3rd World Conference on Learning, Teaching and Educational Leadership (WCLTA-2012)

Statistic analysis of precalculus semantic content with respect to gender differences

Velislava Stoykova a *, Maya Mitkova b

 aInstitute for Bulgarian Language – BAS, 52, Shipchensky proh. str, bl. 17, 1113 Sofia, Bulgaria
 bGulf University for Science and Technology, P.O. Box 7207, Hawally 32093, Kuwait

Abstract

The paper presents results from statistical analysis of both students performance levels in studying precalculus and semantic evaluation of web-based precalculus e-course materials. The analysis takes into account students achievements in final exam, in mastering challenging concepts, in time and efforts spent on homework and self preparation, in attitude towards use of MyMathLab, and relates them to gender differences. The statistic analysis of web-based precalculus e-courses materials is presented using related software technique for extracting word frequency lists, keywords, collocations and co-occurrence words. The evaluation of precalculus e-course semantic content and its understandability by students was made with respect to both semantic relations and language presentation. Finally, the conclusions about related teaching methods and techniques are offered.

© 2012 Published by Elsevier Ltd. Selection and peer review under the responsibility of Prof. Dr. Ferhan Odabaşi

Keywords: Teaching precalculus, e-Learning strategies, web-based courses e-content analysis, gender differences in perception and reasoning;

1. Introduction

Teaching methods can be evaluated with respect to various components however results are the most important ones. At the same time, strong evidence exist that differences among students are not only with respect to their age, educational level, and ability to memorize and interpret studied materials but also with respect to their gender (McCrum, 1994; Johnson, 1996). Various research results, including standardized Program of International Student Assessment (PISA) tests (Steinthorsdottir & Sriraman, 2008a, 2008b) show different results in learning, reasoning, homework preparation, and exam results which demonstrate different levels in achievements for both boys and girls students. It is more important, that at the end of their study they usually get equal opportunity diplomas. The problem is more crucial with studying mathematics where the majority of study materials are presented in a very abstract way and mainly by formulas.

Further, we are going to present results of statistically-based research on understandability and study achievements of students taking course in precalculus with respect to their gender differences, and we will use statistical approach to interpret semantically the content of two web-based precalculus e-courses.

2. Statistical results for gender differences in studying precalculus

The analysis and related interpretations are based on the results of a research reported by Mitkova (2009). It includes investigation of study achievements of 100 students taking course in precalculus who were almost equally

*Velislava Stoykova. Tel.: +359 2 979 2953; fax: +359 2 970 23 02.
E-mail address: vstoykova@yahoo.com, mitkovam@gust.edu.kw
distributed with respect to gender criterion. The study activities have been constantly statistically measured and evaluated during course period according to following tracks:

- students' achievements
- students' ability to acquire and master challenging concepts
- students' time and efforts spent on homework and self preparation
- students' attitude towards use of MyMathLab and web-based study materials for homework and self preparation.

The evaluation of students' achievements uses results of final exam, and was made by using summary statistic analysis for which related grades are evaluated in percentage. The interpretations of final results are according to all statistically investigated parameters and show higher values for boy students.

The evaluation of students' ability to acquire and master challenging concepts uses technique of average grade calculation and results are presented in percentage. It includes nine investigated key studied concepts mostly from reasoning and general mathematics. For all of them, results for boy students are also higher than that for girls.

The evaluation of students' time and efforts spent on homework and self preparation was made by giving percentage frequency distribution of the total time (in hours) spent during the semester on homework. However, with respect to this, gender differences have been occurred as well. Whereas the majority of boy students who passed final exam were working at about 10-20 hours per semester on homework, the majority of girl students were working at about 20-30 hours per semester on homework, so to pass successfully final exam. The difference is significant and express results which relate the time of working hours and self preparation to results of final exam which is twice more for girl students.

Additionally, interesting results were presented in evaluation of students' attitude towards use of MyMathLab and web-based study materials for homework and self preparation. The presented students' opinion about perception of on-line homework and the use of MyMathLab, reveal how students evaluate role of new technologies approaches in mastering basic topics. The survey using a questionnaire with six questions for feedback is introduced for evaluation. The results are given in Mitkova (2009) and presented in Table 1. They evaluate positive answers with related percent of frequency and show very high percent of students of both genders that are using and find easy to use MyMathLab and e-study materials for homework and self preparation. Moreover, the percentage of girl students who find the use of MyMathLab enjoyable and improving their knowledge in technology is approximately twice more than their boy colleagues. Also, within the number of girl students, more than 50% percent evaluate MyMathLab as a reason to spend more time on homework.

Table 1. Statistical distribution of positive answers of girl and boy students.

<table>
<thead>
<tr>
<th>Question</th>
<th>Female</th>
<th>Male</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Do you use MyMathLab?</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>2. Do you find it easy to use?</td>
<td>89</td>
<td>90</td>
</tr>
<tr>
<td>3. Do you enjoy using MyMathLab or this is just a duty?</td>
<td>68</td>
<td>35</td>
</tr>
<tr>
<td>4. Do you think because you use this program, you have to spend more time to do the homework?</td>
<td>53</td>
<td>45</td>
</tr>
<tr>
<td>5. Do you think it would be better if you use only the book to do the homework?</td>
<td>32</td>
<td>25</td>
</tr>
<tr>
<td>6. Does MyMathLab contribute to improve your knowledge in technology?</td>
<td>95</td>
<td>60</td>
</tr>
</tbody>
</table>

2.1. Interpretation of results

The results lead to some very important conclusions. First of all, they show higher performance of boy students at final exam and higher performance in mastering challenging precalculus concepts. Both results are in favor of traditional claim that boy students can acquire and process easily abstract knowledge symbolically presented by
formulas. Moreover, the time spent on homework and self preparation (which is less than that for girl students) lead to conclusion that boy students acquire and master basic precalculus concept during the lessons and consequently, they do not need more time to master and improve related knowledge by self preparation, homework, and web-based study materials. That means that the presentation and structure of study course materials are well suited for them.

