INVESTIGATING STUDENTS' MODELING COMPETENCY THROUGH GRADE, GENDER, AND LOCATION

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Abstract thesis

Main purpose of this study was determining the levels of competency of modelling in grade 9th and 10th Iranian students. In this regard we investigate the role of grade, gender and living location in the modelling competency and barrier level. In this study 779 students are participate (366 students from rural location and 413 students from urban places). Students asked to solve a real world problem. Data source was students worksheet and field notes. For analysing of the data, SPSS was used. Especially Mann-Whitney U test was employed. Finding of this study show there isn't a gender difference in mathematical modelling competency. There is no difference between rural and urban students performance, but grade 10 students have better performance than grade 9 students.

INTRODUCTION

Iranian educational system is centralised. Mathematics education goals are set at the national level and the Ministry of Education develops the syllabi and textbooks (Kiamanesh 2005). Mathematics textbooks distribute in all over the country in each school year. All students have same mathematics textbooks. Mathematics teachers asked for using these textbooks in their teaching as a main material. Upon TIMSS advanced mathematics teachers questionnaire, about 95 percent of mathematics teachers in grade 12 use official mathematics textbooks as a main material in their teaching (TIMSS official website).

Recently, a new reform of school mathematics curricula was started in Iran. In the third edition of national curriculum, there are some part about modelling and application. Mathematics textbooks in the grade 9, 10, and 11 started to change from 2008. These new versions of mathematics textbooks were based on the previous version and have similar chapters, although their order is changed. One of the goals of this new version of math textbook was modelling and application. So, writers of textbooks modified new textbooks upon real world application approach.

There is common myth (Rafiepour, Stacey and Gooya, 2012) about application of mathematics between scholars in Iran. If learners have good background in mathematics then they can apply their mathematical knowledge in solving real world problems. Although this myth rejected by several researchers in mathematical modelling community such as De Lange (2003) and Niss, Blum & Galbraith (2007). So we need to do a large scale study for showing that students haven't good results in solving real world problems.

The aim of this paper is studying Iranian students' mathematical modelling competency. Indeed below research question leading our study:

- Is there any gender difference in mathematical modelling competency?
- What is the role of grade in mathematical modelling competency?
- Are there any differences between students performance on the rural and urban places?

LITERATURE REVIEW

Many countries consider modelling and application in their teaching and learning approaches in last two decade (Niss, Blum, Galbraith, 2007). In Iran educational system, and especially in new version of math curricula, noticed to modelling and application. Although researches upon content analysis of new Iranian math textbooks show that modelling problems are scarce in the textbooks but there are some standard application problems in the textbooks (Rafiepour, Stacey, and Gooya, 20012; Rafiepour, 2012).

When we call modelling approach, we mean a process that started with a problem situated in the extra-mathematical world (EMW) – perhaps a real world everyday problem or a problem from another discipline such as physics or biology. The modelling process continues with formulating the EMW problem in mathematical terms. This is called vertical mathematization by Freudenthal (1991). When this process is complete, the mathematical problem can be solved by the application of mathematical concepts and solution processes. Finally the mathematical solution must be interpreted to provide an answer to the EMW problem, and checked for its adequacy in answering the original question. A new cycle of formulation to improve the model may then begin. In the formulation stage, the problem solver faces a problem situated in a real context or science context, and then gradually trims away aspects of reality, recognizing underlying mathematical relations, organising according to mathematical concepts, and describing the stripped down problem in mathematical terms. In the interpretation stage, the problem solver considers the mathematical result(s), and uncovers their meaning in terms of the real context. In figure 1 a simple diagram of modelling cycle presented.

