Fly-by-Wire: Towards Scalable, Differentiated Instruction

Project Overview
Team Kickoff Meeting
December 16, 2015

Funded by FIPSE. The contents of this presentation were developed under grant P116F150045 from the U.S. Department of Education. However, those contents do not necessarily represent the policy of the U.S. Department of Education, and you should not assume endorsement by the Federal Government.
Introductions

• Dale Allen, QCC
• Jennifer Dunlap, ACC
• Leslie Gerhat, edX
• Sarah Holsted, BbK
• Luwen Huang, MIT
• Vijay Kumar, MIT
• Chad Lieberman, MIT
• Yashu Kauffman, MIT
• Damian Kiernan, QCC
• Jean Mclean, QCC
• Flora McMartin, BbK

• Jeff Merriman, MIT (remote)
• Josh Morrill (remote)
• Kathy Rentsch, QCC
• Casey Sacks, CCCS
• Dipa Shah, MIT
• Cole Shaw, MIT
• Diane Soderholm, MIT
• Glenda Stump
• Karen Willcox, MIT
• Rebecca Woulfe, ACC
• Deb Zulick, QCC
Today’s Meeting Goals
What we hope to accomplish today.

- Understand the intervention
- Solicit input from faculty
- Agree upon collaborative workflow (assessment and user interviews)
10-11am: Introductions & Project Overview
11-12.30pm: Community college perspective (ACC, QCC)
12.30–1.30pm: Lunch
1.30–4pm: FbW logic
9-10am: FbW Technology
10am-lunch: Evaluation
FbW Project

Motivation

Pain points in the classroom today & how technology can help.

• Instructors teach multiple sections; heavy workloads
• Students have different backgrounds & levels of ability
• Difficult to track an individual student and give targeted feedback
• Students have work / life commitments outside of school

• Streamline lower-level tasks that take up instructor time
• Assess an entire class’ ability and fill in inadequate backgrounds
• Record performance and rapidly deliver targeted feedback
• Can be used outside of the classroom, providing flexibility
FbW Project Objectives

- Develop FbW intervention to enable instructors to provide scalable, differentiated instruction
- Develop instruments to measure impact of intervention
- Conduct quasi-experimental study (QES) on group of > 500* students at ACC and QCC
- Measure quantitative improvement in student outcomes (learning outcomes, time to completion, persistence, retention, etc.)
- Collect qualitative feedback from instructors using the intervention (perceived impact on faculty workload, student interaction, ability to adjust to classroom demands, use of in-class time)
What is a “fly-by-wire” system?

Since the flight-control computers continuously "fly" the aircraft, pilot's workloads can be reduced.

source: wikipedia

“Fly-by-wire technology has allowed Airbus to develop a true family of aircraft through the highest degree of operational commonality.”

source: www.airbus.com
The Aero Analogy in the Classroom
An “open-loop” system

- **pilot**
  - desired roll angle
  - control action
- **actuators**
  - moving surfaces on the wing
- **aircraft**
  - rolling moment
- **airplane**
  - achieved roll angle

**actuators** are the things that move, e.g. moving surfaces on the wing.
The open-loop system is **vulnerable**
- to disturbances
- to variations in air conditions from day to day
- to variations from aircraft to aircraft
An “open-loop” system

desired roll angle → pilot → actuators → airplane → achieved roll angle

disturbance (wind)

undesired outcome → instructor → learning resources → student → achieved outcome

disturbance
Closing the loop with sensing & feedback

- **desired roll angle**
- **control action**
- **rolling moment**
- **achieved roll angle**

**pilot**

**actuators**

**airplane**

**disturbance** (wind)

...and **feeds** it **back** to the pilot, who then adjusts the control action accordingly.

Visual observation senses the actual aircraft roll angle...
Closing the loop with sensing & feedback

- **desired roll angle** → **pilot** → **actuators** → **airplane**
  - control action
  - rolling moment
- **airplane** → **achieved roll angle**
  - visual observation

- **disturbance (wind)**

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- **desired outcome** → **instructor** → **learning resources** → **student**
  - visual observation & assessment-driven feedback (but with delay)
- **student** → **achieved outcome**
- **instructor**
A digital feedback control system

- Desired roll angle
- Control logic
- Actuators
- Airplane
- Disturbance (wind gust)
- Achieved roll angle
- Comparator compares the desired and the achieved roll angle
- Control logic determines corrective action as a function of the error
- Sensor system senses the actual aircraft roll angle
A digital feedback control system

