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A Taxonomy to Define Courses that Mix Face-to-Face and Online Learning

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Abstract

The efficacy of courses that mix face-to-face and online instruction, such as blended, hybrid, flipped, and inverted courses, is contested in the literature. Some studies find that they improved learning outcomes and some do not. We argue that these unreliable results are due to inconsistent definitions of these courses. To address this problem, we propose the Mixed Instructional eXperience (MIX) taxonomy to define hybrid, blended, flipped, and inverted based on two dimensions. To test the usefulness of the taxonomy to organize the literature, we reclassified research using the taxonomy. The analysis of the literature after reclassification revealed themes that illuminate how mixing face-to-face and online instruction affects learning. These findings validate the taxonomy as a useful tool for classifying literature and further knowledge in this field.

Keywords: hybrid, blended, flipped, inverted, online learning.

1. A Taxonomy to Define Courses that Mix Face-to-Face and Online Learning

Instructors in higher education courses increasingly use information technologies for their pedagogical, accessibility, and flexibility benefits (Bonk & Graham, 2005). Since the early 2000s, a growing group of educators has been interested in using information technology, particularly computers, to mix face-to-face and online instructional methods for courses that are commonly referred to as hybrid, blended, flipped, or inverted. These types of courses are called mixed instruction courses in this paper. Much research has been conducted in the past several years to assess the effectiveness of mixed instruction courses, but the results of that research as a whole are inconclusive.

Though many studies of mixed instruction courses have found that they improved learning outcomes over traditional courses, just as many have found no differences. For example, for papers that included quantitative learning outcomes (i.e., those included in the current paper's analysis) and were reported as hybrids, 41% (7 out of 17) reported improved learning outcomes and 59% (10 out of 17) reported equivalent outcomes. In addition, for those that were reported as blended, 45% (5 out of 11) reported improved learning outcomes and 55% (6 out of 11) reported equivalent outcomes. These overall results for hybrid and blended course outcomes neither support nor refute the potential learning benefits of mixed instruction courses. To make sense of these papers collectively, an educator or researcher would need to conduct an in-depth analysis of the research, making the cost of useful information exorbitantly high.

We argue that the differences between courses that improved outcomes and those that did not are unclear due to the ill-defined terms used to describe these courses. For instance, the terms hybrid and blended have been used to describe a large range of mixed instruction courses. "Blended" has been used to describe a course in which students learn content before class and practice applying content in class (Melton, Graf, & Chopak-Foss, 2009) as well as a course in which half of the lectures are delivered in class and the other half are delivered online (Gerlich & Sollosy, 2009). The pedagogy of these courses is different, but they are classified as the same type of course.

Better definitions of terms are needed to advance knowledge in this area because inconsistent definitions of mixed instruction courses makes comparing results, replicating experiments, implementing course design, and finding and understanding information from the literature difficult. Furthermore, without agreement about the foundational definitions of mixed instruction courses, research exploring different features of these courses, such as frequency of peer interactions or synchronicity of instruction, cannot be systematic. To address these issues, we propose a taxonomy that identifies pedagogically relevant dimensions that can be used to define terms and discriminate among different types of mixed instruction courses.

2. The Proposed Taxonomy

The taxonomy uses dimensions of instructional experiences that affect the pedagogy of mixed instruction courses to create a tool for defining and distinguishing between different types of courses. It classifies the design of courses focusing on how instruction is provided; therefore, it is designed for classification at a course level rather than a lower (e.g., single class or unit) or higher (e.g., program of study) level. Because the taxonomy focuses on instruction, it captures dimensions of courses that instructors have influence over, but it does not capture other important dimensions, such as study groups. Before we can explore these important dimensions, we need to define the foundations of these courses.

2.1 Identifying Dimensions from Existing Definitions

To identify the relevant dimensions for defining and categorizing mixed instruction courses, previous definitions of these courses in higher education were reviewed. A sample of original definitions (i.e., definitions that were not repeated from a previous source) were selected from a range of publication dates (from 2000, when mixed instruction courses started to become popular in higher education, to present), publication types (peer-reviewed articles, books, magazines), and content areas (science and humanities). Definitions that were cited more than five times (Allen & Seaman, 2010; Lage, Platt, & Treglia, 2000; Strayer, 2012) were also included because they are popular. This sample was taken from the top 10 results on Google Scholar for the each of the following searches: “hybrid class,” “blended class,” “flipped class,” and “inverted class.” After the popular definitions were selected, the other definitions were selected to represent the most diverse publications as possible. In addition, definitions from different countries were included. The sample was qualitatively coded and analyzed using techniques described in Taylor-Powell and Renner (2003) to identify dimensions that researchers have used to describe these types of courses. Four dimensions were identified:

- *Instructional location* described whether the learner receives instruction at home or at another location, such as a classroom or coffee shop,
- *Delivery medium* described whether a person or technology delivers instruction to the learner,
- *Instruction type* described whether the learner is receiving content (e.g., lecture) or applying content (e.g., learning activities), and
- *Synchronicity* described whether learners are following a group pace (i.e., synchronous or real-time) or individual pace (i.e., asynchronous).

Each definition in the sample was then scored by two raters for whether it included information about the dimensions (see Table 1) to determine which dimensions were the most common. The initial interrater agreement was 92%, and raters discussed disagreements until they reached full agreement.

Patterns in Table 1 show which dimensions are commonly used to define each term, and they also highlight some inconsistencies. Flipped and inverted courses are widely considered to be a type of blended course (e.g., Johnson, 2012; Strayer, 2012); therefore, these three types of courses should be consistently defined by the same dimensions, but blended is defined more often by delivery medium and flipped and inverted are defined more often by instructional location. To explore this discrepancy, the delivery medium and instructional location dimensions were examined more closely. It was determined that those two dimensions capture the same instructional dimension – how learners receive instruction – from different perspectives: medium or location. To reduce redundancy, these two dimensions were represented by a single dimension: delivery medium.

Delivery medium was chosen over instructional location because the medium dictates part of the learner's experience during instruction. If instruction is delivered via an instructor, then it is implied that the learner and instructor are face-to-face and the instructor is communicating with the learner. If instruction is delivered via technology, then that instructional experience typically has some inherent flexibility on factors such as location, time, and pace of instruction (Gedik, Kiraz, & Ozden, 2013; Singh & Reed, 2001). In contrast, the physical environment in which instruction is received does not necessarily describe the instructional experience. For example, if a student is learning while working on a computer without interacting with other people, whether the student is at home or at school might not matter. For this reason, specifying how instruction is delivered to students rather than where instruction is delivered was considered more pertinent for defining instructional experiences.

The other commonly used dimension of courses is the instruction type: whether learners are receiving course content or applying that content. This dimension is related to a common pedagogical dimension of courses: whether students interact with the course content passively or actively. Generally, receiving content is considered more passive and applying content is more active, but how students interact with the content is at least partially controlled by the student. For example, students can actively engage with a lecture through taking notes or making connections to prior knowledge (Chi, 2009). Because this taxonomy is a tool to classify the instructional experiences provided in courses rather than students' interactions with course content, it uses the instruction type dimension rather than the passivity-activity dimension.

