PABOCOMMUNITY

Enabling student collaboration with multitouch tablet computers

A Design for Interaction graduation project by

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Introduction

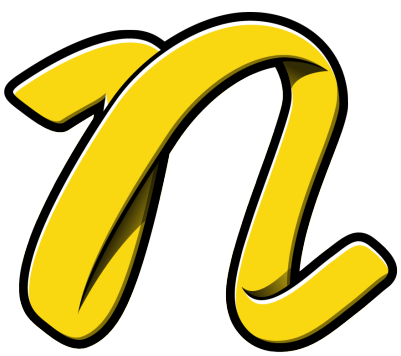
This report details the graduation project of Bruno Scheele, master student at Design for Interaction (DfI) at the faculty of Industrial Design Engineering, Delft University of Technology. The project was done in service of Noodlewerk B.V.

The goal of the project was to research methods that would improve learning of college students through the use of multitouch tablet computers. The report will outline the entire project, named '*Enabling Student Collaboration with Multitouch Tablet Computers*' and describe the development of PaboCommunity, a collaboration e-learning application concept for tablets.

The project ran from November 1 to June 1, 2011 and was done in cooperation with Martijn Thé, CEO of Noodlewerk B.V. The graduation committee consisted of chair ir. Jouke Verlinden, assistant professor, at the department of Design Engineering, and mentor ing. Aadjan van der Helm, design researcher at the department of Industrial Design, at Industrial Design Engineering.

Noodlewerk B.V.

Noodlewerk BV. (Noodlewerk) is a company which specialises in creating mobile applications. Noodlewerk already has an impressive portfolio of successful projects, however these have all been done on behalf of clients. They are now interested in expanding their portfolio with their own applications and are looking for markets for which they could start developing.



One of these markets is the educational sector, in which the drive to innovate is always present. A mobile application that would be beneficial for education would definitely large potential market.

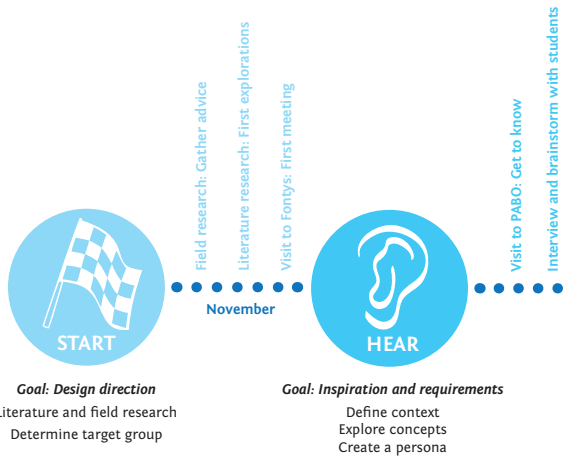
Noodlewerk's focus on iOS [1] (Apple's operating system for mobile devices) devices allows them to look for opportunities centred around *multitouch tablet computers* (*tablets*), particularly the iPad [2]. Since the features of tablets, compared to other personal technology, are particularly suited for educational purposes (see Appendix A), tablets become very interesting to use when exploring opportunities for the educational market. Because of this, the tablet has been used as the platform for this graduation project.

Project Goal

Together with Noodlewerk and following the advice of the graduation committee and the guidelines of Industrial Engineering, we came up with the following design goal for this graduation project;

"To design a mobile software concept that makes use of tablets and can enhance education for students."

Figure I. The five phases of this graduation project.



Methodology

The project was done according to the human centred design approaches taught at DfI, which centres around getting to know the user in an early stage, using an iterative design sequence driven by user feedback and literature research and analysis.

This report has been structured according to the human-centred design approach coined by IDEO, which makes use of three phases; *Hear*, *Create* and *Deliver* [3]which fits the project process rather well. Additionally, the literature research and analysis that was done prior to getting to know the user (in Hear), will be explained in *Start* and our final conclusions and recommendations will be given in *Finish* (Figure I).

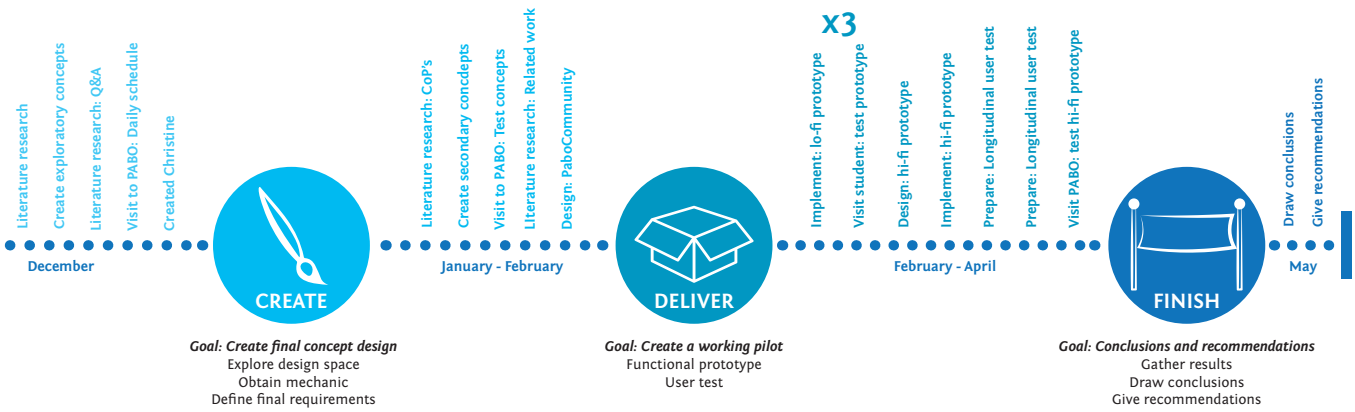
In *Start*, we want to obtain a proper design direction. In order to do this, an analysis of different aspects of the project is performed, such as the tablet and technology's impact on education, through *literature and field research*. This allows us to find a *design opportunity* for this project. We will use this research to determine an appropriate *target group* as well. Using the results of the analysis and the target group we come up with the *design direction*.

The goal of *Hear* is to obtain *inspiration and requirements* based around the target group's context and needs. In order to do this we narrow down our target group for a more focused design and learn more about them through *interviews and creative sessions*. Using these results, *exploratory concepts* are made to further sensitise them for the project and to learn about a need of our target group which the design should fulfil. In the end, this yields a *persona* representing the target group and a set of requirements for the final design.

Create is where we complete *our concept design*. By first creating sacrificial concepts to explore the *design space* for the final concept and getting the target group's opinion, we obtain a *mechanic* which, if implemented properly, will fulfil the design requirements and fulfil our target group's need. Afterwards, a design is made around this mechanic.

In Deliver we create a functional prototype of the completed design. Using an iterative design approach, consistently more sophisticated prototypes were made. For each prototype, a user test was held, to obtain new insights for the next iteration. The final iteration consisted of a high fidelity prototype on which a final user test was held. The results of the user show us the viability of the design.

Finally, in *Finish* we gather all the data we collected during this project and see how PaboCommunity fulfils the different requirements and needs that we encountered. We will end with the conclusions of this graduation project and with recommendations for future research.



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EXECUTIVE SUMMARY

0.1. Introduction

Seven months ago, I was looking for a graduation project for the master Design for Interaction at the faculty of Industrial Design at the Delft University of Technology. Through my supervisory team mentor, ing. Aadjan van der Helm, I came into contact with Noodlewerk B.V., an upcoming iPhone and iPad application development agency.

Noodlewerk was interested in creating their own projects, instead of working only for third parties, and were exploring areas in which they could expand. Together with my supervisory team, chaired by ir. Jouke Verlinden and Noodlewerk, we started looking at the educational market and how a tablet application could help that market to improve education.

And now, we are proud to present:

PaboCommunity

An application that will *enable student collaboration on multitouch tablet computers* and in this way will improve their education. In this executive summary, we will guide you through the most important aspects of PaboCommunity and explain why it will be a successful tool in today's higher education.

We will go through the design and the result of its multitude of user tested iterations. And after that, we will show you the current state of the design (Figure 0.1) and what the future work should be done that will improve it further.

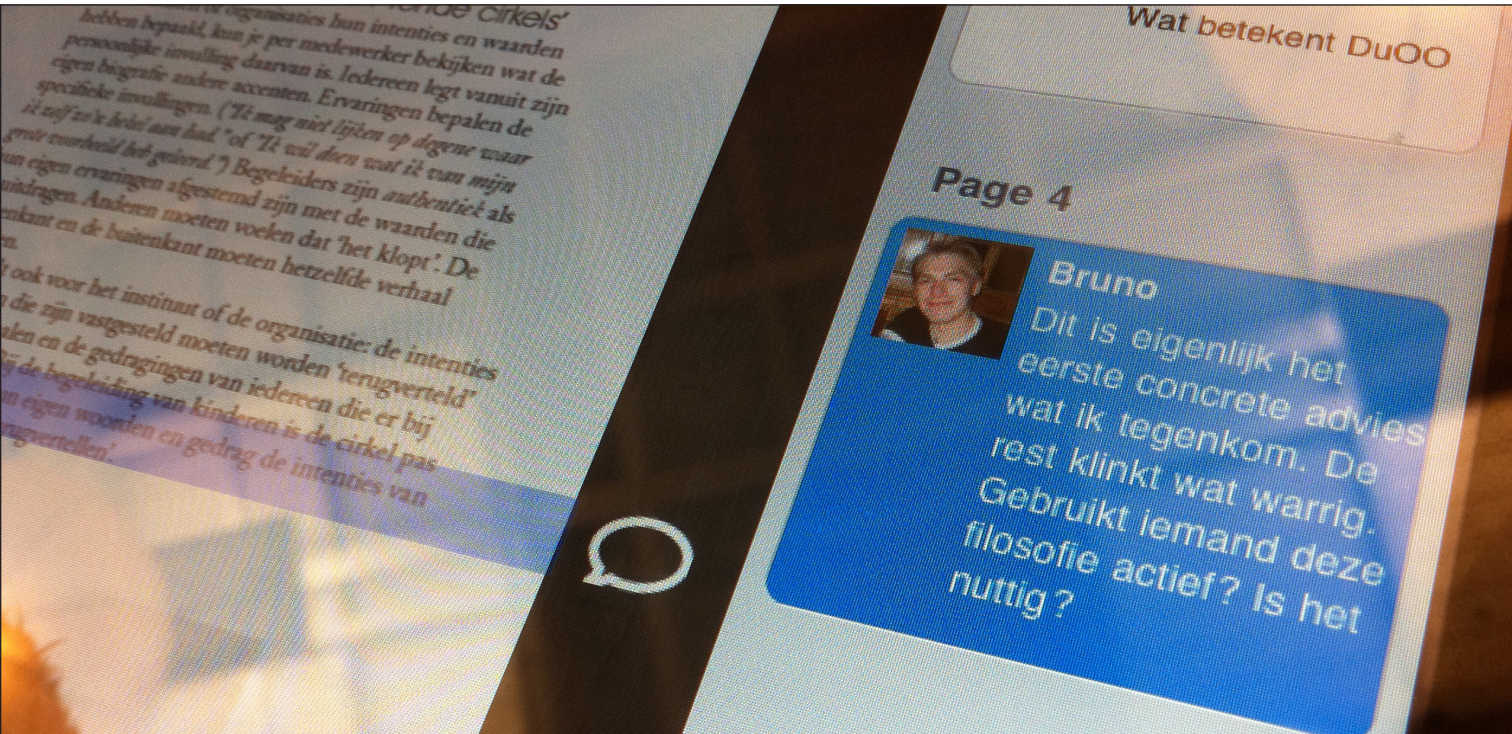

Figure 0.1. A closeup of PaboCommunity's high fidelity prototype in action.

Figure 0.2. The different technology spaces and the tablet's place between them.

0.2. Educational technology

Today's technology is evolving rapidly, allowing people to perform more and more tasks with less devices and in less time. Technology is also becoming a defining force in education, but not without some difficulty.

Technology has been very beneficial for education in the past, but certain limitations have always prevented a smooth integration. Improper interaction design or lack of teacher training have obstructed many technologies from becoming ubiquitous in schools, colleges and other educational institutions.

The form factor of many devices brought limitations, with smart mobile phones having a very tiny screen unsuitable for reading large texts or collaborating in groups. On the other hand you have either desktop computers or laptops, which are just slightly to unwieldy to be used at a moment's notice or surface tables, which work okay in groups, but are immobile.

However, the tablet has solved many of these issues by combining the flexibility of smart phones with the larger screens of laptops This gives tablets their own position between educational technology spaces and an enormous potential for being used in education.

0.3. Aiming for collaboration

Tablets have many features that fit perfectly within education, but there are already many applications for them which offer some kind of educational benefit.

In order to stand out amongst the crowd, PaboCommunity will focus on enabling collaboration between students, an area which remain sadly less explored. Until now...

Collaboration has many benefits for education, none the least that it helps all the people involved to learn better and thus improves your education.

By putting its roots in collaboration theories, such as ubiquitous learning, communities of practice, computer supported collaborative learning and collaborative strategic reading, PaboCommunity aims to improve collaboration between students.

And because collaboration is mostly centred around asking and answering questions, PaboCommunity will focus on this mechanic to achieve its goal.

0.4. Meet Christine

Figure 0.3. Meet Christine, our average PABO student.

Without a suitable target group, a design rarely amounts to anything. Our search brought us to Fontys PABO Eindhoven, who's students are all aiming to become primary school teachers. And recently, many of them have come into possession of a tablet.

The PABO student's (Figure 1.4) concern for education and their newly acquired technology made them the perfect fit for the PaboCommunity project.

Christine (Figure 1.3), our helpful persona, explained about much of the issues that PABO students are struggling with, including:

- Collaboration and feedback is very important at the PABO, where student's have to relate many of their experiences of teaching children and get feedback on it.
- Therefore she wants to remain close to all her peers and mentors, so she always has someone that can help her.
- The things that she like most to use are the very intuitive, easy to get applications on her tablet or computer. An application has to be clear, quick and useful if she is going to use it.
- One thing she doesn't like however is all those heavy books and other study material that she has to carry around. And it's expensive too!

