

## **Revitalizing Electromagnetics Education with the Flipped Classroom**

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We report results of a flipped classroom approach to teaching electromagnetics that was undertaken at the Georgia Institute of Technology. In a flipped classroom, students read or watch videos prior to class. In class, students build on that basic knowledge by participating in active learning, including group problem solving, demos and labs, and design activities.

The flipped classroom is quite trendy now, and has some unique strengths, but it is not easily implemented, and can go awry if not properly executed. Flipping electromagnetics classes is particularly difficult because hands-on activities and demos are not as easy compared to other electrical engineering topics like circuits.

The authors are not educational scholars, but did implement a flipped classroom in three sections (30-50 students) of junior-level electromagnetics, a required course taken by ~300 students per year. It is typically regarded as one of the hardest courses that EE students at Georgia Tech take, and does not have the best reputation.

We were inspired by Peer Instruction and Turn-to-Your-Neighbor or Think-Pair-Share strategies. Most activities, including in-class problems, homeworks, and midterms, are done in two stages, first individually, and then again in small groups. There is a greater focus on challenging conceptual understanding. Discussion in class between the stages was lively.

We found measurable improvements in learning by comparing exam performance to a past lecture-based offering. We were also able to measure the learning impact of the peer discussion on a question-by-question basis. We used this both to adapt and tailor the class live, and to screen out good questions from bad for future semester. Feedback from the students was also very positive.

A flipped classroom is not for everyone. The purpose of this presentation is to share our experience, and present the pros and cons, that might be of interest to others exploring the possibility.