

SmarterAP: The Future of AP Exam Preparation

Patricia Flynn
Georgia Institute of Technology
pflynn9@gatech.edu

Scott Leitstein
Georgia Institute of Technology
sleitstein3@gatech.edu

Joseph Slater
Georgia Institute of Technology
joeyslater@gatech.edu

ABSTRACT

This paper describes the development of SmarterAP, a multi-platform paced-practice assessment tool for use in the high school classroom to enhance the teaching and learning processes in Advanced Placement courses. The goal of SmarterAP is to provide teachers and students with an AP exam preparation tool that is easy to use and that provides valuable feedback to both teachers and students. The use of SmarterAP in a classroom setting will enhance instructional outcomes with the result of building content mastery.

Keywords

Formative Assessment; Learning Management System; Curriculum and Instruction; Advanced Placement; High School; Instructional Technology; Modernized Learning; 1:1 Initiative; Differentiated Instruction; Guided Instruction; Assessment-Driven Instruction; Exam Preparation; Summative Assessment; Paced Repetition

1. INTRODUCTION

SmarterAP provides high school teachers with a classroom-centered tool to help prepare students for an Advanced Placement exam by strategically presenting students with practice questions for any AP subject. The tool enhances traditional AP instruction in several ways. First, it familiarizes students with the format and style of AP exam questions in a given content area while allowing them to self-assess their level mastery in the subject matter. It also provides teachers with valuable formative assessment opportunities to guide instruction and track student progress over time. Finally, SmarterAP acts as a catalyst for initiating classroom discussion aligned with course curriculum around the topics most needed to further student understanding of the content.

Teachers will be able to create and populate a class of students from existing rosters so that the SmarterAP tool can track student progress over time. The SmarterAP tool will focus initially on multiple choice question formats as presented in Section 1 of many AP subject exams. The instructor interface will include the ability to choose multiple choice questions from a test bank either by visually inspecting questions by categories or by specifying topics/skills and difficulty and allowing the tool to present relevant questions. New questions can be imported into the database or created manually. The instructor can schedule when the questions will be available based on how they intend to use the tool (AP practice, beginning/end of class formative assessment, daily challenge, summative assessment, homework assignment, etc.). Real-time assessment analytics of student responses will be available and stored for longer-term performance tracking.

1.1 Inspiration

When high school students are faced with full-length paper-based Advanced Placement practice exams, they are often overwhelmed

with unfamiliar question configurations. These practice exams present students with questions that cover the entire course at once, requiring a student to have learned the entire course content prior to engaging in exam preparation. As a result, marathon practice sessions in the weeks leading up to an Advanced Placement exam become frustrating and demotivating for students and result in less than favorable outcomes. Students would benefit instead from regular daily authentic AP exam paced practice with smaller numbers of questions aligned with course content throughout the duration of the course to build familiarity, efficiency, and accuracy over time rather than in short-term cram sessions just prior to the exam. However, providing this type of daily practice in line with the learning production process is labor intensive for the instructor. Available AP question resources are often in paper-based formats and are organized as full-length practice exams of mixed-topic questions. Creating optimal daily practice assessments requires the instructor to choose, laboriously, questions applicable to current lessons. Furthermore, paper assessments must be created, distributed, collected, and manually graded.

SmarterAP is a technology-based formative assessment tool that resolves these issues by simplifying the process used by teachers to choose questions and deploy formative assessment and practice questions to students beginning early in the course. It will give students an opportunity to become familiar with AP-style questions as they build topic knowledge and serve as a gateway into class discussions.

There are several factors that make SmarterAP stand out from existing exam prep applications and formative assessment tools. Most exam prep applications are preconfigured with questions, such as Learnerator (www.learnerator.com), which presents students with questions that cover the entire course's content at once, which are organized by topic in some tools. This approach relies on student self-pacing and, therefore, does not provide a structure for learning production. Learnerator provides a means of formative assessment, but it does not have the ability to assign specific questions for a guided, consistent, and uniform assessment. SmarterAP puts the teacher in control of how and when the questions are presented to students and allows the teacher to tailor the practice to the flow of content in the course.