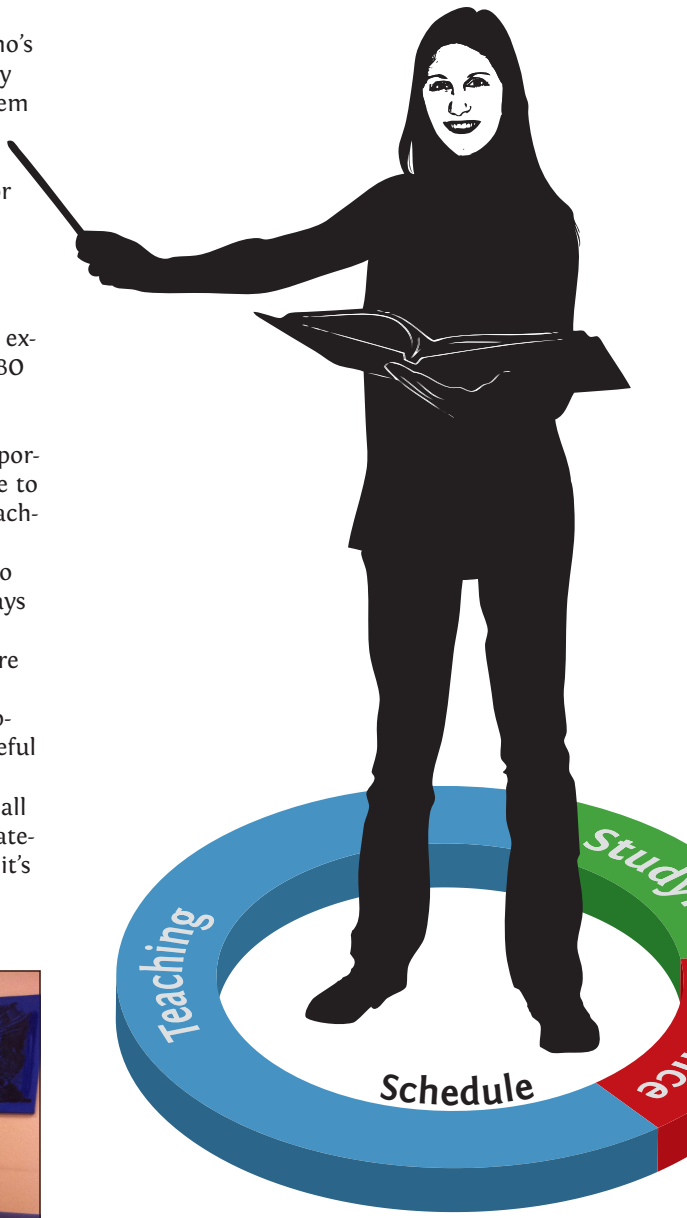

Figure 0.4. The Fontys PABO Eindhoven students during a session.

0.5. PaboCommunity

After many design and many visits to Christine and the other PABO students, PaboCommunity finally crystallised into the following three application areas:

1. an *e-reader* that combines study material with asking and answering questions,
2. a *forum* for questions not directly related to courses or study material (such as experiences of the PABO students) and
3. a *network overview*, which not only lists the chosen contacts of the user, but also all the others that are relevant to his environment.

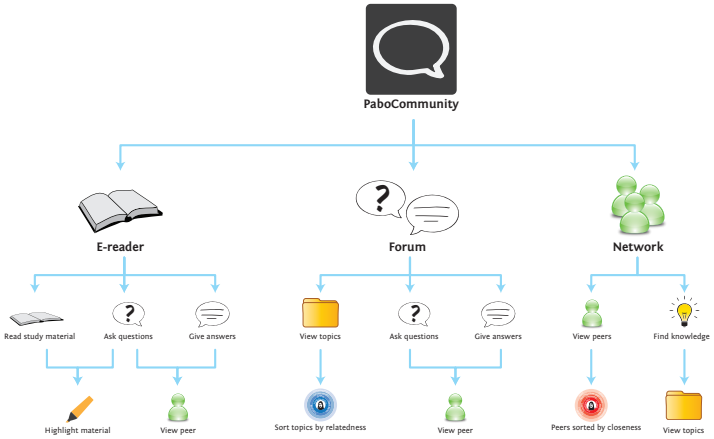

Figure 0.5. The three different areas of PaboCommunity and their functions.

The design of the forum and network area has been deliberately left rough, in order to focus more time and energy into the e-reader area.

The e-reader area has been through many iterations as a low fidelity prototype before finally reaching the phase where it could be implemented as a usable, high fidelity prototype application for a tablet.

At this point, PaboCommunity's e-reader is has become a legitimate design, that has real potential to achieve its goal of enabling collaboration between students.

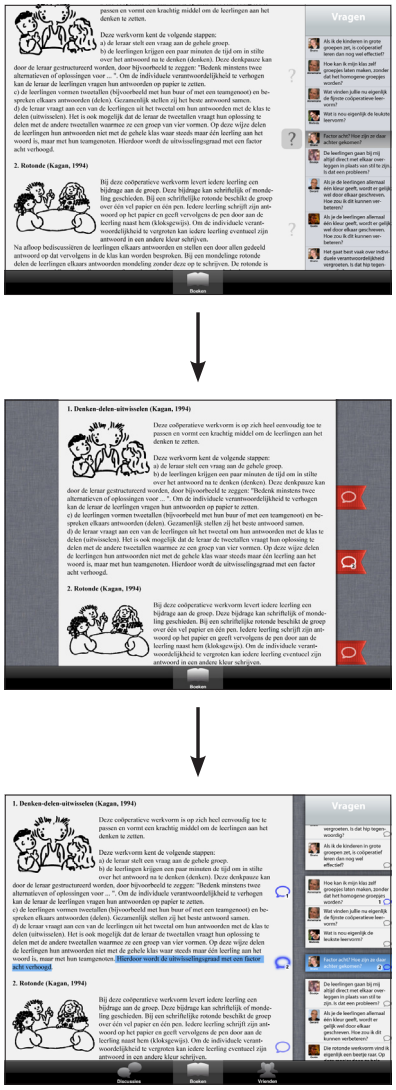

Figure 0.6. (right) The evolution of the interface design for PaboCommunity's e-reader area.

Figure 0.7. PaboCommunity's high-fidelity prototype.

0.6. Current state and future work

Figure 0.8. A PABO student using the high-fidelity prototype to read his study material.

As of this moment, PaboCommunity consists of three areas, of which the e-reader area has been fully designed and implemented as a high-fidelity prototype.

Early exposure of the students to the high-fidelity prototype was very promising. They were enthusiastic about using the prototype and could see how it would work with even more study material inserted in it.

The short and sweet answers that the e-reader area encourages were found to be very encouraging for collaboration and they liked how new activity immediately became clear at the moment where it was necessary.

Thus far, PaboCommunity seems to be a success. However, in order to prove that PaboCommunity really does have an impact on education, we have to prove that its areas elicit more interaction between students that use it to ask and answer questions about their study material.

This has been left for future work on PaboCommunity. There are also some more topics that have to be covered in the future in order to make PaboCommunity into a successful educational tool.:

- The design of the remaining two areas needs to be completed.
- PaboCommunity currently assumes that all students of a study have a tablet. Steps should be taken to see if this can be made possible in the future.
- The current design is aimed at PABO students. However, there are many more studies and not every one of them has the same requirements as the PABO.
- PaboCommunity is used by everyone at the same time. This means you get into problems at moments where duplicate questions may overlap, such as when a college year finishes and new students start on the same course.
- The design functions best if there is a healthy amount of digital study material available for the students to use during their education and with PaboCommunity.

0.7 Conclusion

PaboCommunity is a educational collaboration tool which has the potential to have a great impact on the way that students learn and use study material.

The design is not yet fully tested, but the initial reactions are very positive and the current field of competing tablet applications is very small, allowing PaboCommunity, and its promoters, to shine once it is brought into the market.

As the designer of this project, I sincerely hope that PaboCommunity will find its way into the hands of many students who will then enjoy the benefits of a better education.

Until then,

Bruno Scheele

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START

In *Start*, we want to obtain a proper *design direction*. To come up with this direction, a literature research, combined with field research, was performed to get more information about the different aspects of this project.

Since the 'educational market' is too broad to design for, we have to specify a target group as well. We take a closer look at the possible educational markets, choose the most appropriate one for this design and define our target group from within that market.

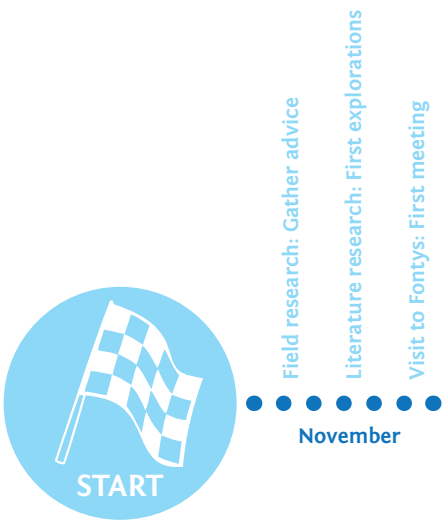
Tablets were the technology of choice for this project, in accordance with Noodlewerk's wishes and the recommendations of the graduation committee. To strengthen this choice, a literature study was performed, which showed the beneficial effects of learning with a tablet (or tablet learning) and of *ubiquitous learning* (section 1.1).

To see how tablets aid this second concept specifically, we take a closer look at the *tablet benefits for education* (section 1.2) and look for gaps in the offering of educational software applications which benefit ubiquitous learning. This showed that there is a lack of *collaborative software aimed at students* (section 1.3).

Finally, we examine the potential educational markets and discuss the choice for higher education as the target market, with students as our *target group* (section 1.4).

We end with our conclusions and based on the tablet benefits (section 1.5)., the lack in collaborative software offerings and our choice of students as the target group, we have come up with the following design direction;

"I want to design something that improves education by allowing students to collaborate more often and effectively, by making use of the capabilities of tablets."



Goal: Design direction
Literature and field research
Determine target group

1.1. Tablet learning

Tablets are, due to their characteristics, particularly suited for education. But because the educational market is centred around giving the best suitable education, it makes most of its decisions based on evidence [4] in order to avoid falling into the trap of adopting every new gadget on the market. Tablets are a relatively new technology and still haven't been proven to the educational market's satisfaction. Therefore it is important to sketch how tablets may benefit education and see whether there is any proof for this. Because if educational institutions will not support tablets in general, then a design for them will not be used either.

1.1.1. Agile space

Examining the concept of tablets, one quickly realises that tablets try to combine aspects of both laptops and smartphones. The devices are nearly as mobile in their application as smartphones, while their larger screen estate allows them to be used for similar tasks as laptops as well.

Ian Wilson has categorised the devices that are commonly used in education in terms of their respective technology spaces and has concluded that tablets belong to what he calls the '*agile space*' [5] (Figure 1.1). This space is situated between the mobility and intuitiveness of the mobile space (e.g. smartphones) and the powerful, yet less approachable portable space (e.g. laptops). These spaces also let us accept that tablets do have their own product category, instead of just being '*a large smartphone*' or a '*small laptop*'.

1.1.2. Electronic learning, ubiquitous computing and ubiquitous learning

The agile space that tablets inhabit suggests that it may be particularly suited to be used for *ubiquitous learning* (*u-learning*). To explain this concept, first we explain two other concepts; *electronic learning* (*e-learning*) and *ubiquitous computing*.

E-learning is a term that is used rather often in this age of digital information. The exact definition of e-learning is still under debate [6]. Experts seem unsure on whether to define e-learning as an umbrella term incorporating every form of learning aided by electronic means [7], or to define it as learning through stationary devices (e.g. desktops), allowing learning through mobile devices to be defined as *mobile learning* (*m-learning*). Since the latter is better defined when we discuss other forms of learning, we'll use this definition.

Early e-learning focused mostly on the transfer of knowledge and experience from an electronic device to the learner. Early electronic devices for which this was applicable were mostly stationary. Desktop computers were loaded with CD-ROMs with the lesson material and a learner was put in front of the computer to interact with the material provided by the CD-ROM. The material could vary from subject to subject, sometimes containing only text and a mediocre navigation scheme, to completely interactive learning experiences, aided by text, images, sounds and animations.

Figure 1.1. The different spaces in IT devices

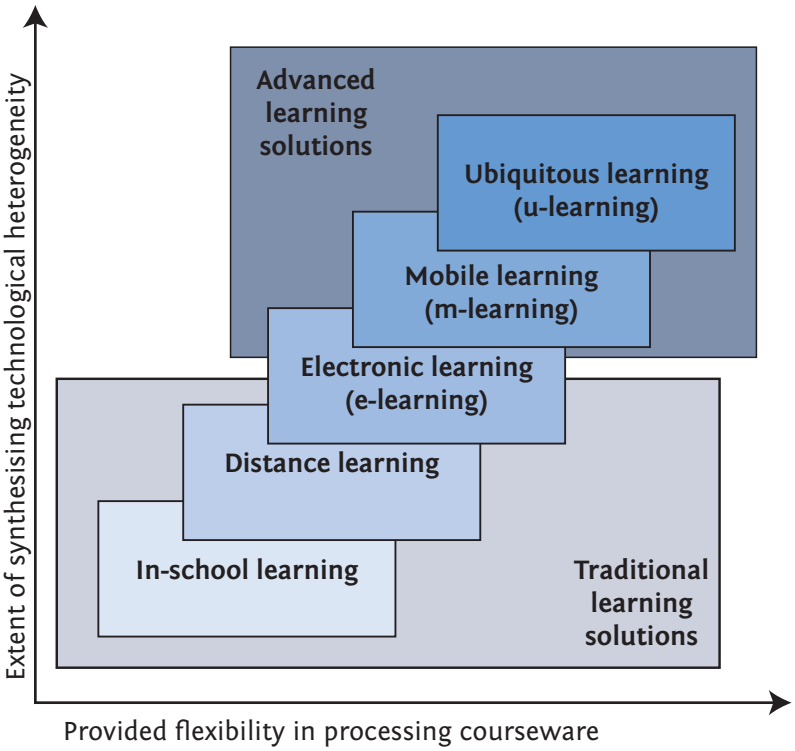


Figure 1.2. Several forms of learning and their respective flexibility in allowing the learner to process study material.

Developments with mobile devices and mobile communication meant that e-learning was adapting to include these developments as well. This notion is also called *m-learning*, which is roughly defined as allowing lesson material to be delivered to the learner through mobile communication. Allowing learners access to lesson material at any given location, gives them a larger amount of flexibility in learning than they would have with just e-learning. However, the notion of m-learning is still limited to mostly static content, with little regard to the context in which the learner currently is.

Further developments in technology and mobile communications gave rise to *ubiquitous computing*. Ubiquitous computing denotes the idea that computational devices are integrated in certain environments and interact with each other and the user. As an example, consider an office worker entering the building where he works. He uses a keycard to enter and the building is notified that he has entered. It immediately boots up his work computer with his personal profile, so he can start working immediately. Also, since he is the first person to arrive in that department, the building also starts preparing the first batch of coffee.

Ubiquitous computing brings us to the latest development in digital learning, namely *u-learning*. U-learning is derived from ubiquitous computing and from both e-learning and m-learning. U-learning is when you use ubiquitous computing in a learning environment, making it a subset of ubiquitous computing and a more advanced version of e-learning. Fisser et al8. proposed the following definition of u-learning:

"Ubiquitous Learning is learning in an environment where different technologies that are necessary to support the learner are integrated with the lesson activities, where the learner can access the learning environment and its communication methods always and everywhere."

