal processes and set them as systematic, ordered and adjustable while interacting with environment. Secondly – Adaptation, this is to adapt one's self in balance with environment. There are two processes to make adaptation, 'assimilation' experiences and keep in cognitive structure and 'accommodation' exist cognitive structure with environment or new experiences. This is why human adapt himself while they get older. From this, Piaget divided intellectual development stages as follow:

First Stage: Sensorimotor (Born – 2 years) is the stage that children learn about relations between sensory and motor. This developed continuously to physical development.

Second Stage: Preoperational (18 months – 7 years) in this period, children will have cognitive structure in which represent objects with symbols e.g. in linguistic development, children will be able to use sentences, etc. For their thinking, mostly still depends on their perception and unable to think of prudent reasoning.

Third Stage: Concrete Operations (7 – 11 years) Children can have reasoning thinking including conceptual thinking in opposite side, which means they have reversibility. They learn to categorized and ranking.

Fourth Stage: Formal Operations (12 years – Adult) Children can seek for reason beyond basic information they have had. They have abilities to created hypothesis, theory and understand what they perceived is not as the possibilities they have. This means children have more abstract thinking.

After Piaget presented his model, his students e.g. Sternberg, Siegler, Klahr & Wallace and Case had created intellectual development theory based on (19) information processing. Thinking ability of each person in different age depends on ability to store the information in short term memory, quality and quantity of information, which get from the situation. Intellectual development depends on change mechanism, and to change is depends on problem solving strategic adjustment that is the continuous process. To analyse children' tasks are important for understanding their intellectual development. By this, Case tried to integrate Piaget's model with Information Processing Theory, so he presented his intellectual development stages by divided into 4 stages like Piaget's model but based on mental representation basis (19).

First Stage: Sensorimotor (4 – 20 months) in this stage, mental representation is sensory – input.

Second Stage: Representation Operations (2 – 5 years) Children start to have imagination or have concrete thought also they can memorized and recalled the information.

Third Stage: Logical Operations (5 – 10 years) Children will be able to store abstract information but it would be in simple transformation step.

Fourth Stage: Formal Operations (11 – 18 years) Children can store abstract information and able to do complex transformation to that information.

Lev Semenovich Vygotsky said that intellectual development is the process of internalization, which comprising with many processes that course higher mental cultures, transforms external processes into internal, thus changing of both structure and functions of the process. One of the most important processes is Mediation process. This process is to create mental tools to represent our perceptions i.e. language, etc. These tools will help individual to get higher mental cultures and to

superintend thoughts, knowledge, and behaviors like other tools that used for control functionality of organs (22). Vygotsky emphasized on cultures, socials, and learning that effects to intellectual development. Child in the different aged could reach to their maximum limit of intellectual development through helps of adults or intimate person like relatives, peers, etc. Vygotsky had divided intelligence into two levels (19). Firstly, the Elementary Mental Processes are natural abilities that child has since he/she was born without learning e.g. suckle, touching, exploring environment, natural abilities to help him/herself e.g. standing by clinging to chair, etc. Secondly, the Higher Mental Processes are coursed from child interacted with intimate adults, who teach him/her of cultures through language. Child will be learning those language, conceptualize and signs that help him/her understand environment. Language is an important mental tool to course the intellectual development.

3. Information Processing

Intellectual approach psychologists interested in studied about intelligence and created intelligence theories to explained e.g. Triarchic Theory of Intelligence by Robert Sternberg (11, 23, 24). This theory focused on three intellectual behaviors. Firstly, Contextual Component (or contextual intelligence), is the ability in self-adaptation to environment. Secondly, Experiential Component (or experiential intelligence), is ability to handle new situation with efficiency and solve problem with creativity thoughts thought and insight in what happened including responses automatically to the encountered situation. Finally, Information-Processing Component (or componential intelligence), is ability to think, seeking information in each problem and planning to solve out the problem. Strenberg's model was created by information processing approach, which studied nature of human's intelligence in get over difficulties, sometime is called Information Processing Theory of Intelligence.

Besides Strenberg's theory that used information processing approach, there is The Planning, Attention-Arousal, Simultaneous and Successive (PASS), which is described ability within structure of information-processing framework. It is Das's

(18, 24) cognitive processing model based on Luria's analyses of brain structure. This is the new theory, explains that human's cognitive process is functioning in three parts, which are Cortical Arousal and Attention, Coding through simultaneous and successive processes, Providing for planning, self monitoring and structuring of cognitive activities. These three brain structure functions are basis of PASS model. Besides, they still are the important part of human's intellectual ability.

Cognitive process, which involved in three parts mentioned above, responded and concerned with all of cognitive activities. 1) Attention - Arousal: when human get many of stimuli at the time, they will choose to memorize and response to only one of those which has unique characteristic. This was called selective attention. 2) Simultaneous and Successive: simultaneous process is to examine that stimulus step by step. Successive process is to linked information together. The process starts from receiving information to analyse and store. 3) Planning: is to plan, control, proof facts that lie under each behavior and take responsibility to that behavior including self – examination ability, which is the most complicated of human's behaviors (18). The PASS Theory is the combination of neuropsychological, cognitive, and psychometric concepts.

4. Neurological - Biological Approaches

Howard Gardner presented the intelligence theory called 'Multiple Intelligence' (19). He defined that intelligence was human ability to solve problems or to make something that was valued in one or more cultures. He added that human's intelligence combined with 7 aspects of intelligence (4, 25)

1. Linguistic Intelligence refers to an individual's capacity to use language effectively as a means of expression and communication through the written or spoken word.

2. Logical-Mathematical Intelligence refers to an individual's ability to recognize relationships and patterns between concepts and things, to think logically, to calculate numbers, and to solve problems scientifically.

3. Musical Intelligence refers to the capacity to appreciate a variety of musical forms as well as being able to use music as a vehicle of expression. Musically intelligent people are perceptive to elements of rhythm, melody, and pitch.

4. Visual-Spatial Intelligence refers to the capability to think in images and orient oneself spatially. In addition, spatially intelligent people are able to graphically represent their visual and spatial ideas.

5. Bodily – Kinesthetic Intelligence refers to the capacity of using one's own body skillfully as a means of expression or to work with one's body to create or manipulate objects.

6. Interpersonal Intelligence refers to the capacity to appropriately and effectively communicate with and respond to other people. The ability to work cooperatively with others and understand their feelings.

7. Intrapersonal Intelligence refers to the capacity to accurately know one's self, including knowledge of one's own strengths, motivations, goals, and feelings. To be capable of self-reflection and to be introverted and contemplative are also traits held by persons with Intrapersonal Intelligence.

8. Naturalistic Intelligence refers to the ability to identify and classify the components that make up our environment. This intelligence would have been especially apt during the evolution of the human race in individuals who served as hunters, gatherers, and farmers.

From above, many intelligence models created by generalized 'g-factor' of Spearman to measured more specific on intelligence e.g. Cattell's model, Thurstone's model, etc. In this research, the researcher is going to use Raven's Progressive Matrices (RPM), which is the culture fair test. Questions in this test similar to Cattell's test, which used for measure fluid intelligence, but the difference between these two tests is Cattell has two tests, one for measured fluid intelligence – similar to RPM, and other one is for measured crystallized intelligence – linguistics ability, mathematics, knowledge and experiences.

The influential factors of Intelligence

Intelligence was different in each individual because it was on one's birth and yet still had many factors influence on difference level of intelligence. One factor is genetic, which is set basic abilities of intellectual and affects on individual's intelligence. This was able to develop to be more complete up to age and environment. In each individual, intelligence would vary and different from one another referring to completion of brain functions, nervous system and environment, which encouraged person to have learning experiences. Factors, which affect to intelligence, are as follow:

Genetic

Intelligence is a characteristic that passed to person by ancestors, which is the basic of success in activities. How intelligence of child turned out to be, mostly, depends on parents' genetics. In some studies of twins found that intelligence score of both of them is almost the same level of one another, especially for the monozygotic twins, which genetic is alike. For the dizygotic twins, whose genetics are 50% alike, their intelligence scores closes to each other only in middle level. By the study of Burt (26) on 30 twins, who raised separately, found that their intelligence related to one another when has been raised separately and correlation of twin, who has been raised together, is 0.92. Therefore, it had been found that no relation of intelligence scores in non-related person (17).

Environment

Different environment have little different affects on intelligence that means no matter how complete the environment is but it couldn't change low intelligence child, whose intelligence reach idiot point and can't take care him/herself at all, into middle level but only help him/her to take care him/herself a little bit more. However, if children' intelligence are in the same range but live in dramatically different environment, this would effect to their intellectual development. According to study of Pairoj Khampiman (27), which compared scores of CPM and WISC-R in language ability of children in urban area to children in rural area in the North-East region,

found that the average scores of both CPM and WISC-R of children in urban area are higher than children in rural area and to change environment to make intellectual development happened, it would be more effective to do so while child is younger than teenager aged. In addition, incomes are important factor for IQ change. In the study about difference of income found that the average IQ scores of people from high-income areas in the Unites States and elsewhere are consistently higher than those of people from low-income communities with the same ethnic makeup (28).