Other solutions, such as Socrative (www.socrative.com) and Nearpod (www.nearpod.com), provide a means to create questions and assessments specific to the learning objectives of a given lesson, but the process is tedious and there is no ability to directly import existing question banks. Both tools provide instant student performance feedback to instructors, but they lack course creation and student registration features, so analytics are therefore limited to individual instances of an assessment and do not track long-term student performance. Furthermore, tools that do allow importing of question banks require adoption by a school district-wide and carry large price tags to utilize the most popular features. Unfortunately, feature rich, full Learning Management Systems such as

Blackboard (www.blackboard.com) or Moodle (www.moodle.org) along with other formative assessment tools such as ProProfs (www.proprofs.com), are not practical when the desired target capability is limited to a few key features.

SmarterAP provides a combination of features not available with existing technology-based formative assessment tools.

2. IMPLEMENTATION

Hosting: [Heroku](https://heroku.com)

Issue Tracker: <https://github.gatech.edu/edu-tech-f15/smarterap/issues>

Backend
Languages: Java Build System: Jetty Program Management: Maven Dependency Injection and Framework: Spring MVC Database: PostgreSQL ORM: Hibernate Security: Stormpath
Frontend
Languages: HTML5, CSS3, Javascript Build System: Grunt Package Manager: NPM and Bower Javascript Framework: AngularJS Style Framework: Sass & Material Design

Figure 1: Architecture

There are a number of changes from the initial design. The biggest change was moving away from Google-based services. In order to implement authentication and authorization, Heroku served as a better resource than Google App Engine (and by accessory, Cloud Storage). Stormpath provides wrappers for both the frontend and backend, offering a variety of languages to connect with. Hibernate wrapped around PostgreSQL facilitates development, using object-based SQL classes to interact with while persisting data. The SmarterAP team also took advantage of the development to learn different languages, architecture styles, and application builds.

2.1 Architecture

SmarterAP took advantage of the Model-View-Controller architecture for both AngularJS and Java. For AngularJS, the division is broken down even further for Controllers with Services and Factories. These items are essentially singletons for multiple controllers to interact, transferring data between views. The basic framework comes from Material Design from the AngularJS team. It not only provides code for basic interface elements, it provides style framework to design a professional looking application similar to Google Docs and Google Classroom.

On the frontend side, Stormpath and UI Router synergize for page view authorization. SmarterAP breaks down users into three groups: STUDENT, TEACHER, ADMIN, and the application

redirects if a user attempts to view something forbidden under their account permissions.