E-learning, m-learning and u-learning show us the development that digital learning is making and also that there is some overlap between the concepts, as mentioned in a study by. Horváth et al (Figure 1.2). Their study has placed the digital forms of learning in the category 'advanced learning solutions', underlining the importance of thinking any design based around these concepts through properly. This also means taking into account the wishes of multiple stakeholders and aiming to improve education, instead of merely trying to beautify education through digital means. This means that this project has to take into account the following aspects of ubiquitous learning;

- *Seamless integration* of the different networks used for communicating with the learning environment **(C1.1)**.
- *Context-aware adaptation of the learning environment,* where the information of the user is used to alter the material presented to him [9] **(C1.2)**.
- *An intuitive user interface,* which allows the user to communicate flawlessly with the learning environment **(C1.3)**.

1.2. Personal technology in education research

An important part of u-learning is the assumption that the learners have their own personal devices with them, that will allow the u-learning to happen. Examples often use smart phones, which enable the user to retrieve data at any given time and moment and allows him to photograph or scan interesting points to learn more about them. But, does all this technology actually benefit learner's education?

A look at the studies that have researched the effect of technology on education seems to give positive results. Rockman et al. [10] has researched the effect that laptops have on teachers and students and their overall performance and attitude towards technology as opposed to teachers and students without laptops. According to their findings, teachers and students that work with laptops are more fluent and skilful towards technology and have a more positive attitude towards technology in education compared to non-laptop users. Laptop users also are better at written assignments. However, they could draw no conclusions in other areas of study, the results still being too similar.

But, when you consider the above results and compare it to now, where digital technology is one of the main methods for finding information and data, fluency with technology indicates having an advantage in education.

Aiding to this, are various case studies that support the use of Tablet PCs (not to be confused with tablets as they are mentioned in this report). Tablet PCs are similar to laptops in form factor and function, but they have added touch interaction (usually with a stylus) on the Tablet PC screen. This allows users to write on certain documents with a stylus when they want to, instead of having to type. The assumption is that hand-written text aids education better than typed text and that the freedom of being able to use handwriting any time in your documents aids understanding as well.

Applying this to education, Brophy and Walker [11] have determined that students report that lesson presented with the aid of Tablet PCs are better to follow than lessons presented without them. This has to do with the teacher being able to illustrate and annotate their lessons easier, right next to the relevant material onscreen.

Taking this a bit further, there are some studies about providing teachers as well as students with Tablet PCs, for example Microsoft's study in the Cincinatti School [12]. So far these case studies, for example's Microsoft's study in the Cincinatti School, present positive results. These positive results are most frequently attributed to the student's enablement for creative learning due to the use of the stylus for annotations and assignments. Even though this example study is influenced by the fact it was not written by a neutral party, it can still be concluded that tablet PC learning has some definite benefits on education. The more because the Cincinattie School itself is still actively promoting the technology.

1.2.1. Technology benefits education

The above all indicates that there are definite improvements when using technology in education. But every study indicates that great care has to be taken to adjust the material and data presented to the technology that will be used to present it, since both students and teacher do not benefit from technology that is haphazardly applied to current materials. For example, the last five years has seen a massive adoption of interactive whiteboards in primary and high school. However, teachers were poorly trained for these devices and classes have suffered because of this [13].

However, when enough time is spent to adjust, then technology is a great boon for education. Even tablets such as the iPad are being used in certain programs to great success, as the iPad project at Hogeschool Fontys Eindhoven [14] and the iPad project at Cedar's School for Excellence [15] can attest to.

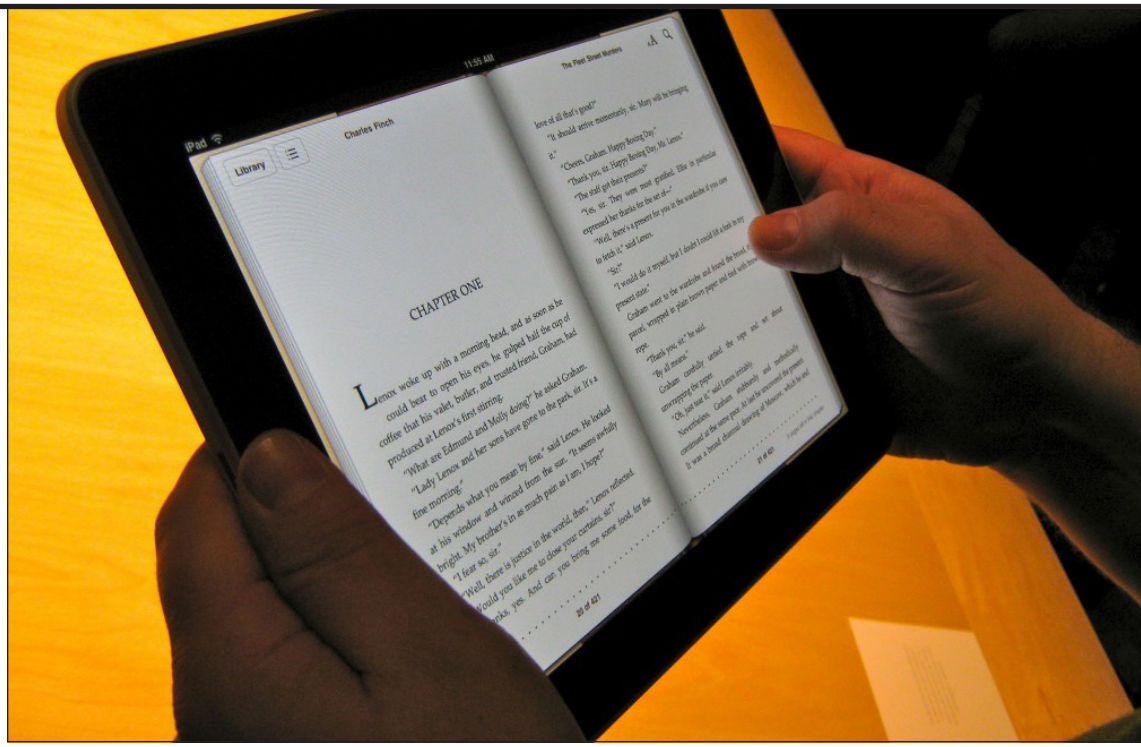


Figure 1.3. Apple iBooks in two page reading mode.

1.2.2. A closer look at the tablet benefits

When trying to improve education, it is important to know which aspects you want to improve and which tools you will use to do so. In this case, the tools that we intend to use are tablets, such as the iPad and the Samsung Galaxy S. As mentioned in Appendix A, the benefits of tablets include the following; *productivity, convergence, mobility, community, price and availability*. Tablets also benefit greatly from their *unobtrusiveness*, which is aided by their mobility.

Taking a closer look at some of these benefits will help us determining how to use them to improve education. This is important, since tablets still have negative aspects which can impact their use as effective education tools.

1.2.2.1. Convergence

There is a current trend in technology to converge many of the functions that people may need into one device. Current tablets do this by combining many of the functions that were previously found in smart phones, such as the ability to communicate with others (through mail and calling), know where you are (through GPS) and take pictures and voice memos, as well as functions of laptops, providing the ability to read documents, such as news and articles, taking notes, browsing the internet and using more complex applications for task-specific functions.

One example of this in the educational context is the e-reader application [16] (Figure 1.3) that provide students with a way of reading their study material and to make notes about it in the same application. This has removed the need for the student to switch from his book to his notebook and it keeps the notes always linked to the relevant pieces of text.

Another example would be the Elements application [17] (Figure 1.4), which not only provides the student with information about the table of elements, but immediately gives examples of the element's practical applications with text and video material. This is something that normally would have taken the student a chart to look up the appropriate element and a computer to find more information about it.

Convergence is an important aspect of making tablets useful for education. An application that aims to improve education, should focus on some specific needs or tasks that student now use multiple tools or moments for to complete.

1.2.2.2. Mobility

One of the biggest benefits of the tablets is their mobility. Combined with the convergence of functions they provide, it allows people to do many of the tasks they normally do in a specific location, at any given place. Think of checking your mail, reading news articles and checking your messages while on the bus or in the train.

The mobility comes to pass because of three main characteristics that tablets have:

- *Form factor*
  The form factor of many of the tablets is focused on keeping them as small and thin as possible, while still providing the least amount of screen real estate that is needed. Because of this, tablets have become very lightweight and small devices, that are more easily carried around and taken out than laptops, which are computers that were made to be portable.
- *Quick and intuitive interfaces*
  Tablets boast that they are never off. Like mobile phones, they can be kept in a standby state and when the user needs to do something, they are started in usually two rapid motions. This is a big difference with the longer startup time that computers and laptops in sleep mode have. The intuitive interface also allows quick access to and through applications and thus makes the task the user wishes to perform quicker.
- *Long battery life*
  Something coming up in multiple pilots [15] [18] that use tablets in education is the long battery life that is associated with them. Battery life has been increasingly important in laptops, since being able to work for longer periods without recharging, allows for a person to be more mobile.
  Tablets have battery lives of up to two class days, which makes them remarkably efficient, especially since there is no need for them to be recharged during class hours. This gives both the teachers as the students less headaches, since less time is spent on managing and distributing power outlets.

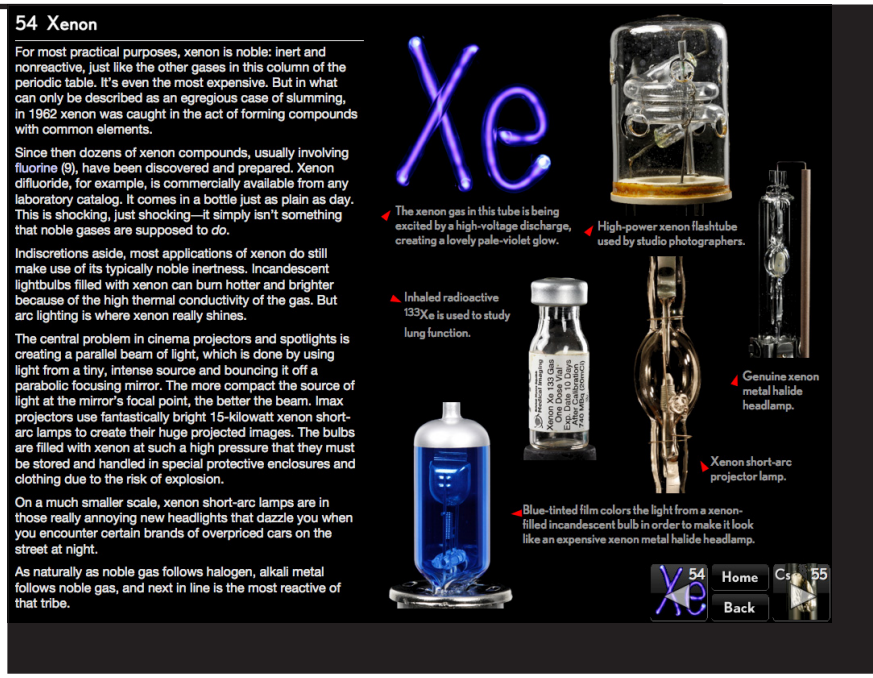


Figure 1.3. The Elements iPad app, showing a mix of information about an element's name, encyclopedia entry and various applications of the element.

1.2.2.3. Convergence and Mobility increase Productivity

If you look at both the convergence and mobility that tablets provide, you can see how tablets can increase the productivity of its users.

Besides being able to work at any time and location, both the mobility and the convergence enable users to make better use of the so-called '*Two Minute Rule*' [19]. The Two Minute Rule is something that has been coined by productivity consultants as a rule that says; "If you can perform a task in under two minutes, do it immediately." Doing this would increase your productivity, since your mind is able to relax since the small tasks have been taken care off. And you're able to focus on tasks which take longer and more cognitive effort.

Since tablets seamlessly integrate applications that allow for the handling of many small tasks (answering mail, reading a short article, etc)., they promote this rule at more moments throughout the day and thus, allowing the rule to come to pass more often.

Mentioned above, concentrating on one task helps us to be more productive [20]. Since the form factor of a tablet doesn't have much screen estate, most tablets only allow the use for only one application at a time, denying the user the ability to multi-task to a degree. Since only one application can be open at a time, it forces the user to focus on only that application and, by extension, on

a single task. This encourages finishing the task in a quicker fashion, allowing the user to move on to other tasks afterwards [21] [22].

Both the Two Minute Rule and the forced single-tasking are mechanics that can be exploited in an educational application for tablets. An educational application should promote performing small tasks that improve education (such as answering a question) and should force the user to concentrate on a single task.

1.2.2.4. Community

Social media is becoming one of the more important forces in today's world. Allowing users to connect to each other and to share anything they want at any given moment, has given birth to some of the largest and most successful internet platforms (ie. Youtube, Facebook, Twitter). This shows that collaboration in any form is something that people find very important, even if it's only to the degree of leaving a comment about something or rating a product for the rest to see.

Even more, social media has given rise to a large number of community platforms that specifically focus around groups of people with similar goals. Integrating social functions in a tablet application can allow users to collaborate more efficiently with each other.

1.2.4.5. Pricing and availability

The pricing and availability of tablets is becoming better as we speak. Since Apple and Samsung have pioneered the new generation of tablets, many companies are releasing their own versions of tablets. This allows users to choose which tablet that suits them best. For educational systems this is also important, since this may allow them to take the tablet best suited to their own work environment.

1.2.4.6. Unobtrusiveness

Another advantage that tablets have in comparison to other devices is their unobtrusiveness. Where a smart phone is too small to easily show something to others and a laptop automatically creates a wall between you and anyone in front of you, tablets can easily be brought out from a bag and near-instantly be turned on and used to show anything. Routes, small presentations, a great article found on the internet; you can show any of these to a number of persons.

This is especially important in education, where the teacher can't really afford to turn her backs to her audience when writing something on a blackboard or IWB. Also, any obstruction like a laptop display, can create a distance between students and between students and teachers which detriments education, for example in a lecture hall, where the teacher is talking to a wall of laptops instead of students.

Considering the current project, where the goal is to enhance education through a design centred around tablets, the more interesting benefits to exploit are the tablet's mobility (to facilitate u-learning), convergence (using the tablet for multiple purposes) and community (taking advantage of collaboration). Unobtrusiveness, pricing and availability are factors that will aid in the general acceptance of tablets in education and thus our design.

1.2.2.7. Conclusions

Thanks to our literature research, we can now conclude the following:

- Technology has a significant and usually beneficial impact on today's education **(C1.4)**.
- The features of tablets also have the potential to benefit education specifically. In particular the following benefits should be taken into account for our design **(C1.5)**:
  - *Convergence*; tablets integrate the best features of smartphones and laptops into one device.
  - *Mobility*; tablets are very mobile due to their form factor, quick and intuitive interface and their long battery life.
  - *Community*; most large social media services have applications for tablets, which enhances the forming of communities.

1.3. Software applications in education

Finishing up our look at technology in education, it seems fitting to see what type of software already exists for education and is already in use. This can also provide us with a direction for the design.

While reviewing all the software applications used in education is next to impossible, a smaller review of applications is enough to indicate what types of educational software exist. Figure 1.5, consisting of a search for the most commonly used software applications (or types) indicates the presence of seven prevalent software groups.

These applications can fall into different categories; *study material, games, reference, organisation and planning, collaboration and cooperation, practice and creativity*. These categories aren't perfect, as often an application has several aspects which place it in several categories at once.