Jensen (29, 30) said that to affect on individual intelligence, genetic goes 80% while another 20% are from environment. In 1987, James Flynn (31, 32, 33) discovered that over the 20th centuries, the average IQ scores have increased in all countries, a phenomenon called the Flynn Effect. The Flynn effect measured about fluid intelligence. In the United States, the increase has amounted to 3 to 4 IQ pointes per decade. Increases of this size could not be due to genetic evolution and therefore must have environmental causes and concluded the improvement of nutrition, education, and living conditions over this century have contributed to real improvements of intellectual functioning.

In 1992 Sandra Scarr and Richard Weinberg (31) found that children, that came from disadvantaged family backgrounds and had biological parents who were poorly educated and below average in IQ, were place in middle-class homes with adoptive parents who were highly educated and above average in intelligence. Adoptee had posted average or above average scores on standardized IQ test.

Gender

Male always has abilities on calculation, mechanism, acuity, and rapidly actions than female, who has more abilities on language and memory. From the study of Brody and Valvatne (3) found that gender difference influences on differences of some aspects of specific intelligence while none of general intelligence, that means female is going to has abilities of language while male tend to has more spatial ability, mechanical ability and mathematical ability than female. By the study of Wechsler, it could said that for specific intelligence, male get more scores in general knowledge, arithmetic, cubic arrangement and object arrangement, female get more scores in

similarities, digit memory and picture arrangement, but there's no difference in general intelligence (12). In Thailand, using APM found that there was difference on general intelligence coursed by gender difference with no statistical significant at 0.05 (1, 12).

Age

Generally, person will have more skills and abilities in the period of childhood and teenager but will drop in the time of senior. From the study about intellectual development found that human's intelligence will reach the peak of development at the age of 15 – 25 years or up to 30 years the top and will slightly drop accordingly to ages (30). Intellectual impotent in each aspect would be in different period (2, 30). In addition, from the study of ages difference affects to IQ score on APM of person in same age range have different scores. Like a study of Raven on norms of APM found that the same percentile position of ages 11 years, 11 years 6 months, 12 years, 12 years 6 months, 13 years, 13 years 6 months and 14 years have decreasingly average scores, those are 16, 17, 18, 19, 20 and 21 points in ordered. For who age at 20, 30 and 40 have average scores at 24, 23, and 21 points in ordered (12). Although in the older age range, it still found that there is affect on I.Q. score by age difference (12). Besides that from a study on CPM of children age 5 – 11 years found that average of I.Q. scores of children in different age are significantly different at 0.01 and the scores are higher when age increases (34, 35).

Education Level

Intellectual ability has been generally recognized to be affect by educational and memory. The ability to perform abstract, symbolic tasks related to education and social class. Education had difference effect on the development of abilities (36). With measurement by intelligence tests, high relationship between education and test performance has been found. The indicators of verbal intellectual status are vocabulary and general information test, two aspects of ability, which obviously developed by education (37). In 1951, Husen (37) tasted 722 boys while they were study in third grade in Swedish school and were retested again ten years afterward, by that time

some had been educational achieved. They were separated into two groups: those who had gone too junior secondary school without achieving certificate and those who had continued in grade 12 and 13. The former had average IQ gained of 2.1 points and 11.0 points respectively.

Intelligence Measures and Evaluation

Intelligence could be measured by intelligence tests, which each test could measure each aspect according to theories. However, to measures intelligence by intelligence test, it still could not tell all abilities, which that person has. Because of in each intelligence test, it will focus on different abilities.

Ministry of Education of France focused on children, who have slow learning ability, to set special education program for them. Therefore, French psychologists and physicians had created individual intelligence test for separated child with brain malfunction from normal child. In 1905, Alfred Binet and Theodore Simon (38) had thought the testing process and standard scoring that called “Binet-Simon Scale”. After that in 1911, Goddard modified Binet’s intelligence test, Terman, psychologist of Stanford University, was the principal author of the first major revision in 1916. This test became known as the Stanford-Binet Intelligence Scale, and was further revised in 1937, 1960, and 1972. (14,38). After that, there were many of psychologists created test referring to this e.g. in 1920 - first created National Intelligence Scale in USA, in 1939 – Wechsler-Bellevue Intelligence Scale and in 1948 – created Wechsler Intelligence Scale for Children by David Wechsler.

For most of intelligence test, there are specific cultures in the context. For the example in verbal scale of WAIS, this questioned about general knowledge, understanding in each situation and vocabulary testing. People who will get high score on this test have to be someone who grown up in the cultures that used English language or American Culture. Although in Performance Scale is still had those specific especially in picture completion, picture arrangement and object assembly, subject has to get used to with those pictures so he/she could do the tests because the pictures that are used in the tests all involved with American Culture. Therefore, the

WAIS is not appropriate use with people who was not live in that culture, although there are revised and translation into other languages because of it could not reduced the specification in the test unless to make it up again for each culture.

Thus to delete the cultural specification is not to use verbal or pictures that involved with any cultures but use the picture of international meaning instead e.g. The Davis –Elles Test, The Cattell Culture Fair Intelligence Tests and Raven's Progressive Matrices (RPM), etc. From many studies showed that for the Davis-Elles Test still had questions in reliability and validity and together with differential between groups of another tests. Because of this test is for evaluate reasoning ability and used animation picture of each situation to be questions that was why there still had cultural different. While in the Cattell Culture Fair Intelligence Test, there were some studies showed that there still was some sub-culture different because of using the verbal (6). Besides, these two intelligence tests are not popular but for RPM, which questioned by geometric shapes, are widely believe that will not give anyone the advantages on doing the test. Therefore, this test is another interesting culture fair test.

Measuring intelligence was one of the processes that make us understand on human's cognitive understanding, which is on processes as follow (39):

1. Knowledge: is ability to remembering things that they have seen or learnt

2. Comprehension: is ability to understand the meaning of the things that they have experienced or learnt, which can be noticed by ability to transforming what they've learnt or ability to predicting future or consequence

3. Application: is ability to modify of what they have learnt into something new i.e. create new theory, principle or concept

4. Analysis: is ability to classify of what they had learnt accordingly with the real factors to understand its construction. This ability based on shrewdness because of it was needed to understand context and construction of it

5. Synthesis: is ability to collect each components and gathering them to get the meaning e.g. writing a story, writing research proposal or understanding interpersonal relationship or relativity of things. This ability is required creativity behavior e.g. able to create or explain new thing

6. Evaluation: is ability to judge or evaluate on value of each thing, hence why it had needed for basic knowledge of general principles. This ability is the highest level of cognitive domain because it is necessary to have enough basic of all of the above

For this reason, it could say that to measure intelligence is one kind of psychometrics. In this respect, it could explain and make us understanding on intellectual different of each individual, which is useful for help them to understand themselves, get insight and able to plan and manage their lives successfully and suitable for their futures. Aside those, it also facilitate to living in everyday life e.g. medical diagnosis, employment selection, education institute selection, etc.

Intelligence test was measure intelligence of each person and compared with others in the same age range by using scores that get from the test calculate accordingly through the formula, which different in each test or by using norms, which is stipulate the intelligence level. Terman created norm based on William Stern's concept (15) to be intelligence index.

$$IQ = \frac{M.A.}{C.A.} \times 100$$

IQ = Intelligence Quotient
M.A. = Mental Age, which get from test result
C.A. = Chronological age

This formula is one of the most popular used in generally but it still has some weak points as in follow:

1) Mental age that can get from tests could not be more than age of 16 years because questions in the test could not discriminate adult's intelligence level, so this formula was suitable for calculates child's intelligence. Because of after passed childhood period, the mental age will not increase according to chronological age. Since chronological age has increased while the mental age has stopped, if we still use this formula to find I.Q., it would be found that the more people's getting old, the less IQ that person has got.

2) For child, the scattering of intelligence in different age is not in the same level e.g. in aged of 2.5 years, the child intelligence is higher than any others ages so it

could not be compared with other ages because it would course the problem in interpret.

Thus to resolve those two weaknesses, there was Stanford – Binet Intelligence Scale: Revised Edition (1960) by Terman and Merrill (29). They used another approach called 'Deviation IQ', which main concept is to change each person's score into z-scores and place in following formula: IQ = 100 + 16(Z). For normal person, the IQ score would be at 100 and the scattering of IQ in every age (SD) would be at 16, which is fixed value in the formula.

In 1955 David Wechsler was the first person who used deviation of intelligence. He presented the Wechsler Adult Intelligence Scale to public for the first time. The scores that get from WAIS could be converted into IQ score by following formula (40): IQ = 100 + 15(Z). The deviation of IQ in this formula is equal to 100 for normal person. The standard deviation of the scatter of I.Q. score for each age was 15, which less then Stanford-Binet 1 point.

To measure I.Q. score in present day, will be done by comparing the score from test with other's, who was in the same age, the scatter of scores were in bell curve or normal curve.

