

What Colleges Should Know about the New AP Computer Science

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What is AP?



the Advanced Placement (AP) Program® is a cooperative effort between secondary schools and colleges and universities

AP works with college & high school teachers to develop college-level courses for high schools (35 courses in 20 subject areas)

including: AP Computer Science A, corresponding to CS1 in colleges
AP Computer Science AB, corresponding to CS2 in colleges

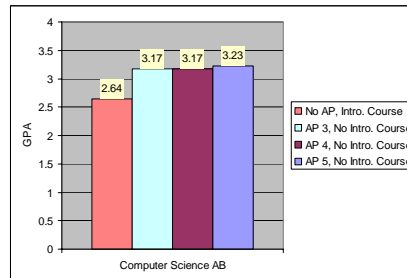
AP develops and administers standardized exams to assess student achievement, which can result in college credit

- the AP Program is offered by the College Board®
 - a nonprofit association of more than 3,900 schools, colleges, and organizations
- AP exams are developed/administered by the Educational Testing Service®
 - a nonprofit, world's largest private educational testing and measurement organization

Who Benefits from AP?



- more than 60% of U.S. high schools offer AP courses
 - more than 115,000 high school teachers
- in 2005, 1,221,016 students took 2,105,803 AP exams
- AP courses provide high school students with college-level challenges, proven curricular models, and a chance to get a head-start on college
 - research has shown that students who place out of courses in college due to AP credit subsequently perform better than peers who don't

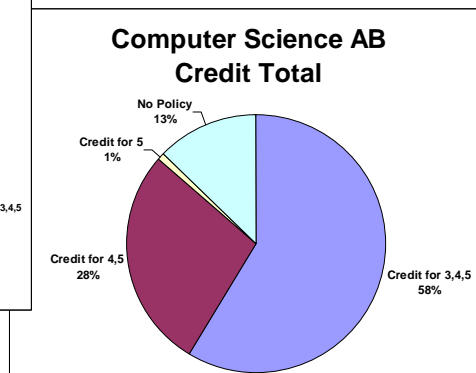
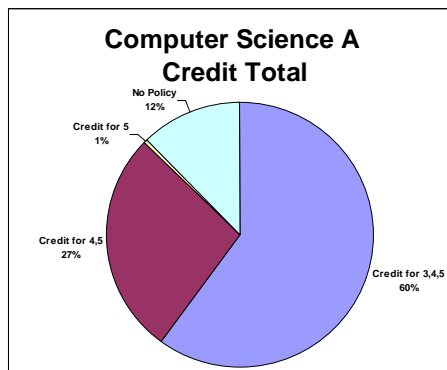


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Who Recognizes AP?



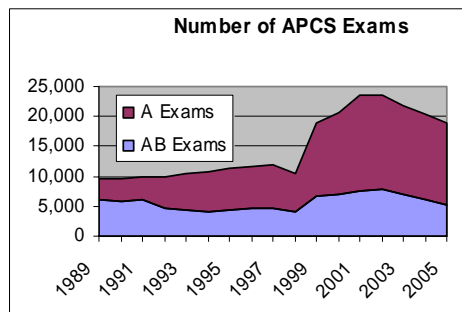
- more than 90% of U.S. colleges and universities award credit and/or placement based on AP exam scores



APCS Exam



- 1984: first APCS exam, in Pascal
(6,911 exams)
- 1992: split into separate A and AB exams
(5,230 + 4,643 = 9,873 exams)
- 1995: first case study introduced
(6,919 + 4,362 = 11,281 exams)
- 1999: exam language switched to C++
(12,218 + 6,619 = 18,837 exams)
- 2004: exam language switched to Java
(14,337 + 6,077 = 20,414 exams)
- 2005: 2nd year of Java
(13,924 + 5,097 = 19,021 exams)



preliminary data suggests the number of exams will rebound this year

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College Involvement



since the program is designed to offer college-level courses for high schools, college faculty are involved in **all** aspects

- curriculum development, test writing and grading, grade setting, ...
- periodically, college faculty are surveyed regarding course content
based on a 1999-2000 survey, the APCS curriculum was revised to emphasize object-oriented methods and (a manageable subset of) Java
- *APCS Development Committee* (3 college + 3 high school faculty) is responsible for curriculum development and exam writing
 - Scot Drysdale, Dartmouth College (chair)
 - Don Allen, Troy High School (CA)
 - Cay Horstmann, San Jose State University
 - Reg Hahne, Marriotts Ridge High School (MD)
 - Laurie White, Mercer University
 - Ann Shen, Bishop Strachan School (Toronto)
- *APCS Chief Reader* is responsible for grading the exams and equating scores with college-level performance
 - David Reed, Creighton University

