

# Peer-Led Team Learning in Introductory CS

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[www.pltlcs.org/sigcse10](http://www.pltlcs.org/sigcse10)

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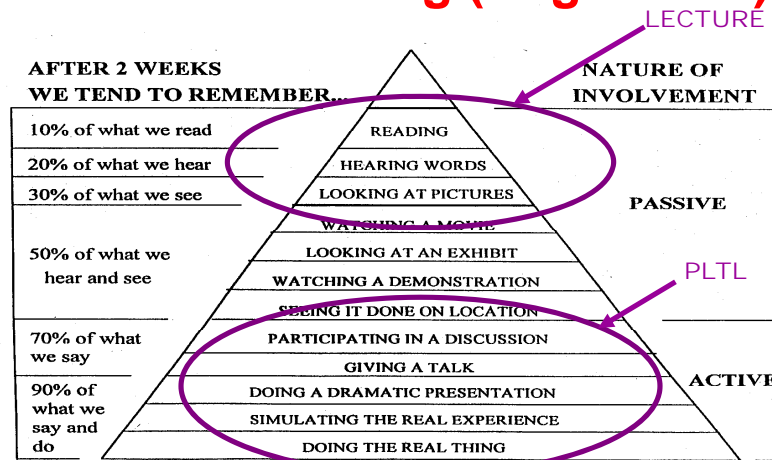
## WHAT IS PLTL?

- Students solve problems in small groups in addition to regular class meeting
- Work on problems related to other class, led by undergraduate “peer” leaders
- Started by chemistry: [www.pltl.org](http://www.pltl.org)
- Beneficial to both students and leaders

## WHAT IS PLTL in CS?

- 2-hour per week **add-on** to CS 1
- Active recruiting (invite under-represented / at-risk students to join)
- Active, cooperative learning in small groups **Students helping, learning from, other students**
- Groups led by undergraduate “**peer**”

## Why PLTL? Cone of Learning (Edgar Dale)



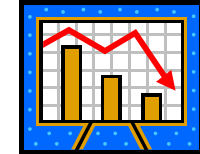
Edgar Dale, *Audio-Visual Methods in Teaching* (3rd Edition). Holt, Rinehart, and Winston (1969).

## Why PLTL: Learning Styles

- Different people learn differently
- Various ways to categorize *learning styles*

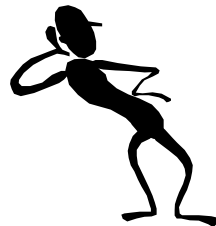
## Why PLTL: Learning Styles

- Different people learn differently
- Various ways to categorize *learning styles*
  - *Visual*



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  - *Visual*
  - *Auditory*
  - *Kinesthetic/Tactile*



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- Various ways to categorize *learning styles*
  - Visual
  - Auditory
  - Kinesthetic/Tactile
  - Read/Write



## Why PLTL: Learning Styles

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  - Visual
  - Auditory
  - Kinesthetic/Tactile
  - Read/Write



**Most successful academics  
are read/write learners; most  
students are not!**

## Why PLTL: Learning Styles

- Different people learn differently
- Various ways to categorize *learning styles*
  - Visual
  - Auditory
  - Kinesthetic/Tactile
  - Read/Write
- **“Don’t teach me all the time in *your* preferred style and think I’m not capable of learning”**

Virleen Carlson, Center for Teaching and Learning Cornell University

## GOALS AND APPROACHES

- GOALS:
  - Increase # of women and minority students
  - Increase learning, retention, enthusiasm for all students
- APPROACHES:
  - Active recruiting of incoming freshmen
  - Optional / required of registered students

## Results from Study

- Susan Horwitz, Susan Rodger and others, [Using Peer-Led Team Learning to Increase Participation and Success of Under-Represented Groups in Introductory Computer Science](#), Fourtieth SIGCSE Technical Symposium on Computer Science Education, SIGCSE 2009.

