# Prospectus for the Use of iPads in Science Classrooms

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## *Overview:*

With the announcement of the Apple iPad tablet, a technology has finally been developed that is ideal for classroom usage. Although previous technologies have shown great adaptability for the classroom, they have all had various drawbacks that have limited their usefulness and acceptance in the mainstream school system.


Desktop computers have generally been too large and too expensive for a typical classroom to have more than a few machines; for each student in a classroom to have access to a computer requires the class to move to a dedicated computer lab. Although useful, this approach loses the immediacy of students being able to use the machines as part of the everyday activities of the class, such as taking notes during a lecture, collecting and interpreting data from probeware, collaborating with other students to create presentations, etc. Laptop computers are more portable and better suited to be used in a laboratory setting for data collection, but their expense is beyond the budget of most high school science programs to buy a complete classroom set. Handheld technologies, such as smart phones or PDAs have also been adapted and used in classroom, but their limited screen size and processing power also make them unsuitable for everyday tasks. It simply takes too long to write anything extensive on PDAs or smart phones, and the files can't be easily transferred or printed. There small size also makes it difficult for teachers to track and monitor their usage.

The new iPad and inevitable copycats will provide a technology that fits perfectly into the niche created by classrooms: extremely portable, powerful, able to run software for taking notes and making presentations, able to display websites at full size, play videos, and read e-books without being too expensive for a teacher to purchase a classroom set with technology funds. This prospectus will specifically explore ways in which the iPad can be used in science classrooms in middle and high schools. It assumes that Apple will continue to improve the iPad and add features that are still needed such as a USB port and Flash website support.

## *Textbooks as E-books:*

Purchasing a set of printed textbooks for a classroom is becoming incredibly expensive, with each copy costing a school district at least $50 even with wholesale pricing. The development cycle for science textbooks takes several years from writing to editing to layout and printing, so that by the time the textbook is available the information it contains is already out of date. Many science teachers have decided that their budgets would be better spend buying computers with Internet capability and having students read articles from the Internet instead, where information is current and relevant. Yet this approach limits the availability of the problem sets and exercises found at the ends of chapters in student textbooks; either the teacher has to create his or her own problems or dig deeply to find websites with these types of resources.

The obvious solution is to move textbooks away from printed media and toward e-media, where the information can be easily updated and uploaded to respond to current events. Some textbook companies are moving in this direction, as is the Open Source movement. These books can be published as Adobe Acrobat .pdf files or e-pub files and downloaded by teachers for a cost much less than a printed textbook. Publishing companies also benefit since the development costs of printing books is eliminated, so more frequent editions and more choices for textbooks can be made available.

The iPad and similar technologies such as the Kindle provide a platform for downloading and reading e-texts.

The iPad has the advantage of having many more functions than just being an e-book reader for the same price. Then there's all of that great content on iTunes and at iTunes University! The iPad will finally allow teachers to interconnect their students with knowledge in a way no other technologies have.

## *On-line Testing Made Easy*

Many states (including Utah, where I live) are moving their student testing to on-line systems instead of using paper and pencil tests that are expensive to print, distribute, and score. On-line testing systems have the advantage of being immediate to score (students know immediately upon completing the test how well they did) but they can also collect and analyze demographical information more effectively and allow for a greater variety of question types than the multiple-choice only questions found in most state tests. With the additional testing required by No Child Left Behind, teachers are hard pressed to find time to teach all of their curriculum as well as give the mandatory tests; with on-line testing, the process can be streamlined and the time spent testing is shortened.

With a classroom set of iPads all linked through the Internet, a teacher could do more than use them provide state end-of-level tests; she or he can have the students take regular unit tests and have the results automatically scored and analyzed. With teacher management software the will doubtlessly be developed, a teacher could design their own tests, then use the management systems to collect, score, and analyze the results, including gathering answers from open-ended questions.


## *Virtual Science Labs*

The major obstacles for most teachers taking students into a laboratory setting and having them experiment with hands-on activities have been managing the students and the expense, mess, and danger associated with most labs. For example, in a chemistry class, it is essential to get the students into the lab as often as possible to actually use the lab equipment to measure and react chemicals. But to ensure student safety, they must have extensive training on labware usage and safety precautions (such as how to use the eyewash station). Chemicals and lab equipment are also expensive. As a result, most teachers have resorted to doing micro-scale labs that use only small amounts of chemicals. This also minimizes the third obstacle: disposal of hazardous chemicals. Yet these micro-scale labs lack the visceral enjoyment of seeing a reaction take place before the students' eyes and truly getting their "hands on" the chemicals.

