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Collaborative learning of calculus contents

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- Teaching mathematics based on computer supported collaborative learning (CSCL) of calculus contents.
- The collaborative learning --- calculus course
- at the University of Novi Sad, Serbia, 2012
- examining the functions and drawing their graphs

The students worked in small four members group.



- Two groups of students:
- the experimental ---with Geogebra
- the control without GeoGebra
- Before collaborative learning the students did pre-test
- And after the test and post test.
- The students in experimental group were significantly
- better than the students in control group



Theoretical framework

- "Computer-supported collaborative learning (CSCL) is an emerging branch of the learning connected with studying how people learn together with help of computers --- <u>Stahl,</u> <u>Koschmann and Suthers (2006)</u>.
- "CSCL research is regarding as a social process, where each individual participant, or learner, is responsible for creating his or her own knowledge through social interaction with human beings by interaction with physical objects in everyday situations" <u>Miyake (2007</u>)



Gokhale (1995 definition of *collaborative learning*:

- An instruction method in which students at various performance levels work together in small groups toward a common goal.
- Students are not responsible for their own learning only, but also for the learning of members in their group, and the success of one member of the group affects the other members to be successful.



Cooperative learning is one of the forms of learning in small groups.

- Research of cooperative learning appeared from the beginning of this century, but from the early 1970, it increased rapidly.
- Johnson, Johnson, & Holubec (1998): cooperative learning is the instructional use of small groups so that students work together to maximize their own and each other's learning.



In cooperative learning environment individuals are looking for outcomes that are both beneficial to themselves and to the other group members.

Spenser Kagan (1994) formulate four developed criteria and basic principles named "PIES" :

Positive Interdependence, Individual Accountability, Equal Participation, Simultaneous Interaction.



Cooperative learning expands a student's range of experience, foster skills of communication, promote higher-level thinking, and increase social interaction (Johnson, Johnson, Holubec (1998), Slavin (1996), Kagan (1994)).



RESEARCH:

- Both the experimental and the control group were structured according to Kagan's, instructions (Kagan, 1994).
- The results of the pre-tests considering their precalculus knowledge, given to students at the beginning of our research are used to form a list order of all the students (ranging from the worst to the best one).
- In order to avoid negative feelings and close friendship in the groups, each student had to make two lists of persons whom he likes or dislikes, particularizing up to three names.



We need help of Computer Science Department Miroslav Maric', Belgrade University for making groups.



The aim of our research was to compare the students' achievements working in collaborative groups with and without the computer.

We consider the results of 180 students major physics and chemistry, each year, both from control and experimental group



The characteristic of the collaborative learning process was a spontaneous division of work occurred among the members:

In 2011:

- 2 students did different calculations,
- 1 student drew the graphs,
- 1 one directed the process of program solving,
- Or three students did calculations and the forth one directed and drew.



In 2012

- 1 student work on computer,
- 2 students rewrote contents from the screen,
- 1 directed and planned the process of program solving,
- or the students working on computer directed and planed the program solving and three students rewrote the solutions of the tasks.

During this process, the students often changed their roles



The task for the students (working in the team of four) was to examine twenty common functions and to draw their graphs at the university, with the help of authors. In 2011 the students finished their task for two times three hours. But in 2012, when they worked with the package *GeoGebra* they finished the whole task for three hours.



Example:

Determine:

- Graph,
- Zeroes,
- First derivative
 —applications
- Second derivative
 —applications
- Asimptotes

$$f(x) = xe^{1/x}, \quad x \neq 0,$$

■ Funkcija ■ f(x) = x $e^{\frac{1}{x}}$ ■ f'(x) = $\frac{e^{\frac{1}{x}} x - e^{\frac{1}{x}}}{x}$ ■ f''(x) = $\frac{e^{\frac{1}{x}}}{x^3}$ ■ Lista ■ lista1 = {y = x + 1} ■ tačka ■ A = (0, 0) ■ B = (1, 2.72)











	Number of solved	Number of correct tasks
	tasks	
Group with GeoGebra	20	18
Group without GeoGebra	16	12



The students working with the computers, CSCL students, finished their job much quicker than the others.

Instead of long calculations

(sign, asymptotes, derivatives, solving equations,...)

they could spend their time on real analysis of the graph of functions and its connections with the properties of function learned theoretically.



The students were very satisfied with cooperative learning.

They really collaborated. They had their roles.....

After the collaborative learning the students got to answer the a questionnaire:





- 1. Have you taken into account, while solving the problems, the graph of the function, or have you used *GeoGebra* only to get formula of the?
- 2. If you have taken into account the graph(s):
- a) Quote the number of tasks you have used it on.
- b) What is the number of tasks you have used the graph(s) in the process of discussing or explaining, your ideas.



- There we no betwen the groups in pre test, but in the test and post test there were really significant difference.
- The average results were about 20% better

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Collaborative learning of calculus contents References

- Johnson, D.W., Johnson, R.T. & Smith, K.A. (1991). Active Learning: Cooperation in the College Classroom (p. 1-6). Edina, Minnesota; USA, Intraction Book CO. Publishing.
- 2. Kagan S. *(1989) Cooperative learning,* Resources for teachers. Laguna Naguel, CA: Resources for Teachers--book
- 3. Kagan, S. (1989a). The structural approach to cooperative learning. Educational Leadership, 47(4), 12–15.



References

- 4. Slavin, R. E. (1980). *Cooperative learning*. Journal of Review of Educational Research. 50 (2), pp. 315-342.
- 5. Slavin, R. E. (1987). *Developmental and Motivational Perspectives on Cooperative Learning: A Reconciliation, Child Development*,Vol. 58, No. 5, pp. 1161-1167



Thanks for your kind attention

