

NEW TRENDS IN TEACHING STATISTICS

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ABSTRACT. The paper deals with possibilities of increasing of effectiveness of teaching statistics through modern methods and forms of teaching, such as project based teaching, problem based learning, heuristic methods, use of humor in teaching, etc. We rely on papers published especially in the major journals of the American Mathematical Society - Journal of Statistics Education and The American Statistician.

KEY WORDS: statistics education, project based teaching, problem based learning, humor, Journal of Statistics Education.

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Introduction

Currently, we encounter a decrease in pupils' and students' interest in mathematics education, and the associated reduced level of mathematical knowledge. Therefore, teachers have to strategically plan the course of teaching in a way to motivate students to active acquisition of knowledge. One of the less favorite mathematical disciplines is statistics, which is considered by students to be too hard and considerably boring. The paper deals with modern methods and forms of teaching, which should improve students' attitudes towards statistics and motivate them to gain more fixed knowledge.

Methods and Material

The problems outlined in the introduction encountered by statistics teachers worldwide, what is supported by the nationality of authors of the available literature dealing with the issue. Since 1993, the American Statistical Association has been publishing an electronic Journal of Statistics Education, in which the authors publish their experience with teaching statistics. The archive is available on-line at the web page of the American Statistical Association, the whole lin is: http://www.amstat.org/publications/jse/. The journal deals with forms, methods and evaluation of statistics education. Another source was the journal The American Statistician. The paper lists new trends in teaching mathematical statistics and experience of teachers from different countries. The most used modern methods include project based teaching, problem based learning, heuristic methods and humorous elements in teaching.

Results and Discussion

One of the most common methods implemented in teaching statistics is project based teaching. In a learning project, students have some influence on the choice, respectively a closer definition of the topic. The process of learning through this aspect is characterized by openness. The program of learning is not fixed in all its details before realization of the project. The project concerns extra-curricular activities; studied problems are not based on a textbook, but are present in a region they live in. The project is based on a premise that pupils or students are involved, they work on it on their own accord and that they enjoy the

work without extrinsic motivation. Learning outcomes lead to actual results, based on which pupils or students may gain the corresponding knowledge and skills, but also the reward resulting from solution.

Clint W. Coakley from Virginia [2] suggests several helpful approaches in teaching statistics, ideas for classroom presentations, projects, and student-generated data. He believes that one of the goals of statistics courses is for students to understand the importance and usefulness of statistics and to discuss the suitability or unsuitability of the used statistic methods. According to Coakley, the most effective way to help student realize the value of statistic methods is through examples - prospects or pamphlets, web pages often include data which can students analyze using statistical methods, e.g. comparison of home prices for two residential areas. As a part of a project, students may carry out a comprehensive statistical analysis of selected problem including introduction, discussion about the used methods, criticism of presumption, data and conclusions analysis. Projects can be carried out individually or in groups. The author also lists some projects done by his students during statistics education: one-sample tests – lengths of needles from white pine trees, weight of 20 random boys, playing times of 32 CDs with classical music, ages of skydivers from one drop zone; paired sample tests – shrinkage of material after washing and drying, men's and women's haircut prices, computer lab usage in July and August; two-sample tests - burning times of an expensive and inexpensive brand of birthday candles, heights of stairs at northwest and southeast corners of a building; variance analysis - toasting time for four slots of a toaster, growth of three varieties of oak trees, prices of three computer printers from 12 suppliers.

According to Smith [8], students often remain only passive participants in statistics classroom and do not gain experience with problems that may arise in real data collection. Hogg [4] states that better than using in the classroom old but real data is to leave the choice up to students – whether it is searching for available data or creating data of their own. Creating projects provides students with experience in asking questions, problem definition, formulation of hypotheses, designing of experiments and surveys; students collect data, work with errors in measurements, analyze data, and communicate their findings. Snee [9] writes that collection and analysis of data is "the heart" of statistical thinking. Data collection supports learning based on experience and connects the learning process with reality. Bradstreet [1] recommends teaching statistics on a basis of lab seminars. The output of projects in classroom led by G. Smith [8] was a final report ranging from 3 to 5 pages that included explanation of project's objectives, the procedure for obtaining data, charts, graphs and formulation of conclusions. He also places an emphasis on writing style of the report - students could use conversational tune, but had to avoid slang, typographical and grammatical errors, redundancy. After submission of reports students presented their results also orally, using visual aids. This way, students also develop their rhetorical skills. Smith [8] also compared study results of groups he taught in the past in a traditional way and groups he taught through project based teaching, and observed a significant improvement in the success rate during exams.

Sandra Fillebrow [3] also considers the method of project based teaching as a very suitable method in teaching statistics for non-mathematical study programs – sociology and psychology. During the project based teaching, students choose their own topic and collected data, conducted a survey or an experiment, or they used the available data. It was only a basic course in statistics which did not cover testing of hypotheses, but students were guided to look at a problem from the view of factors which can affect values of variables. Data were subsequently analyzed using methods of descriptive statistics, tables and graphs. Sandra Fillebrow states that her students often asked for feedback. Students

dealt with, for example, favorite color of jelly beans for men and women, presidential candidate preferences, satisfaction with weight room facilities, lifestyle of students. Some students conducted experiments – for example, they sent mail with and without postal code to six different cities and monitored the time of delivery; they colored socks with different stains and observed the effect of a cheap and branded detergent. Some students used data available on the internet – monthly average temperature and homicide rate, motor vehicle accidents.