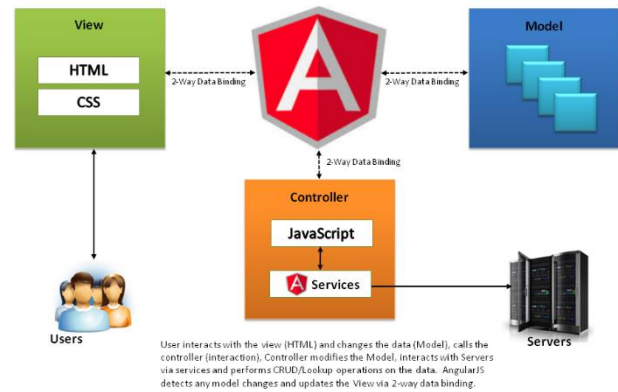


Figure 2: Frontend

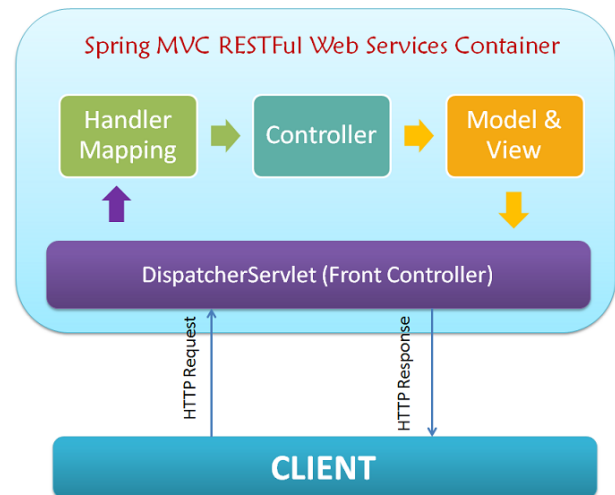


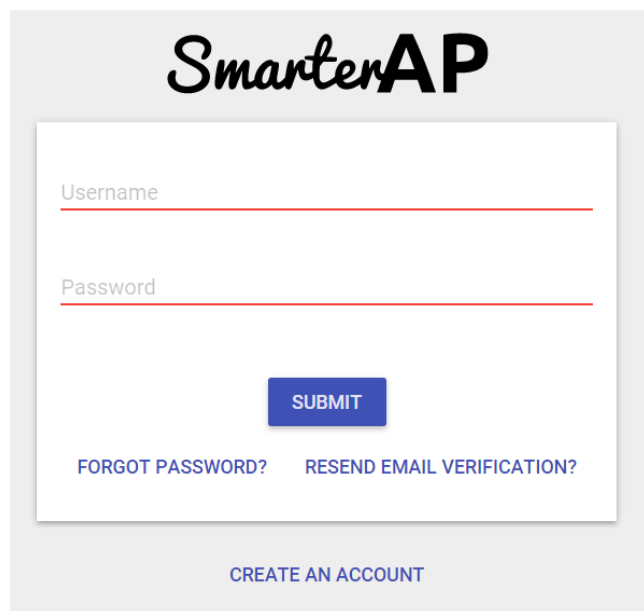
Figure 3: Backend

On the backend, SmarterAP utilizes Spring MVC to create an intricate web oriented model-view-controller system that handles various REST mappings ('/authenticate', '/course/list') and handles database interactions. On a high level, the client approaches the application via Controllers through a REST call. The controller then calls upon a service (middle man between controllers and data) to perform necessary transformations on the inputs and outputs. The service layer accesses the PostgreSQL database through a DAO (Database Access Object) layer, which separates the database operations from the main application. In the case of SmarterAP, the DAO layer is both an interface and concrete implementation. By using an interface-based strategy, developers can swap different implementations for one another without the changing methods.

3. APPLICATION WALKTHROUGH

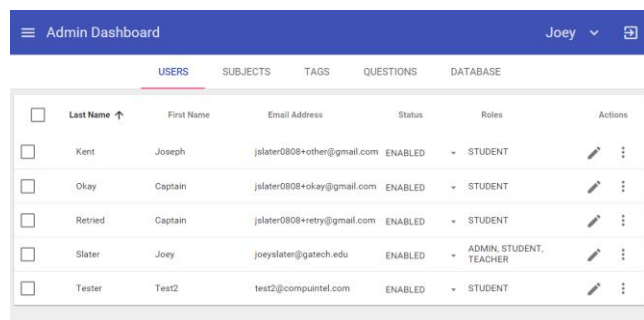
3.1 Admin

By default, all user accounts will be initially configured as student role, and only the administrator will be able to elevate an existing account to either a teacher or administrator role. Furthermore, since student records are critical for retaining student participation and performance records, only the administrators have the authority to delete a course; teachers can archive any of the courses they've created but will not be entitled to delete any course. The administrator role is essentially an elevated teacher role; hence the administrator will be able to perform all functions of a teacher. Administrators also serve as the information guardian, managing subjects and tags for teachers to interact with.



