The Study of the Relation between Comprehension Process and Cognitive Capacities of Students in Mathematics

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Abstract
In the creation of substances for developing and thinking of cognitive levels in mathematics from elementary course and recognizing effective variables of all external factors of mathematics, researchers have considered through designing hypothesis and effort to find the relation of reading literacy level and cognitive levels in mathematics of fourth grade among girls and boys and cognitive capacities of them in Tehran. The evaluation of reading literacy with the definition of comprehension process as index in surface layers spectrum such as focusing and reviewing information that are be stated in text and directive induction has organized. On other hands, mathematics evaluation has implemented for both content and cognitive dimensions. Research process has formed with selecting eight schools and in two tests. Reading literacy tests with the aim of evaluation of comprehension process and math test with the aim of the evaluation of cognitive levels have implemented for two classes of each schools. Research hypotheses have tested based on researching positive correlative between surface layers of comprehension with cognitive levels in mathematics meaningfully that have organized in three levels of knowing, application and reasoning. Instrumentation of the performance of comprehension have included two literary-information texts of PIRLS test 2011 and the collection of two respected notebooks and instrumentation of performance of cognitive levels in mathematics such as on notebook of TIMSS 2011. The procedure of testing hypotheses with Spearman correlative coefficient method have performed that all hypotheses have accepted meaningfully. Therefore, there is significant and directive relation between comprehension processes as reading literacy with cognitive capacities of students in mathematics of fourth grade.

Keywords: Mathematics, comprehension, reading, content dimension, cognitive dimension, PIRLS, TIMSS.
1 Introduction

The fact is that imposed problems on students are in mathematical work or the origin in mathematics of out of mathematics. External problems of mathematics are personal inward or personal external. Internal problems of mathematics arise of the content, nature and abstracting mathematical knowledge and is the kind of math while external problems of mathematics arise of personal features of students in mental process, learning, motivation and attitudes, if it has the origin of internal personal and inverse, it has origin in the problems that did not relate to math and also personal features of learners but are the effect of cultural, social, educational, how teaching and evaluation methods via teachers and the recognition of scientific problems, and improving of math among learners and real efforts for removing them are in the field of mathematics education and are the responsibility on people that teach. In real, it seems that we need to create a space for math work; space that mathematical thinking and meaningful comprehension of concepts and skills to improve and remove memory and non-meaningful learning. The lack of learners' capacity in using self- mathematical knowledge in different statuses of learning-teaching and problem solving is the weakness in providing reasons, self-maker strategies and mistake assumes such as serious problems of mathematical development of learners. The beginning point of education system reform has to form in the direction of improvement to learning- teaching process; where and how. In the external view of mathematics, some present problems design as following regard to list:

- Complexity of thinking action and learning process of human and how mental process and the lack of informing to them via parents and educators,
- The lack of creating space and development status of mathematical thinking and thinking skills in class and out of class,
- The lack of notification to personal differences, mental capacities, information process and growth degree of thinking process of learners,
- The lack of capacity in accessing corrective perception of mathematical concepts and in results, relying learners to routine and non-meaningful learning and algorithmic and emphasis on skills and repeated practices that lead to the lack of improving mathematical thinking, induction power and inability in induction among them and keep in improving mathematics in self- power,
- Conditioning in learning kind based on routine and non-meaningful learning,
- The lack and weakness in making-decision in math work,
- The lack of relating concepts, predications and mathematical operations and ability in creating the relation, combination, generation and integrative versions and in result, the lack of notification to internal structure relations of mathematics contents altogether in higher levels (the lack of unique comprehension of mathematics) that lead to inability for problem solving (as samples, students who did not comprehend internal structural relation among main four factors or geometry figures such as square and rectangular),
- Ignoring emphasis on critical thinking improvement, pictorial thinking, verbal thinking, writing and analysis thinking,
- The lack of notification to ask capacities and self-asking in math work [6].