- *Study material* indicates the category that translates or provides an actual learning method in digital format, such as e-books of study books, or the software that can read those formats (e.g. Inkling, e-readers, PDF-readers).
- *Games* refers to educational games. Games are considered in education to aid the user in understanding concepts or practice theories. Examples are physics-based puzzle games or serious games which simulate real life settings.
- *Reference materials* are applications that let the user look and read specific information. These applications take over the role of encyclopaedias, reference books, dictionaries, news sites, etc.
- *Organisation and planning* are applications that allow the user schedule and organise their life, through schedulers, portals that give overviews of courses, meetings or deadlines, let you make todo's and notes and more.
- *Practice* applications are applications that specialise in giving you exercises on a specific topic or a work environment to practice on a specific topic. Very common ones are language learning applications, giving the user phrases or words that he can memorise or translate. Others include mathematics or physics suite in order to create and run simulations.
- *Creativity* gives home to applications that allow the creativity of the user to bear fruit. Drawing applications, music applications, photo makers and editors, applications that help with choreography; these are all applications that allow the user to express creativity.
- *Collaboration and cooperation* is the most interesting category for this project. As mentioned, there are little dedicated applications that are meant to support collaboration, but there are quite some applications that still facilitate it. Messenger applications, file sharing applications, surface tables and multiple user applications are examples of this.

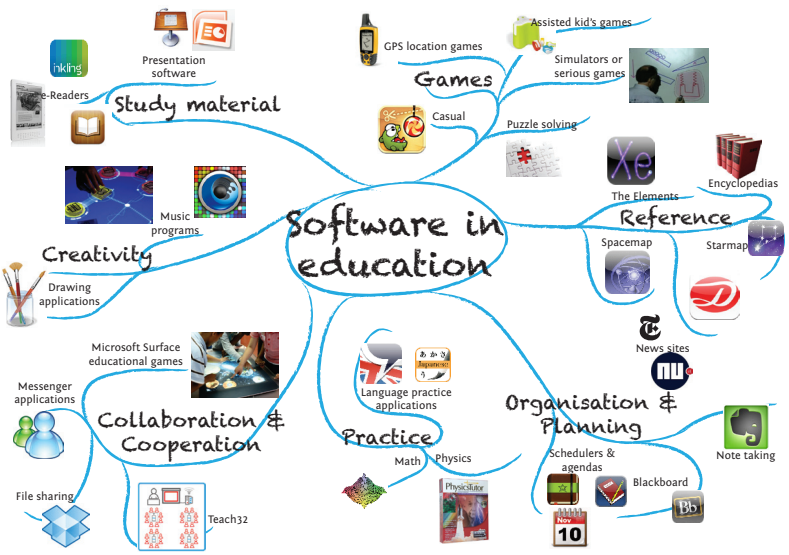


Figure 1.5. Different examples of software in education and their categories

Another way of looking at this information is checking what kind of interaction an application invokes. Is it mostly focused on individual student usage? Is it meant for the teacher to inform his students? Can students interact with the class as a whole? Or can they interact with each other as well? Figure 1.6 attempts to catalogue these interactions.

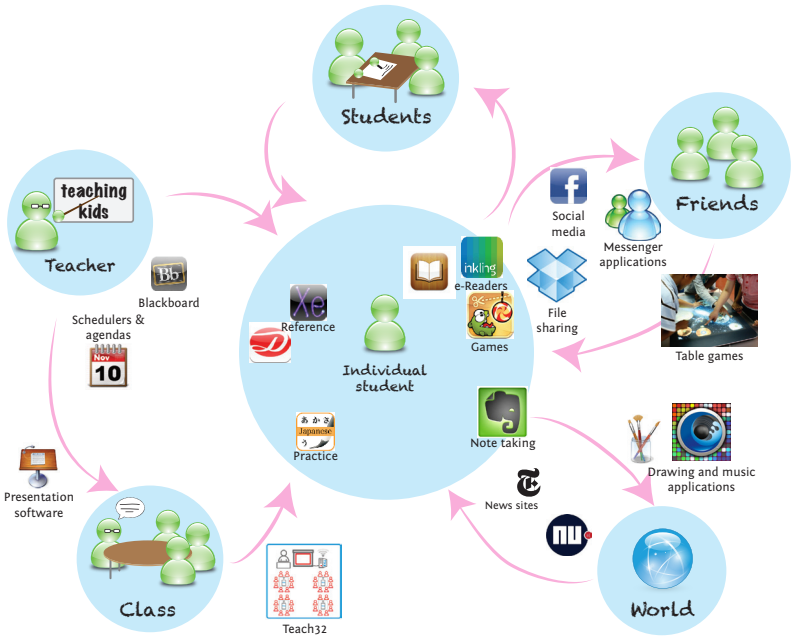


Figure 1.6. Software interactions. Most educational software is centred around individual use or communication from the teacher to the class.

As you can see, there are a lot of applications that tailor towards the teacher giving information to the student or to individuals. However, field research amongst university students indicates that there is a constant search for applications that allow a close collaboration between individuals and, by extension, groups. Currently they're using a multitude of applications together to create collaboration, such as Live Messenger [23] and Dropbox [24]. While students are able to work properly in this way, an application which combines all of these and is tailored towards their own educational wishes is very welcome.

1.3.1. Conclusions

There are seven categories of educational software applications; *study material, games, reference, organisation and planning, collaboration and cooperation, practice and creativity* (Figure 1.5). Looking at the interactions these applications invoke in their users, shows us that there is lack of applications which allow interaction, and thus collaboration, dedicated to students and their peers **(C1.6)**.

Considering this lack of applications that specifically support student collaboration, it is interesting to create a design for tablets that can enable more effective and efficient collaboration between students.

1.4. Target group

The educational market is a large market and designing for large markets is something considered to be incredibly difficult and prone to failure. Therefore it is important to create a focus on a specific target group within the market. A well-thought out design for a specific target group also has more chance of succeeding in different target groups as well.
There are five different educational markets (Appendix B); *schools, higher education, vocational teaching, workplace education, home segment*. Of these markets, schools (especially *primary schools*) and higher education have a higher chance of adopting new educational technology on a larger scale. They have the highest potential for a software application that's centred around a modern personal device.

Primary schools have their history of more easily adopting new technologies. However, the recent growth of interactive whiteboards in this market means that a lot of the budget of these schools is currently tied in that technology for the coming years. Combined with the fact that teachers are currently scarce and often overworked, they have little time for training in new technology, which in this market is a necessity.

Higher education is a good fit as well. Students in this market are somewhat older and are given a higher degree of freedom in their studies. This makes for a nice situation in which to test whether collaboration attempts on tablets would be successful.
The recent interest of higher education in tablet products is also beneficial for this project. Fontys Eindhoven for example recently launched a iPad pilot project, where one hundred students and teachers were loaned an iPad. The catch was that they had to use it for education as well and actively think about applications that they would use in their studies on such a device. After meeting with the coordinator of the project, they proved willing to test prototypes.

1.4.1. iFontys

While searching for a good target group, the media started reporting about *Hogeschool Fontys Eindhoven*. The college in question was starting an iPad pilot project, supplying 100 students with iPads in order to see how the new device would function for the students in education. Considering the history of Dutch education clinging to evidence based technology purchases, this experiment was unprecedented.

The project was part of a larger project, called *iFontys* [25], which aimed to see which technologies would be most beneficial for their education, tested by a more rapid experimentation cycle. Instead of taking years to implement and take the results, iFontys would use more dedicated teachers and students to quickly test and evaluate new technology.

The iPad trial project made Fontys Eindhoven a perfect trial ground for this graduation project. So we approached them with the intention of meeting teachers and students participating in the iPad trial project, learn about their experiences and getting their input for the concepts. The iFontys project leader brought us into contact with the respective mentors of the PABO study (where students train for teaching primary school) and the Communication study (where students train for jobs in the communication industry). Through these mentors, a meeting with two groups of students was arranged.

After meeting with the two groups of students (which we will discuss further in section 2), the students from Fontys PABO Eindhoven seemed to fit the best for the project. Their use of the iPad has been individual in nature, they have a good grasp on the limitations tablets currently provide and they are studying how to be teachers at primary schools, which gives them both the incentive and knowledge to ascertain educational needs and possibilities as well. Also, the focus of their education on collaboration and feedback gives a good connection with the current lack of collaboration software specifically aimed at students (section 1.3).

The rest of the project has been conducted for the context of PABO Eindhoven students. They have helped to provide a much clearer situation and perspective for the project and were willing to meet and elaborate more about the results.

1.5. Conclusion

We have introduced the primary project goal;

"To design a mobile software concept that makes use of tablets that can enhance education for students"

and placed this goal in the perspective of current digital learning trends (section 1.1). Focusing on tablets allows us to place a larger emphasis on u-learning, which deals with providing course material to the student at any time and place, as well as accounting for the context of the student at that moment. The following aspects are the most important to take into account for our project.

- *Seamless integration* of the different networks used for communicating with the learning environment (C1.1).
- *Context-aware adaptation of the learning environment*, where the information of the user is used to alter the material presented to him (C1.2).
- *An intuitive user interface*, which allows the user to communicate flawlessly with the learning environment (C1.3).

Setting our sights on the state of personal technology in education at the moment (section 1.2), it can be seen that it does have a *beneficial impact on education* (C1.4). However, most of the impact is reliant on a good design.Therefore it is important to make use of tablet benefits (section 1.2) that are suited for the project, namely *mobility* (facilitating u-learning), *convergence* (using the tablet for multiple purposes) and and their affinity with *community* (to enable collaboration) (C1.5).

Collaboration isn't well represented amongst current software applications (section 1.3). While there are tools that can facilitate collaboration, none of these tools do this specifically for *students that want to collaborate with other students*. This provides us with a gap in the current offering of software applications in education that the design can exploit (C1.6).

In order to proceed with the project, a more focused target group was necessary (section 1.4). Because of recent events, Fontys PABO Eindhoven has proven to be an excellent target group. The students are currently immersed in an iPad trial which has sensitised them towards tablet learning. And their aim to become primary school teachers gives them a great incentive to cooperate with the project. Finally, their study's focus on collaboration and feedback also gives a great connection with the gap in educational collaboration software.

To conclude, the above gives us sufficient information and context to alter the original design goal to a more specific design direction;

"I want to design something that improves education by allowing students to collaborate more often and effectively, by making use of the capabilities of tablets."

2

HEAR

Hear is about getting inspiration and to create requirements for our final design by exploring the context of our target group. To properly explore the context, it is important to get to know the target group better, which we will do through *group sessions* with the target group, which consist of a *discussion* and an *association and brainstorm session* around the subject of cooperation in education. Because the original target group (college students) was still very broad, two group sessions were held, with different groups of students, respectively studying *PABO* (teaching primary school) and *Communication* at the college *Fontys Eindhoven*. The PABO students were chosen as the final target group.

The insights that were gained from the group sessions were made into *exploratory concepts*. The purpose of the exploratory concepts is to try out different directions the final design may focus on and which would help the target group the most. The concepts were presented to the chosen target group (the PABO students) and the most promising *design directions* were established. We also obtained more information about the needs and wishes of the PABO students.

Taking the established requirements, the most promising design directions and the information about our target group, we can finally create a *persona* for which we can design. The persona helps in designing the final concept, since we can design it for an actual person, someone who can become alive in the designer's mind.

Goal: Inspiration and requirements

Define context
Explore concepts
Create a persona

2.1. Getting to know the target group

In order to properly explore our context, we had to get to know our target group better and gain insight into their situation and product use.. Additionally, 'college students' is very broad target group, so we will narrow it down to a specific study as well. For this, we utilised *group sessions*. As mentioned in section 1.5, two groups of students were willing to meet with us to discuss their tablet experiences and their experience as a student in general. The first group session was held with students of Fontys Communication and their mentor. The second group session was with the Fontys PABO students and their mentor.

2.1.1. Fontys Communication

The first group session was held with the mentor and students of Communication. Attending were three students (Figure 2.1) that were participating in the iPad trial project and their mentor. First, it was necessary to get a sense of what their study encompasses, afterwards we moved onto their experiences with the tablet and finally we held a brainstorm session to see what their associations and ideas were concerning their study, in relation to tablets.

Providing a global understanding of the study, they explained that Communication is divided into two variants; creative communication and business communication. Creative communication deals with sending a message to the consumer in the art sense. For instance, through posters, flyers, magazines and music. Business communication deals with how businesses communicate between themselves and how they make their message clear to the world, through corporate websites, meeting notes and business documents.

Most of the study consists of group work, in which teams of students work together towards a project goal, such as delivering an ad campaign for a fictional client (in the case of creative communication) or a brand message (in the case of business communication).

Business Communication students seemed to fit into the group work rather easily, through a combination of knowing their roles and depending on each other. But the creative Communication student's didn't seem to match all that well. They said that their designer's ego tends to get in the way of collaboration.

Figure 2.1. The three Fontys Communication students that participated in the group session.

This is an interesting development, since Communication decided to hand out single iPads to teams of students, instead of the usual single iPad for a single student.

2.1.1.1. Tablet experience

The tablet experience of the students was nice, though not overly useful. The iPad as it was at that moment (half a year after its release date and the first of the new generation of tablets) had potential, but was *"not yet really useful."*

The Communication students wanted their tablet to have applications that were directly related to their study and could help them perform educational tasks more efficiently. Sadly, so soon after its release date, there was still a great lack of those kinds of applications, which caused the students to look for alternatives that they could still use.

Such alternatives were, for example, Adobe Ideas [26] (a sketching tool), the native Photos [27] application (for showing work in progress to clients) and social applications. The social applications were the ones they were most happy with. They mentioned using the applications for Mail [28], Facebook [29] and Twitter [30] to stay in touch with their teammates and clients, with their respective applications on the iPad to be very intuitive and quick to use. This caused them to use such applications more often to share new work and ideas. The iCal application (which can be used to store your schedule) was used to divide work and keep track of meetings.

Another problem that they encountered (especially the business Communication students) is that the current tablets do not encourage typing long reports. Especially in instances where long pieces of business copy have to be written, using a tablet with its virtual keyboard isn't ideal and slower than using a real keyboard.

A third barrier to using tablets in their education is that the file sharing capabilities is still rather limited, the iPad lacking an USB port for use with USB flash drives and syncing the device with files on the computer is a cumbersome process that has to be done with iTunes [31], which is not built for file sharing. Instead they relied on Dropbox, a file sharing service that operates through the internet to upload files, for their file sharing needs. Dropbox however is not without flaws itself. Problems occur frequently, such as shared filed that haven't been updated or not shared at all, which makes file sharing an ordeal.

Their biggest hurdle was the fact that the iPad has no multi-user capabilities, even though the students were sharing one in a group. The iPad can only sync with a single computer, which in a group setting is not feasible. This did not ease any of the previous problems and instead made them worse. Even more, where the iPad was very useful, such as sketching ideas and communicating with others, only a single person would be able to use the tablet effectively. This means that it has to be passed around frequently and that students can not do tasks in a quick and efficient matter, which is one of the core strengths of tablets in general.