## Results: Why did women enroll in PLTL in CS?

41 women responded in 2005-06

60.5%	mailed invitation
15.6%	other
12.8%	info during orientation
9.8%	academic advisor recommendation
9.8%	class announcement
4.9%	parent recommendation

## Results - Why enroll in main course?

31 female/49 male responses 2005 (select all that apply)

F	M	Reason
71.0%	22.5%	I received an invitation
67.7%	28.6%	To see whether I enjoy CS
29.0%	40.8%	Meets requirement for my major
25.8%	79.6%	I know I am interested in CS
19.4%	18.4%	Programming is useful job-market skill
16.1%	57.1%	I plan to major in CS

## A Typical CS PLTL Session

- **Play Games:**
  - Guess partner's secret word using String methods (substring, charAt, etc)
- **Simulate Code:**
  - Act out lines of code, method calls...
- **Solve Logic Puzzles:**
  - Sudoku, KenKen, chess mysteries...
- **Write Code**

## Other Activities

- Exam review sessions
- Dinners with guest speakers
- “Field trip” to Virtual Reality Cave (Duke)
- “Field trips” to local companies

Goal: **let students know a CS job doesn't mean “sitting alone in front of a computer all day”**

## GET ACTIVE!

- Meet your neighbor:
  - Find 3 things in common, 3 differences
  - Be prepared to introduce neighbor to group

## EXAMPLE EXERCISE

`moveToFront( int pos )`      Move the letter in position `pos` to the beginning of the word (*i.e., to position zero*)

`moveToEnd( int pos )`      Move the letter in position `pos` to the end of the word.

`swap( int pos1, int pos2 )`      Swap the letter in position `pos1` with the letter in position `pos2`.

`reverse( int start, int finish )`      Reverse the order of the letters in positions *start* to *finish*.

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Original word	Java code	word after the code executes?
HIPSH	<code>word.moveToFront(2)</code>	
ZOOLOGY	<code>word.moveToEnd(0)</code>	
PICKLES	<code>word.swap(0,6)</code>	
AVOCADO	<code>word.reverse(4,6)</code>	

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AVOCADO	<code>word.reverse(4,6)</code>	AVOCODA

## EXAMPLE EXERCISE

- Start with the string “DEBIT-CARD”
- Execute the following code:

```
word.moveToFront(7)
word.moveToEnd(5)
word.swap(2,5)
word.reverse(3,6)
word.swap(7,4)
word.moveToEnd(5)
word.swap(8,9)
word.moveToFront(5)
```

## EXAMPLE EXERCISE

- Start with the string “DEBIT-CARD”
- Execute the following code:

```
word.moveToFront(7)  ADEBIT-CRD
word.moveToEnd(5)   ADEBI-CRDT
word.swap(2,5)      AD-BIECRDT
word.reverse(3,6)   AD-CEIBRDT
word.swap(7,4)      AD-CRIBEDT
word.moveToEnd(5)   AD-CRBEDTI
word.swap(8,9)      AD-CRBEDIT
word.moveToFront(5) BAD-CREDIT
```

## EXERCISE GOALS

- Practice with method calls
- Parameters
- Enforce the value of code tracing
- Enforce counting from zero

# LEARNING STYLES

- Kinesthetic: Acting out method effects
- Read/write: using the text of the code
- Auditory (maybe): talking aloud

# EXAMPLE EXERCISE

```
int length( )  
char charAt( int index )  
String substring( int beginIndex, int pastEnd )  
int indexOf( int ch )  
int compareTo( String anotherString )  
boolean equals( Object anObject )
```

String s	method call	value returned by the call?
HIPSH	s.length( )	
ZOOLOGY	s.charAt(0)	
ZOOM	s.charAt(4)	
PICKLES	s.substring(0,3)	
AVOCADO	s.indexOf('A')	
CAT	s.compareTo("DOG")	
CAT	s.compareTo("CAT")	
CAT	s.equals("KITTEN")	

# EXAMPLE EXERCISE

```
int length( )  
char charAt( int index )  
String substring( int beginIndex, int pastEnd )  
int indexOf( int ch )  
int compareTo( String anotherString )  
boolean equals( Object anObject )
```

String s	method call	value returned by the call?
HIPSH	s.length( )	5
ZOOLOGY	s.charAt(0)	Z
ZOOM	s.charAt(4)	-- Error! --
PICKLES	s.substring(0,3)	PIC
AVOCADO	s.indexOf(A)	0
CAT	s.compareTo("DOG")	-1
CAT	s.compareTo("CAT")	0
CAT	s.equals("KITTEN")	false

# EXAMPLE EXERCISES

- Play the String game!
- Write a palindrome algorithm!