The instruction type dimension is similar to a dimension used by Richardson (2002) in a matrix to describe holistic learning environments. Richardson's dimension ranged from "content delivery focus" and "experience and practice focus." He argued that students learn principles that are fact-based through study and procedures that are application-based through practice. His argument is similar to that used to promote experiential learning frameworks that emphasize opportunities to practice application of content (e.g., problem-based learning, Hmelo-Silver, 2004). Supporters of these frameworks argue that students need guidance while applying content, instead of exposition of content, to be the most successful at applying content. Because differences along the instruction type dimension are likely to impact learning outcomes, it was included in the taxonomy.

The last dimension from previous definitions was synchronicity of instruction. Synchronicity was considered an independent dimension because instruction can be synchronous or asynchronous regardless of instruction type when it is delivered via technology. In the sample of definitions, however, describing the synchronicity of instruction was not common.

Furthermore, most courses that mix face-to-face and online instruction have a solely synchronous in-class component and solely asynchronous out-of-class component. Therefore, synchronicity is typically not independent from the delivery medium. For these reasons, synchronicity was not included in the taxonomy at this time, though it is recognized as a distinct dimension of instructional experiences that should be explored in the future. Similar to synchronicity, there are many more dimensions that might affect learning in mixed instruction courses, such as peer learning. We hope that the current version of the taxonomy will be used as a foundation for defining courses and that additional dimensions will be added to the taxonomy in the future to systematically evaluate their effects on learning outcomes.

2.2 Structure of the MIX Taxonomy

For the Mixed Instructional eXperience (MIX) taxonomy, the two dimensions used to define courses are delivery medium (how instruction is given) and instruction type (what instruction is given). Delivery medium is defined as the medium through which instruction is delivered to the learner. The two types of delivery media of interest for mixed instruction courses are via instructor and via technology, so they are the anchors of this dimension (see Figure 1). Delivery via instructor is defined as receiving instruction from an instructor in a face-to-face environment. For example, an instructor lecturing in a classroom using Powerpoint would be classified as delivery via instructor because the instructor is providing the instruction, and the Powerpoint slides are visual aids. Delivery via technology is defined as receiving instruction through the use of electronic information technology, such as computers or mobile phones. For example, if a lecture were recorded and students watched the recording on their computers, then that would be classified as delivery via technology. Though the content of the lecture is the same, the experience of watching the lecture is likely different.

The other dimension, instruction type, is defined by the role that the learner takes during instruction. The two types of instruction of interest are those given while students are receiving content and applying content, so they are the anchors of this dimension (see Figure 2). Receiving content is defined as the student receiving information while instructor-selected content, such as a lecture or educational video, is dictated by an instructor or instructional program. Applying content is defined as the student applying information, such as through solving problems or discussing concepts, while an instructor or program provides guidance and feedback. This guidance might include providing new content, such as a five-minute explanation in response to students' questions. The content in this situation is classified as guidance during applying content rather than receiving instructor-selected content because the students are seeking that information rather than the instructor selecting that information. This differentiation is made because inquiry-based learning, in which instructors provide only the content for which students ask, is considered constructing knowledge (Jonassen, 1999).

The delivery medium and instruction type dimensions are independent and can be used orthogonally to define types of mixed instruction courses (see Figure 3). The MIX taxonomy focuses on learning experiences in which students receive instructional support to acquire new knowledge, such as guidance on the credibility of content, optimal organization of knowledge, strategies for applying content, and students' progress. For this reason, the taxonomy does not specify learning activities that are entirely student-directed. For example, it does not include unmonitored peer discussion or assigned readings that were not designed for educational use (e.g., novels). This distinction does not mean that these learning experiences are not important but that students are not given instruction during these experiences.

The taxonomy is a tool to classify the design of a course based on the percentage of instructional support that students receive while receiving content or applying content and on the percentage of support that is delivered via an instructor or technology. For example, in a course for which students read novels before coming to class and the instructor provides feedback only while students discuss those books in class, 100% of the instructional support that students receive is directly from the instructor while they are applying content in a discussion. Therefore, this type of course would fall in the top right corner of the taxonomy. If this course also included oral summaries of the books' themes given in class by the instructor, then part of the instructional support would be dedicated to receiving content, and the course would fall more towards the center of the instruction type dimension along the top edge of the taxonomy. If instead the course continued discussion in an online forum monitored by the instructor, then part of the instructional support would be delivered via technology, and the course would fall more towards the center of the delivery medium dimension along the right edge of the taxonomy.

2.3 The Fundamental Instructional Experiences

The two dimensions of the taxonomy form four quadrants, and the corners of these quadrants represent the four fundamental instructional experiences (see Figure 3).

Instructor-transmitted describes the top left corner, in which instructional support is primarily delivered via instructor and while receiving content. For example, in a calculus course, students watch the instructor lecture and work through problems without guidance.

Technology-transmitted describes the bottom left corner, in which instructional support is primarily delivered via technology and while receiving content. For example, in a calculus course, students watch video lectures selected or made by the instructor.

Instructor-mediated describes the top right corner, in which instructional support is primarily delivered via instructor while students apply content. For example, in a calculus course, students complete problem solving assignments while the instructor acts as a tutor.

Technology-mediated describes the bottom right corner, in which instructional support is primarily delivered via technology while students apply content. For example, in a calculus course, students work through problems with computerized feedback that provides hints and confirms correct answers.

If a class were to use only one of these fundamental instructional experiences, then it would provide instructional support via one type of delivery and for one type of instruction; therefore, it would be located at the outer corners of the taxonomy. In the taxonomy, courses are classified as one of the four fundamentals if they do not have a substantial portion (defined as more than 25%, which is similar to other percentages used in the literature; e.g., Allen & Seaman, 2010) of instructional support from the other fundamentals. The 25% cutoff is not intended to be an exact cutoff but a general anchor for what constitutes a significant portion of a course. Most courses use some elements from each of the four fundamentals, but that does not mean that the course has adopted each fundamental as a substantive source of instruction. For example, lecture-based courses (i.e., instructor-transmitted) use some technology to manage assignments via course management software or answer questions via email. The courses of interest for this paper, however, need to use substantial portions of two or more fundamental instructional experience to be classified as mixed instruction courses. Courses that provide a substantial portion of support from two adjacent fundamental instructional experiences are called paired instructional experiences in the taxonomy.

2.4 The Paired Instructional Experiences

The taxonomy has four paired instructional experiences: one for each pair of adjacent quadrants (see Figure 4). In this taxonomy, the term *combination* will be used to describe this pairing. *Face-to-face combination* describes the pairing of instructor-transmitted and instructor-mediated instructional experiences. For example, in a calculus course, students watch the instructor solve problems for part of class time, and during the other time they work on problems with instructor guidance.

