Flipped learning research: A summary

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Summary

This document is an overview of published research pertaining to flipped learning. We first give a definition of "flipped learning", then examine historical articles about flipped learning and seminal articles on closely-related concepts. Then we give a brief sample of a few recent research studies on flipped learning.

Defining terms

A broad and yet precise definition of flipped learning is the following (Talbert (2017)), adapted from the definition provided by FlippedLearning.org (Network (2014)):

Flipped Learning is a pedagogical approach in which first contact with new concepts moves from the group learning space to the individual learning space in the form of structured activity, and the resulting group space is transformed into a dynamic, interactive learning environment where the educator guides students as they apply concepts and engage creatively in the subject matter.

FlippedLearning.org further outlines four attributes or "pillars" of flipped learning: A flexible learning environment, a learning culture, intentional content, and professional educators. These can be remembered using the acronym "FLIP". The definition and the "four pillars" distinguish flipped learning from educational practices in the past such as the Oxford tutorial model or case study approaches, while avoiding unnecessary restrictions on what is considered flipped learning. For example, we do not require that classes use video content outside of class to be flipped learning environments.

Theoretical background

At least four major themes in cognitive and educational psychology support the concept of flipped learning:

- **Self-determination theory (SDT)**. Self-determination theory was proposed by Edward Deci and Richard Ryan (Edward and Ryan (1985)) to examine the types of motivation that people can have. These types are intrinsic (motivation inherent in the task itself), extrinsic (motivation that is separate from the task), and autonomous (motivation separate from the task but endorsed by the individual). "Deep" learning of a subject as opposed to "surface learning" (e.g. Chin and Brown (2000)) is traditionally linked with intrinsic motivation (e.g. Fransson (1977)), and therefore a key goal of instruction is to foster intrinsic motivation. Abeysekera and Dawson (Abeysekera and Dawson (2015)) propose that flipped learning provides the necessary personal and social environments for intrinsic motivation to take root by focusing group space on tasks that are within student's skill sets but which are not

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easy. Vygotsky referred to this middle ground as the “Zone of Proximal Development” (see Vygotsky, Veer, and Valsiner (1994)).

- **Cognitive load theory (CLT)**. Cognitive load theory is based on the concept that human working memory is limited in how much it can hold at any given point in time. Based on the work of psychologists such as John Sweller (Kalyuga et al. (2003)), CLT focuses on three types of “load” that can be placed on working memory: intrinsic load (effort required for a task that is irreducibly part of the task itself), extrinsic load (difficulty not inherent in the task but which adds to the difficulty of the task), and germane load (difficulty added to the task that aids in the formation of “schema”, or organized patterns of thought that connect disparate ideas). Abeysekera and Dawson (Abeysekera and Dawson (2015)) assert that flipped learning environments can reduce extrinsic load and promote germane load by placing certain classroom tasks that require attention and effort, such as watching and taking notes on lectures, into contexts where students have more control (i.e. in their individual spaces) while at the same time focusing group space on activities aimed at sense-making and applications.
- **Self-regulated learning**. Self-regulated learning refers to learning in which learners are active participants not only in learning activities but in the process and attributes of learning itself, with a particular view toward learning that involves awareness and initiative of one’s learning. Linda Nilson (Nilson (2013)) writes that self-regulating behavior involves strategic knowledge about study strategies and heuristics, knowledge about cognitive tasks such as understanding directions and time requirements, and self-knowledge such as one’s own strengths and weaknesses and how to improve one’s efforts. Paul Pintrich (Pintrich (2004)) proposed that self-regulated learning involves a matrix of four phases (forethought/planning/activation, monitoring, control, and reaction/reflection) and four areas (cognition, motivation/affect, behavior, and context) and that self-regulating learners are actively engaged in these phases and areas during the learning process. By placing responsibility for first contact with new concepts in the individual space and emphasizing active work on higher-order tasks in the group space, flipped learning provides an environment in which self-regulated learning is practiced on a regular basis.

Historical works

Flipped learning as an organized and coherent instructional paradigm can be traced back to four key developments during the mid- to late 1990’s and early 2000’s.

- **The development of peer instruction at Harvard University.** To address what he perceived as serious conceptual gaps in the knowledge of his introductory physics students, Prof. Eric Mazur at Harvard invented a teaching technique that became known as “peer instruction”, described in detail in Eric (1997). Peer instruction is based on students performing critical reading tasks prior to class, and then class time is focused on small group discussion of difficult conceptual questions based on the reading, mediated by the use of classroom response technology. The effectiveness of peer instruction is documented in a long list of publications (Jessica Watkins (2013), Lorenzo, Crouch, and Mazur (2006), Crouch and Mazur (2001), and others).
- **The “classroom flip” at Cedarville University.** In 1995, responding to a need for greater student activity in a class on website design, J. Wesley Baker made use of a newly-installed campus computer network to put his lecture slides online for pre-class review and then repurposed class time for active work on web design. Baker’s approach represented the first time that the term “flip” was used in conjunction with class design, and is reported in Baker (2000).

