

Experimental Cross-Hybrid Course Formats

Cordelia Brown & Dave Meyer

School of Electrical & Computer Engineering
Purdue University

- Hybrid = “inverted” format in which traditional in-class and out-of-class activities exchanged, also called Directed Problem Solving (DPS)
 - lecture content delivered via streaming video
 - contact hours used for collaborative problem solving in small-group settings
- Instructor walk-through of solution once sufficient time given to work each problem (“directed problem solving”)
- Students’ “homework” score based on attendance and participation in DPS sessions
- Traditional lecture division run in parallel with experimental division
- Students given a choice of course format

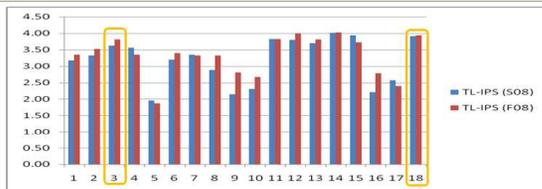
Cross-hybrid variants explored:

- Directed Problem Solving with Virtual Lecture (DPS-VL)
- Directed Problem Solving with Lecture Summary (DPS-LS)
- Traditional Lecture with Integrated Problem Solving (TL-IPS)
- Traditional Lecture with Take-Home Work (TL-THW)

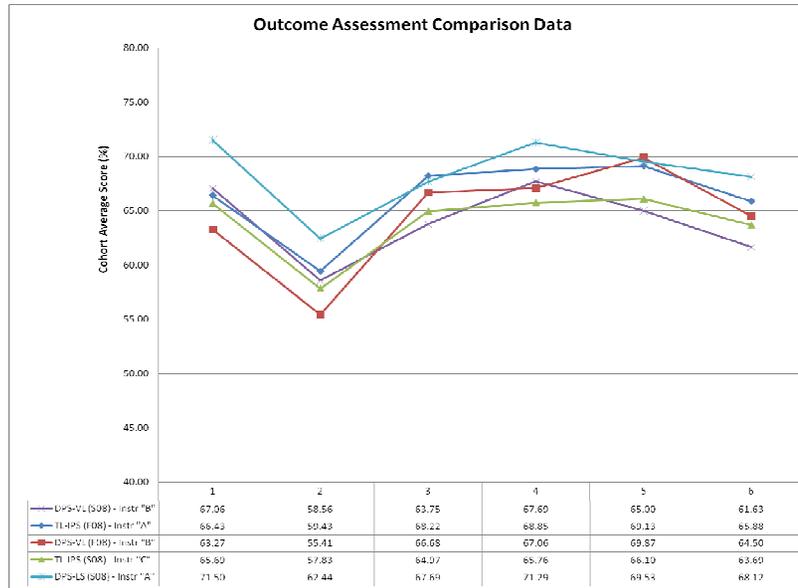
Advantages of hybrid format:

- direct, immediate feedback on problem solving methodology (“bi-directional”)
- ability of students to employ “cognitive rehearsal” (talking through how to solve a problem with their partner)
- students have more control over their education (can attend “virtual lecture” when best for them)
- significantly less day-to-day overhead (handling homework and giving lecture, meeting only twice/week)

Traditional Lecture Survey Results



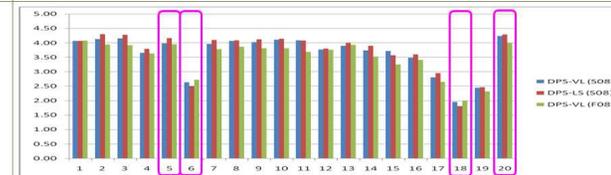
- I chose the traditional lecture option by default (i.e., arbitrarily).
- I chose the traditional lecture option based on my *Index of Learning Styles* survey results.
- I was glad that I had a choice between two different course delivery options.
- I used the on-line lectures in addition to attending the “live” class lectures.
- I used the on-line lectures instead of attending the “live” class lectures.
- The Lecture Workbook class note format helped me learn the course material.
- I made effective use of both formats of the Lecture Workbook (skeleton and annotated).
- I feel that I learn course material better in a traditional live lecture format than in a “virtual” (on-line) lecture format.
- I would not consider taking any ECE courses in a directed problem solving format.
- Use of the “clickers” enhanced my in-class learning experience.
- I took advantage of most of the on-line learning resources available for this course.
- The in-class homework and attendance quizzes helped me learn the course material.
- The practice homework sets and solutions helped me learn the course material.
- The practice exams and solutions helped me learn the course material.
- The modular, on-line (“virtual”) lectures helped me learn the course material.
- This course should only be offered in a traditional lecture format.
- This course should only be offered in a directed problem solving format.
- This course should continue to be offered in both a traditional lecture and a directed problem solving format.



Course outcomes:

- an ability to analyze static and dynamic behavior of digital circuits
- an ability to represent Boolean functions in standard forms, to map and minimize them, and to implement them as combinational logic circuits
- an ability to use a hardware description language to specify combinational logic circuits, including various “building blocks” such as decoders, multiplexers, encoders, and tri-state buffers
- an ability to design and implement arithmetic logic circuits
- an ability to analyze, design, and implement sequential circuits and use a hardware description language to specify them, including various “building blocks” such as counters and shift registers
- an ability to design and implement a simple computer

DPS Survey Results



- I chose the directed problem solving option based on my *Index of Learning Styles* survey results.
- The on-line lecture and directed problem solving session combination helped me learn the material better.
- The on-line lecture and directed problem solving session combination helped me prepare for exams.
- The on-line lecture and directed problem solving session combination helped me prepare for the laboratory experiments.
- I would choose the on-line lecture and directed problem solving session combination in another ECE course (if available).
- I would prefer only a live (traditional) lecture over the on-line lecture and directed problem solving session combination for this course.
- I enjoyed learning course material in the directed problem solving format.
- Having a choice of course delivery options enhanced my ability to learn.
- The directed problem solving sessions enhanced my learning experience.
- I enjoyed interacting with my peers during the directed problem solving sessions.
- I feel that most of the other students enjoyed learning in the directed problem solving format.
- The on-line lecture enhanced my learning experience.
- The on-line lecture prepared me for the directed problem solving sessions.
- I viewed the on-line lecture before participating in the directed problem solving sessions.
- The Lecture Workbook class note format helped me learn the course material.
- I made effective use of both formats of the Lecture Workbook (skeleton and annotated).
- Use of the “clickers” enhanced my in-class learning experience.
- This course should only be offered in a traditional lecture format.
- This course should only be offered in a directed problem solving format.
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Summary and Future Work:

- Preliminary results, based on both exam performance and survey data, confirm the effectiveness of the DPS format relative to the traditional lecture format
- The results also confirm the effectiveness of incorporating collaborative problem solving exercises into traditional classroom presentations
- Future studies will focus on:
 - a comparison of the relative efficiencies of the two approaches (e.g. in terms of resource utilization)
 - an analysis of which approach is “best liked” by students (e.g. more frequent, less personal large-class meetings vs. less frequent, more personal small-class meetings)
 - development of “cross-hybrids” that might be even more effective

Challenges associated with hybrid format:

- ensuring students “keep up” with virtual lecture
 - on-line quizzes and/or resource utilization tracking tools are often easy for students to circumvent
 - in-class quizzes to track progress take time away from problem solving (“useful work”) and incur additional overhead
- ensuring students use the collaborative problem solving sessions “wisely”
 - coming to class with their annotated notes
 - not just “sitting there” and attempting to learn by osmosis
- development (and maintenance) of a standardized testing methodology to ensure reliable comparisons among experimental trials/cohorts