Measuring the Reasoning Skills of Student-teachers from Sagaing University of Education

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Abstract

This study investigated the reasoning skills of student-teachers from Sagaing University of Education. A total of 220 student-teachers in Sagaing University of Education participated in this study. Descriptive research design and survey method were used. As the instrument of this research, Reasoning Skills Test (RST) was used to examine the participants' reasoning skills. The test was developed by using Item Response Test Theory (IRT). According to the research findings, it was found that student-teachers were higher in deductive reasoning than inductive reasoning. Moreover, the result pointed out that girls had more deductive reasoning skill than boys. Again, the reasoning skill of fourth year student-teachers was significantly higher than those of first year and fifth year student-teachers at 0.05 level. Moreover, second year student-teachers' reasoning skill was also significantly higher than that of fifth year student-teachers. This research hopes that the results from this study will be able to contribute to background factors in creating effective teaching learning environment, especially in teacher education.

Keyterms: reasoning skills, inductive, deductive, item response theory

Introduction

Globalization has a significant impact on Myanmar in all the aspects of the well being of the country including education system and teacher's capability in enhancing the progress of the students. According to Hamza (2000), changes in the education system start from schools. Schools have been touted as a "factory of educating and developing people". Schools produce knowledgeable and skilled humen as a product relevant to life in the present. According to Korkmaz and Usta (2010), the most important thing that is expected from education is to raise the individual who can think democratically, creatively, productively, critically, and learn having respectability to the people. Therefore, the teaching-learning environment should be an atmosphere in which curiosity is encouraged, ideas are

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discussed, the feeling of individuals are noticed, personal needs are taken into the consideration and having the real aim to learn.

Cognitive abilities like thinking, reasoning and problem solving may be considered to be some of the chief characteristics which distinguish human beings from other species including the higher animals. The challenges and problems faced by the individual, or by society, in general, are solved through serious efforts involving thinking and reasoning. The powers of thinking and reasoning may thus be considered to be the essential tools for the welfare and meaningful existence of the individual as well as society.

Reason, man's blessing, is also his curse; it forces him to cope everlastingly with the task of solving an insoluble dichotomy. Man is the only animal who finds his own existence, a problem which he has to solve and from which he cannot escape. He cannot go back to the prehuman state of harmony with nature; he must proceed to develop his reason until he becomes the master of nature, and of himself (Khin Zaw, 2001).

Beside this, thinking or reasoning can only bring not only pleasure; but it can also be useful. Many of the reasons for seeking to develop thinking, reasoning and learning skills are instrumental or pragmatic and are to do with the success of individuals and society. Reasoning skills develop gradually through a person's lifetime and at different rates for different individuals. Early investigations on cognitive development and children's reasoning ability typically defined the level of cognitive functioning in terms of performance on one test or the other related measures.

Reasoning is defined by Kirwin (1995) as the cognitive process of looking for reasons for beliefs, conclusions, actions or feelings. Reasoning skills are instruments for making decisions using specific cognitive skills, assessing skills and thinking systematically or abstractly (Fischhoff, Crowell, & Kipke, 1999). Therefore, reasoning plays a significant role in one's environment. It controls not only one's cognitive activities but may also influence the total behavior and personality.

Reasoning may thus be termed as highly specialized thinking which helps an individual to explore mentally the cause-and-effect relationship of an event or solution of a problem by adopting some well-organized systematic steps based on previous experiences combined with present observation (Mangal, 2012).

Today, the teachers' tasks are getting more and more complex because of the technically, economically, socially, and politically changing world. Teachers have to face with increasing challenges (new ways of technology, motivation, team work, differentiation, classroom management, assessment connection with parents). Nearly every class has students facing integration problems, students who are under-motivated, aggressive or have other behavioural problem or students who have learning problems. For this reason, it is important that pre-service teachers who will take responsibility for national education should have prosperous reasoning skills to handle these problems.

Therefore, these factors become the reasons for the researcher to investigate the reasoning skills of the student-teachers from Sagaing University of Education. It is hoped that the results from this study will be able to contribute to background factors in creating effective teaching learning environment, especially in teacher education.