Although used z - score to calculate IQ score from deviation IQ and used area under normal curve distribution to explained I.Q. but it was remain erroneous.

Psychological tests have to be standardized and have testing procedure in the same condition and subjects, who do this standardized test, called 'norm group' which is target population, big group size, various or have scatter of variables e.g. gender, age, educational level, location, etc. Techniques and knowledge used for selecting the sample group to be representative of population and un-bias. The sample group, which been selected, will complete the selected intelligence test and converted raw scores that get from test into standard scores and developed norms to compare with others.

The quality of test consists of (41, 42) reliability refers to the consistency of a person's test score. It was usually obtained by comparing the individual's test score with a second score obtained by re-administering the same test to that person, or with the score from an alternate from of the same test. For this study used the Kuder-Richardson Formula 20 (KR-20) to find internal consistency.

Validity refers to whether the test used actually measures what it purposes to measure, what could be inferred from the test score by reference of it to something outside the test. To measure validity could do either before or after data collecting. Validity consist of content validity, criterion related validity and, construct validity.

In addition, good characteristics of tests will be as follow (43). Reliability at least equal to 0.7, low standard error, have good validity especially construct validity and, high discriminating power that can discriminate smart person from other.

Culture fair Intelligence Test

The Raven's Progressive Matrices (RPM)

In 1938, J. C. Raven created this test (7) in England and had been revised several times until 1956. RPM created for testing g-factor referring to Intelligence Structure Model of Spearman. RPM was base on the premises that general intelligence is a matter of seeing relationships in the things with which we have to deal. The type of item as completing the matrices, two type of progression or relationships are established, one in the horizontal and one in the vertical direction. The examine is required to pick the choice that correctly fill the missing of the matrix. The criteria of answering were to complete a pattern, complete an analogy, systematically alter a pattern, introduce systematic permutations, and systematically resolve figures into part. This test combined with three sets of questions, The Colored Progressive Matrices (CPM), The Standard Progressive Matrices (SPM), and The Advanced Progressive Matrices (APM). In this study was mention on CPM and APM.

The Colored Progressive Matrices (CPM). It was created in 1947 (8, 44) for used with child aged between 5 – 11 years old and senior citizen, for the interests on the studies of anthropology and psychiatric. The results of using were satisfied when used with Non-English users and person who has difficulty in speaking caused by brain disease or deaf (same as using with person who has low intellectual abilities). This test created for evaluating the chief cognitive processes. All the questions in this

test are colored and there are three sets in this test, which are A, Ab and B, each set has different difficulty of each question ordered increasingly from A to Ab and B. There are 12 items in each set of test. There are many researches of norms and quality of test as in follow:

Sunthorn Tunjee (34) and Suwaree Ruerkcharee (35) had found norms of CPM in student aged 5 – 11 years in the Central region and the Southern region. In addition, Sucheera Phattharayuttawat et al. (45) studied 900 students, 450 boys and 450 girls, in the 5 different age ranges those are under 5 years old, 5 – 6, 7 – 8, 9 – 10 and 11 years old, with 180 students in each age range. They found that there was no gender differentiates on intelligence level with significant level at 0.05. The average for boy was 29.02 with standard deviation at 7.82. The average for girl was 28.90 with standard deviation at 7.11. The score range was quite wide, the minimum score was 11 and the maximum was 36 so the curve was skewed to the left (skewness = -1.96)

Validity of CPM

Martin and Weichers (44) found that this test has concurrent validity in high level, which correlated with WISC at 0.91. This shows that the CPM can be use for testing young child's intelligence level. From the study of Fletcher, Todd and Satz (44) to test cultural fairness of CPM by compared with The IPAT Culture Fair Test and WAIS, Spanish version were tested on 30 adults, the correlation coefficient were 0.63 and 0.68 in order. In Thailand, there was a study by item factor analysis by Sucheera Phatthrayuttawat et al. (45) found that the CPM was one component test, which can imply that component was g-factor referring to Spearman's concept, the frame of creating the test.

Reliability of CPM

There were many studies test on reliability of this test; the results were depending on groups of subject. The reliability, which calculated from internal consistencies, was in the good range between 0.85 – 0.90. For test and retest reliability was higher than 0.80 (46) i.e. the study of Jensen (44) by split-half method found that

split-half reliability was 0.90. Miao and Huang (44) studied test retest reliability and split-half reliability in Taiwanese students were 0.92 and 0.93 respectively.

Sucheera Phattharayuttawat et al. (45) studied internal consistency reliability on CPM by Kuder - Richardson formula 20 (KR-20) found that the internal consistency reliability of this test was 0.91.

Discriminating power and Difficulty of CPM

From the study of Sucheera Phattharayuttawat et al. (45), discriminating power of the test (r) was between 0.10 – 0.36, which range of discriminating power for good test will be at least 0.20 (26). It found that there are 16 items less than 0.20 but another 20 items are in the good range.

For difficulty of test studied by Sucheera Phattharayuttawat and colleges (45) found that difficulty of each item was between 0.43 – 0.99 but the average difficulty of over all test was 0.77, which means that this test was rather easy. The item behavior starts with easy (p = 0.99) and increasing in the latest items (p = 0.43). Range of difficulty for good test will be between 0.20-0.80 (26).

Norms of CPM

Norms was used to diagnosis or predict interpretation of scores to let subject knows that what is his/her position when comparing with others in the same age. From the handbook of test, there were the studies of norms, percentile rank and T-score in children aged 4 years 9 months to 12 years and in adult aged between 55 – 100 years i.e. in 1986, to construct norm-based of the United States for ages between 5 ½ to 11 ½ years (44). In addition, Sucheera Phattharayuttawat et al. (45) studied norm of CPM by compared with WISC in subject aged less than 5 years to 11. The result found that there were little changes when compared with norm, which was developed by Somsong Suwanalert and colleague in 1968.

The Advanced Progressive Matrices (APM) created in 1934 (47) using for test on soldier selection in service of British Army between World War II. In 1947, had been revised for being use with normal people, who has high IQ level. Study of Foulds (12), shows that APM test could measure perception ability and systematic thinking ability level accurately. It revised and rearranged items again in 1962 by A.R. Forbes and H.G. Bevans (47); they had separated the test into two sets as in follow:

Set 1: There are 12 items, which get from APM version in 1947; not all these 12 items could precisely classify high IQ from average IQ. Content of the matrices are cover all cognitive processes same as SPM set A, B, C, D and E, which quite easy and used to establish a field of thought for respondents and provide them with training in the method of working (8). Time is limit at 10 minutes. The one who have low IQ will get score less than 6 and who have average IQ always get wrong answer in item no. 5, 10 and could not answer the last two items. For who have high IQ could learn how to solve problem and get no wrong answer. The score from this set will not be including for index the IQ score but could shown the trend of being dull, average, or bright on normal population, which will be 10, 80 and 10 percentage respectively. If subject can get score more than 6 points, he/she was allowed to do next set of test.

Set 2: There are 36 items in this test. Matrices of the test are more difficult and complicate than the first set, which subject has to use logic, prudent thinking and speedily because this is a speed test and be able to classify high IQ and average IQ distinctively. Time for doing test is limit at 40 minutes and there is the same procedure with set 1 of doing it.

Validity of APM

For the validity of APM, Foulds (12) had studied on children age 12 years 6 months in 1947 and found that this test had high construct validity because it could precisely classify children with different learning efficiency i.e. student who get grade A had higher score on the test than student who get grade F. This showed that the APM could measure level of perception ability and systematic thinking of each individual, which means we could evaluate individual's intellectual abilities according to Spearman's concept. From the result of item analysis of the APM test version year

1947, it's been found that there were 12 items that could not classify subject, who had high IQ. So there were rearrange the items to be in two separate sets as in present, which all of the items were on the right side of paper only and there's the procedure before beginning to do the test, this could make us get higher validity on evaluate intelligence level.

In Thailand, there was a study by item analysis approach by Manus Jintanadilokkul (48) and found that there was congruence with study of Sucheera Phattharayuttawat et al. (1) and Wattana Prohmpetch (49) that is the APM test is the test that measured only one factor, which can implied that is g-factor according to Spearman's concept.

Reliability of APM

According to study of Foulds (12) on reliability of the APM. Test in 1947 by test-retest method found that in the group of children who aged 10 years 6 months had reliability (γ) at 0.76, which showed that the APM was not suitable for children aged lower than 11 years. For children aged 12 years 6 months, the reliability was 0.86 and 0.91 in adult group. In report of Fitzgibbon (47), which test in 96 black American students by test – retest method, the reliability was 0.83. In 1990, Miao and Huang (47) evaluated in Taiwan and got 0.92 for reliability. Lui (47) studied in high-school students and had reliability at 0.77, which was the high level of reliability. In several researchers whose study were summarized in the research sections of the manual reported that the APM set 2 has a good internal consistency, with split-half reliability coefficients varying between 0.83 and 0.87 (47). This was turn out in the same direction with the study of Sucheera Phattharayuttawat et al. (1) in undergraduate student of universities in Thailand by studied on internal consistency with Kuder-Richardson Formula 20 (KR-20), which get reliability at 0.90. In the study of Wattana Prohmpetch (49) in high achievement high school students found reliability at 0.80.