- **The inverted classroom concept at Miami University.** Three economics professors at Miami University (Ohio) created what they called the "inverted classroom" in a large-lecture introductory course to address issues involving student learning styles. They placed lectures on tape available in the campus library to supplement student readings, then used class time for a variety of active learning activities. They found (Lage, Platt, and Treglia (2000)) that both students and instructors had notable preferences for the "inverted" approach over traditional instruction and that students benefitted from group space activities that were more flexible in terms of reaching their learning style.
- **The "flipped classroom" of Bergmann and Sams.** Jon Bergmann and Aaron Sams discovered the idea of using recorded online video to replace in-class lectures in their high school chemistry classes, first to help students who were absent from class and later to refocus class time on active learning. Their book Flip Your Classroom: Reach Every Student In Every Class Every Day (Bergmann and Sams (2012)) popularized flipped learning among primary and secondary educators and propelled flipped learning into the mainstream.

Another important early work on flipped learning is the 2007 Ph.D. dissertation of Jeremy Strayer (Strayer (2007)). Strayer's dissertation was the first quasi-experimental study of the effectiveness of flipped learning environments on student learning. Strayer studied the effects of a flipped learning environment on motivation of students in an introductory college statistics course, in which the pre-class individual space work was mediated by an intelligent tutoring system. He found that students in the flipped learning environment were "less satisfied with how the structure of the classroom oriented them to the learning tasks of the course" than their counterparts in a traditional course.

Research on active learning

Since one of the primary purposes of flipped learning is to emphasize active learning in the group space, it is worthwhile to note two landmark studies on the effectiveness of active learning in general.

- **Richard Hake's "6000-student" study.** In 1998, physicist Richard Hake coordinated a controlled study of over 6000 students in 62 introductory college physics courses in the United States (Hake (1998)). The study compared results on the Halloun-Hestenes Mechanics Diagnostic Test and the Force Concept Inventory for students in "interactive engagement" courses versus those in traditional lecture-oriented courses. The study found that the learning gains for interactive-engagement students were almost two standard deviations higher than those for students in traditional courses.
- **The PNAS study.** A meta-analysis of 225 separate studies on active learning in courses in the STEM (science, technology, engineering, and mathematics) disciplines published in the Proceedings of the National Academy of Sciences (Freeman et al. (2014)) found that, on average, student performance on standard assessments of learning increased by about 0.47 standard deviations for students in active learning environments compared to those in traditional lecture environments, and students in traditional lecture environments were 1.5 times more likely to fail those courses than their counterparts in active learning environments.

Recent research on flipped learning

Following Jeremy Strayer's dissertation in 2007, published research on flipped learning was basically nonexistent. An ERIC database query for any peer-reviewed publications featuring

"flipped learning" or "flipped classroom" between 2008 and 2011 returns zero results. However, with the publication of Bergmann and Sams' book in 2012, interest in flipped learning surged, and since 2012 the number of peer-reviewed articles on flipped learning has been growing exponentially (Talbert (2017)) with 293 publications from 2012 to the time of this writing using the same ERIC query as above.

The quantity, diversity, and recentness of the majority of flipped learning research make it difficult to isolate a group of seminal publications or even over-arching themes or best practices among the research. Below we give a short list of some of the most commonly-cited recent research on flipped learning along with some studies that stand out due to their methodological quality.

- A study investgating a redesign of a first-year pharmaceutics course found significant increases in class attendance, learning outcomes, and perceived value of flipped learning among students. (McLaughlin et al. (2014))
- A study of use of flipped learing environments in an undergraduate multimedia course found significant student support and perceived value of the method. (Enfield (2013))
- A quasi-experimental study of flipped learning in an undergraduate business course (Findlay-Thompson and Mombourquette (2014)) found that student views on flipped learning environments were mixed, and learning outcomes were identical between flipped and non-flipped groups. The authors pursue questions regarding implementation of flipped learning environments as a result.
- As a follow-up to his dissertation, Jeremy Strayer investigated the learning environments in a flipped introductory statistics class with those of a traditional lecture setup of the same course. He found that students in the flipped environment were less satisfied with how the environment oriented them to the learning tasks in the course, but became more open to non-traditional teaching methods including cooperative learning. (Strayer (2012)).
- A study comparing learning gains from flipped learning environments to those in a non-flipped environment that used extensive active learning activities found no significant differences in outcomes, suggesting that the flipped learning environment by itself is not responsible for improvements in learning outcomes but rather the use of active learning techniques. (Jensen, Kummer, and Godoy (2015))
- A study of flipped learning in an introductory chemistry course examined the effects of flipped learning on students' out-of-class study time, exam performance, and motivation. The results indicate that flipped learning does not significantly add to students' workload; that there is a small positive effect of flipped learning on student performance; and that the effect on student's motivation was mixed with a strong bimodal tendency in student preferences.

In addition to these, various meta-studies and literature reviews are valuable parts of the flipped learning research literature. Abeysekara and Dawson's study (Abeysekera and Dawson (2015)) is one of these; another commonly-cited literature review is Bishop and Verleger (Lowell Bishop and Verleger (2013)).

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