Online combination describes the pairing of technology-transmitted and technology-mediated instructional experiences. For example, in a calculus course, students watch videos of the instructor solve problems and then solve problems using a computer tutor to get feedback.

The categories of courses discussed up to this point are delivered primarily through one delivery medium. While these categories provide necessary context to define mixed instruction courses, the main focus on this paper is to define hybrid, blended, and flipped courses, which all mix delivery medium. Previous definitions of hybrid almost always describe courses that are delivered partially face-to-face and partially online (e.g., Arispe & Blake, 2012; Johnson, 2012; Sands, 2002). For this reason, the taxonomy uses hybrid to describe courses that deliver instructional support both via an instructor and via technology.

Lecture hybrid describes courses in which students have instructional support for receiving content partially via an instructor and partially via technology. For example, in a calculus course, students listen to lectures sometimes in class and sometimes through a live feed.

Practice hybrid describes courses in which students apply content with guidance and feedback partially via an instructor and partially via technology. For example, in a calculus course, students attend recitation once a week to solve problems with instructor guidance. The rest of the week, they discuss homework problems in online forums that the instructor moderates.

2.5 The Blended Instructional Experiences

The middle of the taxonomy was called the blended instructional experience, and it uses a substantial portion (at least 25%) of delivery via an instructor, delivery via technology, receiving content, and applying content (see Figure 5). Several possible types of blended courses can be defined by the taxonomy, but only a few types are common in the literature. The first is flipped or inverted courses, a course in which students receive content from technology (i.e., technology-transmitted) and apply content with help from an instructor (i.e., instructor-mediated). For example, in a calculus course, students watch video lectures made by the instructor before class, and they work on a solving problems during class with instructor feedback. The definition of flipped is indistinguishable from that of inverted in the literature (e.g., Bishop & Verleger, 2013; Morin et al., 2013; Strayer, 2012). *Flipped blend* will be the term used in this taxonomy because it is more commonly used.

Another common blend is a course in which students receive content from an instructor (i.e., instructor-transmitted) and apply content with help from a technology (i.e., technology-mediated). This type of course is similar to the supplemental model described by Twigg (2003), so it will be referred to as a *supplemental blend* because it adds additional resources to an otherwise lecture-based course. For example, in a calculus course, students watch the instructor solve problems during class, and they use an online tutor to work on homework problems and get computer-generated feedback.

The last common blend is a course that was a face-to-face combination course until about half of the instruction (both from receiving and applying content) was moved online. Because this type of course replaces part of the instructor-delivered component with a technology-delivered component, it will be called a *replacement blend*, similar to the replacement model described by Twigg (2003) as a course that replaces some class activities with online activities. For example, in a calculus course, students watch in-person and recorded problem solving by the instructor, and they solve problems in class with feedback from the instructor and online with feedback from a tutoring software.

2.6 Summary of Taxonomy

The MIX taxonomy uses dimensions that describe types of instructional support in order to provide consistent language for defining and distinguishing between different types of courses (see Figure 5). The taxonomy defines three main types of mixed instruction courses.

- Combination – courses that provide instructional support during both receiving content and applying content. How instruction is delivered determines whether it is a face-to-face or online combination course.
- Hybrid – courses that combine delivery of instruction via an instructor and via technology. What type of instruction is delivered determines whether it is a lecture hybrid or practice hybrid course.
- Blended – courses that combine delivery of instruction via an instructor and via technology and provides instructional support during both receiving content and applying content. Common types of blended courses include
    - Flipped blend – delivers exposition of content online and delivers feedback on application of content face-to-face,
    - Supplemental blend – delivers exposition of content face-to-face and delivers feedback on application of content online,

  - Replacement blend – delivers exposition of content and feedback on application of content both face-to-face and online.

Because these definitions were based on prior definitions, they have clear connections to the existing literature that should make adoption of the proposed definitions easier. In addition, the taxonomy offers new terms to differentiate specific types of courses, such as the two types of hybrid courses. We used these definitions to re-classify studies on mixed instruction courses. Results of studies in these new categories were analyzed to discover themes in the literature.

3. Analysis of Mixed Instruction Courses

To determine whether the MIX taxonomy classifies literature in a productive way, the taxonomy was used to re-categorize and re-analyze studies on mixed instruction courses. For this analysis, a content meta-analysis methodology was employed. Content meta-analyses, like meta-analyses, systematically aggregate information from a number of studies, but they use a qualitative approach instead of a quantitative approach (Jeong, Hmelo-Silver, & Yu, 2014). Given the large variations in research methodology and quantitative data sources (e.g., grades on exams, projects, or concept inventories) of the selected papers, a qualitative approach was more appropriate than a quantitative approach. Research about courses reported as "hybrid," "blended," "flipped," and "inverted," were included in this analysis. This analysis focused on higher education, so only studies of for-credit, higher education courses were included in the analysis.

To find relevant papers, the ERIC, Proquest Education Journals, and Academic Search Complete databases and Google Scholar were queried for permutations of the terms "hybrid," "blended," "flipped," and "inverted" with the terms "class," "classroom," "course," and "learning" in the title or abstract. The title or abstract also had to include "comparison," "experiment," "evaluation," or "performance." Abstracts of articles that met these criteria were reviewed. If the abstract did not mention student "outcomes," "knowledge," "achievement," or "grades," the article was excluded. In the analysis, only research that reported quantifiable results was included. Much of the research and many reviews on mixed instruction courses have focused on student and instructor perceptions instead of learning outcomes (Ginns & Ellis, 2007), but quantitative results are imperative to determine the efficacy of mixed instruction.

We compared the learning outcomes of mixed instruction courses to those of the same courses taught in whatever manner was traditional. Therefore, only experimental or quasi-experimental studies were included in the analysis. In addition, studies must have included a control group that was the original version of the course. Studies must also have measured quantitative learning outcomes and used inferential statistics to analyze those outcomes. Measures of learning outcomes must have been equivalent in the experimental and control groups. Measurements were typically a grade, such as an exam or course grade. To be included in this analysis, these grades must have been a numeric value or at least distinguished between letter grades: A, B, C, D, or a failing grade.

3.1 Reclassification of Studies

The 49 selected studies were reviewed to identify pedagogical components and any other aspects of courses that were consistently reported. Then each of these parts was coded. The designs of the mixed instruction courses were coded for the reported classification, how instruction was delivered to students, and what type of instruction was delivered. No reports included the percentage of time that instruction was delivered through each medium nor the percentage of time that each type of instruction was delivered as the taxonomy specifies, but these percentages are not intended to be exact cutoffs and instead are meant to signify that a significant portion of the course was devoted to a particular instructional method. Therefore, courses were coded as having at least 25% of an instructional method if that method was discussed as a significant portion of the course.

The designs of the original (control) courses were also coded for how instruction was delivered to students and what type of instruction was delivered. The difference between course designs was coded for changes in delivery medium, instruction type, and time spent in class. The assessments used to measure learning outcomes were recorded, and the level of knowledge measured was coded as either understanding (recall or recognition of content), application (application of content), both, or unknown. The domains of the courses were recorded, and levels of the courses were coded.