Newman (1975) believed to the indication of error analysis pattern of students in response to word problems. Learner has to pass hierarchy in problem solving in five parts:

1) Read problem,
2) Comprehend whatever read,
3) Transform the words of problem in self-mind to proper choice of mathematical methods,
4) Apply needful process skills in selected method,
5) Save solution in acceptable and formal text.
Newman has applied hierarchy: since rejecting in each levels of above chains, problem solver cannot pass development in proper solution. From 1977, continuous flow of research papers with error analysis method published based on Newman's data and in emphasis on cited technique, educational society noted to the effect of language factor on mathematical learning. Newman recommends ordering regular written errors in math tasks of learner, have to discuss with him/her in the relation to improve in solving as following:

1) Please read question for me (reading),
2) Tell me what the problem asks you (comprehension),
3) Tell me method that you can apply to find the solution (conversion),
4) Show me how you find the solution (process skills),
5) Save the solution of problem now (saving).

Newman noted in self-research (1977) that reading error, comprehend and conversion that were arose of 124 weaken students of sixth grade respectively: 13%, 22%, and 12% of all error events. Then 50% of errors occur before process skills [7]. Scott (1966) in mathematics education psychology believes that main aim of ever program is forming independent, creative and critical thinking process and this development is possible in passing concepts through educational technologies and sensible materials and it cannot limit to symbolic logic [8]. Then student has to perct of concepts, comprehend and built in self-mind and applied symbols. Learning theory of constructivism designs mental development in proper activities text for make meaning with educational tool and technology in education flow to reach the highest learning level or conceptual image. This research has tried in the study of linear relation between reading literacy level and performance method in cognitive level in mathematics at fourth grade. Reading literacy could consider and order for helping evaluation of comprehension process in two dimensions; literacy-information. On other hands, dominant degree on cognitive levels could evaluate for helping tests that have content fields of mathematics at fourth grade. It tries that collection of given information of this research lead to comprehend of the subject who students comprehend concepts and contents rapidly and deeply and success to get best goals of education in mathematics and recognize to factors as easier or deterrent of this subject. Powerful attitudes needed for studying policies and educational politics reforms in improving learners' mind among factors of this case that can prevent in learning deeply and rapidly and are the pattern beyond cause-effect relation for researchers.

2 Importance and Features of TIMSS and PIRLS 2011

Feature of simultaneous implementation of both studies is common statistical samples of participants that have performed for first time of procedure and it prepared that conditions and possibilities until countries have participated in fourth grade in both studies, could analyze and compare the performance of self-students to other countries for three lessons. These considerations are such as studying this kind and degree of relation between reading literacy level of students and their capacities in response to mathematics questions regard to cognitive levels. This important subject regard to control of conditions such as possibilities, educational sources, social, cultural and economical conditions of samples’ families, have prepared the analysis of performances’ results as one opportunity of national studies. From cases of these analyses that lead to motivate for studying this relation exactly, it can mention to formal reports of TIMSS center for Iranian students who participated in TIMSS 2011:

- Means of mathematical performance in fourth grade (431) has significant difference to TIMSS’s mean scale (500) (normal scale).
- The improvement of learners in mathematics was been increased to 29 points from 2007 to 2011.
• One percent of students are been gotten to the international highest criterion point and 64% students are gotten to the lowest criterion point while international mean are 4 and 90 percent in both criterion.
• Means of reading performance of literacy in fourth grade (457) has significant difference to TIMSS's mean scale (500) (normal scale).
• The improvement of students in this lesson was been increased to 36 points from 2006 to 2011.
• One percent of students are been gotten to the international highest criterion point and 76% students are gotten to the lowest criterion point in reading literacy while international mean are 8 and 95 percent in both criterion [4].