In contrary, girl students have lower achievements at final exam, master challenging concepts also with lower level of understanding and spend more time on homework and self preparation to achieve similar results. At the same time, they evaluate MyMathLab end e-study materials as enjoyable, improving their knowledge in technology, and a reason to spend more on homework. Some conclusions can be drawn that girl students tend to do independent study work and spend more time on it by mastering symbolic formulas concepts through relating them with language explanations, definitions, and exercises. Some proofs for that is the high percentage of girl students that found MyMathLab easy to use (89%) and enjoyable (68%) but not difficult. One possible general explanation of that situation is different ability of both genders to per cept and process both symbolic formula semantic presentation and natural language semantic presentation which boy and girl students possess.

The fact leads to general conclusion that both genders are capable to acquire same knowledge but by using different study approaches. Thus, the problem is to present study materials in appropriate way suitable for both gender students. Further, we are going to analyse semantic content of two web-based e-courses in precalculus, in order to suggest possible teaching approaches based on the use of Information and Communication Technologies (ICT) applications.

3. Semantic content analysis of precalculus web-based courses

It is widely known that in teaching mathematics natural language is considered as a basic media (Stoykova, 2009). In fact, it is impossible to teach any subject without using natural language explanations independently of its subject-specific formal semantic presentations like formulas. At the same time, ICT-based techniques are spread across all subject areas (including language teaching (Frydryhova Klimova, 2011; Frydryhova Klimova & Semradova, 2012) and their cross-curricular and interdisciplinary applications invoke changes of recognized teaching methods in all subjects. Thus, the introduction of ICT in education is essentially a question of teaching methods rather than equipment. Far from replacing traditional teaching methodology, the educational use of ICT is aimed at interactive software applications which can enhances it, by fostering curiosity, discovery and experimentation. It, generally, uses web-based e-learning strategies.

3.1. e-Content analysis

In teaching precalculus, there are some basic concepts which are most important to be mastered. Further, we are going to use technique of semantically-oriented statistic search so, to analyze semantic content of two web-based e-courses in precalculus which are free and generally used by students.

Additionally, we will use a corpus-based approach and we create two electronic text corpora consisting of e-course materials available at Topics in Precalculus (2011) and Precalculus Tutorial (2011) – MathWeb (of 38 000 words) and MathPre (of 50 000 words). We also use the Sketch Engine (SE) software (Kilgarriff & Rundell, 2002; Kilgarriff, Rychly, Smrz, & Tugwell, 2004) which incorporates various statistically-based tools for extraction of keywords, collocations and co-occurrence words. The keyword extraction is widely recognized technique which is used to represent semantic content of a particular text. Generally, keywords extraction is made by the generation of word frequency lists through which basic concepts terms of a related subject domain are defined (Stoykova & Petkova, 2012).

For MathWeb and MathPre corpora, related words frequency lists were generated by the SE and their first top ten most frequent words are presented at Fig. 1 and Fig. 2, respectively. However, they list mostly articles (the, a), prepositions (of, to), conjunctions (and) or related formulas components (x, y, a, b, A) but do not present any content words. Moreover, the results remain similar for both corpora even their size in words was different. Thus, we can
conclude that both text corpora present information about semantic relations rather than language interpretable content words (for related basic concepts).

Figure 1. Word frequency list for MathWeb corpus.

Figure 2. Word frequency list for MathPre corpus.

The semantic information about basic subject concepts can be extracted by generation of collocations and co-occurrences of most frequent content words. Collocations and co-occurrences are words which are most probably to be found with a related content word and they reveal semantic conceptual relations. The SE software incorporates such functions which are based on estimation of related probability. However, the most frequent content words extracted from both corpora include concepts like function(s), numbers, polynomials, graphs, equations, etc (Stoykova & Mitkova, 2011a, 2011b). Figure 3 and Figure 4 present most frequent content words which are most probably to be found with the basic concept function(s) for MathWeb and MathPre corpora, respectively.

Figure 3. Collocations for concept function(s) of MathWeb corpus.

Figure 4. Collocations for concept function(s) of MathPrec corpus.

The results from both corpora express similar semantic relations and present key concepts in teaching precalculus like polynomial, exponential, rational, etc. (Stoykova & Mitkova, 2011a, 2011b) whose meaning and semantic relations are of prime importance to be understood and mastered by students. However, obviously, for girl students they must be presented in a more comprehensive way by using natural language explanations and related practical tasks for improvement with homework and self preparation.
4. Conclusion

The results of research suggest that presentation of study materials must be done taking into account a specific proportion of abstract formula presentation and related verbal explanation so, to be equally understandable by both gender students. Thus, the teacher needs to use more verbal explanations to present challenging concepts in a more simple way, so that the semantics of basic studied precalculus concepts can be equally understandable by both boy and girl students. A possible teaching approaches related to that can use ICT applications as supplementary to the traditional pedagogical practice and methodology. The useful teaching strategy can be “learning by doing” (Aldrich, 2005) widely used to improve basic studied concept by applying them in resolving practical tasks as homework or self preparation.

References


Mitkova, M. (2009). Achievement in basic math courses reflected through the gender difference. Proceedings of the 4th International Conference on Research and Education in Mathematics (ICREM4) (pp. 76-81).


Stoykova, V., & Mitkova, M. (2011a). Defining lexical semantic relationships for terms of precalculus study. Recent Researches in Educational Technologies, Corfu, Greece (pp. 240-244).