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APCS Curricula



Computer Science A and AB

AB only

<p>Program design</p> <ol style="list-style-type: none"> 1. Read and understand a problem's description, purpose, and goals. 2. Apply data abstraction and encapsulation. 3. Read and understand class specifications and relationships among the classes ("is-a", "has-a" relationships). 4. Understand and implement a given class hierarchy. 5. Identify reusable components from existing code using classes and class libraries. <p>Class design</p> <ol style="list-style-type: none"> 1. Design and implement a class. 2. Design an interface. 3. Choose appropriate data representation and algorithms. 4. Apply functional decomposition. 5. Extend a given class using inheritance. 	<ol style="list-style-type: none"> 1. Specify the purpose and goals for a problem. 3. Decompose a problem into classes, define relationships and responsibilities of those classes. 1. Design and implement a set of interacting classes. 3. Choose appropriate advanced data structures and algorithms.
<p>Implementation techniques</p> <ol style="list-style-type: none"> 1. Methodology: Object-oriented development, Top-down development, Encapsulation and information hiding, Procedural abstraction <p>Programming constructs</p> <ol style="list-style-type: none"> 1. Primitive types vs. objects 2. Declaration: Constant declarations, Variable declarations, Class declarations, Interface declarations, Method declarations, Parameter declarations 3. Console output (System.out.print/println) 4. Control: Methods, Sequential, Conditional, Iteration, Recursion 	<p>see apcentral.collegeboard.com for full descriptions</p> <p style="text-align: right;">7</p>

APCS Curricula (cont.)



Computer Science A and AB

AB only

<p>Data Structures</p> <ol style="list-style-type: none"> 1. Simple data types (int, boolean, double) 2. Classes 3. One-dimensional arrays 4. Java Collections: ArrayList <p>Algorithms</p> <ol style="list-style-type: none"> 1. Data Structure Operations: Traversals, Insertions, Deletions 2. Searching: Sequential, Binary 3. Sorting: Selection, Insertion, Mergesort 	<ol style="list-style-type: none"> 3. Two-dimensional arrays, Linked lists, Stacks, Queues, Trees, Priority Queues, Sets, Maps 4. Java Collections: List, ArrayList, LinkedList, Set, HashSet, TreeSet, Map, HashMap, TreeMap 1. Data Structure Operations: Iterators 2. Searching: Hashing 3. Sorting: QuickSort, Heapsort
<p>Testing</p> <ol style="list-style-type: none"> 1. Test classes and libraries in isolation 2. Identify boundary cases and generate appropriate test data 3. Perform integration testing <p>Debugging</p> <ol style="list-style-type: none"> 1. Categorize errors: compile-time, run-time, logic 2. Identify and correct errors (use debugger, output statements, hand-trace code) <p>Analysis of algorithms</p> <ol style="list-style-type: none"> 1. Informal comparisons of running times, 2. calculation of exact statement execution counts <p>Understand error handling, run-time exceptions, Reason about Programs</p> <ol style="list-style-type: none"> 1. pre- and post- conditions, assertions, numerical representations and limits 	<ol style="list-style-type: none"> 3. Big-Oh notation 4. Worst-case and average-case time and space analysis <p>Throw runtime exceptions</p> <p style="text-align: right;">8</p>

APCS Exams



in addition, APCS students are required to know a large case study

- the Marine Biology Case Study consists of > 10 interacting classes
- accompanying narrative discusses design choices & implementation details

my personal observation: the A & AB curricula are far more rigorous than most college CS1 & CS2 courses

each AP exam consists of

- 40 multiple choice questions (~4-6 of which relate to the case study)
- 4 free response questions (1 of which relates to the case study)
free response questions may involve:
 - implementing an algorithm
 - completing methods in an existing class
 - designing and implementing classes in an inheritance hierarchy
 - selecting, implementing, and analyzing data structures
 - ...