The login screen for SmarterAP features the logo at the top. Below it is a white box containing a 'Username' field, a 'Password' field, and a blue 'SUBMIT' button. At the bottom of the box are links for 'FORGOT PASSWORD?' and 'RESEND EMAIL VERIFICATION?'. Below the box is a blue link for 'CREATE AN ACCOUNT'.

Figure 4: Login Screen



The Admin Dashboard shows a navigation bar with 'Admin Dashboard' and a user profile 'Joey'. Below the navigation bar are tabs for 'USERS', 'SUBJECTS', 'TAGS', 'QUESTIONS', and 'DATABASE'. The 'USERS' tab is active, displaying a table of users.

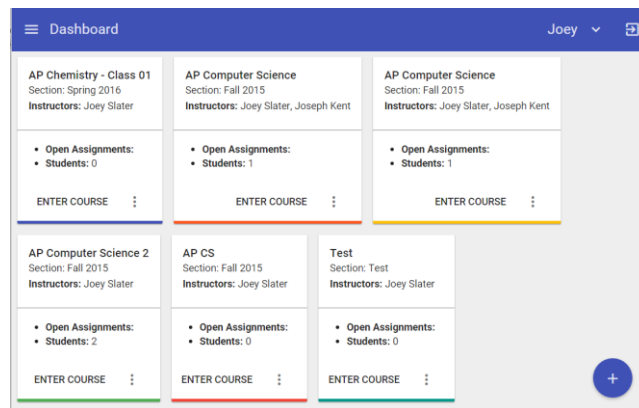
<input type="checkbox"/>	Last Name ↑	First Name	Email Address	Status	Roles	Actions
<input type="checkbox"/>	Kent	Joseph	jslater0808+other@gmail.com	ENABLED	STUDENT	
<input type="checkbox"/>	Okay	Captain	jslater0808+okay@gmail.com	ENABLED	STUDENT	
<input type="checkbox"/>	Retried	Captain	jslater0808+retry@gmail.com	ENABLED	STUDENT	
<input type="checkbox"/>	Slater	Joey	joeyslater@gatech.edu	ENABLED	ADMIN, STUDENT, TEACHER	
<input type="checkbox"/>	Tester	Test2	test2@compunetel.com	ENABLED	STUDENT	

Figure 5: Admin Dashboard

3.2 Teacher

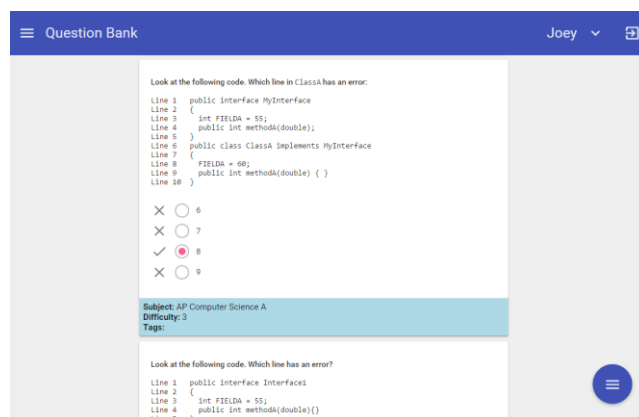
At the beginning of a term, the teacher can create a new virtual class for each of the AP course sections they teach, as well as archive classes no longer needed from previous terms. A teacher can import a class roster to a given class, which will send verification emails to students to enroll in the class. Within a class, question banks can be imported and tagged by question based on topic and difficulty level. Individual questions can also be manually created, tagged, and added to the database. A new assessment can then be created

by choosing questions from the database using these topic and difficulty tags to narrow the choices. Assessments can be scheduled for deployment to a class by specifying open and close dates, allowing for preparation in advance. Previously created assessments can also be reused, for example, a teacher can reuse an assessment created in a previous term of a course in the current term. After students complete an assessment, the teacher can view results analytics for both individual assessments and topics across previous assessments.