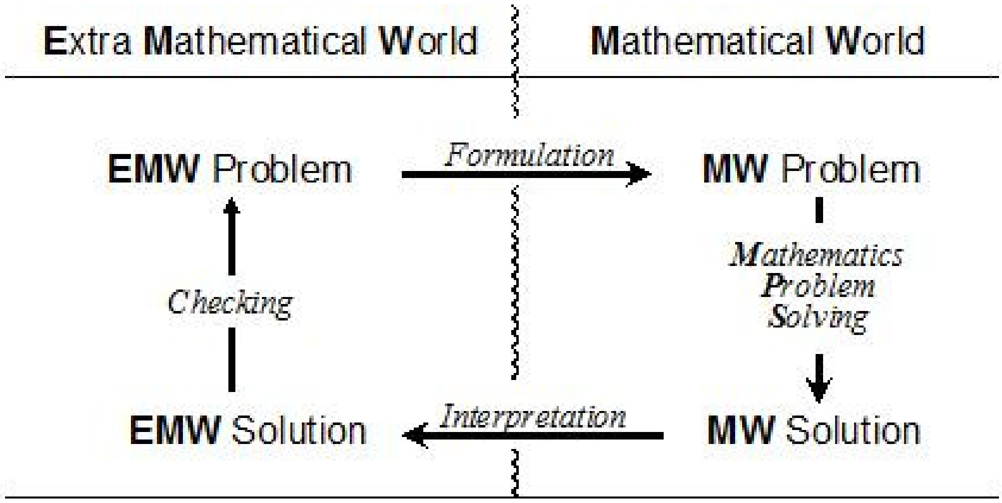

Figure 1: A model of the modelling cycle (adapted from OECD, 2006)

There are several definitions for modelling competency. For example Blum and Kaiser (1997, cited in Maab, 2006) define it by several sub-competencies. Other researchers such as Ikeda and Stephens (1998) address it as an assessment schema. Blomhøj and Jensen (2003) define modelling Competency as someone's insightful readiness to carry through all parts of a mathematical modelling process in a given situation.

However in this study we use Maab (2006, p. 117) definition: "Modelling competencies include skills and abilities to perform modelling processes appropriately and goal-oriented as well as the willingness to put these into action".

For assessing modelling competency, there are several theoretical frameworks. Such as Jensen (2007), that introduced a multidimensional competence-based assessment for Assessing Mathematical Modelling Competency. His model contains 3 dimensions: *Degree of coverage, Radius of action, and Technical level* (Blomhoj & Jensen, 2007). This model isn't as much as easy to use for assessing students' mathematical competency in large scale study. So we didn't use this model as our theoretical framework for mathematical modeling competency assessment.

In this study we use the framework that provide by Ludwig and Xu (2010, p. 80) with six different consecutively levels (Figure 2). Indeed, we need a framework to use it easily for lots of students' worksheet.

- Level 0: The student has not understood the situation and is not able to sketch or write anything concrete about the problem.
- Level 1: The student only understands the given real situation, but is not able to structure and simplify the situation or cannot find connections to any mathematical ideas.
- Level 2: After investigating the given real situation, the student finds a real model through structuring and simplifying, but does not know how to transfer this into a mathematical problem (the student creates a kind of word problem about the real situation).
- Level 3: The student is able to find not only a real model, but also translates it into a proper mathematical problem, but cannot work with it clearly in the mathematical world.
- Level 4: The student is able to pick up a mathematical problem from the real situation, work with this mathematical problem in the mathematical world, and have mathematical results.
- Level 5: The student is able to experience the mathematical modelling process and validate the solution of a mathematical problem in relation to the given situation.

Figure 2: six level for assessing mathematical modelling competency

METHOD

Participants

In this study we use two step cluster sampling. At first stage we identify all districts of Kerman (one of the south province in Iran). Then we determine urban and rural district. Finally in each district we determine one school and collect data from selected classes in grade 9 and 10. In sum 779 students from 33 classrooms were participated in this study. 413 students were female and 366 students were male. 366 students were from rural places (17 classrooms) and 413 students were from urban places (16 classrooms). All of these students were in grade 9 and 10 (15 and 16 years old) in Kerman, one of the province in south of Iran. Details of participants show in table 1. These students haven't any special teaching toward mathematical modelling before the test. They just familiar with some standard application through the new version of Iranian mathematics textbooks in grade 9 and 10.