Objectives of the study

The main aim of this study is to investigate the reasoning skills of student-teachers from Sagaing University of Education. The specific objectives can be expressed in detail as follows.

1. To develop a reasoning skill test by using Item Response Theory (IRT)
2. To examine the reasoning skills of the student-teachers
3. To compare the differences of student-teachers' reasoning skills according to grade level and gender

Related Literature Review

This research focuses on Evans and Over's (1996) dual-process theory, one of the most influential dual-process theories currently pervading a wide range of work on thinking and reasoning.

Evans and over's dual-process theory

Evans's (in press; Evans & Over, 1996) current dual-process account of reasoning incorporates his earlier proposals and is strongly influenced by the kinds of distinctions between cognitive systems set out by implicit learning theorists (Berry & Dienes, 1993). This theory divides reasoning into two systems.

System 1, implicit or tacit process, which is essentially pragmatic, is based on prior experiences, beliefs, and background knowledge and achieves goals reliably and efficiently without necessarily accompanying awareness. It is characterized as implicit, associative, fast, and highly robust, and it is spared by both aging (Gilinksy & Judd, 1994) and neurological damage (e.g., Deglin & Kinsbourne, 1996). System 2 is explicit, intentional, sequential, controllable, and makes high demands of working memory. System 2 does not typically operate according to normative logical conventions, but it is capable of achieving solutions to logical problems as well as a range of problem types (e.g., hypothesis testing, hypothetical thinking, forecasting, and consequential decision making). Compared with System 1, System 2 is slow, but in compensation it affords flexibility and controllability.

Implicit or tacit processes that facilitate reasoning occur without conscious intervention and outside awareness; they typically do not require attention. Such thinking is sometimes described as *associative*, because it depends on the network of ideas and associations in memory (James, 1950). Tacit processes are used when people make a decision in a quick or intuitive way, often because it feels *right* rather than because they have a clearly articulated set of reasons. They are aware of the outcome of these tacit processes, but not of the processes themselves.

Explicit or Intentional reasoning processes, on the other hand, occur within the sphere of human's conscious awareness. Human beings are aware not only of the outcome of their thinking (as with tacit processes), but also with the processes themselves. This is the type of reasoning that is most distinctly human. Such thinking is often described as *strategic* or rule based. It typically requires effort, and it allows people to bypass the relatively slow accumulation of experiences that underlie tacit learning. People can thereby transfer principles (e.g., *always capitalize proper nouns*) rather than an accumulation of varied experiences (e.g., *I always capitalize this word*). Put differently, tacit processes are generally fast, but limited to the range of contexts repeatedly experienced. Intentional reasoning processes, on the other hand, are comparatively slow and effortful, but flexible (Lohman & Lakin, 2009).

Thus, reasoning involves both conscious (or explicit) and unconscious (or tacit) processes. For example, inductive reasoning largely depends on the retrieval and unconscious evaluation of world knowledge, whereas deductive reasoning depends on rule-based or conscious formal procedures.

In fact, reasoning refers to the process of drawing conclusions or inferences from information. Reasoning always requires going beyond the information that is given (Bruner, 1957). In logic, an inference is called *deductive* if the truth of the initial information (or premises) guarantees the truth of the conclusion. The inference is called *inductive* if the truth of the premises makes the conclusion probable but not certain. Many researchers have found that performance on deductive and inductive tests is strongly related (Wilhelm, 2005).

Although there are several kinds of inductive reasoning, this research will focus on analogical, categorical and numerical reasoning.

Analogical reasoning: The ability to reason analogically involves the ability to make judgments or predictions about unfamiliar problems on the basis of perceived similarities and relationships with familiar problems. This form of inferential reasoning also serves a variety of different functions ranging from drawing people's attention to already known relations to the reorganization and development of existing knowledge (Deloache, Miller, & Pierroutsakos, 1998).

Categorical reasoning: According to Bruner, the most important function of categorical reasoning is to categorize information into general characteristics of a certain group of objects or idea, with the aim to simplify the various types of stimuli so as to become briefer, easier to understand, to learn, and to remember.