The Teacher Classes dashboard shows a grid of class cards. Each card displays the course name, section, and instructors. Below this, it shows 'Open Assignments' and 'Students' counts. At the bottom of each card is an 'ENTER COURSE' button. The classes shown are AP Chemistry - Class 01, AP Computer Science Section: Fall 2015, AP Computer Science Section: Fall 2015, AP Computer Science 2 Section: Fall 2015, AP CS Section: Fall 2015, and Test Section: Test.

Figure 6: Teacher Classes



The Question Bank interface shows a list of questions. The selected question is: 'Look at the following code. Which line in ClassA has an error?'. The code is:

```
Line 1 public interface MyInterface
Line 2 {
Line 3 int FIELDA = 55;
Line 4 public int methodA(double);
Line 5 }
Line 6 public class ClassA implements MyInterface
Line 7 {
Line 8 FIELDA = 60;
Line 9 public int methodA(double) { }
Line 10 }
```

. Below the code are radio buttons for options 6, 7, 8, and 9. Option 8 is selected. The subject is 'AP Computer Science A' and the difficulty is '3'. The tags are 'Interface' and 'Method'.

Figure 7: Question Bank

3.3 Student

The student can log in and take an assessment available to them and view their results from previous assessments.

4. THE FUTURE OF SMARTERAP

The next version of SmarterAP can incorporate a "Student Assessment Analysis Engine" to analyze and assess the student's performance and learning progress. For example, each question has tag attributes that can be used to assess a student's aptitude and performance based on how they answer related questions. Question relationships can be established by recognizing patterns using the tag attributes.

SmarterAP questions are currently in multiple choice format, but future versions will allow True/False, Completion, Matching, Essay format, and AP Free Response. In support of Completion, Essay, and Free Response, a synonym or alternative keyword

recognition engine can be implemented for acceptance of alternative student responses.

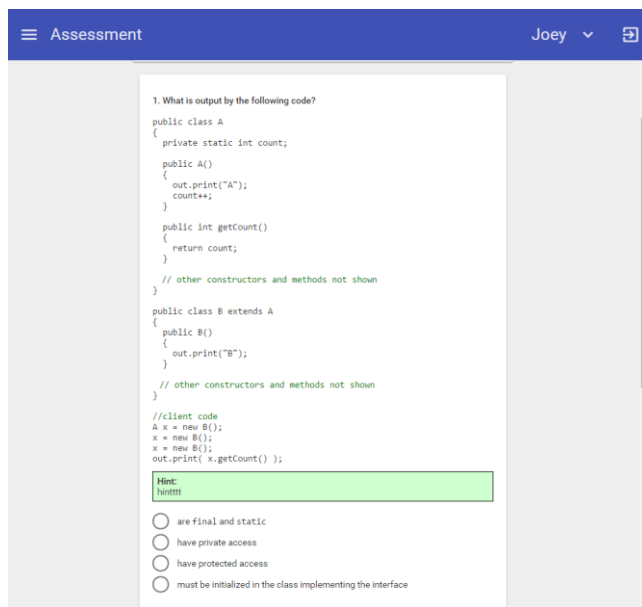


Figure 8: Student Assessment

The initial design of SmarterAP is focused the Computer Science concentration, future versions of SmarterAP will accommodate other AP® concentrations available by [The College Board](#).

Since SmarterAP leverages state-of-the-art technology and the latest software development practices, handwriting recognition would be a practical and productive feature to incorporate. APIs such as [MyScript®](#) would facilitate adding this feature into SmarterAP.

SmarterAP is setup to offer students “hints” for each question, however, future releases could include an “Intelligent Student Hinting Engine” that would provide strategic hints, at opportune times, to assist the student’s progress in the current question.

5. ACKNOWLEDGMENTS

The SmarterAP team would like to thank Dr. David A. Joyner, course mentors, and the other Educational Technology students for providing guidance, feedback, and other useful information that led to the development of our tool.