Cooperative relation of performances for both tests between two domains; mathematics and reading literacy and the results of increasing procedure of two domains' performance that are in the interval of two courses of test, motivate till reach to relation considered between comprehension as reading literacy and cognitive levels in mathematics; regard to if teachers could promote literacy skill among students, have expended learning process in all fields such as mathematics, because reading skill is the key of learning of whole learning. In this research, comprehension process based on framework and theoretical base of PIRLS in the relation to evaluation of reading literacy in defined four levels and accord to reporting method and study of analysis, two levels entitled surface layer of comprehension and third, fourth levels entitled deep layers of comprehension as two measure scales of reading literacy are ordered and evaluated. The framework of this evaluation of two dimensions organize as: literacy and information literacy. Comprehension process in both dimensions define in four levels:
• First level: focus and review of information that are cited clearly,
• Second level: directive induction (simple conclusion),
• Third level: interpret and integration of ideas and information,
• Fourth level: study and evaluation of content, language and textual elements features.

In the research of Karimi (2011); NRC: National Research Coordinator, results have been indicated in the study and comparison of the performance of all testers in TIMSS 2007 and PIRLS 2006 in Iran that included of 5179 people from 240 schools:
• The difference of performance of students is significant in information and literacy. Students acts more weaken in information texts,
• Percent of students who have high attitude regard to reading, performances’ mean are the highest other students who have medium attitude (437 versus 382),
• Iranian students who read story or Roman or book in school or for accessing information every day, have high mean in performance that students who do not read book at all (435 versus 356),
• There is positive relation between self-concept index of students and their performance. Performance's mean of students with high level of reading self-concept index (458) was higher than students have medium level (383) [1].

3 Reading Literacy

Campbell (2006) defines reading literacy as comprehension capacity and using written forms of language that society ask or person valued it [3]. From the view of Wolf & Eelly (1991), reading literacy is the most important of capacities of students in their improvement in elementary and reading skill is learning base of all lessons and non-lessons [2]. The view of Rosenblat (1978) is such as in this relation: meaning via relation between readers and text creates in the form of particular reading experience. Reader gets to thesaurus of cognitive, meta-cognitive skills and strategies and pre-field information [3]. More 50 years that International Association for the Evaluation of Educational Achievement (IAE) performed international studies in the field of educational achievement. Association (2006) with emphasis on the considerable importance of reading in schools and routine living modified this definition as comprehension...
capacity and using different written forms that society need it or valuable for peoples. Novices can find meaning of different texts. They use of reading for learning, participating among readers and routine living and for interesting. This attitude regard to reading is the reflection of various theories that reading literacy introduced as communicational and effective process (Chall, 1983; Anderson & Pearson, 1984; Ruddell & Unrau, 2004; Walter, 1994). In this attitude to reader noted as meaning constructor and people who inform to effective strategies of reading and thinking methods in reading (Clay, 1991; Langer, 1995) [5].

4 Comprehension

In theoretical base and the framework of improvement evaluation of reading literacy- International Study Center (ISC)- Jetton (2000) and Hall (1998) has stated in definition of comprehension: students create meaning to different methods when read a text. They focus on text in the first process of comprehension and find particular information of it. In next process, they conclude to induce, interpret and integrate of information and ideas then consider to study and evaluate of text features. Beyond these processes, meta-cognitive strategies help them that tested self-comprehension and perception and modified self-attitude. In this way, knowledge and experiences that attained through reading, they could percept different texts and helped in various learning until recognize world properly [5]. Evaluation of comprehension needs to provide of concepts and material that student involved in text properly and indicated features of involving. In PIRLS study of selected texts based on theoretical studies, use of four process in the evaluation of comprehension. Collection of questions that relates to each process, students could indicate self-skills and capacities in construction of meaning of written texts. Definition of PIRLS of four process in comprehension are following as:

- Focus on and retrieve explicitly stated information and ideas clearly- 20% evaluation almost,
- Make straight forward information- 40% evaluation almost,
- Interpret and integrate ideas and information- 25% evaluation almost,
- Examine and evaluate content, language, and textual elements- 15% evaluation almost [5].