	Gender	Grade 9	Grade 10
Rural	Boy	121	59
	Girl	120	66
Urban	Boy	120	67
	Girl	83	143

Table 1: participants of this study

Data Collection Instrument

For data collection, we use a real world problem that involve to pealing a pineapple. This problem get from Ludwig and Xu (2010, p. 80). We use only one problem for data collection because of time limitation. Pealing a pineapple problem choose for our study because our pilot study shows that this problem was interesting for most of students.

In the data collection session, we go to the classroom and show a picture about pealing the pineapple as below and ask students to explain that Why does the salesman peel the pineapple in this way? Is there any mathematical way for describing salesman manner?

Figure 3: method of salesman for pealing a pineapple

All of the Students activities were videotaped then transcribed. Students' worksheets and field notes of researchers were considered as a data set in this study.

Data Analysis

For analysis of the data two mathematics teachers code all students worksheet separately upon figure 1 schema. In this process, coders use film of the students' activities and filed notes. Degree of agreement between coders was reported more than 85%. Indeed each coder read every student (779) response and decides about level of competency for each student upon table 2. There are only a few disagreements (80 cases) between two coders to allocating level of competency for each student's response. For responding to the research questions we apply Mann-Whitney U test for two independent groups.

RESULTS[1]

The level of students modelling competency in rural and urban places in grade 9 and 10 reported in table 2 and 3.

Level of competency	Grade 9		Grade 10	
	N	%	N	%
Level 0	94	39	21	16.8
Level 1	89	36.9	37	29.6
Level 2	44	18.3	53	42.4
Level 3	12	5	7	5.6
Level 4	2	0.8	7	5.6
Level 5	0	0	0	0

Table 2: The level of students modelling competency in rural places

Level of competency	Grade 9		Grade 10	
	N	%	N	%
Level 0	66	32.5	53	25.2
Level 1	80	39.4	76	36.2
Level 2	56	27.6	67	31.9
Level 3	0	0	2	1
Level 4	0	0	3	1.4
Level 5	1	0.5	9	4.3

Table 3: The level of students modelling competency in urban places

1 -Output of SPSS omitted because of the space limit.

CONCLUSION AND DISCUSSION

Gender difference is one of the components in equity issue. In the pilot study we confronted with different performance in the case of boys and girls in solving real world problem. So we concentrate on gender issue as a first research question. In the first research question we investigate the role of gender in the mathematical modelling competency. Upon output of SPSS, at the 0.05 significance level we couldn't find gender difference between students, thus our hypothesis about gender difference was rejected. Although we believe that there are some sort of gender difference in solving real world problem, but for discovering this differences we need more in-depth qualitative research.

In the second research question we search for finding a role for grade of students in modelling competency. Indeed we would like to address the impact of grade in modelling competency. Upon output of SPSS, at the 0.05 significance level we find, students in grade 10 was better performance than students in grade 9. As we seen, students in grade 10 have better performance in real world problem solving than grade 9 students. This result is in the line with Ludwig and Xu (2010) results.

In the previous pilot study, we observed that students who living in rural places have better conception about real world problems, therefore we decide to examine this hypothesis. In the third research question we investigate the role of place of living (rural/urban) on mathematical modelling competency. There is no statistical significant difference between rural and urban places in mathematical modelling competency. Indeed rural and urban students have similar performance on solving real world mathematics problem.

Upon new reform in mathematics curricula and mathematics textbooks in grade 9, 10 and 11 in Iran, and considering mathematical modelling and application in new series of textbooks, it seems to be necessary to investigate Iranian students' performance in mathematical modelling competency. Current study examines Iranian students' performance in solving a real world problem and determines their level of mathematical modelling competency. This finding could be use as a base for doing further research in Iran and comparative study with other countries. Descriptive results show weak ability of Iranian students' modelling competency. But still there are some students that can achieve level 5 of mathematical modelling competency. This is a good point. Indeed we are in the start point of a long way; there are lot of things to do.

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