The studies are described in Table 2 with information about the mixed instruction course, original course, and differences between them. Of 17 courses that were originally reported as hybrid in the literature, 5 were reclassified as a type of hybrid, 10 as a type of blend, and 2 as other types of courses. Of the 11 courses that were originally reported as blended, 5 were reclassified as a type of hybrid, 5 as a type of blend, and 1 as another type of course. Of the 21 courses that were originally reported as flipped or inverted, 13 were reclassified as a flipped blend, 4 as a flipped blend with an additional instructor-transmitted component, and 4 as another type of course. These reclassifications based on the MIX taxonomy highlight the fundamental differences between courses that were reported as hybrid, blended, flipped, or inverted in the literature.

3.2 Differences among Mixed Instruction and Original Courses

With courses reclassified based on type of instruction given and delivery medium of that instruction, themes can be found in the results for whether a course design improved learning or not (see Figure 6). In the lecture hybrid, replacement blend, and flipped blend categories, all but a few studies follow a theme of results in each category. Only the results of the four practice hybrids and the four supplemental blends do not follow a theme. To explore why mixed instruction courses did or did not improve learning outcomes, the differences between mixed instruction courses and original courses were considered. Most studies of mixed instruction courses describe the pedagogical differences between traditional and mixed instruction courses in terms of the type of instruction that is given to students and the instruction delivery mechanism, which is consistent with the dimensions used in the MIX taxonomy. The other difference between courses that is consistently described in these studies is the amount of time that students spent in the classroom (see Table 2).

Delivery Medium. Of mixed instruction courses that changed only the delivery medium from the traditional courses (all of those classified as a lecture hybrid, some as replacement blend, and a few others; see Table 2), 74% (14 out of 19) reported no change in learning outcomes. Four out of five studies that did report improved learning outcomes argued that asynchronous delivery of some of the instruction was beneficial to student learning. Several researchers have made similar arguments that asynchronous delivery is beneficial because learning is self-paced, including a meta-analysis that found a small but significant increase in learning in asynchronous online courses over face-to-face courses (Bernard et al., 2004). Many of the studies analyzed in this review did not explain in detail the nature of learning activities that were delivered via technology or delivered via instructor, making it difficult to theorize why they did or did not improve learning. For example, instructors might have moved an in-class lecture on an easy concept to an online recording, freeing up more time in class for students to ask questions about more difficult concepts.

Though asynchronous online learning did not generally improve learning, no difference in learning due to changing the delivery mediums is an important theme. If technology can deliver instruction with the same efficacy as instructors, then technology can be used as a resource to either supplement face-to-face instruction or reduce the amount of time students need to be in class. Possible benefits of using technology to supplement instructors include increasing the quality of instruction by increasing the resources available to students and the accessibility of instruction by reducing the amount of class time required for a course.

Type of Instruction. Type of instruction made a consistent impact on learning outcomes in mixed instruction courses. Of courses that added instruction during application of content to the original courses (most of those classified as flipped blend and supplemental blend as well as a few others, see Table 2), 77% (23 out of 30) reported improved learning outcomes. That percentage increases to 88% (23 out of 26) if the four courses that already had feedback during application and simply added more are removed from the equation. It is important to note that in nearly all of these courses, students in the original course completed application activities, but students in the mixed instruction course received feedback while they completed application activities.

The majority of courses that added instruction during application and reported improved learning (18 of the 23) were flipped courses. These classes typically have recorded video lectures to be viewed before class and then application activities in class completed in small groups and with an instructor's or teaching assistants' feedback. Only 4 of the 22 flipped courses did not report improved learning outcomes. One of those courses had a substantial instructor-transmitted component, in which the instructor gave a review of the recorded lectures that students were supposed to watch before class, and the other three course reduced time spent in class, meaning students in these classes had less time to receive feedback while applying content. Though little information is provided in the papers to explain these null results, it is possible that less time for feedback than other courses contributed.

To determine whether feedback on application of content needs to happen in class, courses that added technology-mediated application were further analyzed. Of the four supplemental blends, which guided application via technology, 50% of them reported learning improvements and 50% of them did not. The half that reported improvements asked students to use technology to practice recurrent skills (i.e., skills that are always executed in the same way), such as practicing conjugation for a language class with vocabulary drills. The half that reported equivalent outcomes asked students to use technology to practice non-recurrent skills (i.e., skills that are executed differently depending on the application), such as solving integral problems in calculus. Two other courses continued application activities online that started in class, and they both reported improved learning outcomes.

Based on these findings, technology might effectively support some application activities but not others. Jia, Chen, Ding, and Ruan (2012) argued that technology can support application activities that would be repetitive and time-consuming for an instructor to support. Technology might even be better in these cases because it typically provides feedback more quickly than instructors, leading to higher student satisfaction (Gikandi, Morrow, & Davis, 2011). If a theme can be found in these six studies, it would support Jia et al.'s (2012) argument by suggesting that technology-mediated applications are more successful when the applications are repetitive, like practice drills or a continuation of an in-class activity. For the two studies that did not find learning improvements, both asked students to solve problems with feedback exclusively from a computer program. The nature of instructional support that students received from these programs was unclear, but based on the predominately positive findings from flipped courses and the neutral findings from these courses, it is likely not equivalent to in-class support that students in flipped courses received.

Time in Class. Because of the increased use of technology outside of the classroom, instructors of mixed instruction courses commonly underestimate the amount of time students will spend on the course, resulting in a more time consuming course referred to as "a course and a half" (Garrison & Vaughan, 2008). Though many of the studies in this review did not directly measure time spent on the course outside of class, many did reduce the amount of time students spent in class to accommodate additional coursework outside of class. Nearly half (22) of the studies decreased time spent in class for the mixed instruction course. Most (15 courses, 68%) of these courses were classified as a hybrid or replacement blend course, and the others were one supplemental blend, three flipped blends, one instructor-transmitted, and two online combinations. The majority (18 courses, 82%) of the courses that decreased time in class did not report improved learning outcomes. These results suggest that, though the hybrid and replacement courses might not tend to improve learning outcomes, they can reduce time spent in class without negatively impacting learning. This finding suggests that technology-delivered instruction can be used in situations that call for reducing resources associated with spending time in class, such as instructor time, classroom usage, or travel costs.

Of the 27 mixed instruction courses that did not reduce time spent in class, most (23 courses, 85%) reported improved learning outcomes. Most of these courses that reported improvements were flipped courses (18 out of 23 courses, 78%), and the others added technology-mediated application. Though these studies did not reduce class time, approximately half of them reported efforts to keep the workload of the students in the mixed instruction course equal to that of the students in the traditional course. It is possible, however, that improved learning outcomes are partially caused by a greater workload. Without more research, it is difficult to speculate on the effect size of workload, but these findings suggest that time in class is valuable for learning outcomes.