The wishes that the students had for the tablet were to gain more access to their study materials (such as theory books and articles) in e-book format, so they can easily read it on the tablet. And as a final note, they said that the tablet had an enormous potential to be a very personal device. If it would be loaded with information about the student, it could, for example, anticipate educational needs and react to that. However, as of the moment there are too little educational applications which were capable of that and the infrastructure that would be needed for such a use still isn't in place.

2.1.1.2. Brainstorm results

The brainstorm session with the Communication students was split into two parts. First, an association session was held, to see what they associate with the terms 'Collaboration' and 'Communication' in order to get them to think about these subjects separately. Afterwards, a brainstorm session was held about 'Encouraging collaboration' and 'Collaboration on Tablets' (Figure 2.2 and 2.3).

Figure 2.2 (top left) and 2.3. (top right) The Communication students and their mentor busy creating post-its for the association session.

The association session showed that the students strongly associate group work, feedback and sharing with both Communication and Collaboration (Figure 2.4). This has a strong correlation with the fact that most of their study has group work involved in it.

The brainstorm (Figure 2.5) also showed a strong inclination towards applications where the sharing of information and the ability to provide feedback to users is prominent. Support for team work, such as team management and the ability to share information instantly with several teams was also something that immediately came to mind.

Examples that they named were web services such as Basecamp [32] and Stack Exchange [33]. The former is a service in which teams can collaborate on a project; it gives options for holding discussions, managing todo-lists, keeping schedules and more. The latter is a Question and Answer (Q&A) site, which focuses on asking questions about a single topic (different per site in that network) and getting quick answers. Questions and answers can be rated to provide them with more credence from the community.

Figure 2.4. (bottom left) The results of the association session.

Figure 2.5. (bottom right) The results of the brainstorm session.

2.1.2. Fontys PABO

The second group session was held with five students of the PABO, where students are trained to become primary school teachers, and their mentor (Figure 2.6 and 2.7). As with Fontys Communication, first they gave a brief overview of their study, then went into their current experiences with the tablet and then moved on to an association session to get their thoughts on '*Collaboration*', '*Tablets*' and '*Wrong collaboration*'.

The study PABO focuses on giving students the experience they need to become full-fledged primary school teachers. While the study does not primarily focus on gaining knowledge in the subject matter they will be teaching, it does make sure that they have the appropriate level to teach. Furthermore, the knowledge that they are taught focuses mostly on didactics and how to use them.

As well as learning theory, PABO students are immediately asked to apply it, being given internships at primary schools from their first year onwards. The internships usually consist of observing a teacher in practice first, though most internship schools quickly let PABO students teach a class of children by themselves.

The PABO students are not graded in the traditional sense, but they are expected to complete a '*portfolio*', which states which competences they have gained during their education. Sufficient competences allows them to advance to the next years and eventually graduate.

2.1.2.1. Tablet experience

The PABO students use their iPads quite a lot, but not exclusively for education. The PABO students tended to use their iPads for things like reading messages and mail, catching up on their social network updates and reading the news.

Why don't they use their iPads for their education? Most specifically, because the study material they need to read isn't available in e-book format. They mostly read articles and the books they need are only available in their paper formats and can usually be read in their faculty's library.

Especially the last option is something that can be noteworthy. Students were reluctant to buy all the books that they supposedly need for their education, since the average amount of money they have to spend a year on books amounts to one thousand euros. Instead, if the material would be available as e-books at a more attractive price, they would be more likely to read it on their tablets.

As we have seen in the group of Communication students, file sharing was an issue for the PABO students as well. They couldn't quickly use their tablets to share files as they would with a laptop. While Dropbox is a viable solution for this problem, they mention that not everyone has Dropbox installed (this is primarily a concern with teachers that need their reports).

Figure 2.6 (bottom left) The five PABO students participating with the group session working association.

Figure 2.7. (bottom right) The PABO student's mentor participated as well.

An interesting point is that their iPads are very useful during their internships. Most of the PABO students mention that they have downloaded a number of educational apps for children, which they have to keep separate from their other applications (something that shows that the tablet's reliance on a single user premise can be restrictive). When the children are done with their assignments, tasks or any bit of the lesson while the rest has to keep working, they are allowed to use the iPad for their own entertainment (Figure 2.8). Since this entertainment means they use educational applications, such as 'children's news' and several educational games, the children are still learning, even while playing.

Figure 2.8. Primary school children working on an iPad. Photo by ictatelier @ Flickr.

2.1.2.2. Brainstorm results

The brainstorm session with the PABO students (Figure 2.9 and 2.10) consisted of association around three terms; 'Collaboration', 'Wrong collaboration', and 'Tablets'. The choice of 'Collaboration' and 'Wrong collaboration' was to see what kind of associations they had with collaboration and how they thought this could go wrong. The association with 'Tablets' was to see how they perceive tablets and to see what the strengths and weaknesses of tablets are in the eyes of the PABO students.

When talking about 'Collaboration', PABO students have much the same in mind as the Communication students. Here, much of the terms and discussion centred around the concept of working in groups towards a single goal. However, there was also a

Figure 2.9. The PABO students working on the association sessions together.

Figure 2.10. The PABO students working on the association individually.

significant presence is seeking help from each other, which is relevant in terms like 'ask questions', 'getting advice' and 'feedback'.

The same goes for 'Wrong collaboration', where most of the ways collaboration could go sour was when people did not communicate properly or did not keep their promises in a team. People not adhering to their role in a team also was a frequent problem.

Finally, the 'Tablets' association showed that the opinions of the PABO students about this technology was positive. They found it a useful tool, which they used mostly for browsing the internet, checking their mail and social media and for relaxation. However, they did come across functions that they couldn't to on a tablet, and instead had to resort to paper and desktop computers.

2.1.3. Conclusions

The meetings with the Fontys students were very fruitful and can be summarised as follows:

2.1.3.1. Tablet use and experience

Tablets are found to be useful in general, but not yet specifically for education. Thing that were found to be very useful were:

- Good, intuitive applications for mail, social networks and internet.
- It's a good tool for small presentations, for example to clients or fellow teammates.
- Children take to tablets very quickly and it captures their imagination. This can be leveraged to let them use educational applications.
- The ability to store a lot of books in a single device. There is a lot of reading that has to be done for any type of education and not having to lug around kilo's of books is found to be very useful.

Things that the students lacked or missed in tablets for education were:

- A good way of sharing files with their peers.
- The device or its applications using their own personal information to anticipate their needs.
- Proper study material specifically for the tablet, preferably at a lower price (this is possible because it has been digitised).

2.1.3.2. Brainstorm results

During the association sessions, most of the emphasis was placed on collaboration. Unsurprisingly, most of the associations that the students made stemmed from group and team work, that was centred around a single project goal. The PABO students however, have made several more references about collaborating outside of groups, for example when seeking and getting advice.

Most of the ideas that sprung from the brainstorm sessions with the students, centred around enabling collaboration, providing proper information and communication between team members. The subject of using social media for this was brought up, but it quickly became clear that students resent having their own social network 'invaded' by school.

2.1.3.3. PABO students as target group

In order to create a more lasting relationship with the Fontys Eindhoven and their students, one of the Fontys studies was chosen to become the main context for the final design. For that, Fontys PABO Eindhoven was chosen, because their use of the tablet (one per individual), their main study method (learn by experience and group work) and their mentality (get feedback from others) fit this project the best.

Summarising, the meetings with the Fontys students have given us a proper target group, as well as the following insights:

- Tablets are an *individual, personal device*. Group use has been found detrimental to the user experience **(C2.1)**.
- Students are actively seeking more methods to *collaborate with each other*, an area in which tablets currently fall behind **(C2.2)**.
- A major barrier to tablet use is the lack of applications specifically for students **(C2.3)**.
- There is a need for cheaper and more portable study material **(C2.4)**.

2.2. Effectiveness of collaborative learning

During the meetings, the Fontys students indicated that collaboration is one of the most important aspects in their study. They spend a lot of effort looking for ways in which they can collaborate more efficiently and a lot of their problems in their education centred around collaboration as well. This leads us to believe that enabling collaboration between students can be a very promising design direction.

But does collaboration really enhance education? In order to complete the project goal by using collaboration as our design direction, we have prove that collaborating does enhance learning and thus the education of the students. A literature study on the topic of collaborative learning yielded a study which helps us in answering this question.

Terwin et al. [34] have performed a longitudinal observational study in which the relationship between the processes of collaboration and giving explanations was compared between several classes. The main form of collaboration that was used was asking and giving help, for example in the form of questions.

What the research group found was that collaboration had a *significant, beneficial impact on learning*, but only under certain conditions are met. This was most noticable when students collaborated by asking and answering questions.

The best way to gain a benefit from collaboration when asking and answering questions is when the students have to restructure their knowledge in their minds. This restructuring causes the mind to make more significant connections with the knowledge, causing it to be *better remembered and mastered.* However, this does not occur when the student isn't open to understanding an answer or isn't ready to give an answer in such a way that his peer will understand.

So when the questioner has tapped all his resources in trying to solve his problem, he will be in the best state of mind to receive an answer and benefit the most from the

Figure 2.11. Primary school children working on an assignment in a group. Photo by Kat Lazima.

collaboration. Likewise, a student should only give solicited advice, which forces him to restructure his own knowledge so the other student will understand. Especially the restructuring when giving answers is the most beneficial to learning and thus education.

Because collaboration benefits education, it is a viable design direction to explore, exploiting the gap in collaborative software (C1.6) and fulfilling the students' need for collaboration (C2.2).

To conclude, *collaboration is an effective way of enhancing learning and thus education, but only when the collaboration is solicited* **(C2.5)**.

2.3. Getting to know the target group

The benefit of collaboration to education and the meetings with the Fontys students inspired three exploratory concept ideas. These ideas are detailed in Appendix C, but will be discussed here briefly. The first two concepts, '*Musical progress*' and '*Task based spaces*', were concepts strongly related to facilitating group collaboration. They would aim to provide students with a tool which made them more aware of the progress in their group. This would then motivate the students to take action according to the progress.

Because of these two concepts, we have also defined the difference between group and spontaneous collaboration and its importance to enabling communities. Afterwards, we created a third concept, named 'Forward reward system', based around spontaneous collaboration.

2.3.1. Group collaboration versus spontaneous collaboration

While working on the concepts and asking people their opinions, it became apparent that there are at least two types of collaboration: group collaboration and spontaneous collaboration.

The original design direction was as follows:

"I want to design something that improves education by allowing students to collaborate more often and effectively, by making use of the capabilities of tablets."

The question then arises if it is sufficient to enhance collaboration within a group.

Project groups (Figure 2.11) already have to collaborate. It is present in the definition of most courses that use them, namely *"Create result X with your group. You all get the same grade."*

Figure 2.12. Students getting together to study for their exams. An example of sponteneous collaboration. Photo by Universiteitsbibliotheek K.U. Leuven.

These project groups can create their own methods of collaboration and are obligated to do so. So motivating collaboration in project groups mostly consists of making the collaboration as smooth and efficient as possible.

Spontaneous collaboration (Figure 2.12) on the other hand involves a group of people who are not necessarily working together, but still have something in common. In this project, this would be a school or a course. Motivating collaboration for this group of people means making it attractive to collaborate at all. Drawing people into collaboration can be done through an attractive interface, where they know they can contact others quickly or that they'll feel rewarded when they actively participate.

In a sense, spontaneous collaboration is more about creating a community than making collaboration quick and efficient. To that end, it's useful to keep the following words by designer Amy Jo Kim [35] in mind:

"A community is a group of people with a shared interest, purpose, or goal who get to know each other better over time."

Using the differences between group collaboration and spontaneous collaboration, how can we use this to come up with a concept that focuses more on the spontaneous aspect, allowing more people to collaborate even if they're not within the group?

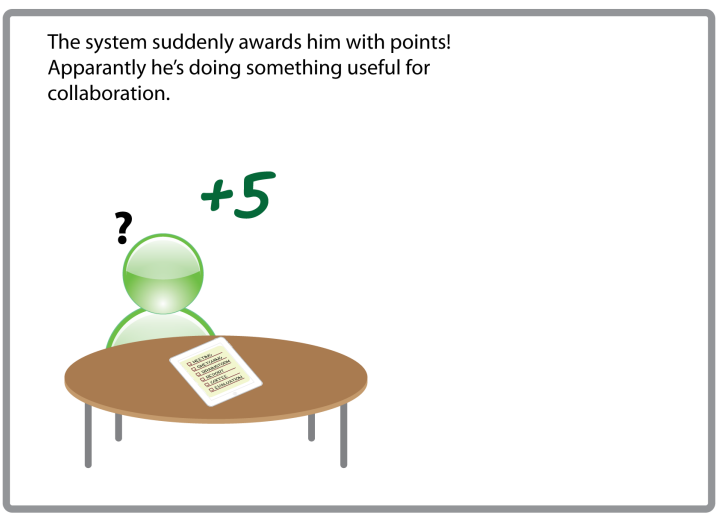
2.3.2. Exploratory concepts

We will introduce the three concepts, named 'Musical progress', 'Task based spaces' and 'Forward reward system' and their specific design directions. Finally, we will discuss the results of presenting these concepts to the PABO students in a focus group meeting.

2.3.2.1. Musical progress and Task based spaces

Two concepts, called '*Musical Progress*' and '*Task based spaces*', were created to facilitate group collaboration. Both concepts were created in a storyboard to be shown to others.

Musical progress centred around creating a kind of ambient awareness of the progress the students are making on their tasks in relation to their deadlines.



Task based spaces aimed at providing a visual record of completed tasks, aiming to give students a better sense of accomplishment after completing them. This would motivate them to work together more effectively.

2.3.2.2. Forward reward system

The distinction between group collaboration and spontaneous collaboration (section 2.1) gave the idea for the concept '*Forward Reward System*' (Figure 2.13 and 2.14). This idea focuses on facilitating a community in which students could ask for help, by giving students rewards in the form of spendable points for any contribution they made to the community, even if it was only asking a question or dropping an helpful resource.

2.3.2.3. Focus group results

The first visit with iFontys students was great for getting grips on the first concept ideas. Therefore it was only fitting to return there with the concepts to see what aspects of each can be used in the a subsequent design.

The students were shown the above concepts with the story boards and asked if they felt that it would help them collaborate more often. The question of whether the concept would be worked out on a tablet device or not was left aside for now, to stimulate their creativity in coming up with better ideas, instead of it being limited by a physical device.

The reactions were mostly positive, though it was felt that the two group collaboration concepts wouldn't be viable in a practical situation. The idea to use music to create awareness was received well, especially since it was build upon their own ideas about getting music for good work. The aspect that would work best in a future design was the aspect of *ambient awareness* of the progress the group was making.

Task based spaces also seemed interesting to the students, since *visual confirmation* of a task being worked on is something that they find useful. However, they found they already had such systems, through the constant notifications of file sharing services such as Dropbox.