College is looking for possibilities of increasing of the effectiveness of teaching also through problem based learning and inquiry based learning. Leigh Lawton [5] recommends teaching testing of statistical hypotheses through problem based learning, for example, using the well-known competition Wheel of Destiny. He describes the situation when Stella Stat launched gambling games. There were 5 numbers on the Wheel of Destiny and a player could place 1 dollar on one of the numbers. In case of a win he earned \$ 4.75. We have to decide whether the Wheel of Destiny is fair, based on 50 attempts and frequency of falling of numbers from 1 to 5. Students work on the given problem in groups of 3-5, while if they are using computer they have available the application Wheel of Destiny and if not, they could make their own wheels of destiny and try. She used the activity in the initial course of statistics for college students after completing confidence intervals. It is recommended to leave one class for this exercise.

Michael A. Martin [6] from the Australian National University puts emphasis on the use of analogy and heuristics with a link to the daily life and the development of statistical thinking. He explains the concepts in testing statistical hypotheses through analogy with concepts from the field of law, e.g. null hypothesis = defendant is innocent, alternative hypothesis = defendant is guilty, gathering of data = gathering of evidence, calculation of the test statistics = summary of evidence, assumption that the null hypothesis is true = presumption of innocence, type I error = conviction of an innocent person, type II error = acquittal of a guilty person, high power = high probability of convicting a guilty person.

Psychological approach to teaching statistics refers to the importance of humor in statistics - David L. Neumann, Michelle Hood, and Michelle M. Neumann [7] give an example: a teacher asks the students how many statisticians does it take to change a light bulb and the answer should be one, plus or minus three. Students should be able to find the statistical background of this joke and realize that it is about a confidence interval (of a number of statisticians required to change a bulb). Martin [6] gives examples of motivational images, for example, how far can a tethered dog reach as an analogy to box plot. The digital library of the Consortium for Advancement of Undergraduate Statistics Education (CAUSE) contains in the fun section 130 fairy tales (3 of them animated), 167 quotes, 24 jokes, 20 poems, 69 songs, 7 µ-Tube videos and gallery of 23 statistical arts (<u>https://www.causeweb.org/resources/fun/</u>). Humor in teaching statistics attracts attention, increases interest, but also encourages logical thinking and memory.

Conclusion

This paper summarizes new trends in teaching statistics, which have proved beneficial to statistics teachers especially at universities in different countries. Teaching methods like project based teaching, problem based learning, inquiry based learning and teaching with elements of humor help students to acquire a positive attitude towards statistics, leading to an increased interest in statistics and motivation to gain new knowledge. This is also confirmed by contributions of statistics teachers published in scientific journals. All the

above mentioned methods are difficult to prepare and require teacher's creative approach and good organizational skills.

References

- Bradstreet, T. E. 1996. Teaching Introductory Statistics Courses So That Nonstatisticians Experience Statistical Reasoning. In: *The American Statistician*, Vol. 50 (1), 1996. P. 69-78. ISSN 0003-1305
- [2] Coakley, C. 1996. Suggestions for Your Nonparametric Statistics Course, accessed February 12, 2014, http://www.amstat.org/publications/jse/v4n2/coakley.html.
- [3] Fillebrown, S. 1994. Using Projects in an Elementary Statistics Course for Non-Science Majors, accessed March 10, 2014, http://www.amstat.org/publications/jse/v2n2/fillebrown.html.
- [4] Hogg, R. V. 1991. Statistical Education Improvements Are Badly Needed. In: The American Statistician, Vol. 45 (4), 1991. P. 342-343. ISSN 0003-1305
- [5] Lawton, L. 2009. An Exercise for Illustrating the Logic of Hypothesis Testing, accessed March 13, 2009, www.amstat.org/ publications/jse/v17n2/lawton.html.
- [6] Martin, M. 2003. "It's like... you know": The Use of Analogies and Heuristics in Teaching Introductory Statistical Methods, accessed March 8, 2014, www.amstat.org/publications/jse/v11n2/martin.html.
- [7] Neumann, D., Hood, M., Neumann, M. 2009. *Statistics? You Must be Joking: The Application and Evaluation of Humor when Teaching Statistics*, accessed March 3, 2014, www.amstat.org/publications/jse/v17n2/neumann.html.
- [8] Smith, G. 1998. *Learning Statistics By Doing Statistics*, accessed March 25, 2014, http://www.amstat.org/publications/jse/v6n3/smith.html.
- [9] Snee, R. D. 1993. What's Missing in Statistical Education? In: *The American Statistician*, Vol. 47 (2), 1993. P. 149-154. ISSN 0003-1305.

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