There have been attempts before at creating virtual chemistry or physics or other science labs, with varying degrees of success. One advantage of the iPad is its ability to program simulations that make use of the accelerometer and the gesture technologies. For example, a virtual chemistry lab could be created using all the reactants specified in the lab manual for a particular textbook, and the student could then see and use the chemicals in a manner that is fairly close to reality; they could pick up a reactant bottle using the pinch gesture, tip chemicals out by rotating the iPad (with the accelerometer), and do other manipulations that resemble the actual experience. Although not a replacement for an actual lab, it can be extremely useful for students to practice a lab first virtually before conducting an actual lab. Discovery or student-directed experiments, which are so difficult to manage in an actual lab can be programmed into an iPad application that allows experimentation without danger, expense, or mess. The labs can be expanded to allow for stoichiometric calculations (such as having a look-up table of atomic weights and formula weights and a mole calculator).

For other sciences, virtual labs can also be highly useful. For a class in Earth Science or geology, the iPad can display random samples of minerals and the student can pick from various field tests (such as scratch test, streak, cleavage, and acid reaction) to determine what the mineral is. In meteorology, videos or photos of cloud patterns over several days can be displayed and the student can be asked to then predict the weather for the next three days. In physics, the gestures and accelerometer can be programmed to do any number of useful virtual experiments, and variables can be changed at will,

such as acceleration of gravity, friction, velocity, force, etc. These are just a few of the possibilities that can be programmed into the iPad with its unique blend of capabilities.

One app that will surely come soon will be a scientific graphic calculator for the iPad. Science and math teachers now have to plunk down quite a bit of money for a set of dedicated graphing calculators; the iPad can be programmed to do the same thing in addition to being useful for so many other things. Graphing calculators can be hooked up to remote sensing devices such as pH meters and the results fed directly into the charts. One iPads come with USB ports, they will become the indispensible science classroom tool for data collection and analysis.

## *Student Collaboration Enabled by iPads*

One area of student work that is receiving added attention lately is the importance of student collaboration. This goes far beyond a group of students acting as lab partners to collect and analyze data. It is now considered an essential technological skill to teach students how to collaborate in an electronic environment, through such tools as social networking and Web 2.0 technologies. My own students used a common wiki web page to collate and consolidate research on topics for the Elements Unearthed project; each team selected a nearby mining or chemical manufacturing site to research, then the teams divided up the assignment so that each member would have unique information to contribute. That information was then written up into a single wiki page and reviewed by a subject expert. Once that had taken place, the student teams traveled to the sites with video cameras and interviewed the expert and toured the site, then used digital video software to edit the footage into video podcast episodes. These episodes are then compressed and uploaded to iTunes and YouTube. In the process of doing all this research, filming, interviewing, and editing, the students not only learn a great deal about the subject but also learn valuable 21st Century digital skills.

The iPad will not have the power to edit video (yet) – dedicated full-scale computers are needed for that – but they will have the ability to allow students to set up and type wiki pages, create blogs, work on common projects and documents, use social networking sites to comment and converse on science topics, and share their ideas with the world. Once our Elements Unearthed podcasts are uploaded, the iPad will be an ideal platform for viewing and commenting on the results. A teacher can assign a podcast to a student or group of students, then have them report or present on what they saw. Students who miss the class can go to the teacher's blog and download the assigned materials (videos or .pdfs) and get caught up. Students in different parts of the country (or world) can connect with peers in other classes and collaborate on research, experiments, observations, etc. The age of Citizen Science will be enabled by the iPad.

By adding the iWorks software to the iPad, Apple has made it more than just a platform to watch or view content (as is the iPhone or iPod Touch now) but also a platform for developing and creating content, including desktop publishing and layout (Page), presentations (Keynote), and spreadsheets (Numbers). There are many advantages for encouraging students to develop and create their own educational content. Gone are the days when a student types a research paper that only the teacher will read.

