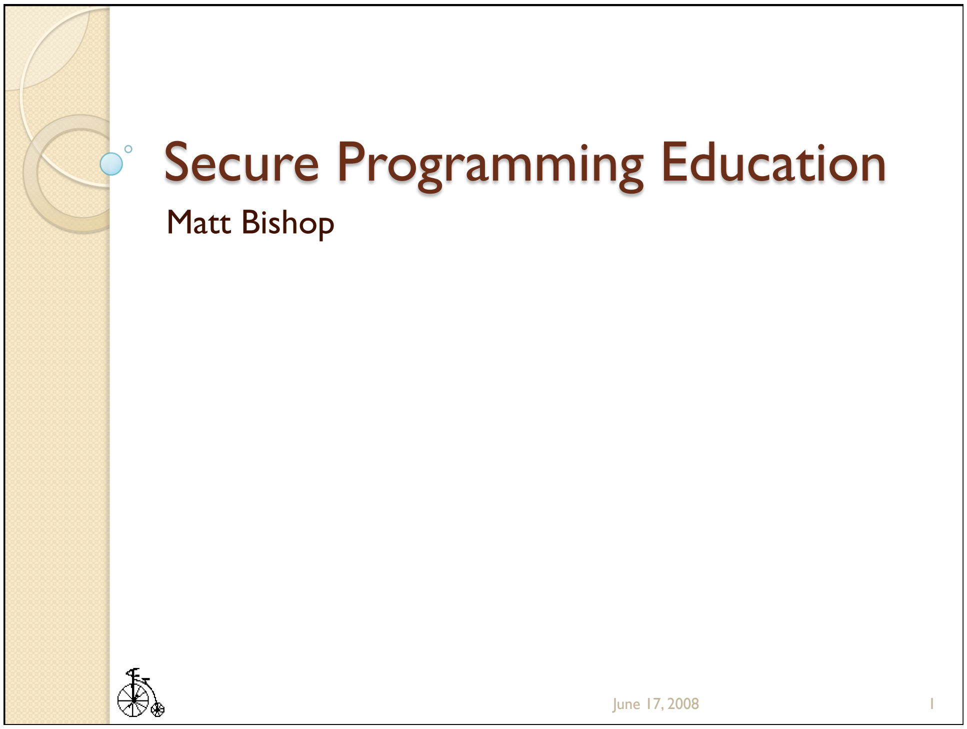


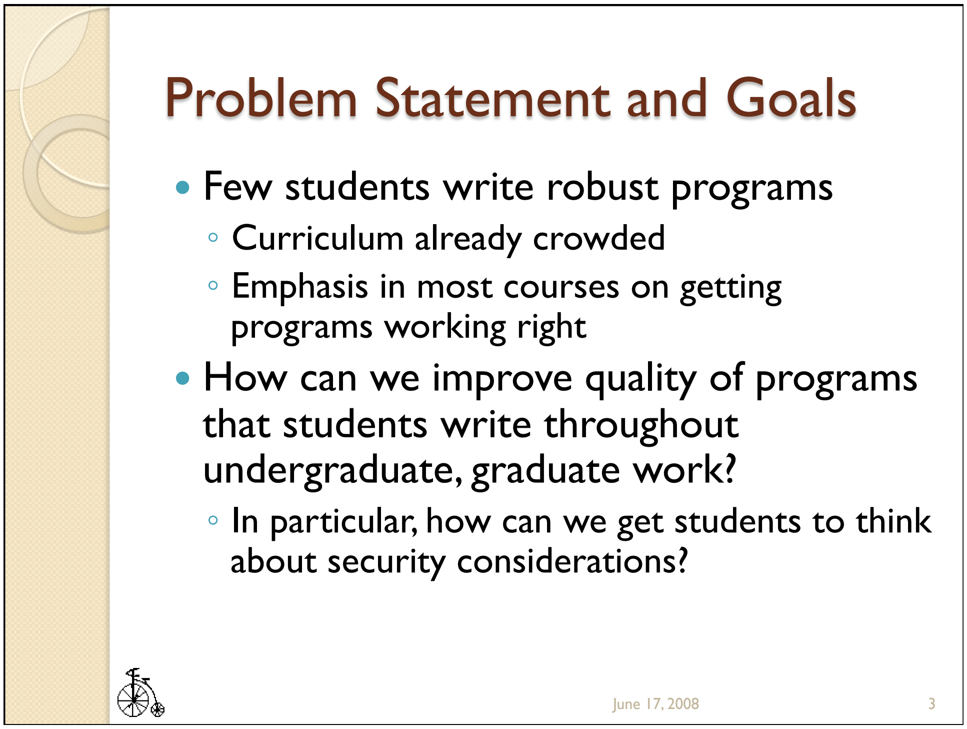
Secure Programming Education

Matt Bishop

Contact Information

Matt Bishop
Department of Computer Science
University of California at Davis
1 Shields Ave.
Davis, CA 95616-8562

