ORIENTAL JOURNAL OF
COMPUTER SCIENCE & TECHNOLOGY
An International Open Free Access, Peer Reviewed Research Journal
Published By: **Oriental Scientific Publishing Co., India.**
www.computerscijournal.org

ISSN: 0974-6471
December 2014,
Vol. 7, No. (3):
Pgs. 401-405

The Evidence for the Effectiveness of Active Learning

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(Received: October 20, 2014; Accepted: November 16, 2014)

ABSTRACT

Active learning has received considerable attention over the past several years. Often presented or perceived as a radical change from traditional instruction, the topic frequently polarizes faculty. Active learning has attracted strong advocates among faculty looking for alternatives to traditional teaching methods, while skeptical faculty regard active learning as another in a long line of educational fads. This study examines the evidence for the effectiveness of active learning. It defines the common forms of active learning most relevant for engineering faculty and critically examines the core element of each method. It is found that there is broad but uneven support for the core elements of active, collaborative, cooperative and problem-based learning.

Key words: Evidence, Traditional teaching methods, Core.

INTRODUCTION

For many faculty there remain questions about what active learning is and how it differs from traditional engineering education, since this is already "active" through homework assignments and laboratories. Adding to the confusion, engineering faculty do not always understand how the common forms of active learning differ from each other and most engineering faculty are not inclined to comb the educational literature for answers.

This study addresses each of these issues. First, it defines active learning and distinguishes the different types of active learning most frequently discussed in the engineering literature. A core element is identified for each of these separate methods in order to differentiate between them, as well as to aid in the subsequent analysis of their effectiveness. Second, the study provides an overview of relevant cautions for the reader trying to draw quick conclusions on the effectiveness of active learning from the educational literature. Finally, it assists engineering faculty by summarizing some of the most relevant literature in the field of active learning.

Definitions

It is not possible to provide universally accepted definitions for all of the vocabulary of active learning since different authors in the field have interpreted some terms differently. However, it is possible to provide some generally accepted definitions and to highlight distinctions in how common terms are used.

Active learning is generally defined as any instructional method that engages students in the learning process. In short, active learning requires students to do meaningful learning activities and think about what they are doing[1]. While this definition could include traditional activities such as homework, in practice active learning refers to activities that are introduced into the classroom. The core elements of active learning are student activity and engagement in the learning process. Active learning is often contrasted to the traditional lecture where students passively receive information from the instructor.

Collaborative learning can refer to any instructional method in which students work together in small groups toward a common goal[2]. As such, collaborative learning can be viewed as encompassing all group-based instructional methods, including cooperative learning[3].

Problem-based learning(PBL) is an instructional method where relevant problems are introduced at the beginning of the instruction cycle and used to provide the context and motivation for the learning that follows. It is always active and usually (but not necessarily) collaborative or cooperative using the above definitions. PBL typically involves significant amounts of self-directed learning on the part of the students.

Common problems interpreting the literature in activelearning

Before examining the literature to analyze the effectiveness of each approach, it is worth highlighting common problems that engineering faculty should appreciate before attempting to draw conclusions from the literature.

Problems Defining

What Is Being Studied Confusion can result from reading the literature on the effectiveness of any instructional method unless the reader and author Does Active Learning Work? A Review of the Research [QA1] take care to specify precisely what is being examined. For example, there are many different approaches that go under the name of problem-based learning[4]. These distinct approaches to PBL can have as many differences as they have elements in common, making interpretation of the literature difficult. In PBL, for example, students typically work in small teams to solve problems in a self-directed fashion. Looking at a number of meta-analyses[5],Norman and Schmidt[6] point out that having students work in small teams has a positive effect on academic achievement while self-directed learning has a slight negative effect on academic achievement. If PBL includes both of these elements and one asks if PBL works for promoting academic achievement, the answer seems to be that parts of it do and parts of it do not. Since different applications of PBL will emphasize different components, the literature results on the overall effectiveness of PBL are bound to be confusing unless one takes care to specify what is being examined. This is even truer of the more broadly defined approaches of active or collaborative learning, which encompass very distinct practices.

Problems Measuring "What Works"

Just as every instructional method consists of more than one element, it also affects more than one learning outcome[6]. When asking whether active learning "works," the broad range of outcomes should be considered such as measures of factual knowledge, relevant skills and student attitudes, and pragmatic items as student retention in academic programs. However, solid data on how an instructional method impacts all of these learning outcomes is often not available, making comprehensive assessment difficult. In addition, where data on multiple learning outcomes exists it can include mixed results. For example, some studies on problem-based learning with medical students[7,8] suggest that clinical performance is slightly enhanced while performance on standardized exams declines slightly. In cases like this, whether an approach works is a matter of interpretation and both proponents and detractors can comfortably hold different views.