Numerical reasoning: Numerical reasoning is a method of measuring the mental ability. It includes the ability to solve problems and arrive at answers, i.e., solution in a logical way and making generalization (Fatima, 2008). Numerical reasoning is also a higher-order thinking skill and an important factor in assessing work performance.

Again, although there are several kinds of deductive reasoning, this research will focus on logical, analytical and abstract reasoning.

Logical reasoning: Logical reasoning is a skill which is determined in the period of abstract process in Piaget’s cognitive development phase.

With logical reasoning skills, learners solve the problem by doing various mental practices or reaches principals or rules by doing some abstraction and generalization.

Analytical reasoning: Analytical skill is the ability to visualize, articulate, conceptualize or solve both complex and uncomplicated problems by making decisions that are sensible given the available information. Such skills include demonstration of the ability to apply logical thinking to breaking complex problems into their component parts.

Abstract reasoning: Abstract Reasoning is also known as fluid intelligence (Cattell, 1963) or analytic intelligence. Fluid intelligence is reasoning ability in its most abstract and purest form. It is the ability to analyze novel problems, identify the patterns and relationships that underpin these problems and extrapolate from this using logic.

Method and Procedure

Sampling: By using stratified random sampling technique, the test was administered to a sample of 220 student-teachers in Sagaing University of Education. Among the student-teachers, 44 first year students (male=23, female=21), 46 second year students (male=24, female=22), 48 third year students (male=25, female=23), 39 fourth year students (male=21, female=18) and 43 fifth year students (male=19, female=24) were selected as samples of this study.

Research design: In this study, cross-sectional and descriptive research design will be adopted. Then, quantitative approach and survey method will be used to come up to the study.

Instrument: For the current study, the researcher developed Reasoning Skills Test (RST) by using item response theory. The test development procedure will be presented in next section.

Developing the Reasoning Skills Test

Content specification of reasoning skills test

Firstly, a table of content specification for the reasoning skills test was detailed as shown in Table 1. All items were multiple-choice items.

The responses in all test items were scored 1 if answered correctly and 0 if answered incorrectly. Therefore, the total score for the test is 90.

Table 1. Table of content specification for reasoning skills test

No.	Names of Subtests	Tasks (Amount of Items)	Total Amount of Items	Time Limit (minute)
1.	Analogical Reasoning	Word (8), Figure (7)	15	6
2.	Categorical Reasoning	Verbal (8), Nonverbal (7)	15	6
3.	Numerical Reasoning	Number Series (4), Word Problems (4), Data Interpretation (4), Mathematical Puzzles (3)	15	20
4.	Logical Reasoning	Sentential Logic (5), Logical Sequence (5), Creative Logic (5)	15	18
5.	Analytical Reasoning	Seating Arrangement (4), Sequencing (4), Combination (4), Ranking (3)	15	20
6.	Abstract Reasoning	Identity (3), Quantitative Pair wise Progression (3), Figure Addition/Subtraction (3), Distribution of three values (3), Distribution of two values (3)	15	12
Total			90	82

Check for non-speediness of the test

After the testing, the non-speediness of the test was investigated by the non-speeded (power) test method (Gulliksen, 1950). The variance of the number of omitted items was compared to the variance of the number of items answered incorrectly. According to Gulliksen, if the variance ratio is close to zero, the test is non-speediness. According to the results, the variance ratios of the six sub tests were nearly zero. Therefore, it could be confirmed that all tasks of the tests in current study were non-speedy.

Item analysis of the test data

In order to obtain the information in which items are appropriate for student-teachers, an IRT parameter estimation procedure was carried out with two parameter logistic model (2 PLM) by utilizing BILOG-MG 3 software (Zimowski, Muraki, Mislevy & Bock, 2003). Item parameters were estimated by using marginal maximum likelihood (MML) method.

With the item parameter estimates determined, the ability parameters were estimated. As the items were calibrated with 2 PLM, the characteristics of the items can be described by item difficulty (*b*) and item discrimination (*a*). Since the ability value range is from -2.88 to 2.94 and the mean value of ability is -0.02 (SD=1), it can be said that the ability parameter distribution of the examinees is a standard normal distribution. The results of the parameter estimation are given in Table 2. Actually, the acceptable range of an item is from 0 to 2 for discrimination (*a*) and from about -2 to +2 for difficulty (*b*) (Hambleton, Swaminathan & Rogers, 1991).

