Using the Readiness Assurance Process and Metacognition in an Operating Systems Course

Michael S. Kirkpatrick
Samantha Prins
Motivation and challenges
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Student preparation
• Accountability for completing reading assignments
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More active learning in systems courses
- Use contact hours for activities beyond low-level Bloom’s
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- Our students are unlikely to become kernel developers
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**Increase project motivation**
- Pintos kernel projects are hard and time consuming

**Move from strategic to deep learning**
- Inspire and train students to become self-motivated, self-guided learners
Readiness Assurance Process

Team-based Learning (TBL)
- Flipped pedagogy developed by Larry Michaelsen
- Course divided into 5-7 modules
- Founded on constructivism and group process dynamics
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| 5  
Instructor Feedback    | 6  
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Readiness Assurance Process

In a multiprocessor system, multiple caches may store values for the same program variable. If the value changes in one cache, it should be updated in all the others. What is this phenomenon called?

(a) cache management
(b) race condition
(c) cache coherency
(d) tertiary storage

File information, such as the owner and associated permissions, are stored in what?

(a) directory
(b) superblock
(c) file-organization block
(d) inode

When critical system configuration files are given read-only permissions, thus preventing a normal user from modifying them, this security goal is achieved.

(a) integrity
(b) availability
(c) authentication
(d) confidentiality
RSQC² and metacognition

Metacognition
• Flavell: “thinking about thinking”
• Winn & Snyder: “monitoring your progress as you learn, and making changes and adapting your strategies if you perceive you are not doing so well”


RSQC² and metacognition
RSQC² and metacognition

Recall
- Identify the most important or interesting point
RSQC\(^2\) and metacognition

Recall

- **Identify** the most important or interesting point

Summarize

- **Explain** that concept in your own words
RSQC$^2$ and metacognition

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- **Ask** a question about a topic you do not understand
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# RSQC$^2$ and metacognition

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RSQC$^2$ and metacognition

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RSQC$^2$ and metacognition
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• What one idea from this week did you find most interesting and why? [recall]
RSQC$^2$ and metacognition

- What one idea from this week did you find most important and why? [recall]
RSQC² and metacognition

• What one idea from this week did you find most important and why?
[recall]

• Explain one concept that you understand more now than a week ago.
[summarize]
RSQC\textsuperscript{2} and metacognition

- What one idea from this week did you find most important and why? [recall]

- Explain one concept that you understand more now than a week ago. [summarize]

- What helped you learn the most this week? [comment, metacognition]
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- Identify one thing from this week that you are confused about. This could be a concept from the lectures and/or book, a requirement of the current project, the relevance of this material, course policies, etc. Try to explain what you don’t understand or why it is confusing. [question, connect, metacognition]
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- What can you do to overcome the confusion you just identified? [metacognition]
Weekly course structure

Complete readings, take iRAT online
Weekly course structure

Complete readings, take iRAT online

Take tRAT in class
Weekly course structure

- Complete readings, take iRAT online
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- Mini-lectures, activities, worksheets
Weekly course structure

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Weekly course structure

![Weekly course structure diagram](image)

**Complete readings, take iRAT online**

**Take tRAT in class**

**Mini-lectures, activities, worksheets**

**RSQC^2**

**Sat./Sun.**

- In class: 
  - tRAT, muddiest points

**Mon.**

- Out of class: 
  - readings, iRAT

- In class: 
  - interactive lecture

**Tue.**

- In class: 
  - interactive lecture

**Wed.**

**Thu.**

- In class: 
  - interactive lecture

**Fri.**

- In class: 
  - RSQC^2
WDF rate

![Bar Chart]

**Offering**
- Fall 2012
- Fall 2013
From 13 to 3
Demographics
Demographics

**Not a “better” class**

- Fall 2012: 23/44 A/B
- Fall 2013: 29/43 A/B
- $\chi^2$ yielded $p = 0.221$
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$p = 0.0551$
Impact on final exam grades

| Factor                           | Estimate | Pr>|t| |
|---------------------------------|----------|-----|
| (Intercept)                     | 37.530   | 1.6 \times 10^{-12} |
| C programming                   | 8.562    | 0.000961 |
| Prerequisite grade              | 7.658    | 2.9 \times 10^{-7} |
| Intervention                    | 24.228   | 0.001015 |
| Prerequisite grade: Intervention| -4.301   | 0.076666 |
Impact on final exam grades

Using the RAP and Metacognition in an OS Course
ITiCSE 2015 • Kirkpatrick and Prins
## Impact on final exam grades

### Linear regression model
- CC transfers not needed
- ANOVA $p = 0.4958$

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![Graph showing CS 450 Final Exam Score vs. CS 350 Grade](image-url)
Impact on final exam grades

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- CC transfers not needed
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- Significance of C programming
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  - Changes slope
- Overall acceptable model
  - $p = 1.153 * 10^{-12}$
  - $R^2 = 0.5114$
Impact on projects

Significant improvement in success

- Pintos userprog project
- Average increased from 28/50 to 40/50
- Weak linear model based on team qualifications
  - $p = 0.09181$, $R^2 = 0.1535$
  - Intervention only significant factor ($p = 0.0678$)
- Interesting: C experience is not significant predictor for projects
- Teams with less experience were able to catch up
Impact on projects

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Sunday, November 8, 15
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Online vs. in-class iRAT
- Practice and self-efficacy vs. in-class discussion
# Variations and discussion

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## Tailor Bloom’s levels to goals
- Establishing foundational knowledge or uncovering misconceptions
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### Tailor Bloom’s levels to goals
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### Project alignment
- iRAT/tRAT questions about connections to project
Take-away messages

RAP and RSQC\textsuperscript{2} as entry points to active learning
Take-away messages

**RAP and RSQC\textsuperscript{2} as entry points to active learning**

- Low cost effort by instructor
  - Use LMS and IF-AT to automate grading
Take-away messages

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- Potentially high reward
  - Overall improvements, especially for low-end students
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  - Individual = letter grade difference
  - Team = no difference in project completion
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- Potentially high reward
  - Overall improvements, especially for low-end students
- Effect of individual vs. team C experience as prerequisite
  - Individual = letter grade difference
  - Team = no difference in project completion
- Positive student feedback
  - Less complaining about project
Why I was tired...
Why I was tired...
Questions?