## Example of Problem Solving: Be A Robot

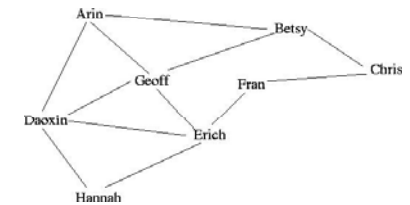


- Group of 4 – brain, eyes, 2 hands
- Only brain knows what you are building
- Only eyes can see
- Must work together precisely like a robot



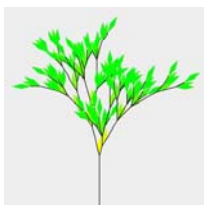
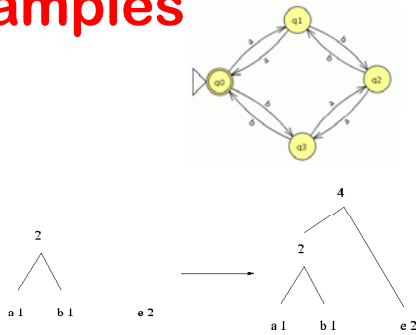
## Example of Problem Solving Finding

- Graph of all friends (of everyone in class, at your university)
- Problems
  - Find number of friends of friends of someone
  - Find the center of the graph – person with smallest sum of shortest distances



## Other Examples

- Finite State Machines
- Turing Machines
- Random Numbers
- Compression (Huffman coding)
- Sudoku, Jumble
- L-Systems
- Genomics



6	1	4	5	
	8	3	5	6
2				1
8	6	4	7	3
7		9	1	4
5				2
	7	2	6	9
4	5	8	7	

## PLTL BACKGROUND

- Started fall 2004 Uwiss, \$\$ from Microsoft
- 2005-2009: 4-year NSF grant with 7 other schools to implement & evaluate PLTL for CS





## Wisconsin Madison PLTL BACKGROUND

- Started fall 2004 with \$\$ from Microsoft
- 2005-2009: 4-year NSF grant with 7 other schools
- **UW-Madison: PLTL for one intro course (would like to expand)**
- **Currently 7 PLTL groups, 50 - 60 students per semester**

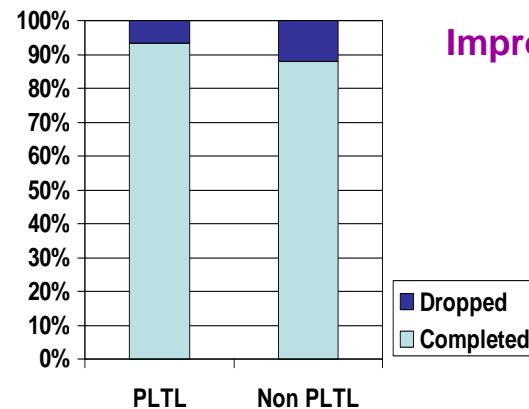
## Duke PLTL BACKGROUND

- Duke Emerging Scholars in CS - Started fall 2005 as NSF ITWF grant
- One year program to learn CS
- **Each semester – take programming course (Alice, then Java) and related seminar course with problem solving in groups (PLTL)**
- **12 students, gender balance, 2 leaders, (55 students in the main course)**

## PLTL in CS variations among 8 universities

- Some focus on non-majors course
- Some focus on CS 1
- Some focus on both (one year)
- Some have just women, most are mixed
- Some include everyone, most are subset
  
- All use active recruiting and undergraduate peer leaders
- All use problem solving in small groups outside of main class period

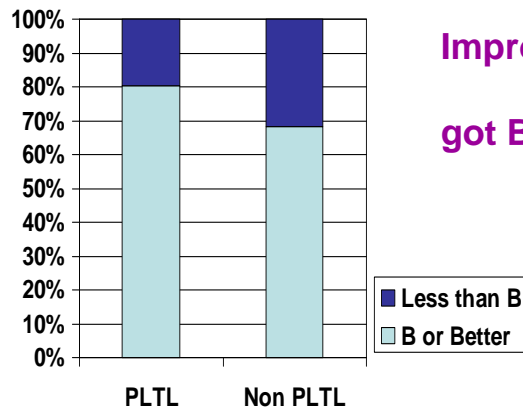
## WHY DO PLTL?