5 Research Hypothesis

H1) There is directive relation between comprehension process as reading literacy index and cognitive capacities of students in mathematics of fourth grade.
H1-1) There is positive correlative between surface layers of comprehension process in reading literacy with the lowest cognitive capacity-knowing concepts, methods and facts- in mathematics of fourth grade.
H1-2) There is positive correlative between surface layers of comprehension process in reading literacy with application of knowledge and conceptual comprehension of cognitive levels in mathematics of fourth grade.
H1-3) There is positive correlative between surface layers of comprehension process in reading literacy with cognitive level of reasoning in mathematics of fourth grade.

6 Research method and Participants

From view of results, research is applied kind and the view of aim, is correlative method. In this research, data have collected via quasi-cluster sampling and stepping method to analyze the relation between comprehension process and cognitive levels among girl and boy students regard to the aim of research. Statistical society of students was at zone 2 for fourth grade (age mean 10-11 years old). That is, researchers are going to find relation degree between two processes (surface and deep) of comprehension with capacities in cognitive domains in fourth grade. Ever state school has two fourth classes in general, 3300 students in state and private schools have 2600 students in same grade. Researchers have chosen three girly schools and three boy schools among state schools and one girly and boy school are been
chosen randomly that two classes and one class are chosen from state and private schools respectively and tests have been performed. Samples of boys were 211 students and girls were 209 students. In general, 420 students were samples of statistical society.

7 Instrumentations

7.1. Reading Literacy Test

Regard to reading literacy dimension that included of two dimensions of literacy-information experiences and using it for evaluating comprehension process, researchers have provided the collection of two literacy-information texts of PIRLS 2011 with question notebook of cited texts that student has to response to questions with using comprehension processes.

<table>
<thead>
<tr>
<th>Questions</th>
<th>Focus on and retrieve explicitly stated information and ideas clearly</th>
<th>Interpret and integrate ideas and information</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Literacy questions</td>
<td>11</td>
<td>5</td>
<td>16</td>
</tr>
<tr>
<td>Information questions</td>
<td>9</td>
<td>5</td>
<td>14</td>
</tr>
<tr>
<td>Total</td>
<td>20</td>
<td>10</td>
<td>30</td>
</tr>
</tbody>
</table>

Table 2: Percent of each comprehension processes in reading literacy test

<table>
<thead>
<tr>
<th>Percent of evaluation questions of comprehension in literacy text</th>
<th>Interpret and integrate ideas</th>
<th>Make straight forward information</th>
<th>retrieve explicitly</th>
</tr>
</thead>
<tbody>
<tr>
<td>Examine and evaluate content, language, and textual elements</td>
<td>7</td>
<td>25</td>
<td>44</td>
</tr>
<tr>
<td>Evaluation process of deep layers of comprehension</td>
<td>32</td>
<td>68</td>
<td></td>
</tr>
<tr>
<td>Evaluation process of surface layers of comprehension</td>
<td>36</td>
<td>64</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Percent of evaluation questions of comprehension in information text</th>
<th>Interpret and integrate ideas</th>
<th>Make straight forward information</th>
<th>retrieve explicitly</th>
</tr>
</thead>
<tbody>
<tr>
<td>Examine and evaluate content, language, and textual elements</td>
<td>7</td>
<td>29</td>
<td>36</td>
</tr>
<tr>
<td>Evaluation process of deep layers of comprehension</td>
<td>36</td>
<td>64</td>
<td></td>
</tr>
</tbody>
</table>

7.2. Mathematics Test

For evaluation of cognitive levels (thinking process) in mathematics, researchers have applied notebook 6 and 7 from collection of questions in TIMSS 2011 that included 12 notebooks. Evaluation field of mathematics organize for two dimensions. Content dimension is for subjective evaluation and cognitive dimension considers to the descriptive of cognitive capacities and evaluate collection of behaviors that it expects to indicate that student involve to mathematics. Math test has 20 questions with percent of cognitive and subjective domains.
Table 3: Percent goals for content and cognitive domains in mathematics evaluation