Table 2. Item parameter estimates for the reasoning skills test

Items		Discrimination (*a*)	Difficulty (*b*)
Analogical	Alg1	0.324	1.044
	Alg2	0.643	-2.782
	Alg3	0.521	-1.615
	Alg4	0.711	-2.421
	Alg5	0.337	-3.238
	Alg6	0.281	-1.031
	Alg7	0.305	-2.11

Items		Discrimination (*a*)	Difficulty (*b*)
	Alg8	0.242	0.642
	Alg9	0.283	-5.98
	Alg10	0.7	-1.345
	Alg11	0.269	-5.921
	Alg12	0.342	-1.955
	Alg13	0.398	-1.153
	Alg14	0.543	-3.319
	Alg15	0.326	-1.607
Categorical	C1	0.195	-1.56
	C2	0.381	-2.338
	C3	0.271	-1.286
	C4	0.331	-2.102
	C5	0.322	-4.446
	C6	0.272	1.09
	C7	0.283	-4.568
	C8	0.258	-2.739
	C9	0.232	-4.644
	C10	0.223	6.101
	C11	0.434	-1.532
	C12	0.388	-4.379
	C13	0.294	-4.408
	C14	0.224	0.742
	C15	0.343	-1.383
gic	L1	0.297	-5.412

Items		Discrimination (*a*)	Difficulty (*b*)
	L2	0.169	5.438
	L3	0.276	-4.386
	L4	0.229	-2.204
	L5	0.492	-0.626
	L6	0.24	-1.139
	L7	0.263	-0.783
	L8	0.522	-1.185
	L9	0.356	-3.152
	L10	0.321	-4.16
	L11	0.256	-0.846
	L12	0.32	-0.296
	L13	0.254	3.28
	L14	0.228	1.337
	L15	0.261	-0.965
Numerical	N1	0.302	-2.277
	N2	0.492	-2.838
	N3	0.202	-2.482
	N4	0.302	-2.584
	N5	0.581	-0.994
	N6	0.433	-1.826
	N7	0.482	-0.582
	N8	0.488	0.714
	N9	0.334	-3.768
	N10	0.389	-0.071

Items		Discrimination (*a*)	Difficulty (*b*)
	N11	0.495	-2.011
	N12	0.244	3.68
	N13	0.257	-5.724
	N14	0.224	0.793
	N15	0.387	2.545
Analytical	Aly1	0.451	-1.767
	Aly2	0.361	-0.106
	Aly3	0.253	-1.512
	Aly4	0.404	0.256
	Aly5	0.591	-2.634
	Aly6	0.803	-2.345
	Aly7	0.641	-2.721
	Aly8	0.858	-2.63
	Aly9	0.636	-2.393
	Aly10	0.612	-2.132
	Aly11	0.734	-2.319
	Aly12	0.588	-1.541
	Aly13	0.454	-5.255
	Aly14	0.302	-4.12
	Aly15	0.302	-2.428
Abstract	Ab1	0.654	-4.783
	Ab2	0.346	-1.893
	Ab3	0.506	-3.817
	Ab4	0.698	-3.742

Items		Discrimination (*a*)	Difficulty (*b*)
	Ab5	0.548	-2.405
	Ab6	0.744	-2.249
	Ab7	0.377	-2.132
	Ab8	0.582	-3.065
	Ab9	0.685	-2.139
	Ab10	0.347	1.393
	Ab11	0.246	0.084
	Ab12	0.351	-1.507
	Ab13	0.272	-0.632
	Ab14	0.491	-1.064
	Ab15	0.51	1.1

For item difficulty (*b*), easier items have lower (negative) difficulty indices and harder items have higher (positive) indices. In this test, the variability of *b* values ranges from -5.98 to 6.10 and the mean is -1.70 (SD=2.26). Therefore, it can be concluded that the test items are a little easy. Although the acceptable range for item difficulty is -2 to +2, DeMars (2010) claimed that the desirable range may be -2 to +2 if the sample used to establish the scale metric is similar to the intended population and so, for some instruments, it might be important to have items with *b* parameters in a particular range. Therefore, in this study, 25 items which have *b* values greater than the range of -3 to +3 were discarded. Afterwards, 25 items with *b* values between the range (-2, +2) and the range (-3, +3) were decided to be improved.