Forward reward system was received best by the focus group. The PABO students saw real potential in making collaboration a class effort and they were eager to test if this would actually work. Being awarded for helping others or being helped is something that they can relate to. They could also see how this would *motivate them to ask questions more often*, since there is always an encouraging reward involved.

However, they had some doubts about the validity of the points being awarded. Therefore they suggested there should be some kind of monitoring involved, particularly by a teacher or by adding ratings from peers.

The findings that were most important for the new concept direction were:

- The students weren't triggered by subtle solutions for enabling group collaboration, such as ambient music **(C2.6)**.
- Adding awareness of the group progress was something that was appreciated. There is a need to get a better grip on how other students are doing **(C2.7)**.
- Visual confirmation is something that is often used by students, though it appears that there already are sufficient ways to perform this within a group process (C2.8).
- Being awarded in some way for collaboration will trigger students to collaborate more often **(C2.9)**.

Summarising, *enabling spontaneous collaboration* was received much better than enabling group collaboration (C2.10).

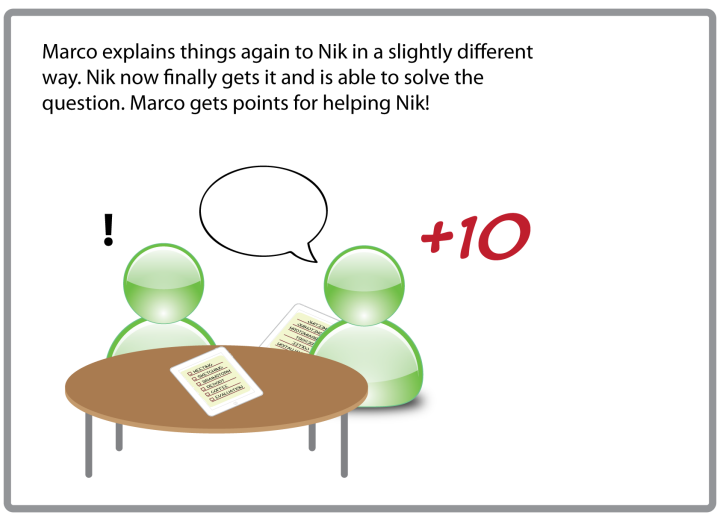


Figure 2.13 (left), 2.14. (right) Storyboard frames from 'Forward reward system'. Both asking a question and answering it gives a positive reward.

2.4. Questions and answers

Looking back at what we said about spontaneous collaboration, one thing that jumps out is the following: the most basic and prevalent form of spontaneous collaboration is asking questions and answering them. Nearly all collaboration boils down to those two mechanics:

"I'm stuck here, how do you solve this?"

"Hey, what do you think of this drawing I made?"

"Want to give me a hand lifting this big log?"

Even relating an experience without a question in it can be an implicit request for opinions on the matter. Certainly the one sharing the experience should be open to this.

2.4.1. PABO daily schedule and question handling

However, only taking the above into account did not yield sufficient information to be specifically useful for the context of PABO students. Therefore, another visit to Fontys Eindhoven was made, preceded by a questionnaire (Appendix D). The questionnaire served to get a grip on two different questions;

- What does a normal daily schedule of a PABO student look like?
- How do they currently handle the questions they have about their education?

2.4.1.1. Daily schedule

PABO students seem to operate on three different types of days and in three different locations (Figure 2.17). Most of their education takes place in the PABO faculty, their internship school and at home. They have three types of days:

- *Class days* (Figure 2.20)
  They get lessons on pedagogical theories and on how to apply them. Often, group work is also scheduled during class days, to make use of the physical proximity to other peers.
- *Internship days* (Figure 2.21)
  After preparing the class and teaching it, they discuss it with both their internship mentor and their PABO mentor.
  Their internship days actually take up at least two thirds of their entire education.
- *Guidance days* (Figure 2.22)
  For most the PABO students consists of discussions with peers and their mentors, where they relate their experiences and questions to get feedback on it.

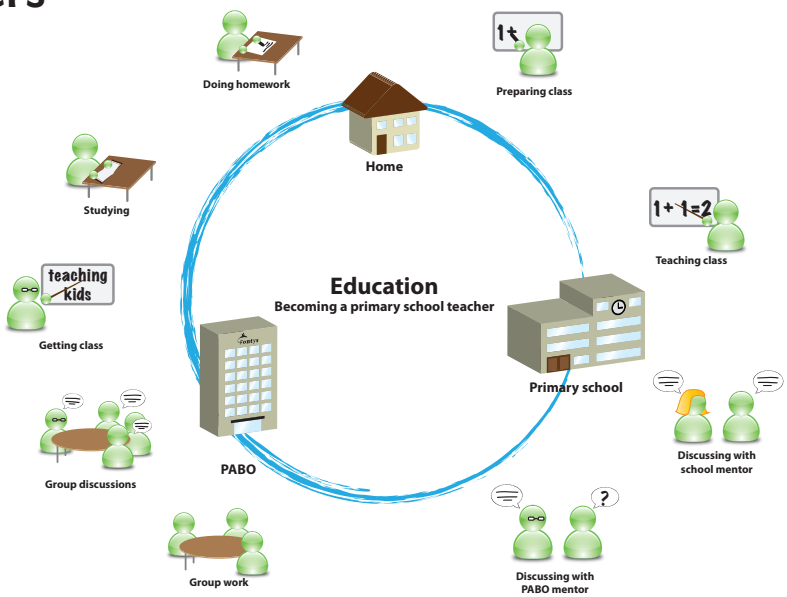


Figure 2.17. A PABO student's activities usually take place at three locations: home, the PABO faculty and the primary school where they have their internship.

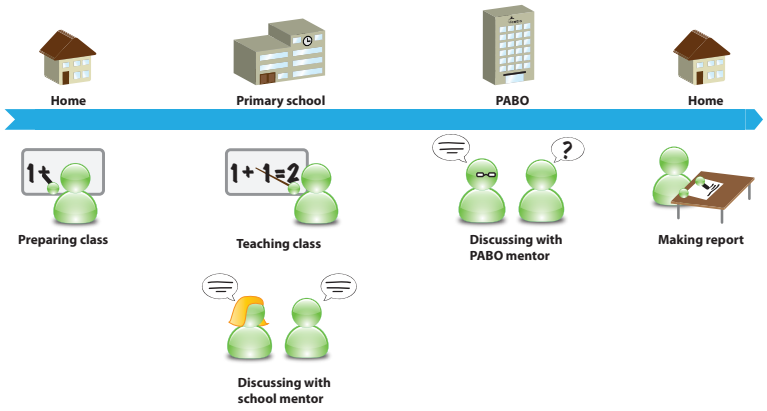
PABO students are not taught a lot of theory. Instead they are taught how to apply the theory in practice and how to teach the knowledge they already have. So most of the classes cover theory sparsely and instead elaborate on examples, anecdotes and other best practices. In other words, experiences are what count. The reading material here mostly consists of articles and excerpts, which are less read than teachers would like.

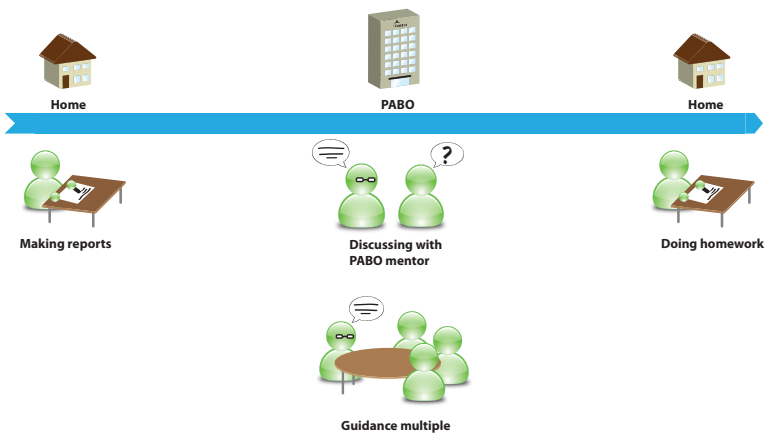
Of course there is still actual theory that has to be studied. This is mostly done for assignments based on a pedagogical theme. Students are expected to read material on a certain theme (for example 'Children with ADHD'), create a 'product' (an assignment

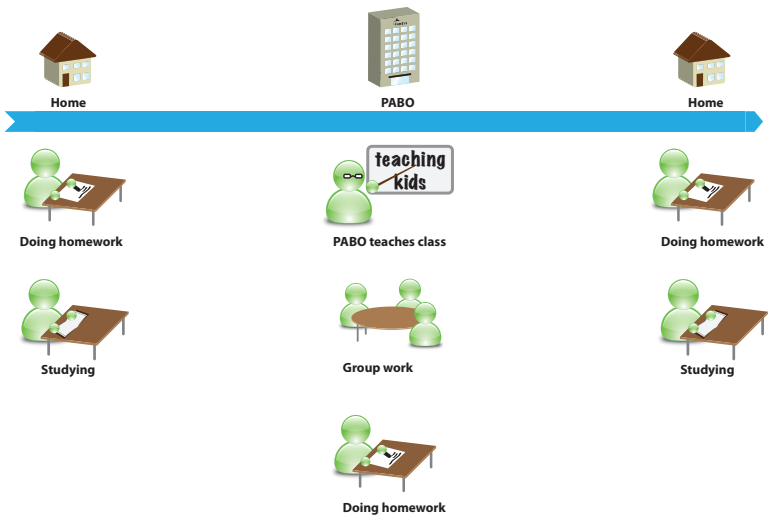
Figure 2.18. (top right) A class day.

Figure 2.19. (middle right) An internship day.

Figure 2.20. (bottom right) A guidance day.







that varies per theme) around it and do a written test. Most of the books students have to read, come into play here.

Finally, there are internships. Students are put in front of actual classes and, under supervision of their school mentor, teach the kids about a subject. Their mentor helps out, gives them pointers and critiques the student's performance. Internships are further discussed with their PABO mentor and in learning communities, which we will discuss later.

All of the above serves to fill the student portfolio, which is a collection of the skills they have acquired. This is their main method of showing their progress and being able to advance between years.

2.4.1.2. Student questions

If you look at the type of questions that the students have, you start to notice that most of their more important questions gravitate around experiences. Since their education is centred around teaching children things that they already know from their time in primary school, their study can focus on how they should teach it. And in this manner, students start having questions that focus on how others handle certain situations. They want to hear other people's experiences, to acquire new options and ideas to choose from.

Most of the questions of the PABO students are directed towards their colleagues (Figure 2.21); the questions usually relate to problems in their practical experiences and they seek out people that have had the same problems. Teachers and mentors are used as secondary sources (except when they can deal with them directly) and the internet serves as a good tertiary source. This is something that is crucial in the learning communities that the PABO employs.

A learning community consists of all the students that have an internship under a certain PABO mentor, including also the mentor in question, their school mentors and other interested teachers. Like the name implies, learning communities closely resemble Communities of Practice (CoP's) [36]. A main

Figure 2.21. Questions of PABO students are usually asked to their direct peers.

factor of these communities is however that they should be trusted by the student. It has to feel 'safe' to relate their experiences.

Another interesting fact is that they often have questions at moments in which they have no direct access to colleagues or teacher/mentors, who are their main source for answers. Just before sleeping, for example, or when students have questions about the 'products' they have to finish during their internships. However, these questions are best asked to colleagues of the same year or to PABO mentors, both of which are in short supply in the school the student's are teaching at.

2.4.1.3. Conclusions

The visit yielded interesting information about how PABO students operate and how they handle the questions they have about their education. The fact that most questions are about experiences requiring feedback is important for our design **(C2.11)**.

The emphasis that the PABO is placing on communities of practice is also interesting. It relates to the fact that students like to ask questions about experiences to a more abstract level. Enabling a trusted *community of practice* may very well be one of the better ways to enable collaboration (C2.12).

Also, students often have questions at moments when they don't have access to their peers, teachers or mentors. This offers an opportunity to use u-learning in the design **(C2.13)**.

2.4.2. Stakeholders in PABO

Finally, looking at all the information above, we can get a decent idea of all the stakeholders that are involved with PABO students (Figure 2.22). A final design has to take into account all the stakeholders. If stakeholders aren't convinced of the validity of the design, it lessens the chance the design will be adopted. The most important stakeholders that the PABO student is looking at are his peers, his teachers and the primary schools.

His peers are, as already mentioned, the first place a PABO student will go when he has a question. Friends are the preference, but other peers will help as well, especially if the student knows they have some experiences with his current issues.

The PABO teachers all work for the PABO and aim at training the students to become excellent primary school teachers. They are however tied to the PABO by their jobs, the policy and the equipment they are provided. Also, they have to divide their attention amongst many students.

PABO students are also in frequent contact with primary school teachers. They supervise the students' internships and share their experiences. In exchange, they often scout potential teachers for their primary schools by way of the internships. However, their first priority is always to ensure the education of their pupils in the primary school.

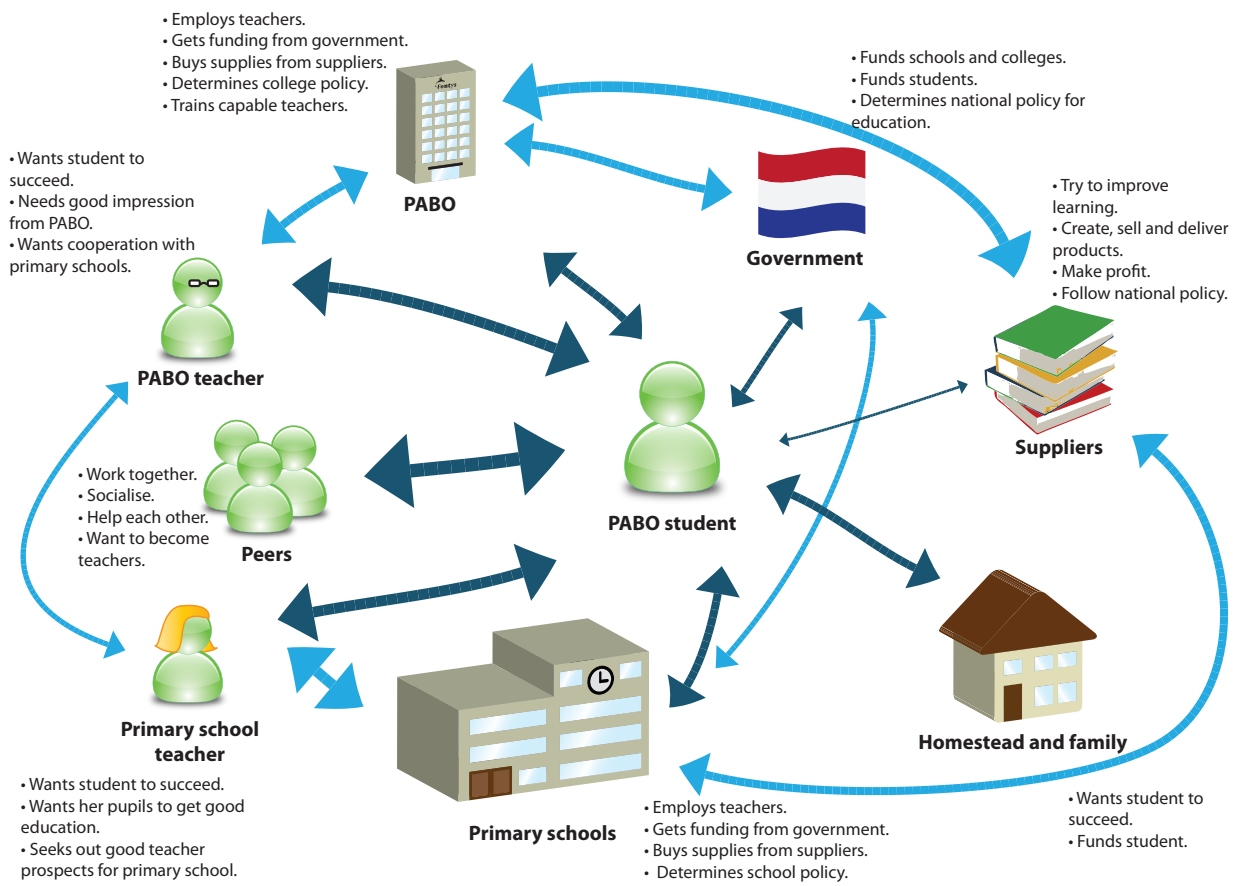
Another important stakeholder for an educational application or technology are the *suppliers of educational material*, who effectively control the its distribution. Since this also includes digital versions of study material (e-learning content), negotiations have to be made with them in order to ensure a healthy amount of content for the application or technology. This can be a difficult thing, since suppliers adhere more strictly to the 'evidence-based education' dogma than educational institutions themselves13. Logical, since they have to make a profit out of it and perceive digital study material more susceptible to illegal distribution.

