An Experiment with Peer Instruction in Computer Science to Enhance Class Attendance

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Outline

1. Motivation

2. Materials & Methods

3. Results
   - Peer Instruction and class attendance
   - Course evaluations
   - Peer instruction learning curve

4. Discussion

5. Conclusions
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Setting

- Computer Science courses in HE
- Lecture attendance is not compulsory
- Declining lecture attendance during the semester
- Various hypotheses and opinions exist to explain why this is the case
- Assumption: a different set-up of the lecture, being a more interactive way of knowledge transfer and learning, will increase attendance
Interactive lectures

- “flipped classroom” (Tucker, 2012)
- Make it partially ‘tutorial-like’
- Peer instruction (Crouch and Mazur, 2001)
- Other research-based options (Borrego et al., 2013)
Peer instruction (in a nutshell)

- Is about students teaching each other (their peers)
  - Concept test (‘MCQ’) posed by the lecturer
  - Students vote on an answer, then see the response
  - Students discuss the question and answers with their neighbours
  - Students vote again on the same question
  - A class-wide discussion of the question
- Variations exist (e.g., Zingaro & Porter, 2014; Koppen et al., 2013)
PI in CS

- Main online resource http://www.peerinstruction4cs.org
- Gaining momentum in CS (Bailey Lee et al., 2013; Borrego et al., 2013; Koppen et al., 2013; Simon et al., 2013; Zingaro & Porter, 2014)
- Shown to work also for the more abstract topics such as theory of computation (Bailey Lee et al., 2013)
- Normalised Gain of PI (regardless topic) about 34%-45% (Bailey Lee et al., 2013)
- Personal experience with small 3rd-year course and large service course with low-resource PI positive
Student-centered viewpoint

- Mostly positive feedback (e.g., Duncan (2006), Good (2013))
- Lectures with PI overwhelmingly “interactive” (argue/explain concepts, learn from or teach partner) cf. plain “active” (listening and/or note-taking) (Simon et al., 2013)
- Interactive decidedly deemed positive, thanks to, a.o., valuing the interaction in the classroom with peers, higher perceived approachability of the lecturer, and a community spirit (Simon et al., 2013)
- Students learn the concepts better (Crouch and Mazur, 2001 and many others)
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Given the positive perception of PI by students, can inclusion of PI increase class attendance?

- Duncan (2006) claims yes, but reference to the study claiming an increase from 60-70% to 80-90% is missing.
- Kaleta & Joosten (2007) indirectly indicate that PI may increase class attendance (64% of the students would sign up for another course that uses clickers).
- Thus, this still leaves unanswered whether including PI will increase class attendance, or at least not decrease it.

Hypothesis: PI increases class attendance.
Questions and hypothesis

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Set-up, running, and evaluation of the peer instruction (condensed overview)

- Choose software for medium-resource PI (software-based ARS)
- Choose course, select which lectures to have PI
- Develop the questions online and offline
- Record the number of students in class for each of the 19 lectures by silent manual headcount by the lecturer
- Make any other notes that may be relevant
- Conduct PI and record participation in the quiz and the answers
- Evaluate the data in standard spreadsheet software
- Use the general course and lecturer evaluation forms to obtain feedback about the PI specifically
Methods: PI procedure

A. Classic PI process

- Question 1 individual vote
- Group discussion
- Question 1 revote
- Class-wide discussion

B. PI process used in the experiment

- Question 1 individual vote
  - if $>75-80\%$ correct vote
  - if $30-75\%$ correct vote
  - if $<30\%$ correct vote
- Group discussion
- Question 1 revote
- Class-wide discussion

- Class-wide discussion of a wrong answer
Materials

- Wireless connection and online voting with a ‘software-based clicker’ (ARS)
- Evaluation of ARS software:
  - (McGraw Centre for Teaching & Learning, 2012), covering 19 different software-based ARSs,
  - Socrative and eClicker did not meet requirements upfront
  - 4 selected for evaluation:
    - Google Forms and Pinnion are too cumbersome for releasing the individual questions
    - Qurio had an annoying website.
    - Mentimeter chosen (by elimination)
- Mentimeter limitations: 100 char max, no figures, no symbols, no saving results
Materials: the course

- “Networks course” 2014
- Third (and last) block of the larger 3rd-year CS compulsory course
- From mid-April to the end of May over 19 lectures, one each working day from 9:00-9:45, except the (many) public holidays
- Typically about 100 registered students
- Networks is a ‘run-of-the-mill’ CS course
- Chapters 1-6 of the textbook (Kurose and Ross, 2013)
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L15Q5. Consider the following network configuration and addresses.

Host A wants to communicate with B. It did so yesterday. Which of the following will NOT happen/is NOT true?