After reclassifying courses based on the MIX taxonomy, the literature provides much stronger evidence for whether hybrid, blended, and flipped courses improve learning outcomes. As with any type of meta-analysis, though, these themes might be exaggerated by not including studies with contradictory findings that were not published. Many of the studies included in the analysis were conducted by professors who are not primarily educational researchers; therefore, it is possible that some professors who conducted similar research and had poor results did not publish their results because it is not crucial to their career. On the other hand, many successful mixed instruction courses have likely been implemented by professors who have not published their results. The results of the present analysis, therefore, are likely not entirely representative of the impact of all mixed instruction courses, but the themes are strong enough that they serve as a good starting point for future work.

4. Conclusion

The MIX Taxonomy (see Figure 5) provides consistent terms for researchers and educators to discuss different types of courses. The taxonomy not only differentiates hybrid, blended, and flipped courses, but it also includes a range of other teaching methods to situate these courses. Although detailed descriptions of a particular course in a study will always be necessary, classifying courses by the terms used in the taxonomy can help people aggregate general information about instructional methods. After reclassifying studies with the categories in the taxonomy, reanalysis of results in this literature allowed two main themes to be identified:

- Courses that used mixed instruction to reduce time spent in class by delivering part of instruction online maintained equivalent learning outcomes while reducing time spent in class.
- Courses that used mixed instruction to start providing feedback while students applied content improved learning outcomes, while commonly maintaining the time that students spent on a course.

These results provide insight into the efficacy of mixed instruction courses and validate the dimensions used in the taxonomy as a meaningful way to categorize courses.

For the educators who will be implementing mixed instruction courses, the definitions provided by the taxonomy tell them exactly what instructional methods they should include in their courses to achieve their desired results based on their goals and the results of educational research. For example, if they want to reduce time spent in class but not hinder learning, they can implement a hybrid course, and the taxonomy defines exactly what a hybrid is. For educators who want to improve learning outcomes, they should focus on providing feedback to students while they apply content. The results of the present analysis are somewhat simplistic for an educator to implement in a course that has many more dimensions than delivery medium and instruction type. To develop robust knowledge of effective practices in mixed instruction courses, dimensions should be added to the taxonomy.

The current two dimension of the taxonomy are intended to be the foundation upon which other course dimensions can be added and systematically explored. By controlling for delivery medium and delivery type, other dimensions, such as synchronicity or peer interactions, can be manipulated to measure their impact on the success of mixed instruction courses. For example, one could compare two mixed instruction courses that both had activities in class with feedback form the instructor course and content delivered via technology, but one in one of the courses the content was delivered asynchronously and in the other course content was delivered synchronously. By keeping the other aspects of the mixed instruction course constant, the effect of synchronicity on online content delivery in mixed courses could be explored. Other dimensions of particular interest include peer teaching and collaborative learning activities, which can have powerful effects on learning (Bruffee, 1993; Chi, 2009; Goldschmid & Goldschmid, 1976). These dimensions are especially important for mixed instruction courses because their effects may differ depending on whether communication is face-to-face or online (Garrison & Vaughan, 2008).

Beside these possible additional dimensions, other aspects of students, courses, and assessments might impact learning outcomes but need to be more consistently reported to explore their effect. For example, Guzdial (1997) found that students do not necessarily use provided online resources as frequently as expected, but rarely was usage of online resources reported. The list below details information that would be helpful if collected and reported in future studies to determine how these factors affect learning in mixed instruction courses. Many of these details can be provided by the instructor of the course, but information about learners might require them to complete a short survey.

- Learner information in addition to demographic data
    - Measure of prior academic success, such as GPA
    - Year in school
    - Prior experience with online or mixed instruction courses
    - Comfort with and attitude towards technology
- Course information

  - Level of course
  - Number of students
  - Whether the course is required and why
  - General goals or learning objectives for the course
- Course design information
  - Description of learning activities
  - Which learning activities are conducted in which delivery mediums
  - Rationale or motivation for changing teaching methods
- Assessment and learning outcomes information
  - Level of knowledge assessed (e.g., recall versus application)
  - Participation rates in online and in-class learning activities
  - Rate of students who drop or withdraw from the course

Reporting this information in future studies can help future analyses better determine the impact of mixed instruction.

Not all mixed instruction research needs to include a controlled, quasi-experimental design to contribute to our knowledge on effective courses. The current analysis focused on whether mixed instruction courses improved learning outcomes over the original version of courses, but that is not the only measure of a successful course. Many questions, such as those about student and instructor satisfaction, do not require control groups but are important to understand the impact of mixed instruction courses. Studies like these should also classify their courses by the MIX taxonomy and include details listed above about learners, course design, and assessment to make it easier to aggregate findings from multiple studies into a cohesive whole.

The MIX taxonomy is intended to be a starting point for classification in this literature. By layering additional dimensions on top of the two presented in this paper, we can determine other dimensions' effect on learning. Similarly, the analysis discussed in the current paper is intended to be an intermediate step towards building further knowledge about mixed instruction courses. The analysis uncovered important findings, but confirmatory research is needed to ensure that the findings are valid. Much work is left to be done, but the taxonomy can help us to more efficiently determine the best implementations of mixed instruction courses.

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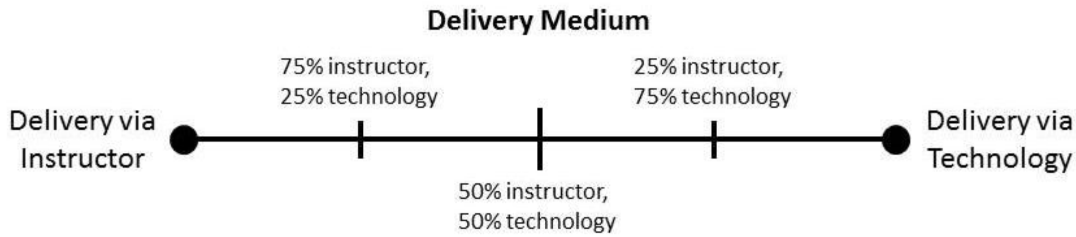

Figure 1. Delivery medium dimension of instructional experiences ranging from 100% delivery of instructional support via an instructor to 100% delivery via technology.

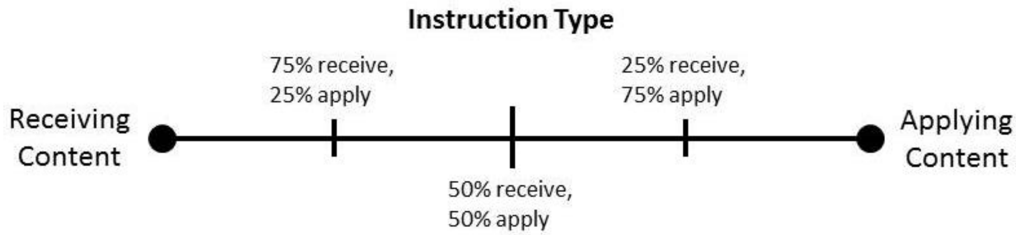

Figure 2. Instruction type dimension of instructional experiences ranging from 100% of instructional support given during content reception to 100% during content application.