Discriminating power and Difficulty of APM

For discriminating power of the APM, Sucheera Phattharayuttawat et al. (1) found that the discrimination (r) was between 0.10 – 0.59 and t value was between 2.01 – 2.30 while $P<0.05$. It means that each item could precisely classify the one who

get high score from the one who get low score significantly at 0.05 level. In addition, Wattana Prohmpetch (49) found that the discriminating power was between 0.30-0.71 and average was 0.32.

Raven study about item difficulty (47) found that the item behavior of APM started with easy and more difficulty in later items. This study was the same direction as the study of Sucheera Phattharayuttawat et al. (1) found that the APM had difficulty between 0.12 – 0.99 and the item behavior was start with easy (p = 0.99) and more difficult in the later items (p = 0.12). Wattana Prohmpetch (49) found that the item difficulty was between 0.37-0.99 and average was 0.76.

Norms of APM

Every kind of tests, it had been necessary to have norms for the use of diagnosis value or prediction. Without norms, it is unable to interpret the scores. Nevertheless, norms are not only telling us the average of population but also relative frequencies of deviation in different level apart from average both higher and lower. It could say that it makes tester knows the position of subject when compared with group and could compared with the other tests.

Raven (50) created norm of undergraduate students in Australia, which studied by Yates and Forbes (50), by converted raw scores to percentile and showed the position of each individual by comparing score with others in the same aged group. He seted norms accordingly to age range i.e. every half-year for 8 – 14 years old and every 5 years for age between 20 – 65 years old. There were many psychologists created norms of the APM in many countries e.g. Europe, America, Australia. In United States (47) had constructed norm on ages between 20 to 70 years. In Thailand, it was limited in undergraduate students and high achievement high school students e.g. studies of Sucheera Phattharayuttawat et al. (1), Chalitta Kaiyanand (12), and Wattana Prohmpetch (49). For general teenagers in high school are also able to use the APM for testing on intelligence. Thus, this study aims to constructed norm of the APM on secondary educate students.

Scoring Criteria

All these two tests had the same scoring criteria that were 1 point for correct answer and in each set, there is norms in form of percentile compared with score that subject get from testing accordingly with their age. To evaluate intelligence was to evaluate from percentile that subject had got. This test classified intelligence into 5 different level as follow (44):

Grade 1 "Intellectually superior", if a score lies at or above the 95th percentile for people of that age group.

Grade 2 "Definitely above the average in intellectual capacity", if a score lies at or above the 75th percentile. (2+, if a score lies at or above the 90th percentile.)

Grade 3 "Intellectually average", if a score lies between the 25th and 75th percentiles. (3+, if a score is greater than the median or 50th percentile. 3-, if a score is less than the median.)

Grade 4 "Definitely below average in intellectual capacity", if a score lies at or below the 25th percentile. (4-, if a score lies at or below the 10th percentile.)

Grade 5 "Intellectually impaired", if a score lies at or below the 5th percentile for that age-group.

IQ score also divided into ranges to use of comparing IQ score and result in intelligence, which categorized as table 1(39):

Table 1 Level of IQ score

IQ.	Level
130+	Very Superior
120-129	Superior
110-119	High Average
90-109	Average
80-89	Low Average
71-84	Borderline
50-70	Mild Mental Retardation
35-49	Moderate Mental Retardation
20-34	Severe Mental Retardation
20-	Profound

CHAPTER III
MATERIALS AND METHODS

This research was a descriptive to study the characteristics of The Colored Progressive Matrices (CPM) and The Advanced Progressive Matrices (APM) in Thai student age between 6 -18 years, who study in 2nd semester of academic year 2004 in the Northern region-Lampang was representative province. The procedures of study were as follow:

1. Population and Sample
2. Materials of the study
3. Data Collecting
4. Data Analysis

Population and Sample

The population for this study is students of the Northern region of Thailand, consists of Chiang Mai, Chiang Rai, Mae Hong Son, Lamphun, Lampang, Phayao,Phrae,Nan and Uttaradit, aged between 6-11 years, who have been studying in primary school and aged between 12-18 years, who have been studying in secondary school in 2nd semester of academic year 2004. The total number is 550,570 students including 456,411 for primary school students and 94,159 for secondary school students (51).

In order to estimate sample size by calculated at confidence interval at 95% (α = .05) and allow error of selection (E) for primary school student at 0.69 and 0.44 for secondary school student. The size of sample group could get by formula below (52):

$$n_{\mu} = \frac{\left(NZ^2\right)\sigma_x^2}{NE^2 + Z^2\sigma_x^2}$$

n_{μ} = Sample size

N = Size of target population

Z = Value of normal curve at area under curve range ($\alpha/2$)

σ_x^2 = Variance of population in each variable, which already studied in the previous research

E = Value of error, this research determine E = 0.05

The sample was 1,388 students which 614 students in primary level for the CPM and 774 students in secondary level for the APM.

The sampling processes were as follows:

First stage: Cluster random sampling from 9 provinces in the Northern region, which are Chiang Mai,Chiang Rai,Mae Hong Son, Lamphun, Lampang, Phayao, Phrae, Nan and Uttaradit. Lampang can represent because the commonness to others as a provinces that has both rural and urban communities, most of population do agricultural, merchant and some of home industry such as mulberry-pulp paper and ceramic factory (53). Gross provincial product is about 33,432,665 Thousand Baht (54). For culture and belief, this province has the same as others provinces because Lampang was the part of Lanna king- dom .

Second stage: Random schools from size of school, which divided into three sizes -small, medium, and extra large– by the Department of Elementary Education, to have various of intelligence level. This was random by stratified random sampling. From that method, the sample schools are as follow: Small primary school is Anuban Muang Lampang (Tong Chai Suksa) School, Medium primary school is Anuban Maemoh School, Extra large primary school is Anuban Lampang (Kelangrut Anusorn) School, Small secondary school is Pong Luang Wittaya, Medium secondary school is Maemoh Wittaya and Extra large secondary school is Bunyawat Wittayalai.

Materials of the study

Materials of this study was The Colored Progressive Matrices (CPM) designed for use with children aged between 5-11 years mentally retarded and the elderly which

consists of 3 set,A,Ab and B, each set has 12 items. Presenting the test as colored illustrations printed in a book. A working period was 30 minutes. Each item presented in such a way that a piece of it was missing and the subject had to choose one of the six alternatives that could make it completely. For scoring, one point given for correct answer and zero point given for wrong answer.

The Advanced Progressive Matrices (APM) designed for use with children aged 12 years and above which consists of two set. Set I contains of 12 items to prepare subject with familiarity with the test and how to do the matrices before do set II. There is time limitation at 10 minutes. Test score would not be added with score from set II. Set II had 36 items, which were more complicated and difficult than Set I. The way to do and scoring were the same as CPM.

Data Collecting

Two phases of data collecting procedure are:

1. Testing Preparation:

1.1 According to large number of subjects in this study and there were many tasks to perform in an administration. Researcher had to administer in the same standard.

1.2 Classrooms were be used as a test location.

2. Testing Operation:

2.1 The researchers introduce herself to subject and clarify for objective of this study.

2.2 Prepare for testing by distributing the test, answer sheet, and pencil. Researcher asks subject to write down their identification as: name, gender, age, educational level, date of birth, date of testing and name of school on the answer sheet. Subjects did not allow doing the test before permission.

2.3 Researcher read the instruction of the test for subject and given them for example.

Data Analysis

1. Statistical analysis the characteristics of test.

1.1 Item analysis: Calculate difficulties index, done by using the number of subjects who given the correct answer of that item by total number of subjects who answer that item. The point-biserial correlation between item score and total score was performed to analyse item discriminating power.

1.2 Reliability analysis: By carry out an internal consistency with Kuder-Richardson Formula 20 (KR-20).

1.3 Construct Validity analysis: Factor analysis by using principal components method with varimax rotation.

2. Compare the difference of mean classified by sex, age, and educational level by t-test or ANOVA.

3. Develop IQ score norm classified by age and educational level: converted raw score to percentile rank and IQ score.

CHAPTER IV
RESULTS

The objective of this study was to study the characteristics of the Colored Progressive (CPM) and the Advanced Progressive Matrices (APM) and develop norm of both tests for Thai students age between 6-18 years, who study in 2nd semester of academic year 2004 in the Northern region-Lampang province was representation. The results were as follow:

The Colored Progressive Matrices (CPM)

Part 1 The characteristic of CPM

Part 2 Norm of the CPM

The Advanced Progressive Matrices (APM)

Part 1 The characteristic of APM

Part 2 Norm of the APM

The Colored Progressive Matrices (CPM)

Part 1 The characteristic of CPM

The basic statistics of CPM in Thai students age between 6-11 years (614 samples) were found that the minimum score 6, maximum score 36, mean score 26.86, median 28.50, mode 34, standard deviation 7.12 and skewness -.818. The reliability coefficient was .92 and the standard error of measurement 2.01. The discriminating power was range from .13 to .64 and mean of discriminating power was .50. The difficulty was range from .27 to .99 and mean of difficulty was .74.