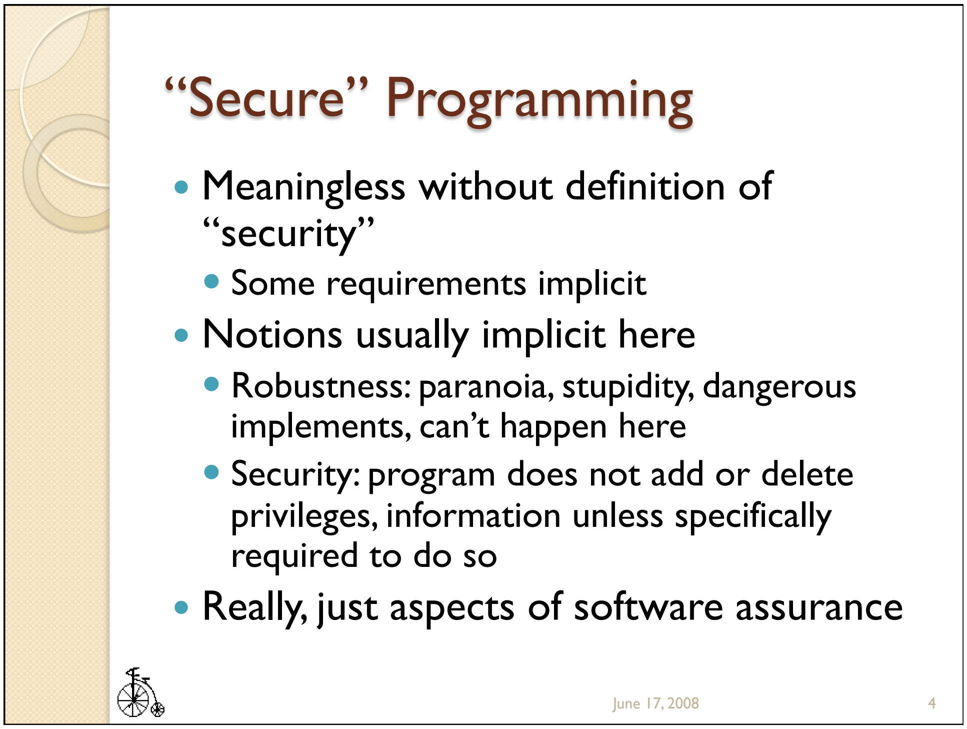
phone: (530) 752-8060
email: bishop@cs.ucdavis.edu
www: http://seclab.cs.ucdavis.edu/~bishop



Problem Statement and Goals

- Few students write robust programs
  - Curriculum already crowded
  - Emphasis in most courses on getting programs working right
- How can we improve quality of programs that students write throughout undergraduate, graduate work?
  - In particular, how can we get students to think about security considerations?