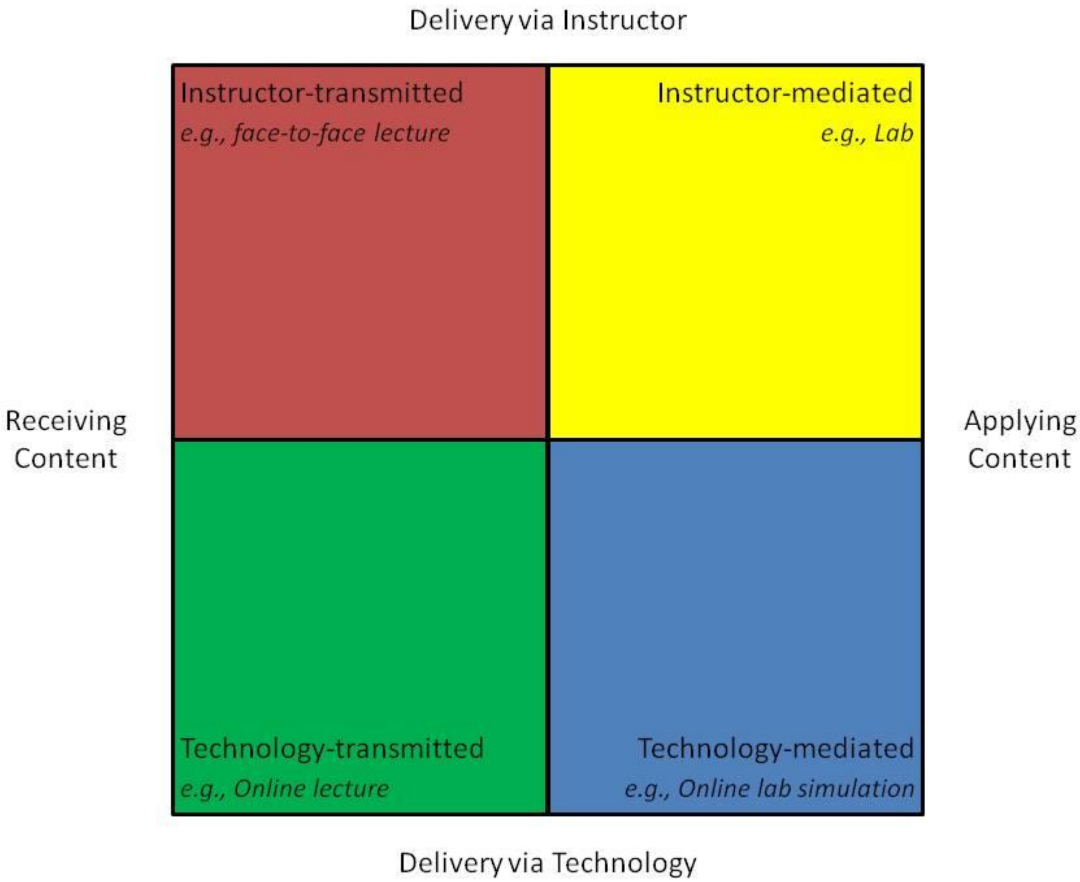

Figure 3. The four quadrants of the taxonomy with the fundamental instructional experiences at the corners of each quadrant.

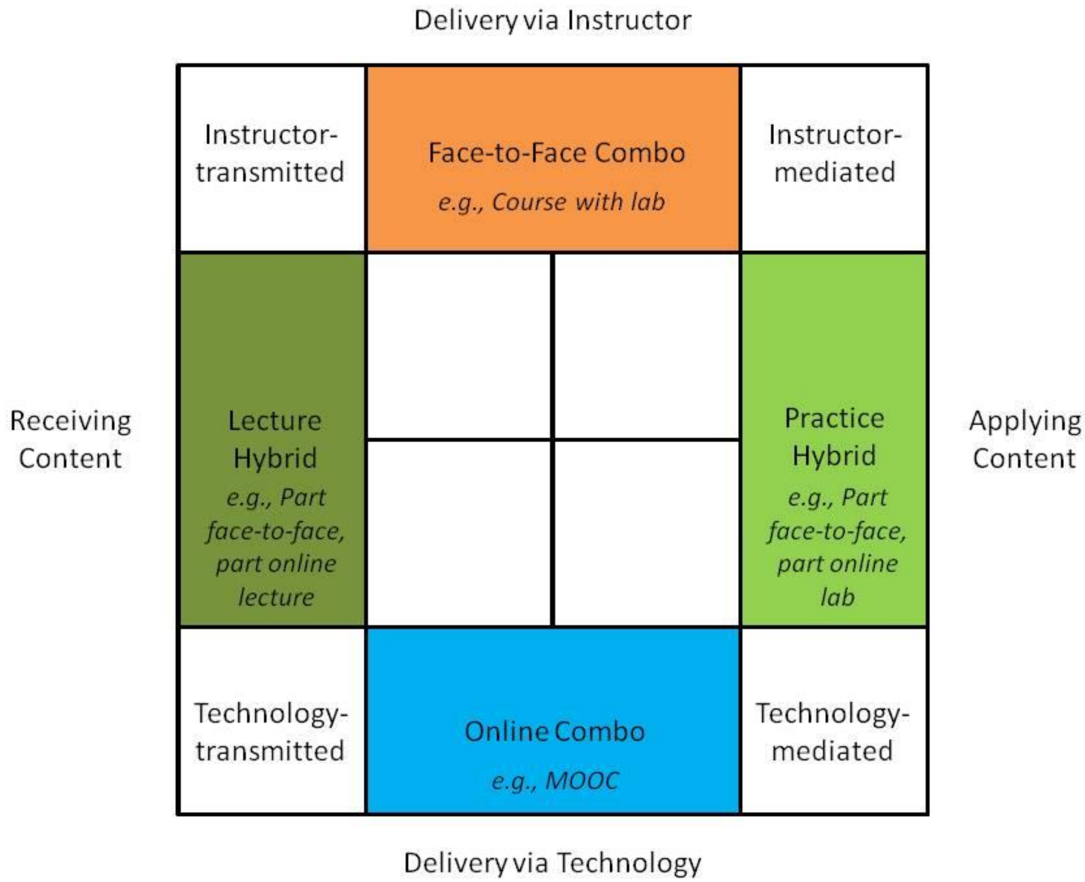

Figure 4. Paired instructional experiences include a substantial portion (25% to 75%) of learning methods from two adjacent fundamental instructional experiences.

