iSlate 1 - iWeight

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Release of educational software Mock-Up,
Teacher and developer information
iSlate Product Team, November 2010

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Contents

Abstract
1.0 Introducing iPad to the Classroom
2.0 Project Origins
2.1 Learning math using an interactive simulator
3.0 Motivation as an important factor in learning
4.0 Product Development
4.1 How to use iWeight
4.2 An example of a task
4.3 Pedagogical support
4.4 Technical overview
5.0 Challenges related to the product development
5.1 Future development – if you plan to develop educational software
6.0 Phase Two
7.0 Conclusion
Appendix:
Technical information
Product Sheet
References
Abstract

A group consisting of civil engineering and cognitive science students have during the larger part of this autumn term collaborated using the SCRUM method in finding a good use for the iPad in a school setting. By using an interdisciplinary approach of research, graphic design and interaction design, we have made a small, fully working program that can be run on the iPad, using some of its strengths.

The project is developed with students from age 11 and onwards in mind, focusing on what use they could have of a small program helping them build on their math skills, grounding them in real physics by using interactive scales, with a further potential for learning equations and other, related subjects. By using the iPad, the students can work alone or in small groups, in the classroom as well as at home.

We have based our work on research in cognitive science concerning learning, understanding and motivation, and have bent our collective creativity to making something which could be potentially useful. Abstract ideas have found an expression in an interface and the underlying programming architecture by using the constraints and affordances of the machine, and this meeting of minds has been quite fruitful.
1.0 Introducing iPad to the Classroom

One of a teacher’s primary tasks is to monitor the students’ progress so that they don’t get on the wrong track, because progress based on false knowledge will lead to problems when the individual tries to understand other phenomena that are based on this previous knowledge. One possible solution is to use technical aids. If you are a math-teacher seeking new ways to integrate educational technology into the classroom, there is a number of benefits of using the new iPad from Apple, as part of daily teaching, or for homework. iPad has been highlighted for a number of positive attributes that make it ideal in a school context. The iPad is very handy, it consists of merely a big screen and is much more mobile than an ordinary computer. You can use it alone, but in a school context, one of the main benefits is that children can use the new interactive blackboard in minor groups. When used with educational software applications of high quality, the intuitive, interactive, and tactile nature of the iPad makes learning quite appealing and fun for the children, as well as the teacher. However, as a teacher you should also consider the negative consequences that the use of an iPad in the classroom may cause. By introducing new technology there are always side effects that sometimes are hard to predict. A possible disadvantages when using educational technology in a classroom might be that the computer and/or the software applications becomes too much play and too little learning, that the activity is too much anti-social and that it fails to inspire the individual.

2.0 Project Origins

In the beginning of the project we contacted a teacher working with the relevant age group. The teacher shared with us that mathematics can be very tricky for some individuals, especially fractions, negative numbers and equations. She also mentioned that the current software available was mostly used for quantity practice rather than quality. This sparked our interest in providing an application based on quality learning and the concept of equations. The next step was to develop an iPad application that for some part integrates the six criteria that Peter Gärdenfors refers to in the book Lusten att förstå (2010). In chapter eight he describes how technologically supported learning materials should incorporate narrative forms (e.g. text, numbers, pictures, movies) in the presentation of a given task. The technology should also be adaptable to the individual’s learning style, and support collaboration between students, as well as building a bridge to metacognition. If technology is to function optimally in a learning situation, it is of great importance, that the educational software is based on relevant interaction features and include modules for feedback. The idea of collaboration is also shared by Donovan and Bradsford, as they talk about the importance of making the student’s way of thinking visible through math talks. When talking about mathematical thinking and even making drawings and sketches of a given task, it can help you solve a complex math problem. (Donovan & Bradsford, 228).
2.1 Learning math using an interactive simulator