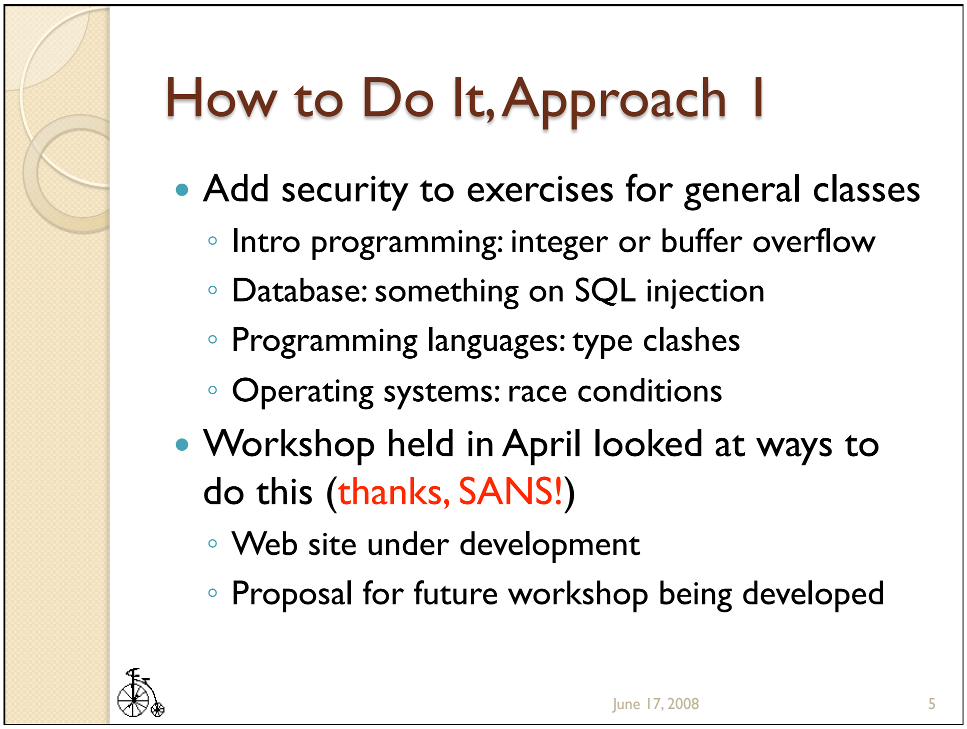
June 17, 2008 3



"Secure" Programming

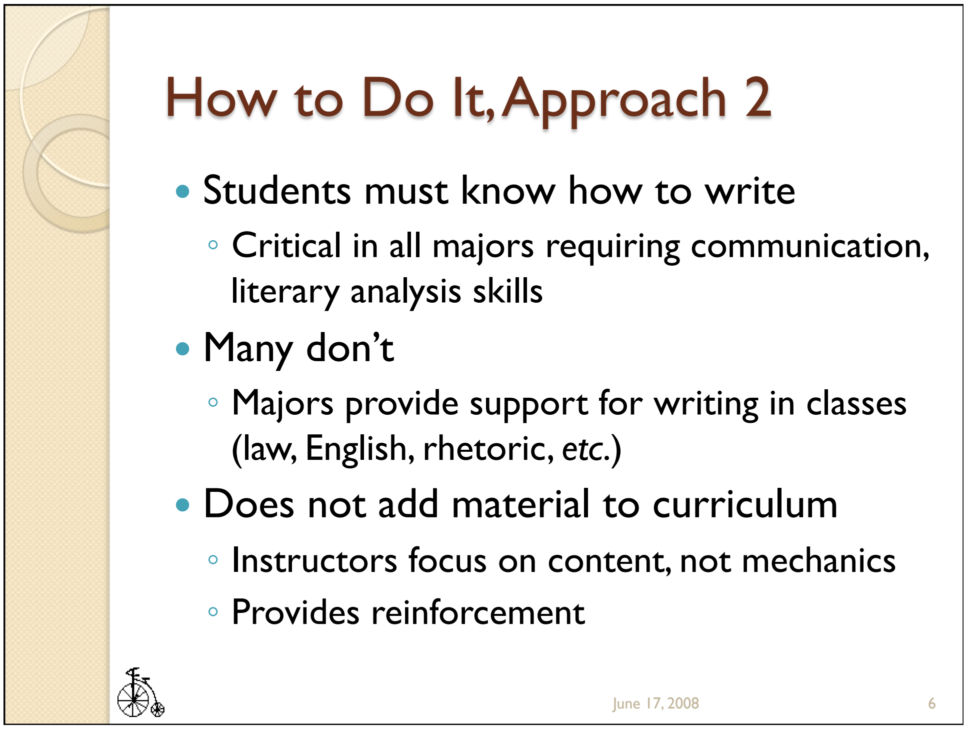
- Meaningless without definition of "security"
  - Some requirements implicit
- Notions usually implicit here
  - Robustness: paranoia, stupidity, dangerous implements, can't happen here
  - Security: program does not add or delete privileges, information unless specifically required to do so
- Really, just aspects of software assurance

June 17, 2008 4



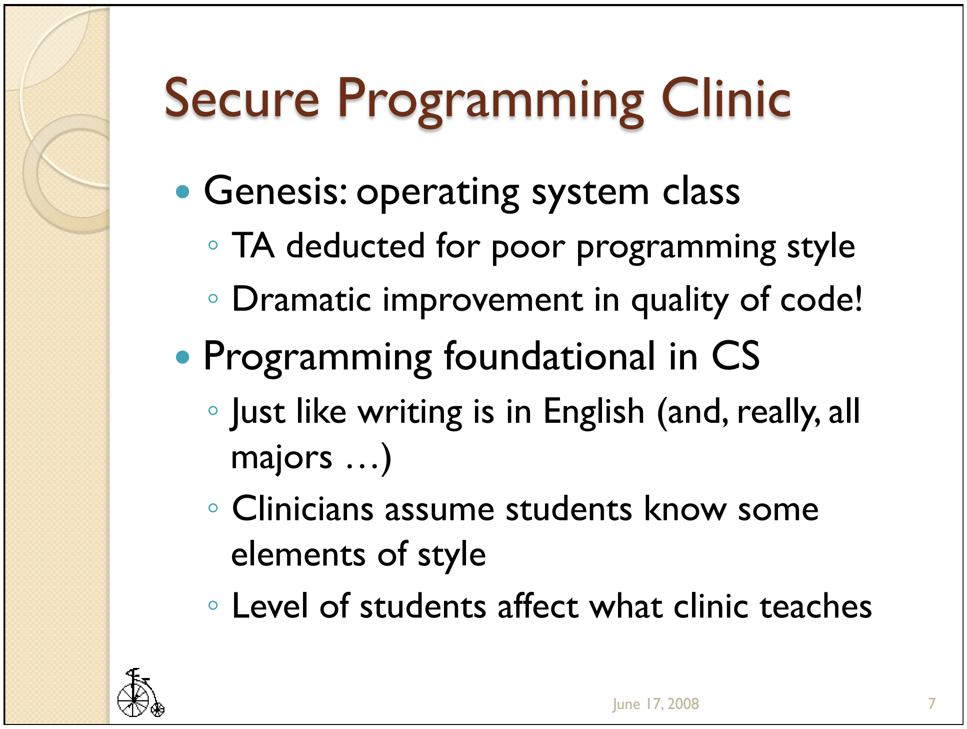
How to Do It, Approach 1

- Add security to exercises for general classes
  - Intro programming: integer or buffer overflow
  - Database: something on SQL injection
  - Programming languages: type clashes
  - Operating systems: race conditions
- Workshop held in April looked at ways to do this (thanks, SANS!)
  - Web site under development
  - Proposal for future workshop being developed