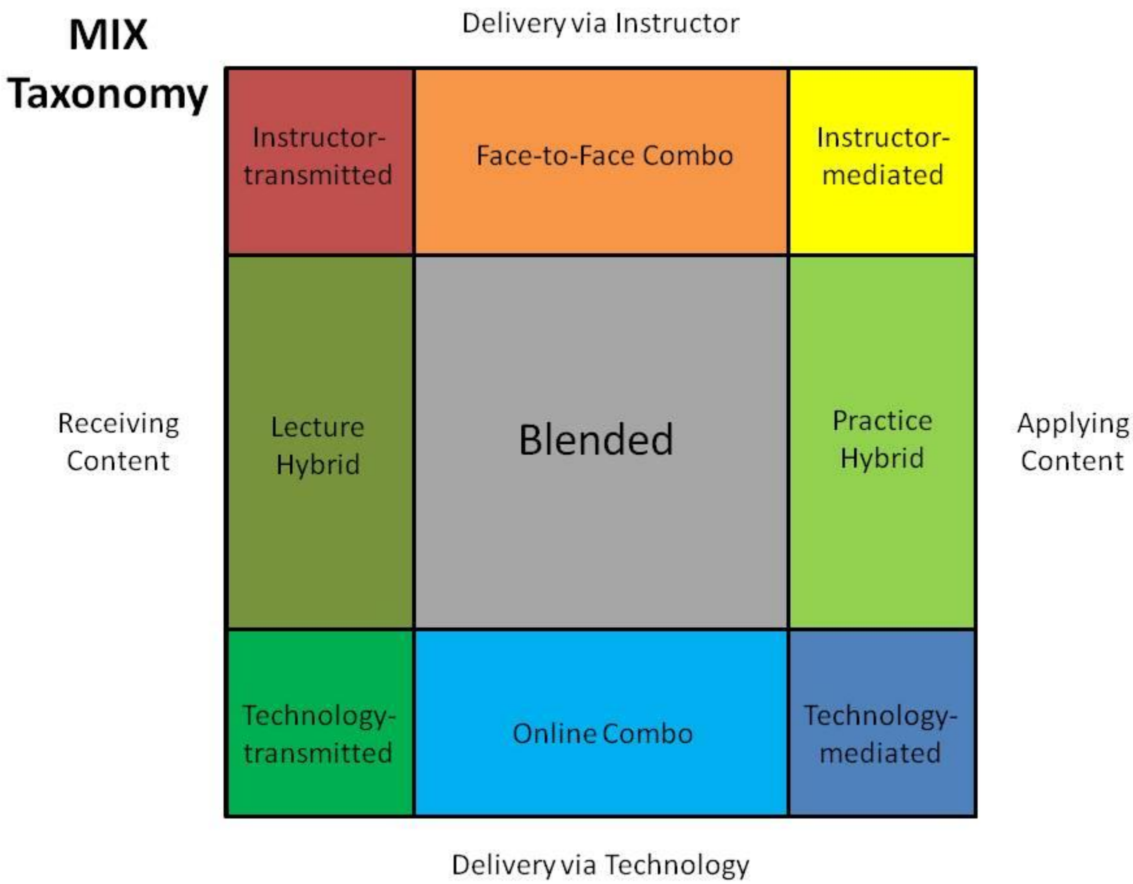

Figure 5. The Mixed Instructional eXperience (MIX) Taxonomy provides terminology to consistently categorize mixed instruction courses.

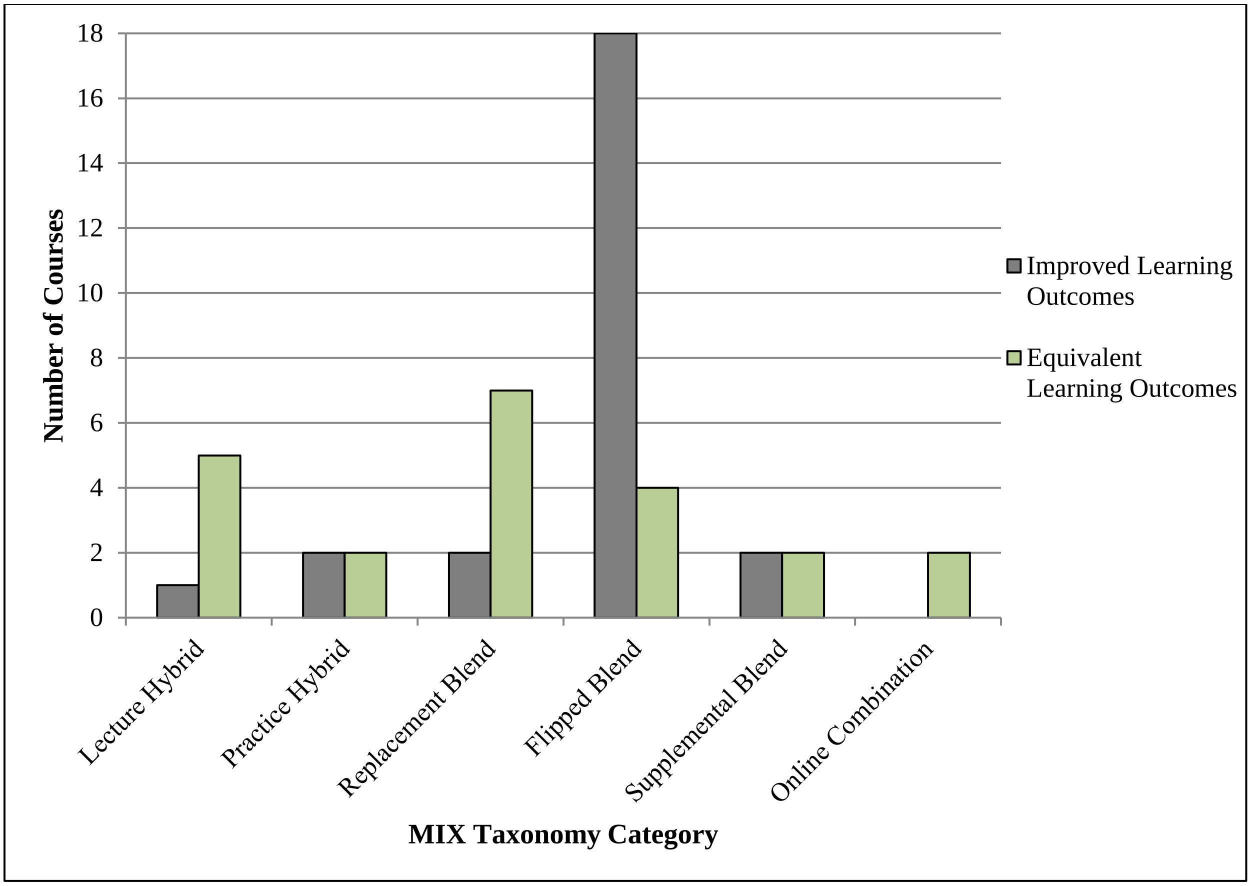

Figure 6. Mixed instruction courses categorized by type of course and split by reported learning outcomes (i.e., either improved or equivalent). Courses that were classified as instructor-transmitted and instructor-mediated are excluded because they did not mix instruction.