“Since ancient times, man has tried to understand the world we live in and our place in it. First through legends and later on with the help of scientific theories, chief among them physics” (Gärdenfors 2006, 65). “In understanding physics we learn that not everything has purpose” (Gärdenfors 2006, 81). The world of mathematics offers a variety of concepts and methods, and not all are easy to learn. Some concepts are difficult to acquire through traditional blackboard based teaching, because the children find it almost impossible to visualize a complex math problem, perform calculations on a mental level, rearrange figures and abstract shapes in the mind, and at the same time adopt what the teacher is saying aloud in a lecture, or describes at the blackboard. “Activity such as arithmetic problem solving does not take place in a vacuum, but rather, in a dialectical relationship with its settings... the most relevant theoretical traditions do not take experience in the lived-in world as their analytic object” (Lave, 148)

A well known problem is, that if you don’t understand a given math task, you might not have many clues to lean on. With language it is different, if you don’t understand a specific word, you might understand the other words and then build up a scheme for understanding the whole text. Donovan & Bransford (217) describe why associations with mathematics are so negative for many people, and one classic misunderstanding is, that the teacher or the textbook focuses too much on the instructions (rules to be used in order to solve the task), rather than focusing on the reason for solving the task. All these procedures and rules, in the end, disconnect the student from reaching a metacognition level. The student ends up with only a weak understanding of the rules to be followed in order to solve a given math task (The I know that theory), and they might fail to reach the I know how level, where they can apply and transfer their knowledge of a given math task to another situation in daily life (also described by Bransford and Schwartz in: Rethinking Transfer: A Simple Proposal With Multiple Implications).
Viewed from this perspective it is a major challenge to encourage children towards the metacognition level, but not impossible, because we are all born with an awareness of numbers as well as with language. Brazilian street children are able to perform mathematics and develop strategies for making sales in the street, but they fail when they are presented to similar tasks in a school task, because they can’t build a bridge between informal and formal mathematics (Donovan & Brandsford, 219).

The universal awareness for numbers and calculations however indicates, that things could be changed if only the learning conditions are set up to support the way we intuitively plan a strategy and solve a mathematical problem. We believe that one solution to this problem could be the use of a weight simulator. You can for some part move the real-life situation back into the classroom. Of course a simulator is not as complex as the real world, but it can illustrate the connection between the abstract math and real life situations, and in this way strengthening the mental performance of the individual.

The iWeight application builds on this concept, however as a teacher you should not rely on this technology platform alone, but always ask the question, what your role as a teacher is in the planning of the learning process, when the simulator does half of your work. It’s important that the application is designed in such a way that the students can not solve a problem by testing all possible combinations, because the aim for the application is to enhance the students’ mathematical skills. This is something we need to have in mind for future development.

An added bonus of the technological platform is, that the real-teacher is visible as a virtual teacher (through the iProfessor icon), so when you are at home, and need to get in contact with your supervisor, you are not completely lost.

**3.0 Motivation as an important factor in learning**

Peter Gärdenfors (2010, 68) claims that motivation is an important factor in learning new skills. If you have motivation to do something you will put more effort into it and perform much better. When emotionally invested in a problem the individual can reach new heights and has the perseverance to understand even the most intricate problems. Most individuals will however also face problems during the acquisition of new skills.

For most people, it takes lots of practice in order to improve, even if you’re talented or enjoy what you’re doing, but because not everybody is the same, it is important that the teacher allows for some flexibility when deciding on how to address the children. If you have confidence that your ability is worth building on, and a purpose to find some goal or other, it is possible to keep your faith and apply yourself even when things do not go as well as you would hope. It is also important that there is a gradual increment of the level of difficulty, rising the bar just slightly ahead of the expanding knowledge base and skill set of the student to make rising to the challenge a tempting prospect instead of an insurmountable task. But most importantly, the whole experience should incite interest and inspire the student to learn more about the subject in an easy setting allowing for several ways in solving the problem, while at the same time having some option for the teacher to gain an insight into the reasoning of the student.
4.0 Product Development