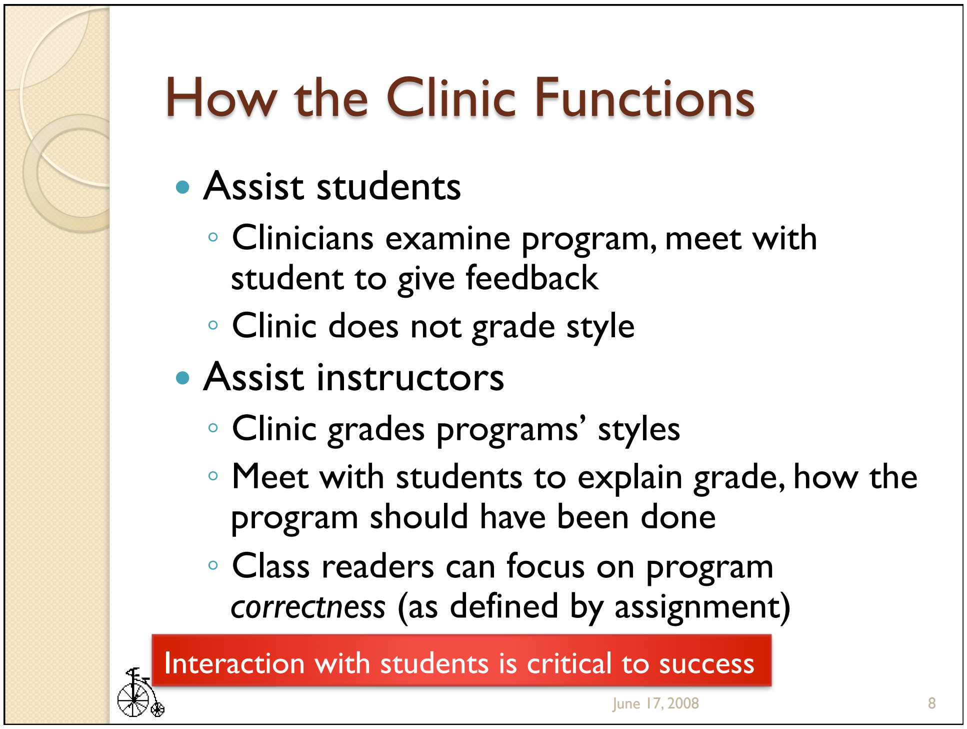
How to Do It, Approach 2

- Students must know how to write
  - Critical in all majors requiring communication, literary analysis skills
- Many don't
  - Majors provide support for writing in classes (law, English, rhetoric, *etc.*)
- Does not add material to curriculum
  - Instructors focus on content, not mechanics
  - Provides reinforcement



Secure Programming Clinic

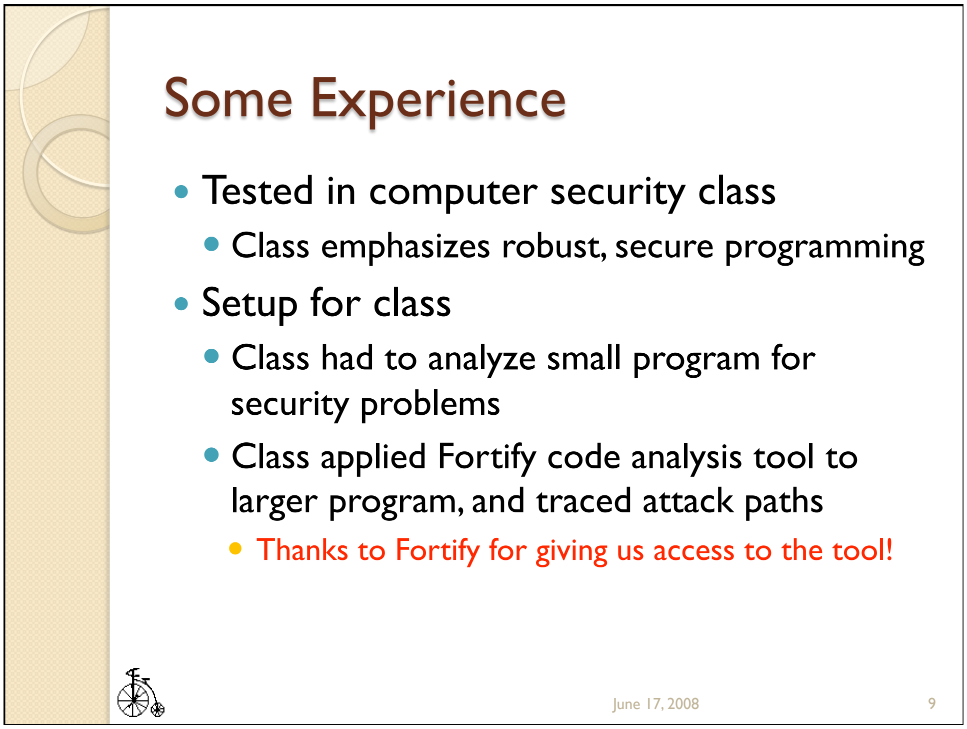
- Genesis: operating system class
  - TA deducted for poor programming style
  - Dramatic improvement in quality of code!
- Programming foundational in CS
  - Just like writing is in English (and, really, all majors …)
  - Clinicians assume students know some elements of style
  - Level of students affect what clinic teaches