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Performance Assessment



the Chief Reader is responsible for assigning final scores (1 – 5)

a score of **5** on the exam is meant to equate to *average A-level* performance in college
a score of **4** on the exam is meant to equate to *average B-level* performance in college
a score of **3** on the exam is meant to equate to *average C-level* performance in college
a score of **2** on the exam is meant to equate to *average D-level* performance in college
a score of **1** on the exam is meant to equate to *F-level* performance in college

periodically, comparability studies are performed to equate scores with college-level performance

- representative colleges administer sections of the exam in actual courses
- they report each student's grade on the exam, and his/her final course grade
- the correlation of exam score to college grade contributes to AP score setting

in addition, some multiple choice questions are reused each year to allow for scoring consistency between exams

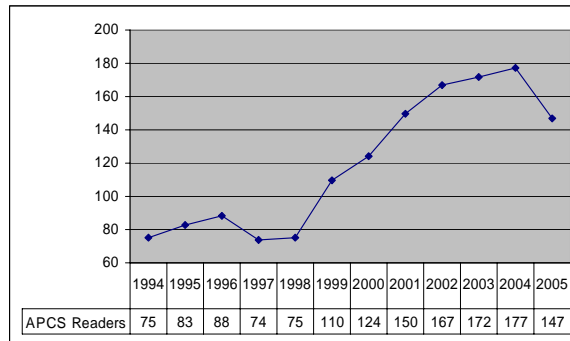
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Grading ("Reading") Process



free response questions are graded by high school and college faculty in June at Clemson, SC

- 2005: 111 readers, 17 table leaders, 16 question leaders, 3 exam leaders
- roughly a 45/55 college-to-high school ratio



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Grading Roles



the Chief Reader designs scoring standards (rubrics)

- questions are scored 0 to 9 (or – for "off task")

a few days before the reading, leaders examine sample responses and apply/refine the rubrics

- *question leaders* focus on refining/managing the rubric
- *table leaders* focus on applying the rubric and mentoring readers

readers (a.k.a. faculty consultants) arrive and grade the exams over the course of a week

- can specify preferences for which question they will grade

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Exam Grading



readers receive extensive training on their problem and the scoring rubric in order to ensure consistent grading

- the reading starts with a short orientation
- leaders review the problem, canonical solutions, & rubric
- readers apply the rubric to "training packs" of pre-selected solutions, comparing results with question leaders
- readers then grade a "split pack" of 25 exams with a partner, comparing and discussing the results
- finally, they are ready to grade packs of exams on their own

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Grading for Consistency



additional consistency checks are built into the process

- readers can consult with partners or table leaders for clarifications; even "star" difficult cases
- table and question leaders "backread" each pack of exams, reviewing starred questions and spot-checking others
- statistics on reader scoring tendencies are collected electronically and are reviewed by leaders
- periodically, reliability studies are conducted in which packs of exams are graded twice and scores correlated

Computer Science is consistently one of the most reliable and consistent grading subjects

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Benefits for Participants



- community of computer science educators
- broad perspectives on CS1/CS2
- assessment experience and expertise
- professional development

to become a faculty consultant

- go to: <http://www.ets.org/reader/ap>
- or send an email to: apreader@ets.org

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A High School Teacher's Perspective



Joe Knoch – Tech Coordinator Consultant, Milwaukee Public Schools

- educational background
- teaching background

APCS experience

- as a teacher
- as a reader
- as a consultant

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Challenges in high school CS



computer access may be an issue

very different schedule from colleges

- short classes that meet every day
- competition with other scheduled events (e.g., programs, clubs, athletics)

teachers are required to pay much more attention to structural activities

- e.g., having a "sponge" activity at the beginning of class to engage the kids immediately.

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Students & the AP course



like other AP courses, APCS is a superb opportunity for students to deal with college-level curricula, books, thinking, homework assignments, and testing

- students think more critically and more deeply (remember Bloom's taxonomy where analysis, synthesis, evaluation are at the highest levels)
- students evaluate and embrace new ideas and get exposure to the rigors of college courses.

studies have shown that students who took an AP course, even if they did poorly, perform better in college

- to be sure, these are the kinds of kids, regardless of their actual test scores, that you want to have in your college classrooms.

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Professional Development



APCS teachers are often isolated, sometimes the only CS teacher
→ networking and easy access to resources are essential

- College Board provides training and professional development for high school teachers
 - summer institutes, regional workshops
 - training is conducted by endorsed consultants
- online resources include
 - AP Central repository, personal APCS-related Web sites, APCS listserv
- professional organizations include
 - CSTA, ISTE/SIGCS, ACM/SIGCSE
- go to the reading!

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FYI



- <http://apcentral.collegeboard.com>
AP Central: AP info, course descriptions, reference materials, ...
- <http://apcentral.collegeboard.com/program/research>
AP Research and Data: exam data, research studies, ...
- <http://www.collegeboard.com>
College Board: general info about the association, AP program
- <http://cs.colgate.edu/APCS/Java/APCSJavaMaterials.html>
Unofficial APCS site, by Chris Nevison (former Chief Reader)

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