Teaching Electromagnetic Radiation with Cross-Age Peer Tutoring

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Abstract. This talk reports findings about the teaching method *cross-age peer tutoring* (CAPT) with regard to high school students‘ academic achievement in electromagnetic radiation, and their motivation. Within CAPT, elder students (tutors) teach younger ones (tutees). Additionally to previous studies, revealing evidence that CAPT works effectively in specific contexts, the outcomes of tutors and tutees are compared to those of a control group. The results show that the level of knowledge increases significantly, revealing that the effect of CAPT is in comparable order with that of the control group. Additionally, here was a positive effect on the motivation observed.

Introduction

In STEM education there is always a need to find new and motivating ways to impart content-specific concepts. As shown in various previous studies, e.g. summarized by Korner [1], the teaching method Cross-Age Peer Tutoring (CAPT) is a promising candidate for this endeavor. In this talk we will report about how and why CAPT works, what academic achievement can be acquired, and to what extend it affects the students’ motivation. The underlying intervention uses the context of teaching electromagnetic radiation with tutors from the upper and tutees from the lower secondary level. Moreover, the results of CAPT are tested against those of a control group.

Theoretical framework

Cross-Age peer tutoring is a process where elder students (tutors) who are not professional teachers work together with younger students (tutees) [2]. Interestingly, several studies report positive results regarding attitudes as well as a gain in knowledge in various contexts for all participants [3-5]. The advantage is not only detected on the tutees’ side, but tutors also benefit as well from the process [1, 3, 6, 7]. A clue for the success of this teaching method is the give-and-take friendship between peers which typically differs from the teacher-student interaction [5]. In their studies, Galbraith and Winterbottom [6] found that CAPT has a particularly great effect on tutors when they reach their own limits in tutoring. In this case, students have to construct and reorganize explanations based on existing knowledge which is a kind of cognitive activation.

In order to prepare the tutors for the CAPT intervention, tutors undergo a so-called mentoring, which is a conceptual and context-related training. Some studies put emphasize on the necessity of this training [1, 5], and Berger et al. [8] even developed a special tutor training program, which equips tutors with autonomy-supporting skills. Usually, the work sheets for the CAPT intervention are also discussed in the mentoring. In addition to refreshing the tutors’ knowledge, they receive important basic information on the social-communicative factors of CAPT.

According to Deci and Ryan's [9] Self-determination Theory of Motivation, the needs for autonomy and competence are particularly important for intrinsic motivation which are likely to be supported by CAPT.

Within the framework of CAPT and motivation, the two main research questions arise regarding the tutees' and tutors' conceptual growth on the topic of electromagnetic radiation and the influence of CAPT on the motivation of tutors and tutees.

Method and findings

The study was conducted at an Austrian high school, with tutors (grade 10) and tutees (grade 8), with 2 classes each of tutors (N_{tutors} = 35), tutees (N_{tutees} = 47), and control groups (CG) (N = 43, grade 8). Teaching method of the CG was conventional instruction, using the same work sheets.

Mentoring and tutoring were conducted according to the implications found in literature: the mentoring approximately one week before the tutoring. Materials used within CAPT were based on the empirically validated curriculum for teaching electromagnetic radiation developed by [10].

The achievement in (conceptual) knowledge was tested in a pre-post-test-design before and after the tutoring for both tutees, and tutors. The test items were derived from the conceptual test by [10] (max. 16 pt). After the tutoring, a motivational test [11] was conducted.

Data analyses (descriptive statistics, t-tests, ANOVA) reveal that tutees improve in knowledge (+ 5.5 pt, effect size (*es*) =1,81) as well as tutors (+1.97 pt, *es* = 0.84), and the control groups (+ 5.2, *es* = 2,8). Regarding motivation, analyses show that tutees are more motivated than the control group with respect to each of the subscales of the motivational test (*es* between 0.84 and 1.84; differences (highly) significant).

Conclusion

Despite the almost equal increase in knowledge for the tutees and the control group, the results of the motivational testing suggest a positive outlook for further CAPT interventions. If a teacher is merely aiming for a high level of academic performance, the disadvantages of CAPTs tend to outweigh compared to regular physics lessons. The amount of time required to create the working materials, organize mentoring and tutoring, and coordinate with colleagues due to schedule changes should not be underestimated. However, if teachers strive for varied exciting and motivating lessons with social interactions that bring positive results in performance levels, the CAPT teaching method is definitely worthwhile.

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