## *The Ultimate Educational Game Platform*

There has been much resistance on the part of teachers toward using educational games in the classroom. The reasons aren't about the educational virtue of the games; it has more to do with deployment of the games so that the whole class can play them at once. So far, most games have been played at console or laptop computers; generally a few students clustered around one machine and the rest of the students working on exercises or other textbook-centered activities. If every student can have a game-capable machine at the same time, and if those games can be networked so that teams or individuals can compete against each other from different machines, then the educational games become much more palatable for a teacher. Instead of scheduling the computer lab two weeks in advance in the hope that some football pep rally won't come along and derail your plans, a teacher can play the games any time in his or her own classroom.

The iPhone and iPod Touch have proven themselves to be excellent game platforms. Their main limitation has been their small screen size and the reduced pixel count necessary for the graphics in these handhelds. With the iPad, the screen has all of the touch sensitivity of the iPod Touch with much higher resolution, allowing for a whole new line of dedicated iPad games and custom apps. This is where the iPad will truly shine.

When I taught chemistry courses, at the end of each unit the day before the unit test I would develop a review game; something simple like a Jeopardy-style quiz or Concentration game. I would draw these up on the whiteboard and have them played by teams. Those same games (and much more) could be programmed into an iPad application called "Elemental Mentals." The

interface would be a virtual lab bench with chemistry apparatus, such as beakers, test tubes, and Bunsen burners, on it. Each piece of equipment is a button that takes the student to a game or several games on a related topic, such as the periodic system, the history of chemistry, or chemical formulas. On the day before a unit test on a particular topic, the teacher could hand out the iPads and assign the students to play the game or games as a review, either individually or in teams. The same type of interrelated review games could be done for any science course, and take advantage of the iPad's capabilities.

As a teacher of Media Design courses, I taught my students how to develop interactive projects using Adobe Director and the Lingo programming language. Each student was required to design, create, build, and program a game related to a specific topic; one year, we were involved in the Mars Exploration Student Data Team program which allowed us to access and analyze scientific data coming in from space probes orbiting Mars. We not only developed the ability to use Mars 3D altitude data to create animations and build geographical models, but the students also developed a series of games about Mars exploration. One was a matching game to place images of Mars probes in their correct places on a timeline, or a jigsaw puzzle of Mars features, or a Concentration game about Martian geography, or a game that allowed us to fly over 3D land forms rendered using Shockwave 3D. The concepts of these games could be ported to the iPad. I am very familiar with game interface design, and although I am good at Lingo, I do not know the iPad SDK and would need the help of programmers or a development company to bring these ideas to reality.

As a final vision of possibilities, here is an idea for a little game I'd like to develop for the iPad called "Mendeleev's Maze of Madness." The basic point of the game is to work one's way through a building built like the periodic table of the elements; each element is a room in the tower. The player(s) would enter in the middle of the Actinides (say at americium) and work their way room-to-room, element-to-element to the top of the table (hydrogen) in order to win the game. Unlike a standard maze where there is only one correct path, this maze has as many paths as the player wishes to try out; one can go any direction up, down, or sideways in the table. Each doorway has a puzzle or challenge to solve; if the player can't make it through one door because the challenge is too hard, he or she can go another way. The challenges will be related to the element the player is trying to enter; for example, to go from zinc to copper, there will be a type of slot machine that randomly chooses copper compound formulas; the player must type in the correct English name for that compound. Once five compounds have been correctly named, the door will open. I see this game as being fun and motivating, but also highly educational. It will be playable by individual students or set up as a multi-player game (each player has a time limit and they can meet each other and work together) playable over the Internet.

These are just a few of the possibilities of the iPad as a science education tool. Just as the applications that have been built for the iPhone have been creative and surprising in their versatility and usefulness, so will the apps for the iPad, with even more content being created specifically for use in educational settings. Science classrooms won't be the only ones that will benefit from this new tool; one can imagine how they might be used to teach languages, English, history, math, cooking, art, perhaps even PE.

As an independent media designer and science education content provider, I am excited about the prospects and hope to see Apple truly get behind the iPad as an educational tool, marketing it to classrooms in the same way they have so successfully done with other technologies. The possibilities are endless.