How the Clinic Functions

- Assist students
  - Clinicians examine program, meet with student to give feedback
  - Clinic does not grade style
- Assist instructors
  - Clinic grades programs’ styles
  - Meet with students to explain grade, how the program should have been done
  - Class readers can focus on program *correctness* (as defined by assignment)

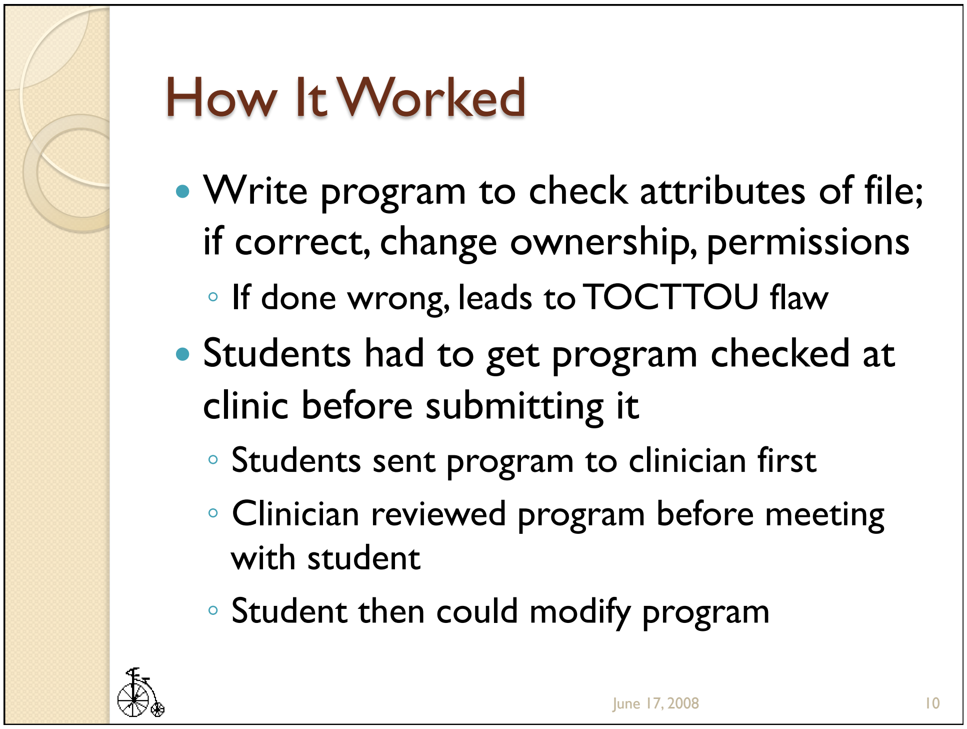
Interaction with students is critical to success



Some Experience

- Tested in computer security class
  - Class emphasizes robust, secure programming
- Setup for class
  - Class had to analyze small program for security problems
  - Class applied Fortify code analysis tool to larger program, and traced attack paths
    - Thanks to Fortify for giving us access to the tool!