The used of the factor analysis by principal components found 7 factors that had eigenvalue over 1.00. Factor I had percent of variance 27.15 while all 7 factors had percent of variance 52.98 as Table 2.

Table 2 Eigenvalue and total variance of CPM

Factor	Eigenvalue	Percent of Variance	Cumulative Percent
1	9.77	27.15	27.15
2	3.13	8.69	35.83
3	1.64	4.55	40.38
4	1.31	3.63	44.01
5	1.16	3.21	47.22
6	1.06	2.94	50.16
7	1.01	2.81	52.98

Kaiser-Meyer-Olkin Measure of Sampling Adequacy = .931

Bartlett's Test of Sphericity = 7759.241; P< .000/df = 630

Table 3 showed extraction of factor loading. The factor loading of first factor more than .30 and positive coefficient in every item. It was implied that each item of CPM could measure common factor and different unique factor of intelligence.

In order to make clear of the relationship of the extracted factors, the orthogonal rotation was performed by varimax method. This yielded factor loading a simple structure and made the coefficient of the principle axis positive manifold. The results of analysis and axis rotation by selecting the factor at .30 or more to represent each factor were seen in Table 4.

Table 3 Factor loading of CPM before varimax rotation

Item	Factor						
	1	2	3	4	5	6	7
B3	.642	.304					
A9	.641				.334		
Ab8	.637						
B4	.633						
B5	.624						
Ab4	.623						
Ab6	.620						
Ab7	.611		-.316				
B10	.611	-.382					
B2	.601	-.380					
Ab5	.596						
B8	.582	-.371					
Ab9	.581						
B11	.576	-.412					
B1	.569	.457					
B9	.566	-.402					
A11	.566						
A10	.561						
A7	.552				.362		
Ab3	.511	.467					
B7	.508						
Ab11	.473						-.361
Ab12	.465	-.392					
B6	.459						
Ab11	.453	.451		-.325			-.305
A6	.432						
A5	.413	.373	.366				
B12	.390	-.367					
A12	.378						-.303
Ab2	.551	.553					
A3		.316	.530				
A4		.359	.420				
A2			.403				.306
A8	.372				.539		
A1		.318				.596	.433

Table 4 Factor loading at .30 or more of CPM after varimax rotation

Item	Factor						
	1	2	3	4	5	6	7
B11	.775						
B9	.729						
B10	.724						
B8	.705						
B12	.638						
Ab12	.627						
Ab9	.418	.381		.342			
B7	.404						
Ab7		.685					
B3		.643	.367				
B4		.603		.307			
Ab8		.527					
B5		.521					
Ab6		.475		.466			
Ab4		.473					
Ab1			.774				
Ab2			.714				
Ab3			.691				
B1		.552	.560				
B2		.549	.556				
Ab11				.598			
A12				.597			
Ab5		.300		.561			
Ab10				.488			
A10				.455		.359	
B6	.332			.369			
A3					.691		
A4					.658		
A2					.642		
A5			.304		.623		
A6					.447		
A8						.664	
A7						.596	
A9		.315				.574	
A11	.324					.520	
A1							.841

A seven-factor solution provided the interpretable structure. Factor I was composed of items in which the solution was based on the ability to modify figure that called ‘Creation’. Factor II was based on the ability to perceive symmetry and orientation of missing part that called ‘Balance’. Factor III was based on the ability to perceive difference, similarity, and identity that called ‘Category’. Factor IV was based on the ability to continuous the discrete pattern that called ‘Continuity’. Factor V was based on the ability to perceive identity of the continuous pattern that called ‘Distinguish’. Factor VI was based on the ability to perceive the identity of the continuous pattern that called ‘Connection’. Factor VII was based on the ability to perceive difference, similarity for complete pattern that called ‘Assembly’.

Table 5 The item of each factor and the name of factor

Factor	Item	Name of factor
1	Ab9,Ab12,B7,B8,B9,B10,B11, B12	Creation
2	Ab4,Ab6,Ab7,Ab8,B3,B4,B5	Balance
3	Ab1,Ab2,Ab3,B1,B2	Category
4	A10,A12,Ab5,Ab10,Ab11,B6	Continuity
5	A2,A3,A4,A5,A6	Distinguish
6	A7,A8,A9,A11	Connection
7	A1	Assembly

Part 2 Norm of CPM

T-test or F-test was used to compare the mean of difference between sex, age, and educational level groups. Sex was no different of mean but mean of age and educational level was significant at 0.05 level.

Table 6 The comparison of mean differences between sex, age, and educational level

Group		Number of student (n)	Mean	S.D.	t / F	Sig.
Sex	Boy	322	62.95	7.11	.34	.74
	Girl	292	26.75	7.14		
Age (year)	6	57	17.98	6.01	86.19	.00
	7	99	21.59	6.35		
	8	120	25.33	6.15		
	9	104	27.94	5.81		
	10	101	30.81	4.91		
	11	133	32.11	3.72		
Educational level	prathom 1	119	19.79	6.13	81.67	.00
	prathom 2	114	24.04	6.86		
	prathom 3	113	26.65	5.93		
	prathom 4	99	29.86	5.36		
	prathom 5	110	31.55	3.96		
	prathom 6	59	33.12	2.55		
Total		614	26.86	7.12		

According to comparative of the mean score in age group by Scheffe's method found that age 10 was not different from age 11 other age was significant at 0.05 level (see Table 7). The norm could classify into five groups of age that were 6, 7, 8, 9, 10-11 years.

In educational level revealed that educational level between prathom 1-3 significantly different at .05 level but in prathom 4 were not different from prathom 5, and prathom 5 were not different from prathom 6 (see Table 8). The norm could classify into five groups of educational level that were prathom 1, prathom 2, prathom 3, prathom 4, and prathom 5-6.

Table 7 The mean difference comparative by age group

Age (year)	6	7	8	9	10	11
6	-	3.60*	7.34*	9.96*	12.83*	14.12*
7		-	3.74*	6.36*	9.23*	10.52*
8			-	2.62*	5.49*	6.78*
9				-	2.87*	4.16*
10					-	1.29
11						-

*P < .05

Table 8 The mean difference comparative by educational level

Educational level	prathom 1	prathom 2	prathom 3	prathom 4	prathom 5	prathom 6
prathom 1	-	4.25*	6.86*	10.07*	11.76*	13.33*
prathom 2		-	2.61*	5.81*	7.51*	9.07*
prathom 3			-	3.20*	4.90*	6.46*
prathom 4				-	1.70	3.26*
prathom 5					-	1.56
prathom 6						-

*P < .05

The norm was converting raw scores to IQ scores, which mean 100 and standard deviation 15 for each group (the detail of table to convert the raw scores to percentile was showed in Appendix). The results were as follow in table 9 and 10.

Table 9 Converted raw score to IQ of CPM classified by age

Raw Score	Age				
	6	7	8	9	10 – 11
36	145	134	126	120	114
35	143	132	123	118	111
34	141	129	121	115	108
33	138	127	119	113	105
32	135	125	116	111	102
31	133	122	114	108	99
30	130	120	112	106	96
29	128	118	109	103	93
28	125	115	107	101	90
27	123	113	105	98	87
26	120	111	102	96	84
25	118	108	100	93	81
24	115	106	97	91	78
23	113	104	95	89	75
22	110	101	93	86	72
21	108	99	90	84	69
20	106	97	88	81	66
19	103	94	86	79	-
18	101	92	83	76	-
17	98	90	81	74	-
16	96	87	79	71	-
15	93	85	76	69	-
14	91	83	74	67	-
13	88	81	72	-	-
12	86	78	69	-	-
11	83	76	67	-	-
10	81	74	-	-	-
9	78	71	-	-	-
8	76	69	-	-	-
7	73	67	-	-	-
6	71	-	-	-	-
5	69	-	-	-	-
4	66	-	-	-	-
3	-	-	-	-	-
2	-	-	-	-	-
1	-	-	-	-	-

Table 10 Converted raw score to IQ of CPM classified by educational level

Raw Score	Educational level				
	prathom 1	prathom 2	prathom 3	prathom 4	prathom 5–6
36	139	126	123	116	115
35	137	124	121	113	111
34	135	121	118	111	107
33	132	119	116	108	104
32	130	117	113	106	100
31	127	115	111	103	96
30	125	113	109	101	93
29	123	111	106	98	89
28	120	109	104	96	86
27	118	107	101	93	82
26	115	105	99	91	78
25	113	102	96	88	75
24	111	100	94	86	71
23	108	98	92	83	67
22	106	96	89	80	-
21	103	94	87	78	-
20	101	92	84	75	-
19	99	90	82	73	-
18	96	88	79	70	-
17	94	86	77	68	-
16	91	83	75	65	-
15	89	81	72	-	-
14	86	79	70	-	-
13	84	77	67	-	-
12	82	75	65	-	-
11	79	73	-	-	-
10	77	71	-	-	-
9	74	69	-	-	-
8	72	66	-	-	-
7	70	-	-	-	-
6	67	-	-	-	-
5	65	-	-	-	-
4	-	-	-	-	-
3	-	-	-	-	-
2	-	-	-	-	-
1	-	-	-	-	-