A. Host 111.111.111.112 also receives a frame from A.
B. Router R will put <111.111.111.111, 74-29-9C-E8-FF-55, 20> in its ARP table, if not already there
C. A's frame has destination addresses 222.222.222.222 and 49-BD-D2-C7-56-2A
D. Router R sends a frame containing addresses 1A-23-F9-CD-06-9B and 49-BD-D2-C7-56-2A, and 111.111.111.111 and 222.222.222.222

(Correct Answer: C)
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Attendance and participation

![Number of students per lecture and quiz participation](image-url)
Attendance and participation

Number of students per lecture and quiz participation

- **Number of students**
- **Avg number of votes**

<table>
<thead>
<tr>
<th>Week</th>
<th>Number of Students</th>
<th>Avg Number of Votes</th>
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Peer Instruction and class attendance

Attendance and participation

Number of students per lecture and quiz participation

![Graph showing number of students and average number of votes per lecture and quiz participation.](image)
Attendance and participation

Number of students per lecture and quiz participation
Peer Instruction and class attendance

Attendance and participation

Number of students per lecture and quiz participation

- 67% attendance
- 57% participation
- 49% attendance
- 43% participation
- 40% attendance
Aggregate results course evaluation on PI

- 43 answers for the question about ‘quizzes’
- 11 below average, most students average (n = 22, i.e., 51%), and 10 above average; overall *slightly positive*
- Lecturer evaluation form about PI: 26 answers (of which 7 N/A) with a mean of 3.38 out of 5 (5-point Likert scale)
- Better evaluation PI in lecturer evaluation than in course evaluation
Course evaluations

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Course evaluations

Free comments section (selection)

- “I liked the quizzes, they made the lectures more interactive.”
- “The online voting tool that [xxx] used made the lectures more interesting and useful, as it encouraged class participation.”
- “Using GoVote really added to the lectures.”
- “enjoyed the online classes quizzes helped me stay awake!”
- “… boring …” (but with low lecture attendance)
Peer Instruction

- Learning curve for peer instruction among students
- Waiting & revoting vs. discussion and revoting—latter good illustration of PI.
- Last PI: few voters, but active engagement in the lecture
What is true about sockets?

- They are APIs for the network layer: 2 responses
- A socket is identified by its IP address and a socket number: 6 responses
- A process sends/receives messages to/from its socket: 7 responses
- The transport layer assigns a port number to the socket: 5 responses

Go to [www.govote.at](http://www.govote.at) and enter 21 27 22 to vote

20 responses
Example of a PI success (L7Q1-v2)

What is true about sockets?

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- 2: A socket is identified by its IP address and a socket number
- 2: The transport layer assigns a port number to the socket
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(Correct Answer: C)
Peer instruction learning curve

Example where PI fails—but useful feedback (L15Q5-v1)

Host A wants to communicate with B. It did so yesterday. Which of the following will NOT happen/is NOT true?

1. Host 111.111.111.112 also receives a frame from A.
2. Router R will put 111.111.111.111, 7A-23:9C-EB-FF-S5, 20 in its ARP table, if not already there.
3. A’s frame has destination addresses 222.222.222.222 and 49-BD-D2-C7-56-2A.
4. Router R sends a frame containing addresses 1A-23-F9-CD-66-9B and 49-BD-D2-C7-56-2A, and 111. [...]

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14 responses
Peer instruction learning curve

Example where PI fails—but useful feedback (L15Q5-v2)

Host A wants to communicate with B. It did so yesterday. Which of the following will NOT happen/is NOT true?

- Host 111.111.111.112 also receives a frame from A
- Router R will put 111.111.111.74-29-9C-88-FF-53, 20 in its ARP table, if not already there
- A’s frame has destination addresses 222.222.222.222 and 49-BD-D2-C7-36-2A
- Router R sends a frame containing addresses 1A-23-F9-CD-06-93 and 49-BD-D2-C7-36-2A, and 111. [...]
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45% ‘lost’ upfront
Core set of students diligently attends lectures regardless the quality of the lectures?
Type of feedback in line with other works (Simon et al., 2013)
- Limited features of the ‘software clickers’
- Decreasing voting participation also elsewhere (Koppen et al., 2013), but only 1% without device “didn’t think along”, vast majority worked together with their neighbour(s), validating (Smith et al., 2009).
Thus, a lower measured voting rate does not imply lower participation rate.
Discussion

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Quality of the Concept Test quiz questions used

To better choose interventions to increase lecture attendance, one will have to find out why attending students do attend, and why those who do not, stay away
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- Overall decline in attendance from about 45% to 25-30%
- Participation rate in voting decreased from 57% to 40%
- Student evaluations indicate a moderately positive opinion of the use of peer instruction.
- Results are moderately in favour of continuation of peer instruction (just not for class attendance)
- Unclear whether attendance is thanks to the peer instruction or a hard-core group diligently attend lectures anyway
- Need to determine why students stay away/attend
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Future (current) work

- More concept tests
- Better concept tests?
- Better software-based ARS (recently funded project)
References I


References II


Thank you!

Questions?