<table>
<thead>
<tr>
<th>Content domain</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number</td>
<td>50</td>
</tr>
<tr>
<td>Geometry figures and measurement</td>
<td>35</td>
</tr>
<tr>
<td>Data representation</td>
<td>15</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Cognitive domain</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Knowing</td>
<td>40</td>
</tr>
<tr>
<td>Application</td>
<td>40</td>
</tr>
<tr>
<td>Reasoning</td>
<td>20</td>
</tr>
</tbody>
</table>

Regard to technical report documentations of international studies center, collection of questions have emphasized on validity and reliability in the evaluation of related factors with achievement. Estimation and computation of validity and reliability of tests perform through elementary tests for participated countries then after difficult index and discriminative index, questions have not proper validity and reliability, are removed and other questions replace. All steps of this work have performed under studying international association of achievement evaluation, board of international study center, data processing center, educational testing service and Australian center for educational research [5]. In this research, validity of reading literacy and mathematics test equal to 0.8 and 0.78 through split-half method.

8 Findings

In this section, descriptive of features relate to testers, research variables and performances has been provided. In following Tables, intervals are following as:
- Points interval for the evaluation of surface layers of comprehension is defined between 0 and 14,
- Points interval for the evaluation of knowing level is defined between 0 and 8,
- Points interval for the evaluation of application level is defined between 0 and 8,
- Points interval for the evaluation of reasoning level is defined between 0 and 4,

<table>
<thead>
<tr>
<th>Testers</th>
<th>Girl</th>
<th>Boy</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>N</td>
<td>209</td>
<td>211</td>
<td>420</td>
</tr>
</tbody>
</table>

As it clears in Table 5, mean of data for knowing level is more than other levels. The least mean relates to reasoning level. In addition, the least STD relates to reasoning level. Also it is indicated in Table 6 that mean of data for surface layers of comprehension process is more among girls than boys.

Table 4: Testers regard to sex

<table>
<thead>
<tr>
<th>Cognitive domains</th>
<th>Knowing Mean</th>
<th>Knowing STD</th>
<th>Application Mean</th>
<th>Application STD</th>
<th>Reasoning Mean</th>
<th>Reasoning STD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Girls</td>
<td>5.33</td>
<td>1.76</td>
<td>4.24</td>
<td>1.77</td>
<td>2.05</td>
<td>1.29</td>
</tr>
<tr>
<td>Boys</td>
<td>5.31</td>
<td>1.77</td>
<td>4.42</td>
<td>1.72</td>
<td>1.82</td>
<td>1.18</td>
</tr>
<tr>
<td>Total</td>
<td>5.32</td>
<td>1.76</td>
<td>4.33</td>
<td>1.75</td>
<td>1.94</td>
<td>1.24</td>
</tr>
</tbody>
</table>
Table 6: Descriptive statistics of reading literacy test in comprehension process scale

<table>
<thead>
<tr>
<th>Samples</th>
<th>Surface layers of comprehension process Mean</th>
<th>STD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Girls</td>
<td>9.68</td>
<td>2.76</td>
</tr>
<tr>
<td>Boys</td>
<td>8.65</td>
<td>2.99</td>
</tr>
<tr>
<td>Total</td>
<td>9.16</td>
<td>2.92</td>
</tr>
</tbody>
</table>

Through normality test is be indicated that all variables were not normal then used of nonparametric methods for analyzing.

8.1. Findings for H1-1
There is positive correlative between surface layers of comprehension process in reading literacy with the lowest cognitive capacity-knowing concepts, methods and facts- in mathematics of fourth grade. Regard to that data is not normal then Spearman correlation coefficient has applied and results are indicated in Table 7.