This research was a part of study in seven regions of Thailand consists of represented provinces: Nakornsawan, Nakornsrithammarat, Bangkok, Kanchanaburi, Lampang, Chantaburi, and Udon Thani. Mean and standard deviation were as follow:

Table 11 Mean and standard deviation of CPM in 7 provinces classified by age

Age (year)		Province							
		Nakorn-sawan	Nakonsri-thammarat	Bangkok	Kan-chanaburi	Lampang	Chanta-buri	Udon Thani	Total
6	Mean	17.26	21.75	24.79	18.83	17.98	15.41	18.00	18.71
	S.D.	6.12	8.89	6.53	6.20	6.01	5.98	4.58	6.92
7	Mean	22.48	22.88	24.75	20.08	21.59	21.76	19.78	21.85
	S.D.	6.39	7.26	7.13	6.97	6.35	6.38	6.42	6.85
8	Mean	24.73	23.71	27.50	25.49	25.33	25.84	25.29	25.56
	S.D.	6.30	7.54	5.70	6.77	6.15	6.72	6.69	6.55
9	Mean	27.62	27.02	30.39	28.25	27.94	28.60	27.41	28.30
	S.D.	5.78	5.40	4.59	5.88	5.81	4.95	5.76	5.52
10	Mean	30.86	30.96	31.32	30.35	30.81	30.73	29.50	30.66
	S.D.	4.02	4.36	4.67	5.35	4.91	4.47	5.51	4.79
11	Mean	31.71	31.46	33.16	32.14	32.11	31.23	31.48	31.93
	S.D.	5.32	4.74	3.50	3.33	3.72	4.76	4.58	4.36

Table 11 showed that mean of all age in 7 provinces was different. In Lampang, mean scores of age 6-9 years were less than mean of total but mean scores of age 10 and 11 years were higher than mean of total.

The Advanced Progressive Matrices (APM)

Part 2 The characteristics of APM

The basic statistics of APM in Thai students age between 12-18 years were found that the minimum score 2, maximum score 35, mean score 17.76, median 19, mode 22, standard deviation 7.00 and skewness -.211. The reliability coefficient was .88 and the standard error of measurement 2.43. The discriminating power was range from .07 to .93 and mean of discriminating power was .49. The difficulty was range from .09 to .99 and mean of difficulty was .60.

The used of the factor analysis by principle components found 9 factors that had eigenvalue over 1.00. Factor I had percent of variance 21.18 while all 9 factors had percent of variance 46.90 as Table 12.

Table 12 Eigenvalue and total variance of APM

Factor	Eigenvalue	Percent of Variance	Cumulative Percent
1	7.63	21.18	21.18
2	1.63	4.54	25.72
3	1.18	3.27	28.99
4	1.15	3.18	32.17
5	1.10	3.05	35.21
6	1.08	3.01	38.22
7	1.06	2.95	41.17
8	1.04	2.89	44.07
9	1.02	2.83	46.90

Kaiser-Meyer-Olkin Measure of Sampling Adequacy = .938

Bartlett's Test of Sphericity = 5258.894; P< .000/df = 630

Table 13 showed extraction of factor loading. The factor loading of first factor more than .30 and positive coefficient in every item. It was implied that each item of APM could measure common factor and different unique factor of intelligence.

In order to make clear of the relationship of the extracted factors, the orthogonal rotation was performed by varimax method. This yielded factor loading a simple

structure and made the coefficient of the principle axis positive manifold. The results of analysis and axis rotation by selecting the factor at .30 or more to represent each factor were seen in Table 14.

Table 13 Factor loading of APM before varimax rotation

Item	Factor								
	1	2	3	4	5	6	7	8	9
11	.681								
10	.666								
2	.605								
5	.597	-.342							
16	.586								
14	.584								
3	.583								
4	.577								
15	.568								
7	.550								
21	.544								
8	.540								
12	.530								.353
22	.525	.310							
18	.524								
19	.512								
9	.509								
17	.475								-.341
23	.466	.398							
25	.464								
6	.460								
20	.431								
33	.409		.301				-.310		
26	.332								
30		.426		-.359					
31	.332	.406							
35			.598		-.303				
36				.631				-.407	
29					.581	-.408			
32		.306	-.377		-.390				
34			.301		.371				
27						.416			
28				-.300		.409	.391		
13	.328		-.359			.375			.372
24	.341					.369			
1				.380				.651	

Table 14 Factor loading at .30 or more of APM after varimax rotation

Item	Factor								
	1	2	3	4	5	6	7	8	9
11	.706								
5	.676								
2	.639								
3	.622								
10	.617								
14	.595								
7	.585								
4	.558								
15	.541								
9	.528								
17	.514								
8	.490								
19	.465								
12	.445					.306			
6	.432								
18	.417								
16	.410	.332							
25	.311								
31		.598							
34		.581							
33		.543							
30		.497							-.354
32			.676						
20	.391		.493						
26			.493						
28				.710					
24				.522					
23			.350	.368					
21	.352			.359					
22			.337	.350					
36					.771				
27					.382				
35						.702			
29							.807		
13								.713	
1									.882

A nine-factor solution provided the interpretable structure. Factor I was composed of items in which the solution was based on mergence and split, shifting and grouping that called ‘Organization’. Factor II was based on the ability to perceive the continuous pattern that called ‘Relation’. Factor III was based on mergence pattern that called ‘Combination’. Factor IV was based on summarize of identity to pattern that called ‘Summation’. Factor V was based on modified pattern that called ‘Creation’. Factor VI was based on overlap and reduces identity that called ‘Subtraction’. Factor VII was based on grouping the continuous pattern that called ‘Transformation’. Factor VIII was based on addition of identity that called ‘Increase’. Factor IX was based on the ability to perceive the similarity and orientation that called ‘Category’.

Table 15 The item of each factor and the name of factor

Factor	Item	Name of Factor
1	2,3,4,5,6,7,8,9,10,11,12,14,15,16,17,18,19,25	Organization
2	30,31,33,34	Relation
3	20,26,32	Combination
4	21,22,23,24,28	Summation
5	27,36	Creation
6	35	Subtraction
7	29	Transformation
8	13	Increase
9	1	Category

Part 2 Norm of APM

T-test or F-test was used to compare the mean of difference between sex, age and educational level groups. Sex was no different of mean but mean of age and educational level was significant at 0.05 level.

Table 16 The comparison of mean differences between sex, age, and educational level

Group		Number of student (n)	Mean	S.D.	t / F	Sig.
Sex	Male	351	17.90	7.34	.49	.62
	Female	423	17.65	6.72		
Age (year)	12	107	13.76	6.61	27.67	.00
	13	128	14.65	6.54		
	14	123	16.14	6.55		
	15	111	17.98	6.40		
	16	102	21.96	5.82		
	17	113	20.29	6.71		
	18	90	20.99	5.71		
Educational level	prathom 6	59	12.14	5.90	33.65	.00
	mathayom 1	131	14.04	6.67		
	mathayom 2	136	16.33	6.41		
	mathayom 3	118	17.06	6.11		
	mathayom 4	100	21.42	5.72		
	mathayom 5	122	20.07	6.47		
	mathayom 6	108	21.94	6.11		
Total		774	17.76	7.00		

According to comparative of the mean score in age group by Scheffe's method found that age 12-14 years and age 16-18 years were not significantly different at 0.05 level but this two group of age were significantly different at .05 level from age 15

(see Table 17). The norm could classify into three groups of age that were 12-14, 15, 16-18 years.

In educational level revealed that educational level between mathayom 4-6 were not different, prathom 6 was not significantly different from mathayom 1, mathayom 1 was not significantly different from mathayom 2, mathayom 2 was not significantly different from mathayom 3 (see Table 18). The norm could classify into five groups of educational level that were prathom 6, mathayom 1, mathayom 2, mathayom 3, mathayom 4-6.

Table 17 The mean difference comparative by age group

Age (year)	12	13	14	15	16	17	18
12	-	.89	2.38	4.22*	8.20*	6.54*	7.23*
13		-	1.49	3.33*	7.31*	5.64*	6.34*
14			-	1.84	5.82*	4.15*	4.85*
15				-	3.98*	2.31	3.01
16					-	-1.67	-.97
17						-	.70
18							-

*P < .05

Table 18 The mean difference comparative by educational level

Educational level	Pra-thom 6	matha-yom 1	matha-yom 2	matha-yom 3	matha-yom 4	matha-yom 5	matha-yom 6
prathom 6	-	1.90	4.20*	4.92*	9.28*	7.94*	9.81*
mathayom 1		-	2.29	3.02*	7.38*	6.04*	7.91*
mathayom 2			-	.73	5.09*	3.74*	5.61*
mathayom 3				-	4.36*	3.01*	4.89*
mathayom 4					-	-1.35	.52
mathayom 5						-	1.87
mathayom 6							-

*P < .05

The norm was converting raw scores to IQ scores, which mean 100 and standard deviation 15 for each group (the detail of table to convert the raw scores to percentile was showed in Appendix). The results were as follow in table 19 and 20.