The iWeight Application features a welcoming and child friendly design, with a set of vibrant colours and easy to reach icons. As the objective of the application is to support children’s learning processes, we have used a simple graphical interface, which consists of only a few screens, each introducing a particular main function. In the application, all the objects, text and numbers that are not able to be changed are set in black e.g. the description of a task, the numbers to use at the sketch paper, or the library text. However, the objects you may interact with, are set in colours. We have also tried to divide the screen in a consistent way where the same areas perform similar function throughout the program. Many such guidelines are promoted by Apple. This design, of the application itself as well as the interface, is meant to build on theories we have learned during previous education, e.g. from the field of cognitive science. In order to remember important information, one should try to intelligently reduce the amount of information on screen. We did that by categorizing all the information into only a few – but hopefully meaningful features.

The children navigate through the application by touching the screen and by dragging and dropping objects from the menu line. The graphical interface is currently built in landscape format, but with the future possibility to change it to portrait format, only by moving or shaking the iPad. The design supports the reading direction (upper left to lower right), and has a good usability for both left- and righthand users.

We think the idea of using your fingers to touch the screen and pick up, drag and drop information or plan an action on a higher level, supports how the human brain really works, and in particular how children initiates actions, when we are placed in natural environments. For example, we draw a message in the sand with our finger, use our hands to reach out after objects of interest and plan cognitive strategies on the basis of information gained from our surroundings. An important idea in this project was to not use a computer-mouse, but to use your own hands to grab information from the outer world to your inner mind, and reverse.

4.1 How to use iWeight

Now let’s have a short introduction to how you use iWeight, both as a teacher and a student. It is important to notice, that all main features are not realized at this stage, but only described on a conceptual level, and for a minor part then followed by a sketch in our Lo-Fi Prototype sketchbook, and maybe realized by a program code. However programming takes time.
When you press the iWeight button at the desktop at your iPad, the application opens, and a welcome screen introduces the application. Here you see a animated scale. You can turn on the sound button in order to get a verbal two minute introduction. When the animation stops, a log in page is shown. Choose either iProfessor log in, if you are a teacher and has received a password and license to use the application, or choose the student log in button. The children fill in their name and class, and the application immediately recognize their handwriting, and accepts the individual, if the teacher has signed them to a given class.

The next step for the child is to choose a math level. Each child has their own page, describing learning goals, and what assignments to fulfill during the semester. At this page the child can also read feedback notifications, see results from previous tasks, and gain rewards, e.g. fruit symbols or interactive sound buttons, related to a given task, which the child has succeeded in solving.

As Lisa from class 5b already has logged in, the application has recognized her, and will soon offer three different assignments to choose among, unless the teacher has decided all the children should solve a common task.

The iWeight application features two main levels, one where you work with real objects on the scale (e.g. fruits), and a higher level, where you work only with symbols and numbers. At the second level you don’t have any visual references to real life situations to lean on. Both levels present math tasks ranging from simple to
When you have chosen the assignment to work with, the application will direct you straight to the iWeight Simulator and Assignment Screen, where you start preparing to solve the different tasks in today's assignment, which is presented to the right of the screen. If the text is difficult to read just zoom in with two fingers moving apart from each other (a standard feature in iPad).

To the left Lisa very quickly spots the iWeight simulator and starts to drag objects on the scale. We hope her reaction is like this; “Oh, this is fun!” But soon she will realize that in order for the fun to continue, she has to activate the Sketch Paper by a touch on the paper icon, and start solving the task. A pop-up screen introduce the interactive Sketch Paper, where Lisa can write down her thoughts and calculations.

**4.2 An example of a task**

In one of the tasks, Lisa has to figure out how many hay bales of straw a farmer has to produce in next year's production, in order to fulfill the needs of all the animals at the farm. First Lisa must count the total weight of how much straw (weight) each animal needs, then she finds the results for how much straw all the animals needs, and at last she has to figure out if the farmer has space enough for all these hay bales of straw. This is quite a complex task, but can be solved in multiple steps.