On the other hand, a higher value of item discrimination (*a*) indicates that the item discriminates between high and low proficiency examinees better. In this test, the variability of *a* values ranges from 0.17 to 0.86 and the mean is 0.41 (SD=0.16). Therefore, it can be concluded that the test items can provide appropriate discrimination for the test. Since there are no items which have more than 2 (*a* value), all items can be acceptable.

Therefore, after discarding 25 items, the total remaining items are 65 items. According to the result, the reliability of the test was 0.83.

Data Analysis and Results

An Analysis of student-teachers' reasoning skills: Firstly, student-teachers' reasoning skills were analyzed by six skills. According to Table 3, it was found that the student-teachers' highest mean percentage stands on analytical reasoning skill (79.23%) and lowest mean percentage is in logical reasoning skill (58.89%).

Table 3. Descriptive statistics for student-teachers' reasoning skills by six skills

	Mean	Std. Deviation	Mean Percentage
Analogical Reasoning	7.65	1.977	69.55%
Categorical Reasoning	5.79	1.801	64.33%
Numerical Reasoning	7.47	1.905	62.25%
Logical Reasoning	5.3	2.670	58.89%
Analytical Reasoning	10.3	1.337	79.23%
Abstract Reasoning	7.23	1.988	65.73%

Table 4 shows a comparison of student-teachers' inductive and deductive reasoning. It pointed out that they are higher in deductive reasoning than inductive reasoning.

Table 4. Descriptive Statistics for Student-teachers' Reasoning Skills by Two Main Skills

	Mean	Std. Deviation	Mean Percentage
Inductive Reasoning	20.91	4.126	65.34%
Deductive Reasoning	22.84	4.258	69.21%

Comparison of Male and Female Student-teachers' Reasoning Skills: To find out gender differences in student-teachers' reasoning skills, t-test analysis was made. Based on Table 5, there were no differences for student-teachers' inductive reasoning and total reasoning by gender. However, significant difference was found in deductive reasoning by gender (p<.05). Specifically, girls had more deductive reasoning skill than boys.

Table 5. t-test results for student-teachers' reasoning skills by gender

Reasoning	Gender	Mean	Std. Deviation	Mean Difference	t	Sig (2-tailed)
Inductive Reasoning	Male	21.02	3.773	0.212	0.381	0.704
	Female	20.81	4.477			
Deductive Reasoning	Male	22.28	4.127	-1.149	-2.015	0.045
	Female	23.43	4.332			
Total	Male	43.29	6.908	-0.937	-0.962	0.337
	Female	44.23	7.525			

The Differences in Reasoning Skills Among Grades. To explore the differences of in reasoning skills among grades, one way analysis of variance (ANOVA) was conducted. ANOVA results showed that there were significant differences in reasoning skills among the groups at 0.05 level (see Table 6).

Table 6. ANOVA results in the differences among groups

Reasoning	***df***	**Mean Square**	***F***	***p***
Between Groups	4	314.059	6.653	.000
Within Groups	215	47.202		

To obtain more detailed information of which particular group had the differences, Post-Hoc test was executed by Tukey HSD method. It became apparent that the reasoning skill of fourth year student-teachers was significantly higher than those of first year and fifth year student-teachers at 0.05 level. Moreover, second year student-teachers' reasoning skill was also significantly higher than that of fifth year student-teachers. (see Table 7).