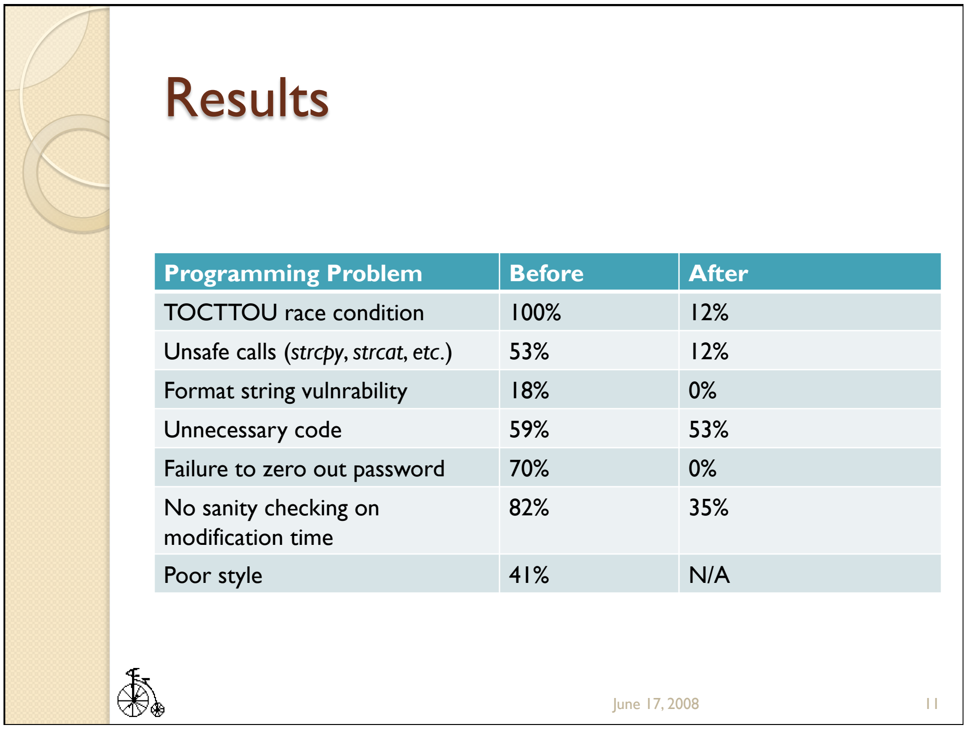
June 17, 2008 9



How It Worked

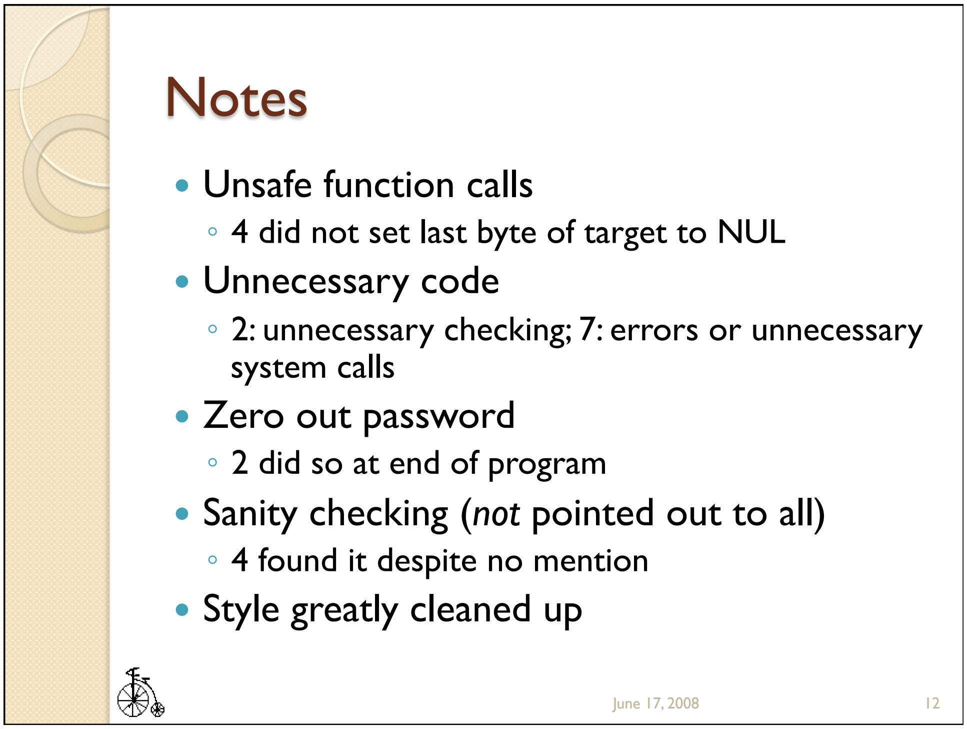
- Write program to check attributes of file; if correct, change ownership, permissions
  - If done wrong, leads to TOCTTOU flaw
- Students had to get program checked at clinic before submitting it
  - Students sent program to clinician first
  - Clinician reviewed program before meeting with student
  - Student then could modify program