2.4.2.1. Conclusions

For the project it is the most important that the PABO students are able to use the design well and intuitively. Allowing them to connect to their all-important peers is a big benefit as well as facilitating connections between the students and their PABO teachers and the primary school teachers **(C2.14)**. This also helps build acceptance of the design within educational institutions.

The design must take into account potential *supplier wishes*. The suppliers control the flow of content to the schools and any design making use of educational content has to ensure that that flow is available for the design as well **(C2.15)**.

Figure 2.22. The different stakeholders centred around a PABO student.



2.5. Conclusions

We have discussed three meetings with students from Fontys, two of which were exclusively with PABO students. These meetings gave us valuable insights into the context of the students and suitable design direction.

We have also shown that collaboration is a viable method for enhancing education, due to the fact that students that collaborate have to restructure knowledge in their minds. This restructuring improves the student's recollection of it and how they use it (C2.5).

Summarising the PABO student and distilling the most important results, we get acquainted with the persona *Christine* (Figure 2.23). Christine is a rather typical PABO student, who got into teaching because her parents also teach. She has finished her first year at the PABO and is coming to grips with the new technology used in education. Because of this, she bought a tablet, to see if this would help her education and would be a good teaching aid. Also, it's a lot of fun to use.

- She works on her education in three locations; at home, at the PABO faculty and at the primary school where the interns Two thirds of her time is spent on her internship, with the rest divided between guidance from her teachers, group work and classes. This makes asking questions somewhat hard at times (2.13)
- Whenever she doesn't know something or isn't sure, she can always ask questions to her friends. If even they don't know, teachers are available as well (2.2).
- She likes her tablet, which has some interesting applications that help her education. However, none of the applications is truly targeted at her situation, which lessens the usefulness (C2.3). However, she does use it to engage pupils during her internship, which she thinks is great.
- There's a lot of study material that she needs, but having them all is expensive and carrying them around is heavy. Putting all her study material in the tablet would make things a lot easier too (and hopefully cheaper) (C2.4).

Together with Christine, the following insights for the design direction have been created;

- Sharing a tablet is detrimental to the user experience, because it is inherently an individual, personal device. (C2.1)
- Confirmation of tasks and work well done is important to them, so they can keep track of what is happening around them as well (C2.7, C2.8).
- However, subtle solutions to achieve this are not found to be practical. Students react better direct clarity of their situation (C2.6).
- Giving positive rewards encourages the student to collaborate (C2.9).
- Collaboration is mostly centred around asking and answering questions. Taking this further, it's one of the base requirements for PABO students, since they are very dependent on relating their experiences and getting feedback (C2.11).
- This makes communities of practice a viable way to enable collaboration (C2.12).

Finally, we have learned something about the relation of the students to their various stakeholders.

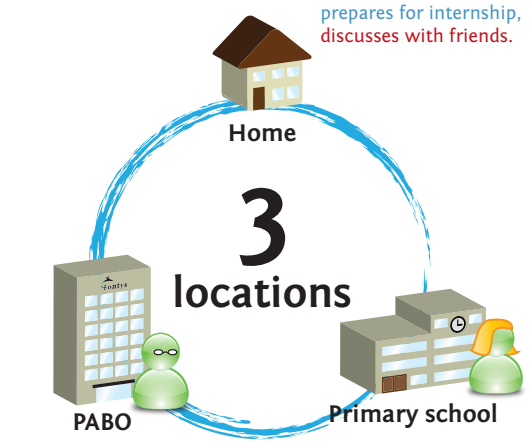
A design that is supposed to improve student's education will have to take into account the students' desire to communicate with their peers, while still allowing an amount of communication with teachers and mentors as well. This secondary communication will help build support for the design within educational institutions (C2.14).

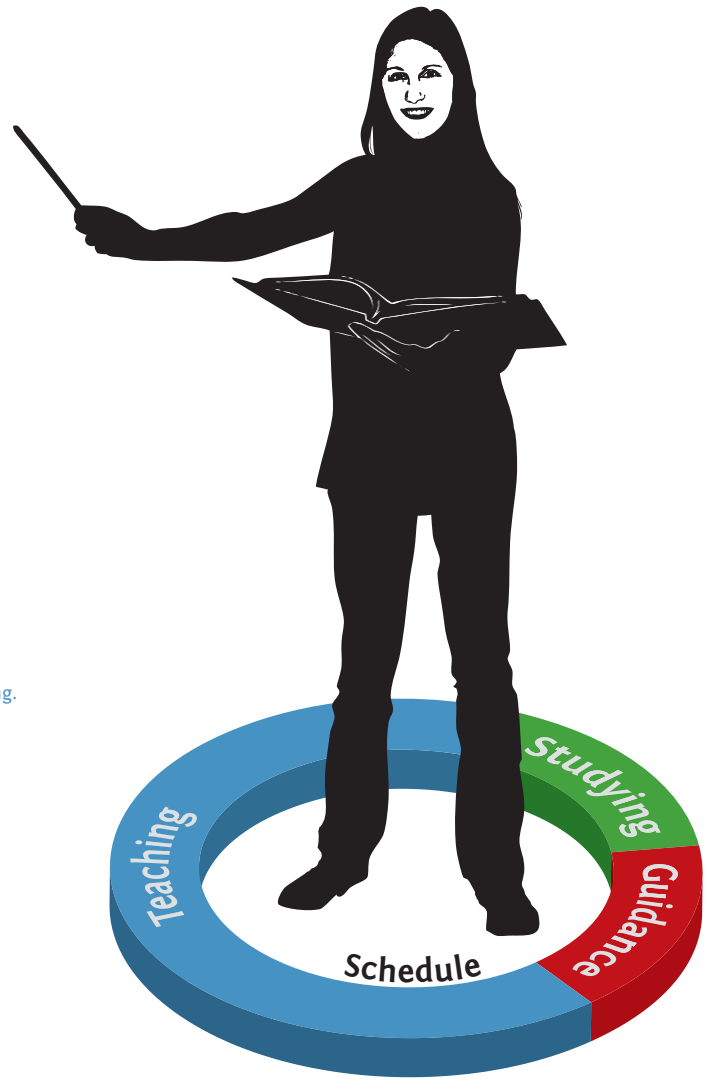
Since an educational design will nearly always relate to content, it is important to note how the supplier's wishes will impact the design (C2.15).

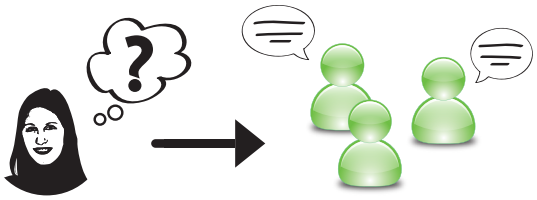
Figure 2.23. The persona 'Christine', who is a summary of the average PABO student with a tablet.

Christine

20 years old
2nd year PABO student





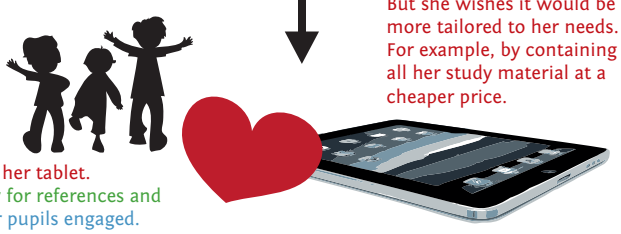


When she has a question, she asks others...

... preferably people that are close to her.

Needs lots of study material,
which is **heavy**, and expensive.

But she wishes it would be more tailored to her needs. For example, by containing all her study material at a cheaper price.



She loves her tablet.
It's handy for references and to get her pupils engaged.

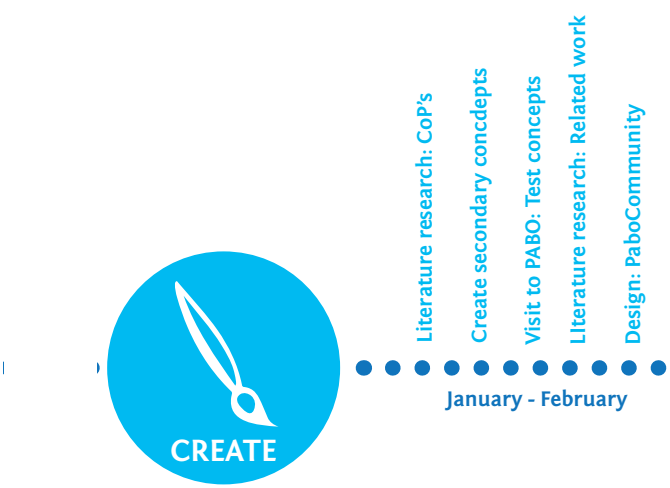
3

CREATE

Create is about developing a more concrete concept design, of which at least a part can be developed into a testable prototype. Continuing in the context of enabling more collaboration between PABO students, a last concept idea was created from the previous findings. Of all the findings, the following were key in creating this final concept, called *PaboCommunity*.

- Instead of enabling more group collaboration, the concept will focus on *enabling spontaneous collaboration*. (C2.9)
- The concept should be *immediately practical* for students, linking directly to their current activities. *Providing study material* in the application goes a long way in this. (C2.5)
- The motivation for collaboration is increased by the following:
  - Being *aware the progress* is made by others as well. (C2.7)
  - *Positive feedback* on collaboration. (C2.8)
  - *Swiftness and ease* of sharing. (C1.5)

We delve deeper into *communities of practice*, which PaboCommunity will try to encourage, as well as to try and determine major design problems and considerations. Based on these considerations, a couple of concepts have been created in the form of storyboards. The success factors of these concepts will bring us to our final concept design.



Goal: Create final concept design
Explore design space
Obtain mechanic
Define final requirements

3.1. Communities of Practice

The emphasis on study material and enabling spontaneous collaboration helps us remind ourselves of the existence of *communities of practice* (CoP's). Etienne Wenger [37] defines CoP's as;

"Communities of practice are groups of people who share a concern or a passion for something they do and learn how to do it better as they interact regularly."

CoP's are defined by three characteristics, which we will link to our PABO context immediately; *the domain* (PABO education), *the community* (PABO students, teachers and experts) and *the practice* (learning and sharing experiences about teaching). PaboCommunity will have the best chance at succeeding if it can motivate students to share their experiences with more people than merely their direct friends and peers. Where and how a CoP exists is irrelevant, but because we are dealing with tablets, we will focus on virtual CoP's.

3.1.1. Barriers for the success of virtual communities of practice

CoP's are beneficial for education, since their existence implies that a group of people is interested enough in a topic to get together and discuss it fairly often. This makes them an ideal way to motivate students to share their experiences more often. However, implementing a CoP runs into quite a number of challenges. Gannon-Leary and Fonthainha [38] have determined barriers to the success of virtual communities;

- *Terminology, jargon and language*
  Virtual communities often exist online, where the nationality and background of members may shift, causing misunderstanding and friction between the members. However, for the PABO this is less of an issue, since the domain is limited to one country and the educational setting ensures that most members will have the same relevant background.
- *Collegiality and lack of face-to-face communication*
  Virtual communities have a lack of face-to-face communication. Because of this, members may opt to ask a peer their questions in person instead of visiting a virtual community. This excludes all other members of the CoP from valuable interaction. For the PABO this may be a major issue, since groups are often formed out of colleagues in the same educational year. Their close proximity will make face-to-face communication easier than using a virtual CoP.
- *Shifting membership of CoP's*
  Not all members participate evenly in a virtual community and the membership often shifts, as people lose interest or become busy and new people become members as well. This doesn't affect the PABO as greatly, since any loss in membership is usually due to graduation. Graduated students are replaced by new first year students, which will help keep the membership alive.
- *Electronic delivery of content and experiences*
  Getting experiences and content across properly over electronic means is difficult. Many people do not have much affinity with electronic devices and may struggle in using a virtual community. However, PABO students are trained in their electronic skills so they may use those while teaching.
- *Lack of trust in the virtual entities*
  Not knowing who you're talking to may generate distrust. You do not discuss problems easily with strangers. However, for the same reason where collegiality is a bigger problem for PABO, this is less of an issue. The virtual entities are always coupled with close-by real persons, which you can be trusted.
- *Legal and intellectual property rights issues*
  Publishing content in a virtual community steps on all manner of toes. Publishers of PABO related study material will

not take kindly to people discussing their work online, if the work itself is published as well.

- *Difference in skill of the CoP's members*
  The difference in skill of the members in a virtual community can be a problem, since less proficient people may either not keep up with the rest of the membership, or may drag the virtual community as a whole down. However, this is one barrier in which the PABO may shine, since this discrepancy between members is something that they are already using in their own learning communities.

3.1.2. Possible solutions for the barriers

Looking at the above barriers, three of them are important for PaboCommunity; *collegiality and lack of face-to-face communication, electronic delivery of content and experiences, legal and intellectual property rights issues* **(C3.1)**.

3.1.2.1. Collegiality and lack of face-to-face communication

Looking at issue of PABO students contacting each other personally rather than using a virtual community of practice, you have to look at the reason why this may happen. Asking and answering questions is about providing sufficient context for the other party to understand what you're saying. Students and teachers use books, whiteboards, gestures and more to relate and enhance this context. In a virtual community, these options are limited.

