Brain-based Teaching in Programming Courses

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ABSTRACT
Brain-based teaching is neither a method nor a concept. It is rather a way of teaching that tries to support the whole learning and memory process by considering how the brain works. The concept of “Brain-based Programming” is one attempt of putting neurodidactical principles into practice in order to improve the learning outcomes in introductory programming courses. In the pilot project this aim could be achieved [1] and the results of the ongoing study in three of seven parallel groups confirm the success in part.

Categories and Subject Descriptors
K.3.2 [Computer and Information Science Education]

General Terms
Human Factors.

Keywords
Computer science education, brain-based learning, neurodidactics.

1. INTRODUCTION
Proposals for brain-based teaching come from the field of neurodidactics that combines findings of brain and memory research, didactics, pedagogy and psychology. The original aim was to support children with learning difficulties. Therefore, it seems reasonable to apply neurodidactical principles in all subjects when learning is considered difficult, e.g. in Computer Science. Integrating brain-based teaching methods in introductory courses can improve the learning outcomes as shown in the project “Brain-based Programming”, described below and more detailed in [1].

2. BRAIN-BASED TEACHING
2.1 Brain-based Programming
Brain-based Teaching includes various concepts and methods proposed by neurodidactics. One example is “Brain-based Programming”, a new teaching concept for introductory programming courses. It has been developed during a pilot project of the same name and was implemented as a didactical experiment in one of seven parallel practical courses of “Introduction to structured and object-based programming” at our university. Usually they have a high failing rate (50% -70%); hence, the project aimed at improving the learning outcomes by considering neurodidactical principles in the teaching methods (e.g. discovery learning, cooperative learning, peer tutoring, questioning, pair-programming) as well as in the design of material (e.g. reading corners, step-by-step exercises, competence-oriented mini exercises with solutions). [1]

2.2 Methods and Results
To compare the learning results in the different groups the achieved points in the mid-term and final exams (the same for all) as well as the students’ grades were compared. In the pilot project the experimental group reached a better average grade, more students successfully completed the course and female students could benefit even more than males. [1].

In the current semester the concept is tested in three of seven parallel courses with different teachers and the results of the mid-term exam confirm the success of the pilot project. Table 1 shows the number of the students in the different experimental (EG) and control groups (CG) as well as the results of the mid-term exam: the average points (max. 25) and grades (1=best, 5=failed). The learning outcomes in the experimental groups with an average of 20.8 points (grade 2.0) were significantly better than in the control groups (17.98 points, grade 2.5). A T-test for independent samples proves that the students of the brain-based groups (EG1-3) were significantly better than those of the control groups. The effect size Cohens d = 0.42 shows a small effect in favor of the brain-based teaching method. This effect is even higher regarding the results of the female students (Cohens d = 0.6). Females seem to benefit more from cooperative learning; perhaps they are used to solve problems by discussing them [2]. In the final exams the difference between experimental and control groups was not so clear. More students of the brain-based groups (EG) completed the course with success (52% in the EG, 41% in the CG) and in average they reached more points than those of the control groups (EG=10.73; CG=8.82 points). But, the difference is not significant (T=-1.545; p=0.124). Possible reasons for the significant effect in the mid-term exam may be a probable positive effect of previous knowledge or less complex tasks. Regarding the final results of the course, an overall effect (Cohens d = 0.41) confirms the effectiveness of the brain-based methods.

3. DISCUSSION AND OUTLOOK
The results of the study demonstrate that it is worth continuing the neurodidactical approach in teaching programming. This regards lesson structure, teaching methods as well as the design of appropriate material. In a follow-up project the concept is being adapted for and tested in further subjects at university and secondary school level. Then a closer look at specific aspects like the use of pattern recognition in classroom, the impact of cooperative methods and gender aspects will be taken.

4. REFERENCES


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