In order to motivate Lisa, she can look up different subjects in the iProfessor library, and here we placed a central text for understanding weight and volume, as well as
information about the life of a farmer. This information might in future development be supported by a sound feature of e.g. the sounds of animals living at a farm yard.

If Lisa needs help, there is of course also the possibility to ask the iProfessor, which is actually her teacher, but could also be a parent, a grandparent or a friend, this is done by sending an email. When she has finished the task or closed down the application, she will be asked to email the result to the iProfessor as a pdf file.

4.3 Pedagogical support

The application comes with a help function and an introduction paper, describing all included features and examples of learning tasks. The instructions will also serve as guidance to how the teacher should upload assignments as word documents, as well as uploading library papers and images. A main idea of the concept is also, that this application should invite teachers from different fields to work together.

Why not collaborate with a colleague from another field, and set up tasks like how to calculate energy in a meal? As part of future development, we plan to present a webpage, where you can share knowledge with other iWeight users, seek further inspiration and get support on how to design cross-scientific weight tasks for children.

4.4 Technical overview

In order to get the development tools, iOS SDK 4.1 and Xcode 3, our developers had to get Apple development certificates. Our device and application had to get IDs signed to them so that the application could be tested on device.
Used Apple's own programming language Objective-C for the iPad development. The application is also using the open source framework Cocos2d, which has the physics engine box2d included.

5.0 Challenges related to the product development

The biggest problem has been to come up with a good idea for the application, and ideas take time to develop properly, on all sides of the project both from a conceptual, educational, and technical point of view. We tried to base it in cognitive science concerning learning and understanding. But to get the final result look like the conceptual design is always a challenge. On the technical level the major problem has been that the production team is still new to working with objective-c and the cocos2d framework, which causes things to take more time. We have also tried out different solutions for a weight simulator, and at this point we have sketch out three different designs for an interactive weight, that fits the layout of the iPad screen and tried to get it to work from both a technical and conceptual (task-solving) perspective.

We think that all team members have contributed with personal ideas and solutions. In a later stage the challenge was to compare ideas and find the best option through discussion. We have worked this way at least a little, which was good. However, we then went more into handing out roles, due to time constraints. It might have been better if we all could have worked at the same location for a week or so. Face-to-face communication would have made the process easier, and we had been able to share and compare ideas with regards to both the conceptual and technical design in a more natural way.

We used the SCRUM methodology. Its advantage is that there is more focus on getting things done rather than how to do them. With an agile method the workflow can be more dynamic and it’s easier to change things. A disadvantage is however that it’s harder to know exactly what is to be done, because you can easily set another agenda from one minute to the next. Writing things down on small index cards is very good, and short, intensive meetings can be a good way to start off the work day. But in the end it all depends on the people, and whether you click or not. And also, some projects are probably less ideal for the SCRUM method than others. If we would have had a budget to deal with, it might also have encouraged us to streamline our work. However working towards a common goal does release a sense of team-spirit and the feeling of being member of a community, which can be very inspiring.

5.1 Future development – if you plan to develop educational software

For an application such as this, the goal is to keep everything very basic from the beginning and from early achievements build a vision on what might be in the future. Try to keep things simple or at least feasible. Start small and then try to expand on your original idea. It is tricky to combine abstract ideas with technical limitations. It is often good to shoot for the stars, but it can be frustrating if the goals are never achieved.

Try also to be very clear in defining your conceptual and technical problems, and with regards to managing the project, you should formalize the way communication is made and agree on certain milestones, with regards to how ideas, information and knowledge shall be shared both at face-to-face meetings and when communicating by e-mail, for instance when planning date and time for a meeting with a client or
supervisor. The client should of course get the feeling, that you are professionals, this effectiveness will save you from unnecessary speculations, and save time to do, what really needs to be done.