Improve retention rates:  
**93.2% vs 88.0%**

All schools combined: 2005 - 2007

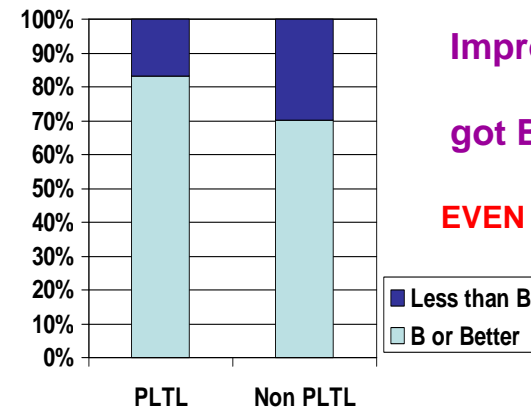
## WHY DO PLTL?



Improve grades:  
80.2% vs 68.4%  
got B or better

All schools combined: 2005 - 2007

## WHY DO PLTL?



Improve grades:  
83.3% vs 70.1%  
got B or better

**EVEN BETTER FOR WOMEN!**

All schools combined: 2005 - 2007

## WHY DO PLTL?

- Great for students
- Great for Peer Leaders
  - rewards of “giving back”
  - improved leadership skills
  - cements own knowledge of material
- A lot of fun!

## WANT TO TRY PLTL?

- Most important resource = YOU
- Institutional support
  - Initially very time consuming
  - Need to coordinate with CS 1 instructor
- \$\$ helpful (pay Peer Leaders, field trips, dinners...)
  - institution (Chair, Dean)
  - donations from companies

## WHAT WILL YOU DO?

- Hire Team Leaders
- Recruit Students
- Train Team Leaders
  - ½ day before start of semester
  - weekly meetings
- Write weekly exercises (many available)
- Organize extra activities

## Resources

- Two PLTL Workshop Project books
- Our website [pltlcs.org](http://pltlcs.org)
  - Database of exercises
  - Info on setting up program, peer-leader training
  - Listserve
- pltl.org from Workshop Project

## PLTL SUMMARY

- PLTL improves retention and grades
- PLTL help Peer Leaders
- PLTL is fun!
- Many resources available: try it soon



## END PLTL OVERVIEW

## QUESTIONS / COMMENTS?

## **REST of SESSION OUTLINE**

- Student Perspectives:
  - Benefits for participants
  - Benefits for Peer Leaders
- Starting PLTL
- Team Leader Selection
- Team Leader Training

## **Benefits for Participants**

- Learn the material at a deeper level
- Learn to work together and use everyone's strengths to solve problems
- Learn to see concepts or situations from differing perspectives
- More comfort discussing ideas because of small group size

## **Benefits for Participants**

- Stay engaged via hands-on activities
- Easy to form study groups
- Have fun learning
- A wonderful new set of friends!

## **Benefits for Team Leaders**

- Develop skills:
  - leadership & communication skills
  - writing new exercises
  - learn to explain new concepts in many ways
  - adapt to different personalities in a positive way
  - working effectively in a group
- Solidify own knowledge via helping others learn

## Benefits for Team Leaders

- Try out teaching
- Get to know faculty
  - Prize/fellowship nominations
  - Research opportunities
  - Letters of recommendation

"I have several lectures that same day, and I originally thought, *Oh my God, by the time this comes around I'm going to be like, get me out of here.* But it's actually really enjoyable. It has to be the fastest two hours of my day."



We really help each other out. Some people are better at certain things than others, so when someone has a question someone will step up and explain it.

"I thought the group would be full of CS geniuses, but actually it was a fun group."



I wish my discussions were like this for every class!"

## END STUDENT BENEFITS

## QUESTIONS / COMMENTS?

## STARTING PLTL Critical Components

- Admin support
- Course instructor closely involved
- Appropriate physical environment
- Trained and closely supervised leaders
- Small groups (5-8 students); attendance required
- Appropriate materials

## Critical Components

- Admin support
  - \$\$ for team-leader salaries
  - “Credit” for program supervisor
- Instructor involvement
  - Reviews materials, suggests topics
  - Attends weekly meetings
- Appropriate physical environment
  - Not desks in rows!