- Points interval for the evaluation of surface layers of comprehension is defined between 0 and 14,
- Points interval for the evaluation of knowing level is defined between 0 and 8,

Table 7: The results of Spearman correlation test in knowing level

<table>
<thead>
<tr>
<th>Comprehension process (surface layers)</th>
<th>Mean</th>
<th>STD</th>
<th>N</th>
<th>Sig</th>
<th>r</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cognitive domains in mathematics (knowing level)</td>
<td>9.16</td>
<td>2.92</td>
<td>420</td>
<td>0.000</td>
<td>0.45</td>
</tr>
</tbody>
</table>

Correlative coefficient equals 0.45 with P-value; 0.000. Since P<0.05, H1-1 has accepted. That is, with 95 percent of confidence, there is positive correlative between surface layers of comprehension process in reading literacy with the lowest cognitive capacity-knowing concepts, methods and facts- in mathematics of fourth grade.

8.2. Findings for H1-2
There is positive correlative between surface layers of comprehension process in reading literacy with application of knowledge and conceptual comprehension of cognitive levels in mathematics of fourth grade.

- Points interval for the evaluation of application knowledge and conceptual comprehension level is defined between 0 and 8.

Table 8: The results of Spearman correlation test in application knowledge and conceptual comprehension level

<table>
<thead>
<tr>
<th>Comprehension process (surface layers)</th>
<th>Mean</th>
<th>STD</th>
<th>N</th>
<th>Sig</th>
<th>r</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cognitive domains in mathematics (application level)</td>
<td>9.16</td>
<td>2.92</td>
<td>420</td>
<td>0.000</td>
<td>0.43</td>
</tr>
</tbody>
</table>

Correlative coefficient equals 0.43 with P-value; 0.000. Since P<0.05, H1-2 has accepted. That is, with 95 percent of confidence, there is positive correlative between surface layers of comprehension process in reading literacy with application of knowledge and conceptual comprehension of cognitive levels in mathematics of fourth grade.
8.3. Findings for H1-3
There is positive correlative between surface layers of comprehension process in reading literacy with
cognitive level of reasoning in mathematics of fourth grade.

- Points interval for the evaluation of reasoning level is defined between 0 and 4,

Table 9: The results of Spearman correlation test in reasoning level

<table>
<thead>
<tr>
<th>Comprehension (surface layers)</th>
<th>Mean</th>
<th>STD</th>
<th>N</th>
<th>Sig</th>
<th>r</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cognitive domains in mathematics (reasoning level)</td>
<td>9.16</td>
<td>2.92</td>
<td>420</td>
<td>0.000</td>
<td>0.42</td>
</tr>
</tbody>
</table>

Correlative coefficient equals 0.42 with P-value; 0.000. Since P<0.05, H1-3 has accepted. That is, with 95 percent of confidence, there is positive correlative between surface layers of comprehension process in reading literacy with cognitive level of reasoning in mathematics of fourth grade.

9 Conclusion

Researchers have collected data based on studied samples in the study of relation between two variable
collections. First collections of variables evaluate comprehension processes. Cited processes regard to
cognitive language are ordered in four levels that researchers in this study regard to PIRLS study regard to
respected country, these category in each levels include of first category and second as comprehension and
surface receive for the evaluations of the performances. The policy of categories is that the evaluation of
performance in this level will have more clear results. After researchers found the relation between
collections of variable, evaluated three hypotheses through Spearman correlation. Reading and
comprehension are stable part of success in problem solving process. In research process, researchers
regard to positive correlations in the relation between all elements (P<0.05) and with accepting main
hypothesis indicate that there is directive relation between comprehension process as reading literacy index
and cognitive capacities of students in mathematics of fourth grade. That is reading comprehension
capacity can as meaningful predicator in the development of cognitive levels in mathematics for teaching-
learning process and made to develop in mathematics. Positive relations indicates that field problems in
mathematical learning observed in elementary. Weakness in corrective perception of written texts and
following steps in operations for getting problem solving heuristic make to confuse and abandon of it via
student. Of course, improving students’ capacity for promoting higher cognitive levels in mathematics in
the view of improving reading literacy is not short time process that can enter to educational centers
rapidly as new technology. It has to recognize factors and obstacles of capacities with effort of application
and implementing positive factors from primary years to elementary level, fostered cognitive capacities in
him/her.

References

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(2010).