It is not unlikely that project members sometimes have very different visions of how the application should work, for instance due to different background in education, interest and age. In our team we met this kind of challenge several times. Sometimes the uncertainty of what was expected of our team was a bit worrying. However this is also a very common aspect in real-life business settings, and the only way to react to this problem, is to face the client or in this case the SCRUM master of the project and ask about what expectations they have with regards to realizing a specific goal. This reduction of uncertainty should be improved by us in future projects.

We think it is very important to quickly get some kind of prototype out to potential customers. SCRUM facilitates this idea by short sprints and focus on deliverables. There is so much knowledge and so many great ideas hidden everywhere and they might only surface by such stimulation as test groups.

6.0 Phase Two

In the second leg of this two-parter project, we tried to refine the product, which meant that we abandoned or backburned some ideas while trying to build on the ideas we felt were most realistic. We also tried to keep the course name, interaction, in mind; how did the developers interact with the program, how did our test subjects fare, and how did we, as team members, interact with each other?

If one should outline the content of the second course, our work could be categorized into three levels: At one level, we have been working with interaction from the perspective of how test subjects interact with the technical equipment (the iPad and the iWeight application). On a second level we have explored both the highlights and the difficulties, which a product developer team meets, when they interacts with an iPad. It is not always easy to realize an idea on a technical level, even though you might find it original on a conceptual level. To make a math task designed for a special undergraduate level is likewise difficult if you do not work as a math teacher. The way we as a developer team think of math, is most likely very different from what motivates a nine year old girl or boy. Then on a third level there is the schedule perspective, and the question; How interaction takes place between group members. Did we understand each others intentions, did we collaborate, did we listen carefully to each other, and did we all participate in the process of developing this iWeight application.

This time around, we tried to use the SCRUM methodology more, in that we met more as a group every Friday, working for several hours together. That meant that we could bounce ideas and give instant feedback. In phase one, our meetings were much more hap-hazard, and shorter, something that was easier to fit into schedules but not really conducive to SCRUM teamwork. We started by trying to come up with assignments that would work with our application, taking inspiration from old standardised tests and teachers’ forums as well as real-life events.

The most rewarding in this second course, was the unique possibility to test the application and see how our concept was received among different groups of users. As a product developer team you might find you idea original, but you would not know if other people thinks the same, unless you test the application. We got very
valuable information from the two different test experiments – and even though we did not set up a completely professional experiment, where you carefully decide what information, the participant should be given previous and after the experiment, as well as writing a set of ethical guidelines and a project description to be handed out to the user, we still managed to get some important feedback from the two test situations.

For the half-time account day, we had entered one of our assignments into the program, making it possible to really interact with it in a way that was closer to our initial ideas. Our test subjects, comprising a small selection of course mates and supervisors, got to see the half-finished product and were challenged by the assignment. More concretely, we realised after the first testing that we needed a waste-paper basket, as the earlier option of getting rid of weights and other objects was not intuitive. We also added a counter beneath each icon in the row at the top, as the layout makes it a bit hard to distinguish between objects in a crowded pan. A slightly frivolous but early idea was finally implemented; the possibility of erasing the session by shaking the iPad. Another addition was the option of entering the answer right beside the assignment instead of having to go to another screen. Since we had made that possible, we removed that whole second page, with the sketch-paper option seeing as nobody had availed themselves of the opportunity. We were still fond of the idea, so we kept playing with different means of implementing it in a different way. We also realised that we needed to reword the assignment, as it proved a bit difficult even for graduate students, and some of the icons we thought would be obvious turned out to be more obscure than we had realised, so there was some redesigning too.
An interesting observation at the Lovisa School, where we tested five children, was that it seemed much more rewarding for the children to solve a math task on the Ipad together with a friend (in groups of two), than by interacting individually with the iPad. Suddenly they began making conversations about maths, and they continously planned new strategies step by step for how to best solve the task. This was very inspiring to observe. Likewise we were able to observe different and also original ways of decision-making among the children, as they exemplied to each other how a task could be solved. We realized that even though there might only be one answer to the task we gave the children, the result could be found by use of different strategies. This observation is probably not surprising if you are a math teacher working with children every day. But for the product developer team is was interesting to follow the childrens inner thoughts, as they shared their knowledge with their friends. The children were generally were good at collaboration, and they showed great skills in listen to the other test subject. Besides this we were surprised of how good they were in using their memory and do mental calculations. What we learned from this test was, that the application could be extended with more interactive features like sound and video, in stead of describing the math task in a written form. The children had some issues with our program, which we tried to address. We found out that even our reworded examples were a bit difficult to understand, as there is a fine line between making assignments too hard or too easy, something we of course had no prior experience in doing. The waste-paper basket posed some difficulties too, as it was still necessary to drag and drop the items, whereas the children’s intuition told them to just fling the objects in that general direction. They also had a bit of trouble figuring out how to respond using the counters.
Future possible developments include a) an alternate presentation of the assignments, perhaps through watching a small animation, b) the possibility of throwing objects into the waste-paper basket, c) a more obvious way for the user to know where and what to reply, d) better feedback to the replies, not just by a pop-up and e) the option of using a semi-transparent, drag-down sketch-paper. This latest development is actually implemented as of this week-end.