## Critical Components

- Trained and closely supervised leaders
  - Pre-semester training
  - Weekly meetings
  - E-mail journals
- Appropriate materials
  - Good fit with course material; relevant!
  - Engaging; appropriately challenging
  - Variety of styles
  - Suitable for groups

## Timeline

- Get institutional support
- Ensure compatible program leader, course instructor
- Do team-leader recruiting
- Do participant recruiting
- Do team-leader training (materials available)
- Do materials preparation (much available)

## RESOURCES: PRENTICE-HALL



## The PLTL Books

- Guidebook: faculty-focused
- Handbook: student-focused
- Books produced by the Workshop Project
  - Project grew out of chemistry
  - Some material is too chemistry-focused

## Guidebook Chapters

1. Overview: useful, but high-level
2. Peer leader experiences
  - Useful, short essays by leaders
3. Writing activities: ideas on writing but examples are all chemistry
4. Selecting and training peer leaders
  - Excellent, with many details
  - One-day training is not enough, need weekly meetings
5. Institutionalization

## Handbook Chapters

1. Workshop philosophy:
  - Good, modulo some doctrinal issues
2. Excellent discussion of ethics
3. Group management issues
- 4-6: Learning theory material
  - Your mileage may vary
7. Race, class, gender: very good
8. Disabilities: good, but low chance of utility

## WE CAN HELP, TOO!

[www.pltcs.org](http://www.pltcs.org)



The screenshot shows the homepage of the Peer Led Team Learning in Computer Science (PLTL in CS) website. At the top left is a logo with five stylized figures in different colors (red, purple, green, yellow, blue) surrounding a black circle containing the text 'PLTL CS'. To the right of the logo, the text 'Peer Led Team Learning in Computer Science' is displayed in blue. Below the logo and title is a navigation menu with links: 'Home', 'PLTL in CS Activities', 'Search Exercises', and 'Provide PLTL Materials'. The main content area is titled 'Welcome' and contains a paragraph about PLTL, a link to a workshop at Duke, a news item about a New York Times article, and a list of PLTL in CS sites including University of Wisconsin-Madison, Duke University, Georgia Tech, Detroit College, University of Wisconsin-Milwaukee, Rutgers University, Loyola College, and Purdue University.

Peer Led Team Learning  
in Computer Science

Home  
PLTL in CS Activities  
Search Exercises  
Provide PLTL Materials

Welcome

Peer-Led Team Learning (PLTL) involves students working cooperatively in small groups, led by trained undergraduate "peer leaders". PLTL has been used successfully for many years in Chemistry and other science courses to improve retention, boost grades, and increase students' enthusiasm for the subject. With funding from NSF, eight universities (listed below with links to their program sites) have been applying PLTL in Computer Science for the past three years.

PLTL in CS Workshop at Duke - April 28-29, 2007

News

Barbara Ryder mentioning our project in *New York Times Article* April 17, 2007

PLTL in CS sites:

- University of Wisconsin-Madison
- Duke University
- Georgia Tech
- Detroit College
- University of Wisconsin-Milwaukee
- Rutgers University
- Loyola College
- Purdue University

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## Search Exercises

**Title:**

**Language:**  
(check at least one)

- Alice
- C++
- Java
- Other
- Any Language (over-rides other selections)

**Topic:**  
(check at least one)

- Algorithms
- Code Simulation
- Concept
- Games
- Learning Techniques
- Logic
- Programming
- Team Building
- Any Topic (over-rides other selections)

**Key Words (comma delimited list):**

Search

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**Key Words (comma delimited list):**

Search

## Search Exercises

You searched for:  
Title:  
Language: java,  
Topic: programming,  
Keywords: maze  
Results Returned: 1

Title	Topic	Language	Creator	Answer for registered user
<a href="#">Java Programming to Solve a Maze</a>	programming	java	rodger@cs.duke.edu	Not available

### Description

Gain programming experience with Java through solving a maze problem.

### Materials Needed

computers

### Keywords

maze

# STARTING PLTL

# QUESTIONS / COMMENTS?

## TEAM LEADER SELECTION

- **Important attributes:**
  - “People” skills
  - Responsible!
  - Good knowledge of material
  - PLTL experience
  - Ability to adapt
  - Availability (PLTL sessions, weekly meetings)

## WHERE TO LOOK

- Best students from PLTL groups (peer leader recommendations)
- Best students from CS 1, CS 2
- Targeted population (women, minorities)
- Advertising & Interviews

## TEAM LEADER TRAINING

- One or two ½-day sessions before the semester starts
- Weekly meetings

## TEAM LEADER TRAINING

- Ice breakers
- Learning styles
- Working in groups
- Responsibilities and boundaries
- Concerns and expectations
- Practice leading an exercise (with role playing?)

**END TEAM LEADER  
SELECTION / TRAINING**

**QUESTIONS / COMMENTS?**