Table 19 Converted raw score to IQ of APM classified by age

Raw Score	Age		
	12 – 14	15	16 – 18
36	137	141	136
35	135	139	133
34	133	137	131
33	131	135	129
32	129	132	126
31	127	130	124
30	125	128	122
29	123	126	119
28	121	123	117
27	119	121	115
26	117	119	112
25	115	116	110
24	113	114	107
23	111	112	105
22	109	110	103
21	107	107	100
20	105	105	98
19	103	103	96
18	101	100	93
17	99	98	91
16	97	96	89
15	95	94	86
14	93	91	84
13	90	89	81
12	88	87	79
11	86	85	77
10	84	82	74
9	82	80	72
8	80	78	70
7	78	75	67
6	76	73	65
5	74	71	-
4	72	69	-
3	70	66	-
2	68	-	-
1	66	-	-

Table 20 Converted raw score to IQ of APM classified by educational level

Raw Score	Educational level				
	prathom 6	mathayom 1	mathayom 2	mathayom 3	mathayom 4–6
36	159	146	145	146	136
35	157	144	143	144	133
34	154	142	141	141	131
33	152	140	139	139	129
32	149	138	136	137	126
31	147	136	134	134	124
30	144	134	132	132	122
29	142	132	129	129	119
28	140	130	127	127	117
27	137	127	125	125	114
26	135	125	123	122	112
25	132	123	120	120	110
24	130	121	118	117	107
23	127	119	116	115	105
22	125	117	113	112	103
21	122	115	111	110	100
20	120	113	109	108	98
19	117	111	107	105	96
18	115	109	104	103	93
17	112	107	102	100	91
16	110	104	100	98	88
15	107	102	97	96	86
14	105	100	95	93	84
13	103	98	93	90	81
12	100	96	91	88	79
11	98	94	88	86	77
10	95	92	86	84	74
9	93	90	84	81	72
8	90	88	81	79	70
7	88	86	79	76	67
6	85	84	77	74	65
5	83	82	75	71	-
4	80	79	72	69	-
3	78	77	70	67	-
2	75	75	68	-	-
1	73	73	65	-	-

This research was a part of study in seven regions of Thailand consists of represented provinces: Nakornsawan, Nakornsrithammarat, Bangkok, Kanchanaburi, Lampang, Chantaburi, and Udon Thani. Mean and standard deviation were as follow:

Table 21 Mean and standard deviation of APM in 7 provinces classified by age

Age		Province							
		Nakorn-sawan	Nakornsri-thammarat	Bangkok	Kan-chanaburi	Lampang	Chan-taburi	Udon Thani	Total
12	Mean	13.60	14.31	17.57	13.72	13.76	15.14	12.01	14.44
	S.D.	7.06	6.07	6.51	6.56	6.61	6.21	5.70	6.59
13	Mean	13.85	18.47	16.98	16.91	14.65	16.43	11.36	15.49
	S.D.	6.72	6.08	6.16	6.69	6.54	5.90	6.04	6.66
14	Mean	15.58	18.91	16.16	17.34	16.14	18.77	13.82	16.78
	S.D.	7.45	6.48	6.35	6.64	6.55	7.17	6.48	6.95
15	Mean	16.99	20.17	17.45	18.65	17.98	18.45	16.79	18.19
	S.D.	8.11	6.27	6.32	5.74	6.40	6.62	7.14	6.68
16	Mean	18.95	21.15	17.58	20.14	21.96	20.29	18.07	19.83
	S.D	7.42	7.03	5.61	5.66	5.82	5.84	7.09	6.44
17	Mean	19.31	22.84	17.39	19.14	20.29	21.28	18.56	20.16
	S.D.	8.32	5.93	6.62	6.89	6.71	5.7	6.92	6.86
18	Mean	20.98	21.15	16.33	21.06	20.99	21.41	17.02	20.24
	S.D.	7.71	6.47	5.56	7.20	5.17	6.16	6.36	6.65

Table 21 showed that mean of all age in 7 provinces was different. In Lampang, mean scores of age 12-15 years were less than mean of total but mean scores of age 16-18 years were higher than mean of total.

CHAPTER V
CONCLUSION, DISCUSSION AND RECOMMENDATIONS

The objective of this research was to find characteristics of the Colored Progressive Matrices (CPM) and the Advanced Progressive Matrices (APM) for children aged between 6 – 18 years old, who study in the Northern region of Thailand: Lampang is representation in second semester, academic year 2004. A sample consists of 1,388 students, 614 students aged 6 – 11 years and 774 students aged 12 – 18 years respectively.

Conclusion

Part 1 The characteristics of the Colored Progressive Matrices (CPM):

1. From the analysis upon intelligence test, the CPM, it shows high quality of the test as in details follow

1.1 Quality of the CPM: reliability (KR-20) 0.92, standard error of measurement (SEM) 2.01, discriminating power ($\bar{r}$) 0.50, difficulty ($\bar{p}$) 0.74 and the descriptive statistic were mean 26.86, median 28.50 and mode 34, standard deviation 7.12, minimum 6, maximum 36, and skewness -0.818.

1.2 Factor analysis: Before rotate that 7 factor which item accounted factor I for 27.15 percent. Seven factors accounted for 52.98 percent of the total variance. After rotate the factor loading coefficient of factor I had upper than 0.30 and positive, it indicated each item of the CPM measured common factor of intelligence. Factor I was composed of items in which the solution was based on the ability to modified figure measured the modifying figure, which called ‘Creation’. Factor II was based on the ability to perceive symmetry and orientation of missing part, which called ‘Balance’. Factor III was based on the ability to perceive difference, similarity, and identity, which called ‘Category’. Factor IV was based on the ability to continue the discrete pattern, which called ‘Continuity’. Factor V was based on the ability to

perceive identity of the continuous pattern, which called 'Distinguish'. Factor VI was based on the ability to perceive the identity of the continuous pattern, which called 'Connection' and the factor VII was based on the ability to perceive difference, similarity for complete pattern, which called 'Assembly'.

2. IQ score norm of CPM classified by age and educational level. Norm of CPM was developed in five age group consists of 6, 7, 8, 9, and 10-11 years and five educational group consists of prathomsuksa 1, 2, 3, 4 and 5-6.

3. Mean and standard deviation of the CPM summary: For Nakhonsawan, Nakhonsrithammarat, Bangkok, Kanchanaburi, Lampang, Chanthaburi and Udon Thani provinces classified by age group. In Lampang, mean score of students age 6-9 were less than mean of total but mean scores of age 10 and 11 were higher than mean of total.

Part 2 The characteristics of the Advanced Progressive Matrices (APM):

1. From the analysis upon intelligence test, the APM, it shows high quality of the test as in details follow:

1.1 Quality of the APM: reliability (KR-20) 0.88, standard error of measurement (SEM) 2.43, discriminating power (r) 0.49, difficulty (p) 0.60 and the descriptive statistic were mean 17.76, median 19, mode 22, standard deviation 7.0, minimum 2, maximum 35, and skewness -0.211.

1.2 Factor analysis: Before rotate that 9 factor which item accounted factor I for 21.18 percent. Nine factors accounted for 46.90 percent of the total variance. After rotate the factor loading coefficient of factor I It showed the extract of the factor I had upper than 0.30 and positive, it indicated each item of the APM measured common factor of intelligence structure and uniqueness of intelligence. Factor I was composed of items in which the solution was based on mergence and split, shifting and grouping that called 'Organization'. Factor II was based on the ability to perceive the continuous pattern that called 'Relation'. Factor III was based on mergence pattern that called 'Combination'. Factor IV was based on summarize of identity to pattern that called 'Summation'. Factor V was based on modified pattern that called 'Creation'. Factor VI was based on overlap and reduces identity that called 'Subtraction'. Factor VII was based on grouping the continuous pattern that called

'Transformation'. Factor VIII was based on addition of identity that called 'Increase'. Factor IX was based on the ability to perceive the similarity and orientation that called 'Category'.

2. IQ score norm of APM classified by age and educational level. Norm of APM was developed in three age group consists of 12-14, 15, and 16-18 years and five educational group consists of prathomsuksa 6, mathayomsuksa 1, 2, 3, and 4-6.

3. Mean and standard deviation of the APM summary: For Nakhonsawan, Nakhonsrithammarat, Bangkok, Kanchanaburi, Lampang, Chanthaburi and Udon Thani provinces categorized by age group. In Lampang, mean scores of age 12-15 years were less than mean of total but mean scores of age 16-18 years were higher than mean of total.