June 17, 2008 10



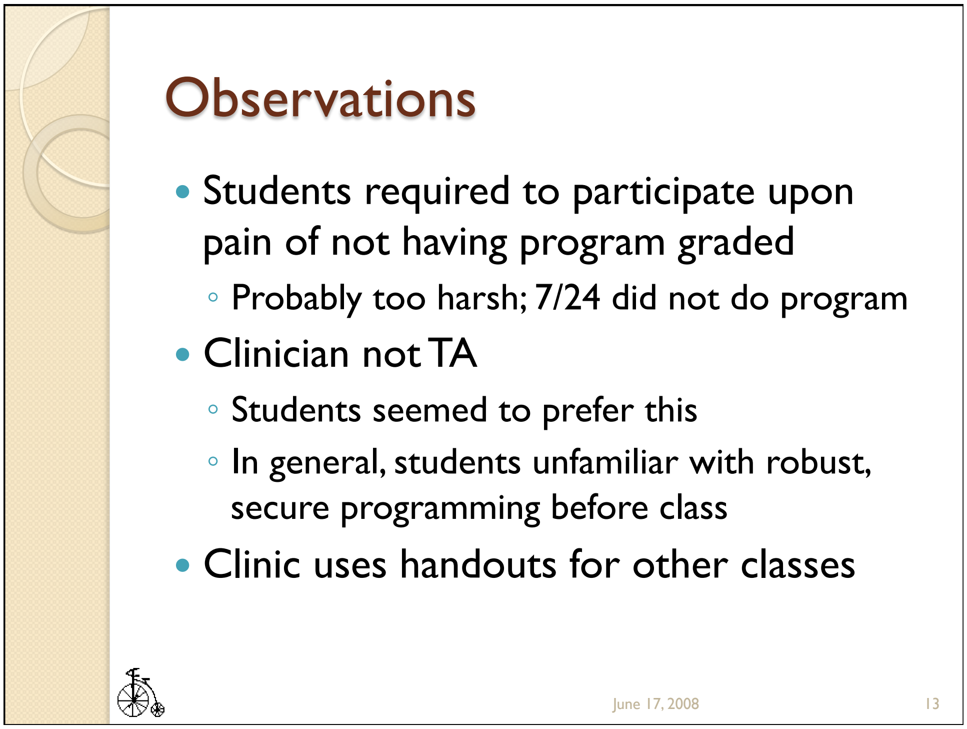
Results

Programming Problem	Before	After
TOCTTOU race condition	100%	12%
Unsafe calls (*strcpy*, *strcat*, *etc.*)	53%	12%
Format string vulnrability	18%	0%
Unnecessary code	59%	53%
Failure to zero out password	70%	0%
No sanity checking on modification time	82%	35%
Poor style	41%	N/A



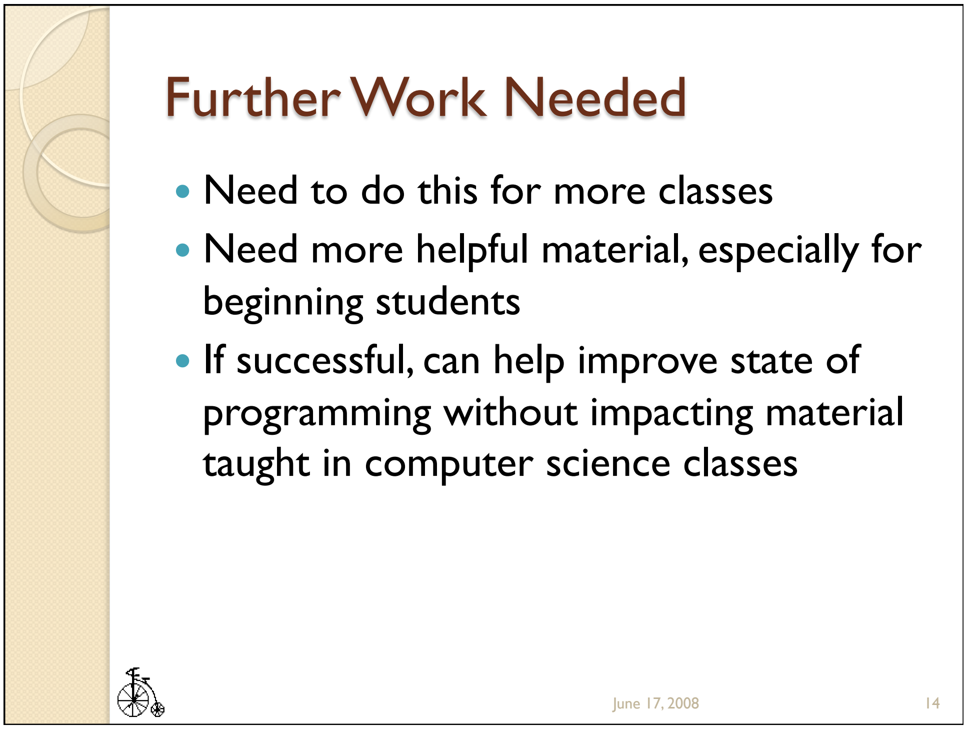
Notes

- Unsafe function calls
  - 4 did not set last byte of target to NUL
- Unnecessary code
  - 2: unnecessary checking; 7: errors or unnecessary system calls
- Zero out password
  - 2 did so at end of program
- Sanity checking (*not* pointed out to all)
  - 4 found it despite no mention
- Style greatly cleaned up