7.0 Conclusion

As we joined this course, we did not all have the long list of professional skills one might wish, as a product developer team. And since we did not have access to inhouse graphic designers, as one group member asked for, we had to roll up our sleeves and do the work ourselves, from programming, to making a graphic Lo-Fi prototype and write a simple math task. Arm-chair thinking can not be underestimated, but what we got from this second course was invaluable information about design, communication and usability, which we can draw upon the next time we sit in our Arm-Chairs and make original plans for future product developments. The highlights of being part of an interaction process, as we tried to implement our features was for instance the times, where a group member would create an icon for the application, and then the technical staff would continue working on that icon and
make it interactive, like e.g our waste basket, where you can open or close the lid or e.g. the pencil and eraser icon from the sketchpaper, which the user in an earlier version of the application could activate with a touch, and use when drawing with the fingers upon the screen or erase the text again. Here the technical staff demonstrated a great sense of creativeness.

Did we succeed in developing a math application and weight simulator for iPad? If our goal was to create a finished product, then we are still far from the target. However if the aim in itself, was to learn to manage group processes, collaborate, share knowledge and work together in teams to develop cross-interdisciplinary projects, then perhaps our more realistic goals were met. We have experienced both the difficulties and the rich opportunities, that are created when several minds try to cooperate towards one common goal. A project like this broadens ones horizon, and you are better equipped when it comes to being a part of future projects in real business or scientific settings.

With regards to the iWeight simulator, it is our hope that children one day can solve mathematical equations and problems by paper and pen with a better knowledge of the abstract thinking after training with our math simulator. The aim is that children like Lisa (used in our example) can connect the real-life situations she encounters, with a new insight into different kinds of maths and physics, and get a widened understanding of other science subjects.

When and if this is within reach - we are indeed very satisfied.
Appendix

Technical information:
The iWeight Application runs on iPad, and requires iOS 3.1.3 or later version.

Product Sheet

iWeight is an Educational Software Application for learning Maths, specially developed for children 9-12 years of age. This software teaches children to calculate weight and to understand the concept of mathematical equations, and also tries to give an intuitive feeling for weight and balance.

A special feature in the Application is the interactive weight simulator, where the children can balance weight bricks or real world objects like fruits, animals and vehicles, which they drag and drop from a menu bar. The simulator counts the total amount of weight interactively, and the user can follow the change of the balance visually.

iWeight also features an interactive sketch paper, where the children are able to write down their calculations and thoughts, as they solve different predefined assignments. If they need help, they can either look up a subject in the iProfessor library or email a friend, or their teacher.

iWeight is an excellent application for children to have fun with, both individually or in groups, and at the same time learn a serious topic in the world of mathematics, that has traditionally been difficult for children to understand the significance of, when presented in classic textbooks or on a blackboard in traditional classroom lectures.

References