Discussion

Part 1 The characteristic of tests

The coefficients of point-biserial correlation between item score and total score were positive, and range from 0.13 to 0.64. That were mean each item had good discriminating power and concurrent valid to discriminate the students with high ability from the lower ($\bar{r}$ = 0.50). The study was consistence to the study of Sucheera Phatthrayuttawat et al. (45) that found discriminating power was between 0.10 – 0.36 with 16 items had less than 0.20 while another 20 items had the good discriminating power.

The results of APM were the same as CPM and consistence to the study of Sucheera Phatthrayuttawat et al. (1) and Wattana Prohmpetch (49). The CPM was rather easy for student age 6-11 years ($\bar{p}$ = 0.74). The item difficulty was between 0.27 – 0.99. The difficulty of APM was in moderate level ($\bar{p}$ = 0.60). The item difficulty was between 0.09 – 0.99. The reliability coefficient of CPM and APM was in high level (CPM r_{tt} = 0.92, APM r_{tt} = 0.88) (52). CPM like the study of Jensen's study (44), which had high reliability (r_{tt} = 0.90) and Sucheera Phatthrayuttawat et al. (45), which got 0.91 for reliability. From this research, it found that this test had high quality. APM was the same level for the study of Sucheera Phatthrayuttawat et al. (1) and the study of Wattana Prohmpetch (49). In addition, the reliability of APM was

similar to studies from other countries too e.g. Fitzgibbon (48), which got reliability at 0.83 and 0.92 from the study of Miao and Huang (47).

The component of the CPM and the APM for this study found that in the same as the construct test of Raven, which had 5 approaches; complete a pattern, complete an analogy, systematically alter a pattern, introduce systematically permutations, and systematically resolve figures into part. Factor analysis of CPM found that there were 7 factors in these 36 items. All 7 factors were parallel to Raven approach. Factor I was parallel to the introduction of systematically permutations. Factor II was parallel to the complete and analogy. Factor III was parallel to the systematically resolve figure into part. Factor IV and VI were parallel to the systematically alter a pattern. Factor V and VII were parallel to the complete pattern. There were 9 factors from APM. Factor I and IX were parallel to the complete pattern. Factor II was parallel to the introduction of systematic permutations. Factor III and IV were parallel to the complete and analogy. Factor V and VII were parallel to systematically alter a pattern. Factor VI and VIII were parallel to the systematically resolve figure into part. From the components of CPM and APM, which measure cognitive ability accord with objective in creating CPM and APM, to measure the chief cognitive process (44).

The results implied that both the CPM and the APM were fair quality tests, which used measure intelligence of Thai students in the Northern region.

This research constructed norm classified by sex, age, and educational level but the results revealed that sex was not significantly different, therefore, norms were constructed in age and educational level. Each age group, which mean of raw score had no difference could construct norm in the same group. These types of norm were the same as classification in other standardize tests such as Wechsler's Intelligence Test. Norm could construct in percentile norm and IQ score norm. Percentile norm was applied in case, examiner was not familiar with interpretation of the IQ score norm. Norm of this research converted raw score to IQ score which mean 100 and standard deviation 15. Interpretation of result could take criterion of Raven that had five grades to use in this study (the detail of table to convert raw score to percentile was showed in Appendix).

This research study in Lampang which was representative of students in the Northern region by together with 6 researchers that studied other provinces i.e. Nakhonsawan (58), Nakhonsrithammarat (59), Bangkok (60), Kanchanaburi (61), Chanthaburi (62) and Udon Thani (63), which are representative of students in Central region, Southern region, Bangkok, Northern region, Eastern region and Northeast region respectively.

Recommendations

1. To complete standardize tests: Besides doing accordingly to instruction of being examiner, it is necessary to consider on readiness of examinee, both physical and psychological. Moreover, should control other interfering factors, which might effect to subject's concentration and attention that cause obtaining lower score than their real abilities.

2. The APM could do by individual or group, which might effect to the scores of subject due to the test situation. If there were too many people, it might interfere subject's attention and concentration.

3. The study has been found that age and educational level have influence on IQ. Hereby norms table was created accordingly to age and educational level. To use the table as reference should consider both factors and select the suitable one. Namely, if subject was in educational system, they can use both age and educational level table, but if not, the age table should be used.

4. Norm of this research provided more advantaged in clinical application than that of educational field. However in order to expand educational advantage, grade equivalent should be developed.

5. This research was only studied intra test validity, the inter test validity should be studied for further research.

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APPENDIX

The Colored Progressive Matrices (CPM)

Table 22 Mean ($\overline{X}$), Standard Deviation (S.D.), Difficulty (p), and Discriminating power (r) of CPM

Item	$\overline{X}$	S.D.	p	r	Item	$\overline{X}$	S.D.	p	r
1	.99	.06	.99	.13	19	.82	.38	.82	.59
2	.98	.12	.98	.24	20	.73	.44	.73	.63
3	.97	.14	.97	.18	21	.65	.47	.65	.60
4	.96	.18	.96	.26	22	.63	.48	.63	.49
5	.93	.24	.93	.37	23	.55	.49	.55	.50
6	.92	.26	.92	.40	24	.47	.49	.47	.52
7	.76	.42	.76	.55	25	.93	.24	.93	.49
8	.80	.39	.80	.37	26	.90	.29	.90	.53
9	.79	.40	.79	.63	27	.90	.29	.90	.58
10	.76	.42	.76	.55	28	.85	.35	.85	.59
11	.54	.49	.54	.59	29	.77	.41	.77	.61
12	.41	.49	.41	.42	30	.65	.47	.65	.49
13	.95	.19	.95	.38	31	.57	.49	.57	.53
14	.95	.21	.95	.46	32	.46	.49	.46	.62
15	.95	.20	.95	.43	33	.50	.50	.50	.60
16	.83	.36	.83	.59	34	.57	.49	.57	.64
17	.77	.41	.77	.58	35	.47	.49	.47	.62
18	.73	.44	.73	.62	36	.27	.44	.27	.44

Table 23 Percentile norm table of CPM in Thai student of the Northern region age 6-11 years old

Raw Score	f	Percentile	Raw score	f	Percentile
36	21	98.29	20	17	19.14
35	41	93.24	19	23	15.88
34	53	85.59	18	11	13.11
33	52	77.04	17	14	11.07
32	47	68.97	16	7	9.36
31	36	62.21	15	5	8.39
30	34	56.51	14	14	6.84
29	23	51.87	13	5	5.29
28	25	47.96	12	6	4.40
27	31	43.40	11	5	3.50
26	27	38.68	10	8	2.44
25	24	34.53	9	4	1.46
24	21	30.86	8	3	0.89
23	22	27.36	7	1	0.57
22	20	23.94	6	3	0.24
21	11	21.42			

The Advanced Progressive Matrices (APM)

Table 24 Mean ($\overline{X}$), Standard Deviation (S.D.), Difficulty (p), and Discriminating power (r) of APM

Item	$\overline{X}$	S.D.	p	r	Item	$\overline{X}$	S.D.	p	r
1	.99	.03	.99	.07	19	.62	.48	.62	.75
2	.78	.40	.78	.80	20	.66	.47	.66	.64
3	.81	.38	.81	.76	21	.41	.49	.41	.82
4	.74	.43	.74	.79	22	.35	.47	.35	.79
5	.78	.40	.78	.78	23	.37	.48	.37	.72
6	.81	.39	.81	.61	24	.29	.45	.29	.52
7	.69	.46	.69	.77	25	.38	.48	.38	.70
8	.64	.48	.64	.78	26	.30	.46	.30	.52
9	.79	.40	.79	.66	27	.20	.40	.20	.44
10	.67	.46	.67	.93	28	.20	.40	.20	.34
11	.73	.44	.73	.01	29	.16	.37	.16	.18
12	.67	.46	.67	.76	30	.23	.42	.23	.42
13	.44	.49	.44	.53	31	.24	.42	.24	.50
14	.66	.47	.66	.83	32	.18	.38	.18	.33
15	.51	.50	.51	.84	33	.25	.43	.25	.60
16	.52	.49	.52	.88	34	.16	.37	.16	.41
17	.59	.49	.59	.69	35	.24	.42	.24	.44
18	.46	.49	.46	.78	36	.09	.28	.09	.08

Table 25 Percentile norm table of APM in Thai student of the Northern region age 12-18 years old

Raw Score	f	Percentile	Raw score	f	Percentile
35	1	99.93	17	36	41.99
33	1	99.80	16	25	38.05
32	5	99.42	15	31	34.43
31	5	98.77	14	26	30.75
30	11	97.74	13	27	27.33
29	13	96.19	12	16	24.55
28	24	93.80	11	36	21.19
27	21	90.89	10	28	17.05
26	21	88.18	9	28	13.44
25	33	84.69	8	17	10.53
24	35	80.30	7	23	7.95
23	45	75.13	6	11	5.75
22	52	68.86	5	15	4.07
21	36	63.18	4	12	2.33
20	48	57.75	3	10	0.90
19	43	51.87	2	2	0.13
18	37	46.71			

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