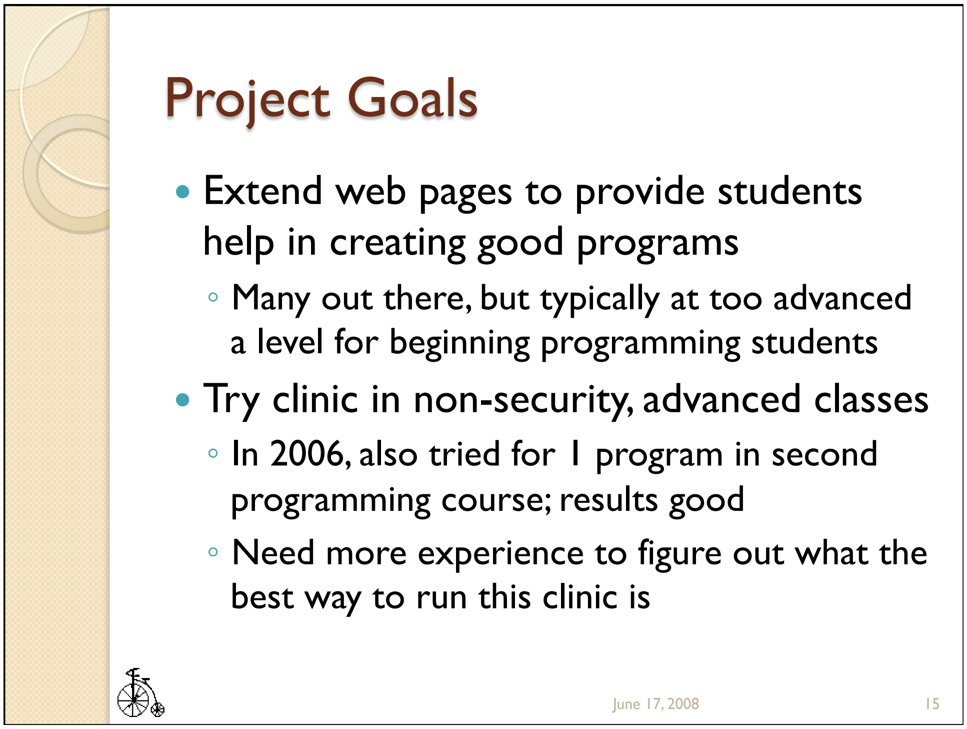
Observations

- Students required to participate upon pain of not having program graded
  - Probably too harsh; 7/24 did not do program
- Clinician not TA
  - Students seemed to prefer this
  - In general, students unfamiliar with robust, secure programming before class
- Clinic uses handouts for other classes



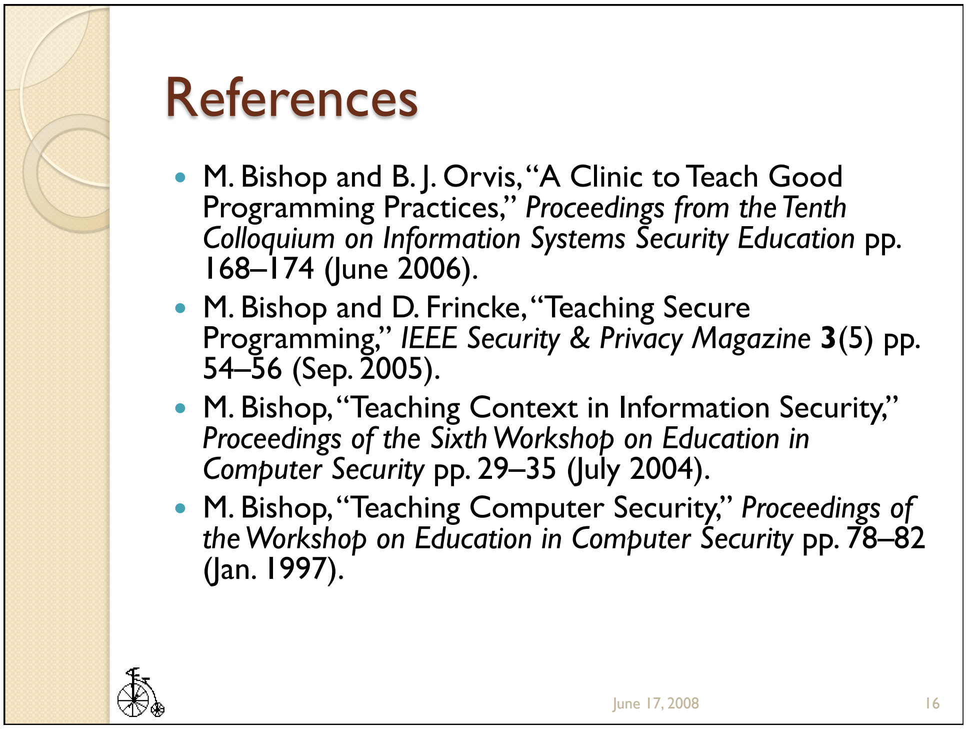
Further Work Needed

- Need to do this for more classes
- Need more helpful material, especially for beginning students
- If successful, can help improve state of programming without impacting material taught in computer science classes



Project Goals

- Extend web pages to provide students help in creating good programs
  - Many out there, but typically at too advanced a level for beginning programming students
- Try clinic in non-security, advanced classes
  - In 2006, also tried for 1 program in second programming course; results good
  - Need more experience to figure out what the best way to run this clinic is



References

- M. Bishop and B. J. Orvis, "A Clinic to Teach Good Programming Practices," *Proceedings from the Tenth Colloquium on Information Systems Security Education* pp. 168–174 (June 2006).
- M. Bishop and D. Frincke, "Teaching Secure Programming," *IEEE Security & Privacy Magazine* **3**(5) pp. 54–56 (Sep. 2005).
- M. Bishop, "Teaching Context in Information Security," *Proceedings of the Sixth Workshop on Education in Computer Security* pp. 29–35 (July 2004).
- M. Bishop, "Teaching Computer Security," *Proceedings of the Workshop on Education in Computer Security* pp. 78–82 (Jan. 1997).