Table 7. The result of Tukey for reasoning skills among groups

Dependent Variable	**(I) Grade**	**(J) Grade**	**Mean Difference (I-J)**	**Sig.**
Reasoning Skills	1st Year	2nd Year	-3.046	.223
		3rd Year	-1.443	.852
		4th Year	-4.722*	.017
		5th Year	2.385	.487
	2nd Year	1st Year	3.046	.223
		3rd Year	1.603	.790
		4th Year	-1.676	.796
		5th Year	5.432*	.002

Dependent Variable	Dependent Variable	Dependent Variable	Dependent Variable	Dependent Variable
Reasoning Skills	3rd Year	1st Year	1.443	.852
		2nd Year	-1.603	.790
		4th Year	-3.279	.179
		5th Year	3.828	.064
	4th Year	1st Year	4.722*	.017
		2nd Year	1.676	.796
		3rd Year	3.279	.179
		5th Year	7.107*	.000
	5th Year	1st Year	-2.385	.487
		2nd Year	-5.432*	.002
		3rd Year	-3.828	.064
		4th Year	-7.107*	.000

* The mean difference is significant at the 0.05 level.

Conclusion and Suggestion

Accoding to Skinner (1968), reasoning is the word used to describe the mental recognition of cause and effect relationships. It may be the prediction of an event from an observed cause or the inference of a cause from an observed event (cited in Mangal, 2012). The main aim of this study is to measure and analyze the reasoning skills of student-teachers from Sagaing University of Education. Before the analysis, the researcher developed a reasoning skill test based on Item Response Test Theory. After that, by using that test, the reasoning skills of student-teachers were analysed.

According to the research findings, it was found that the student-teachers from Sagaing University of Education are better in analytical reasoning than in other reasoning skills. Therefore, it can be said that they possess the ability to visualize, articulate, conceptualize or solve both complex and uncomplicated problems by making decisions that are sensible given the available information. However, they are poor in logical reasoning.

In comparing two main reasoning skills, student-teachers are better in deductive reasoning than in inductive reasoning. Therefore, they may reason deductively rather than inductively in facing problems.

Again, according to the comparison of male and female's reasoning skills, although there is no difference in inductive reasoning and the total reasoning, female student-teachers are higher in deductive reasoning than male student-teachers. Therefore, female student-teachers may well possess the ability to draw logical conclusions from known statements or evidences.

Based on the Post Hoc test result, the reasoning skill of fourth year student-teachers was significantly higher than that of first year and fifth year student-teachers. This may be the causes of any psychological and learning factors. Therefore, it is needed to explore these causes as further study.

Based on the findings and all views discussed in the literature review, the following suggestions were brought out as ways to improve the reasoning skills of student-teachers.

(1) The teacher educators need to reserve part of the class time to conduct activities that would develop the reasoning skills.

(2) To improve student-teachers' reasoning skills, teacher educators can make the academic tasks more intrinsically reasoned and thought by students and interesting by using novel or unexpected approaches to instruction.

(3) By providing students with a reasonable degree of control over their own learning, students can feel autonomous and self-determining.

(4) The test items intended to evaluate the quality of student-teachers should contain the items which can elicit the student-teachers' thinking and reasoning skills.

The findings reported in this study justify the importance of reasoning skill to teacher education. The findings have implications for the teacher educators to motivate their students' thinking during the course of instructions. The parents as well as the authorities should engage in programmes that can promote the student-teachers' reasoning skills. It is therefore, hoped that these findings will serve as resource materials for teacher educators, counselors, parents, teachers and significant others who are concerned with the teacher qualification progress of the student-teachers.

Acknowledgements

First of all, I would like to offer respectful gratitude to Dr. Saw Pyone Naing (Rector, Sagaing University of Education) and Dr. Myo Thant (Pro-Rector, Sagaing University of Education) who allowed me to do this research.

Secondly, I am also grateful to Dr. Tin Maung Win (Professor & Head of Department, Department of Educational Psychology, Sagaing University of Education) for his guidance, precious suggestion and encouragement which enable me to carryout this study.

Next, I would also like to pay my thanks to my supervisor, Dr. Khin Pyone Yi (Professor & Head of Department, Department of Educational Psychology, Yangon University of Education) for her expert guidance, precious advice and supervision for the completion of this study.

Then, I would like to express special thanks to Professor Dr. Mi Mi Gyee (Head of Department, Department of English, Sagaing University of Education) for her positive attitude, precious suggestions and valuable editing towards this paper.

Finally, I owe a lot of gratitude to all experts for their time and constructive comments on the process of developing the test. To all teachers, friends, colleagues, students who contributed to this study by acting as participants and the individuals who helped, shared and supported me for this paper, I greatly appreciate.

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