- Desired roll angle
- Control logic
- Actuators
- Airplane
- Sensors
- Disturbance (wind gust)
- Achieved roll angle

Desired outcome
- Control logic
- Online learning resources
- Student
- Automated assessments
- Achieved outcome
- Disturbance
Pilot + computer → Fly-by-Wire system

- Pilot
- Control logic
- Actuators
- Airplane
- Sensors
- Sensors + visual observation
- Desired roll angle
- Achieved roll angle
- Disturbance (wind gust)
Pilot + computer → Fly-by-Wire system

- **Pilot**
  - Desired roll angle
  - Control logic
  - Actuators
  - Airplane
  - Sensors
  - Sensors + visual observation

- **Control Logic**
  - Pilot
  - FbW logic
  - FbW actions
  - Student
  - FbW assessment
  - FbW & other assessment + visual observation

- **Disturbance** (wind gust)
  - Achieved roll angle

- **Instructor**
  - Desired outcome
  - FbW logic
  - FbW actions
  - Student
  - FbW assessment
  - FbW & other assessment + visual observation

- **Achieved outcome**
Pilot + computer → Fly-by-Wire system

- Pilot + computer
- Fly-by-Wire (FbW) system
- FbW actions
- Student
- Disturbance
- Achieved outcome
- Instructor
- Desired outcome

FbW logic

FbW assessment

FbW & other assessment + visual observation
Proposed FbW system for education

FbW is more than just an analogy – it is a structured framework for designing the components of our system.

**FbW logic**
- mapping the relationships among outcomes, and the linkages between assessments and outcomes
- designing and developing the FbW assessments *(sensor system)*
- designing the FbW logic and FbW action reacting to student response *(controller logic, actuators)*

**FbW technology**
- designing and creating the student-facing and instructor facing apps
- designing and developing the technology to be flexible, modular and open-source
Proposed FbW system for education

**Proposed intervention:**

Students take frequent interval assessments on a student app.

The student gets immediate, targeted feedback on assessments.

Instructors get info and recommendations on an instructor app and can act upon recommendations.

**Literature:**

Assessment and **feedback** is central to student achievement\(^1\)

**Targeted** feedback is more effective than simple verification\(^2\)

**Rapid** feedback is more effective than delayed feedback\(^3\)

\(^1\) Hattie 1987, Black & William 1998, Gibbs & Simpson 2004

\(^2\) Shute 2008

\(^3\) Corbett & Anderson 2001, Mason & Bruning 2001
**Project structure**

- **PIs**
  - Willcox
  - Kumar

- **Executive Committee**
  - Allen
  - McMartin
  - Gerhat
  - Sacks

- **FbW Logic**
  - Team:
    - Community college faculty,
    - Lieberman, Shah, Shaw

- **FbW Tech**
  - Team:
    - Huang,
    - Merriman, Shaw, edX

- **Integration Thrust, Project Manager**
  - Huang

- **Evaluation**
  - McMartin, Holsted, Morrill
10-11am: Introductions & Project Overview
11-12.30pm: Community college perspective (ACC, QCC)
12.30–1.30pm: Lunch
1.30–4pm: FbW logic
Fly-by-Wire Intervention

Instructor + Computer

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What is the Fly-by-Wire intervention?

And what it is not.
Technology for blended instruction

Designed to be a “low-load” intervention.

- What is the difference between a FbW class and a regular class?
- How students do their homework and get feedback
- How instructors *might* decide to change lesson plans on-the-fly
What do instructors do?

Instructors use the Instructor App outside-of-class.

- Require students to do assessments on the Student App
- Approve assessments to be served on the Student App
- Get and act upon recommendations (course correction)
What do students do?

Students use the Student App outside-of-class.

- Take assessments on the app
- Get feedback on answers
What FbW is not.

Banishing misconceptions.

- Not Artificial Intelligence taking over the classroom.
- Not just another “quiz” app.
- Not an in-class question polling tool.
What is needed to achieve this?

Project activities for faculty, deans & MIT design team
| Logic team and faculty collaboratively create assessments. |
| Technology team holds focus groups, sits in on classes, interviews students and holds usability tests. |
## In-depth look at next 9 months

### Design & Development

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<th>Jan ‘16</th>
<th>Apr</th>
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<td>UX interviews</td>
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<td>Assessment &amp; logic design</td>
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Year 3

Pilot test of QES

- Conduct trial run of QES to iron out potential issues and practice collecting data.
- Faculty teach one FbW section
Year 4

FbW intervention in all sections

- Conduct QES in all sections.
- Faculty teach multiple FbW sections