Table 1

Previous Definitions of Hybrid, Blended, Flipped, and Inverted Characterized by Their Underlying Dimensions

Article	**Term**	**Instructional Location**	**Delivery Medium**	**Instruction Type**	**Synchronicity**
Sands, 2002	Hybrid	x	x	x	
Allen & Seaman, 2010	Hybrid	x	x		
Johnson, 2012	Hybrid	x			
Arispe & Blake, 2012	Hybrid	x			
Singh & Reed, 2001	Blended		x	x	x
Garrison & Vaughan, 2008	Blended		x		
Allen & Seaman, 2010	Blended	x	x		
Johnson, 2012	Blended	x	x		
Carpenter & Pease, 2012	Flipped	x	x	x	
Johnson, 2012	Flipped	x		x	
Bishop & Verleger, 2013	Flipped	x	x	x	x
Morin et al., 2013	Flipped	x		x	
Lage et al., 2000	Inverted	x		x	
Strayer, 2012	Inverted	x	x	x	
Bishop & Verleger, 2013	Inverted	x	x	x	x
Morin et al., 2013	Inverted	x		x	

Table 2

Information for Studies on MIX Classification, Traditional Course (Control Group) Classification, and the Differences between the Control and Experimental Groups.

Note: "Change in medium" notes a change in the delivery medium of instruction. "Added application feedback" indicates that the mixed instruction course added instruction during the application process but not necessarily that the mixed instruction course added more application activities.

Authors	**MIX Classification**	**Comparison Course(s)**	**Pedagogical Difference**	**Time in Class Difference**
Aly, 2013	Lecture hybrid	Technology-transmitted	Change in medium	More time in class
Ashby et al., 2011	Lecture hybrid	Instructor-transmitted, technology transmitted	Change in medium	Same
Gerlich & Sollosy, 2009	Lecture hybrid	Instructor-transmitted	Change in medium	50% less time in class
McFarlin, 2007	Lecture hybrid	Instructor-transmitted	Change in medium	50% less time in class
Rivera & Rice, 2002	Lecture hybrid	Face-to-face combo, online combo	Change in medium	Less time in class
Sherrill & Truong, 2010	Lecture hybrid	Face-to-face combo	Change in medium	33% less time in class
Akhras & Akhras, 2013	Practice hybrid	Instructor-transmitted	Change in medium	Same
Charlevoix et al., 2009	Practice hybrid	Face-to-face combo	Change in medium, added more application feedback	50% less time in class
Dantas & Kemm, 2008	Practice hybrid	Instructor-mediated	Added application feedback	Same
Riffell & Sibley, 2005	Practice hybrid	Face-to-face combo	Replaced 2 hours of lecture with online application	66% less time in class
Bigham, 2013	Replacement blend	Instructor-transmitted	Change in medium, added application feedback	Same
Brown & Liedholm, 2002	Replacement blend	Instructor-transmitted, online transmitted	Change in medium	66% less time in class
Chin, 2014	Replacement blend	Instructor-transmitted	Change in medium, added application feedback	Same
Delialioglu & Yildririm, 2008	Replacement blend	Face-to-face combo	Change in medium	Less time in class
Demirer & Sahin, 2013	Replacement blend	Face-to-face combo	Change in medium	Less time in class
Du, 2011	Replacement blend	Face-to-face combo	Added technology-supported instruction	Same
Olitsky & Cosgrove, 2014	Replacement blend	Face-to-face combo	Change in medium	Less time in class
Priluck, 2004	Replacement blend	Face-to-face combo	Change in medium	50% less time in class

Authors	MIX Classification	Comparison Course(s)	Pedagogical Difference	Time in Class Difference
Reasons et al., 2005	Replacement blend	Face-to-face combo, online combo	Change in medium	Less time in class
Adams, 2013	Flipped blend	Face-to-face combo	Change in medium	Less time in class
Bagley, 2013	Flipped blend	Instructor-transmitted	Change in medium, added more application feedback	Same
Day & Foley, 2006	Flipped blend	Instructor-transmitted	Change in medium, added application feedback	Same
Fisher & Pfeifer, 2014	Flipped blend	Face-to-face combo	Change in medium	Less time in class
Horton et al., 2014	Flipped blend	Instructor-transmitted	Change in medium, added more application feedback	Same
Kadry & Hami, 2014	Flipped blend	Instructor-transmitted	Change in medium, added more application feedback	Less time in class
Kurtz et al., 2007	Flipped blend	Instructor-transmitted	Change in medium, added more application feedback	Same
Marcey & Brint, 2012	Flipped blend	Lecture hybrid	Change in medium, added application feedback	Same
Mason et al., 2013	Flipped blend	Instructor-transmitted	Change in medium, added more application feedback	Same
McLaughlin et al., 2014	Flipped blend	Face-to-face combo	Change in medium, added application feedback, reduced content	Same
Melton et al., 2009	Flipped blend	Instructor-transmitted	Added application feedback	Same
Missildine et al., 2013	Flipped blend	Instructor-transmitted, lecture hybrid	Added application feedback	Same
Pierce, 2013	Flipped blend	Instructor-transmitted	Change in medium, added application feedback	Same
Redekopp & Rasgusa, 2013	Flipped blend	Instructor-transmitted	Change in medium, added application feedback	Same
Talley & Scherer, 2013	Flipped blend	Instructor-transmitted	Change in medium, added application feedback	Same
Tune et al., 2013	Flipped blend	Lecture hybrid	Added application feedback	Same
Yelamarthi & Drake, 2014	Flipped blend	Instructor-transmitted	Change in medium, added application feedback	Same
Lape et al., 2014	Flipped plus instructor-transmitted	Face-to-face combo	Change in medium	Same

Authors	**MIX Classification**	**Comparison Course(s)**	**Pedagogical Difference**	**Time in Class Difference**
McCray, 2000	Flipped plus instructor-transmitted	Instructor-transmitted	Change in medium, added application feedback	Same
Morin et al., 2013	Flipped plus instructor-transmitted	Instructor-transmitted	Change in medium, added application feedback	Same
Papadopoulos et al., 2010	Flipped plus instructor-transmitted	Instructor-transmitted	Change in medium, added more application feedback	Same
Stickel, 2014	Flipped plus instructor-transmitted	Instructor-transmitted	Change in medium, added more application feedback	Same
Lopez-Perez et al., 2011	Supplemental blend	Instructor-transmitted	Added application feedback	Same
Scida & Saury, 2006	Supplemental blend	Instructor-transmitted	Added technology-supported application feedback	Same
Utts et al., 2003	Supplemental blend	Face-to-face combo	Added technology-supported content and application feedback	66% less time in class
Riffell & Merrill, 2005	Supplemental plus instructor-mediated	Instructor-transmitted	Replaced one hour of lecture with one hour of online problem solving	33% less time in class
Keller et al., 2009	Instructor-transmitted	Face-to-face combo	Removed instructor-guided application	50% less time in class
Wilson, 2013	Instructor-mediated	Instructor-transmitted	Change in medium, added application feedback	Same
Dixon et al., 2009	Online combo	Lecture hybrid	Removed face-to-face instruction	Less time in class
Ward, 2004	Online combo	Face-to-face combo	Change in medium	50% less time in class