Another significant problem with assessment is that many relevant learning outcomes are simply difficult to measure. This is particularly true for some of the higher level learning outcomes that are targeted by active learning methods. For example, PBL might naturally attract instructors interested in developing their students' ability to solve open-ended problems or engage in life-long learning, since PBL typically provides practice in both skills. However, problem solving and life-long learning are difficult to measure. As a result, data are less frequently available for these outcomes than for standard measures of academic achievement such as test scores.This makes it difficult to know whether the potential of PBL to promote these outcomes is achieved in practice. Even when data on higher-level outcomes are available, it is easy to misinterpret reported results.

Summary

There are pitfalls for engineering faculty hoping to pick up an article or two to see if active learning works. In particular, readers must clarify what is being studied and how the authors measure and interpret what "works." The former is complicated by the wide range of methods that fall under the name of active learning, but can be simplified by focusing on core elements of common active learning methods. Assessing "what works" requires looking at a broad range of learning outcomes, interpreting data carefully, quantifying the magnitude of any reported improvement and having some idea of what constitutes a "significant" improvement. This last will always be a matter of interpretation, although it is helpful to look at both statistical measures such as effect sizes and absolute values for reported learning gains. No matter how data is presented, faculty adopting instructional practices with the expectation of seeing results similar to those reported in the literature should be aware of the practical limitations of educational studies. Educational studies tell us what worked, on average, for the populations examined and learning theories suggest why this might be so. However, claiming that faculty who adopt a specific method will see similar results in their own classrooms is simply not possible. Even if faculty master the new instructional method, they can not control all other variables that affect learning.

The evidence for activelearning

Bonwell and Eison[1] summarize the literature on active learning and conclude that it leads to better student attitudes and improvements in students' thinking and writing. They also cite evidence from McKeachie that discussion, one form of active learning, surpasses traditional lectures for retention of material, motivating students for further study and developing thinking skills. Felderetal[9] include active learning on their recommendations for teaching methods that work, noting among other things that active learning is one of Chickering and Gamson's "Seven Principles for Good Practice"[10].

However, not all of this support for active learning is compelling. McKeachie himself admits that the measured improvements of discussion over lecture are small[11]. In addition, Chickering and Gamson do not provide hard evidence to support active learning as one of their principles. Even studies addressing the research base for Chickering and Gamson's principles come across as thin with respect to empirical support for active learning. For example, Scorcelli[12], in a study aimed at presenting the research base for Chickering and Gamson's seven principles, states that, "We simply do not have much data confirming beneficial effects of other (not cooperative or social) kinds of active learning."

Despite this, the empirical support for active learning is extensive. However, the variety of instructional methods labeled as active learning muddles the issue. Given differences in the approaches labeled as active learning, it is not always clear what is being promoted by broad claims supporting the adoption of active learning. Perhaps it is best, as some proponents claim, to think of active learning as an approach rather than a method[13] and to recognize that different methods are best assessed separately.

First, it allows the reader to examine questions that are both fundamental and pragmatic, such as whether introducing activity into the lecture or putting students into groups, is effective.

Second, focusing on the core element eliminates the need to examine the effectiveness of every instructional technique that falls under a given broad category, which would be impractical within the scope of a single paper. Readers looking for literature on a number of specific active learning methods are referred to additional references[1, 6, 14].

CONCLUSIONS

Although the results vary in strength, this study has found support for all forms of active learning examined. Some of the findings,such as the benefits of student engagement, are unlikely to be controversial although the magnitude of improvements resulting from active-engagement methods may come as a surprise. Other findings challenge traditional assumptions about engineering education and these are most worth highlighting. For example, students will remember more content if brief activities are introduced to the lecture. Contrast this to the prevalent content tyranny that encourages faculty to push through as much material as possible in a given session. Similarly, the support for collaborative and cooperative learning calls into question the traditional assumptions that individual work and competition best promote achievement. The best available evidence suggests that faculty should structure their courses to promote collaborative and cooperative environments. The entire course need not be team-based, as seen by the evidence in Springer , nor must individual responsibility be absent, as seen by the emphasis on individual accountability in cooperative learning. Nevertheless, extensive and credible evidence suggests that faculty consider a nontraditional model for promoting academic achievement and positive student attitudes. Problem-based learning presents the most difficult method to analyze because it includes a variety of practices and lacks a dominant core element to facilitate analysis. Rather, different implementations of PBL emphasize different elements, some more effective for promoting academic achievement than others. Based on the literature, faculty adopting PBL are unlikely to see improvements in student test scores, but are likely to positively influence student attitudes and study habits. Studies also suggest that students will retain

information longer and perhaps develop enhanced critical thinking and problem-solving skills, especially if PBL is coupled with explicit instruction in these skills. Teaching cannot be reduced to formulaic methods and active learning is not the cure for all educational problems. However, there is broad support for the elements of active learning most commonly discussed in the educational literature and analyzed here. Some of the findings are surprising and deserve special attention. Engineering faculty should be aware of these different instructional methods and make an effort to have their teaching informed by the literature on “what works.”

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