In order to create sufficient motivation for PABO students to ask questions through a tablet application, a good idea is to capitalise on their desire to have all their study material in one place, preferably in a tablet (C2.4). By providing a mechanic in which the questions and answers are directly connected to the relevant study material, the step towards generating sufficient context for the question decreases dramatically **(C3.2)**.

3.1.2.2. Electronic delivery of content and experiences

Getting the study material content and students' experiences across properly through an electronic medium presents challenges. As with the issue of collegiality, context is an important factor here. Especially getting the experience across that people have questions about certain things and topics is important, since this enables students to participate in the community.

A way to solve this may be to visually remind the student while he is using the application as to where there is activity. PABO students have shown a preference for visual reminders, since these give satisfaction when pursued personally **(C3.3)**.

3.1.2.3. Legal and intellectual property rights

The issue of collegiality can partially be solved using the tablet application, as the single repository for all PABO related study material. However, this comes with the significant drawback that the suppliers of this material have to be reimbursed for this distribution of their intellectual property. This reimbursement quickly becomes very costly.

However, there is no solution for this possible in a tablet application itself. However, if the design is convincing enough, the stakeholders can negotiate appropriate reimbursement for supplier's if they allow their material to be used in the design **(C3.4)**.

3.2. Secondary concept ideas

The first concept ideas gave a very good indication in which area to continue exploring. The meetings with the PABO students showed that they were most triggered by the '*Forward reward system*', because it gave them *positive feedback* (C2.8) and they could *see the progress* (C2.6) of more people than just their own group mates.

Moving away from only enabling groups that are working on the same goal to collaborate more efficiently, the next phase focuses on two concepts called '*Proximity*' and '*Notes*' that would enable students to more actively seek each other out. The complete concepts with the user's interaction can be found in Appendix E, but we will discuss them here as well. The concepts also make use of two of the more prominent interactive features of tablets, respectively the GPS sensor (allowing the tablet to know where you are) and internet capabilities.

Since we have established that building extra motivation for the students to use the tablet application is very important, both concepts will make use of study material that is directly integrated into the application, in order to increase the practicality.

3.2.1. Proximity

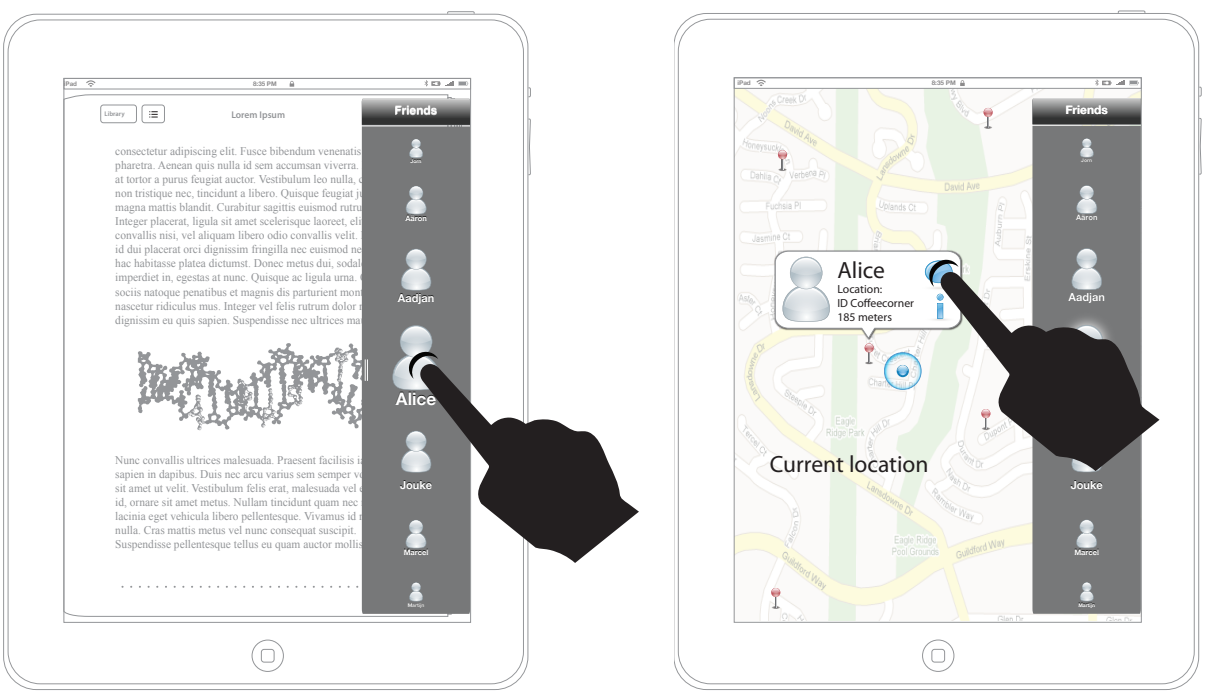
Proximity (Figure 3.1 and 3.2) is a concept that allows the user to see whether other people are currently working on the same subject or goal are in the neighbourhood. So, when a user seems to be completely stuck on certain aspects, he or she can try to make contact with a peer to see if they can solve the problems together.

Because Proximity shows the physical distance and location of the user's peers, it invites him to physically visit them. This creates a tighter bond between the two peers and will make it easier for them to collaborate again in the future.

Proximity delivered a strong mechanic, though students themselves said that they would not use this function if it was offered to them. Physically visiting someone to ask for help is something that they are not comfortable doing with strangers. And in the case of people they know, they have sufficient ways to contact them if necessary. Tools like social networks (Twitter, Facebook, Hyves) or Messenger services (such as Google Chat and Microsoft Live Messenger) fulfil the needs of the students in this scenario sufficiently.

Figure 3.1. (left) One of the frames of the 'Proximity' concept. The user is looking at the list students working on the same material and chooses one.

Figure 3.2. (right) One of the frames of the 'Proximity' concept. The user sees that the chosen person is close and decides to communicate with him, to ask if he can come by for help.



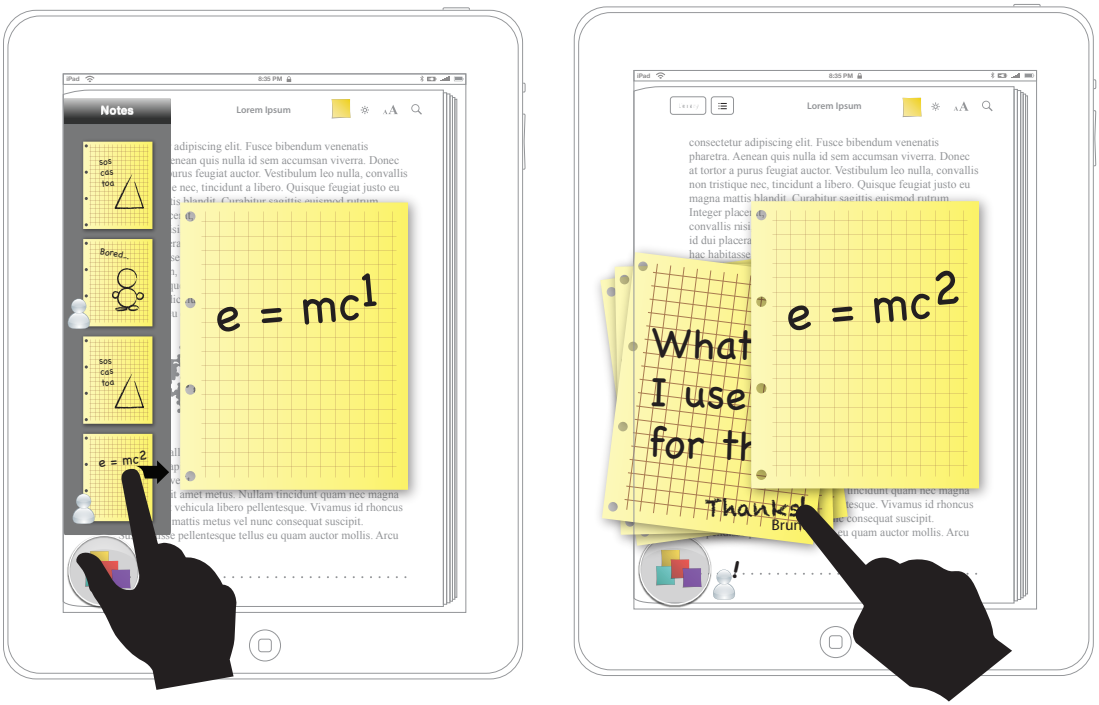


Figure 3.3. (left) One of the frames of the 'Notes' concept. The user got stuck on a question and tries to see who else is currently making notes about the study material. He slides the last to the work area to view that student's notes.

Figure 3.4. (right) One of the frames of the 'Notes' concept. The user managed to solve his question and is happy with the notes that he viewed. He leaves a 'thank you'-message to show his appreciation.

However, something that may have potential is using this in conjunction with specific geographical areas. For example, if a student walks into his faculty near exam time, his tablet can *notify him of any groups* of students in the building that are currently studying the same subject. This way, the student can join these groups. Because he already attends the same classes as the group, this bypasses the issues the students have with looking up strangers. They are not actively seeking out individuals and they can always get a visual confirmation if the help from the group is needed.

3.2.2. Notes

Notes (Figure 3.3 and 3.4) focuses on users sharing their notes about study materials. It functions as an e-reader where you can read books and do assignments and that offers note taking capabilities as well. Even more, Notes makes the user aware of others that are working on the same thing and gives access to their shared notes.

So when a user is stuck on a certain topic or assignment, he can look up the notes that someone else made and use those to help himself. Additionally, the user is encouraged to leave a 'thank you'-note in the margins of the notes, so his peer knows that someone found his notes useful. This will *motivate that peer to keep sharing his notes*, while the user is *encouraged to share his own notes* as well.

3.2.3. Focus group

In order to gain insights from the concepts, a focus group session with PABO students was held. They were shown the storyboard panels and asked to navigate through them as they would. The author would observe them and present new panels as they navigated.

Notes was deemed very useful, since *sharing notes* is something that appeals to students. Especially because they would be able to see the thought processes that the note taker wrote down. Being able to peek at complete calculations helps most students a lot.

Even though this goes against the philosophy that people giving answers have the biggest benefit (section 2.2), it does help the students that would have asked a question, since the students now has to wrap their heads around the thought process of someone else. This restructuring of the questioner's thoughts may have the *same beneficial results as restructuring thoughts* when explaining.

Being able to leave a 'thank you'-note was deemed to be useful, since students indicated that they would be very pleased if they

received a thank you. The majority indicated that they would be triggered to leave more notes if they noticed that it was useful.

Another plus point of Notes is the *immediateness of manual note taking*. Because notes taken by the user are written swifter than possible with a virtual keyboard, it saves on the effort that a transcription of handwritten notes would take if they were to be copied from paper (with a virtual keyboard). This immediateness helps in letting students decide if they want to share notes and lowers the threshold for doing so.

3.2.4. Conclusions

The concepts were presented to both students and to the mentors of this project. The results quickly showed that the concepts made interesting use of tablet capabilities and could elicit more collaboration.

Proximity would not work, because it focuses too much on contacting individuals. If the individuals are strangers, this is too big of a barrier **(C3.5)**. Using the locational awareness within geographical locations would be interesting however.

Notes on the other hand has a lot of potential. It has a low barrier and it is a good incentive for sharing notes. This increases the likelihood that it would be actively used and thus would improve collaboration **(C3.6)**.

3.3. Related work on digital note sharing

We take the conclusions from the previous focus group test on the concepts and analyse what they mean. The above findings about enabling CoP's, while avoiding the barriers to their success, and the results from the second concept ideas provide us with a good basis for our final concept.

However, we still have no definite collaborative mechanic on which the design should focus its efforts. Therefore we will attempt to find one by returning to literature research, looking at other areas of study that may help us find such a mechanic.

Creating an application that enables a CoP amongst PABO-students introduces us to *computer-supported collaborative learning* (CSCL), an area which currently is under extensive research.

Likewise, the success of the concept Notes was partially because of the *low barrier to share one's own notes* on study material with peers. Taking this note-taking behaviour into account, a review of work done on *digital annotation* can also aid in the development of a final concept design.

3.3.1. Computer-supported collaborative learning

CSCL is a pedagogical approach where learning takes place through social interaction using digital means, such as computers and the internet. It is centred around the *constructivist view of learning* [39], where participants develop knowledge by relating new things to their own experiences. Thus, sharing those experiences with others and looking at experiences of other people creates a more fertile ground for building knowledge, empowering the idea of collaborative learning.

Research in CSCL is still in its infancy and its goals and constraints are not clearly defined [40]. However, it is clear that CSCL strives to improve the learning of the students through enabling computer supported collaboration. Several different types of applications have been developed towards this goal

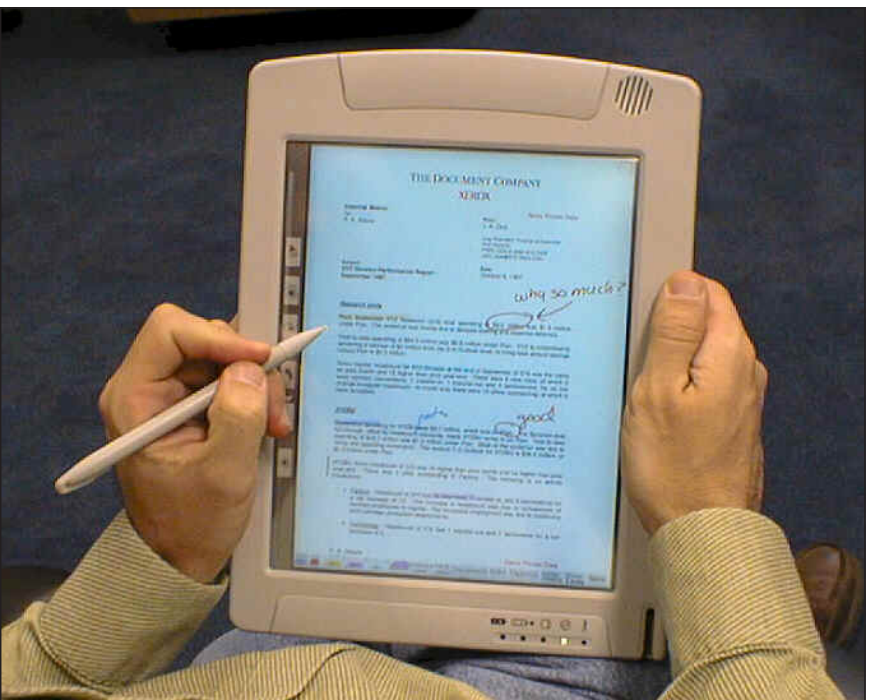
(e.g. wiki's and collaborative writing tools) and existing applications are being employed for this goal (e.g. messenger applications, Dropbox). One type of application stands out, namely the collaborative annotation tools, since they are closely related with the concept Notes (section 3.2.2), which was well-received by the target group.

3.3.2. Collaborative annotation tools and active reading

Collaborative annotation is a collaboration approach which lets multiple users create, view and respond to annotations. A common approach to collaborative annotations is sharing physical sources with annotations written directly on it, for example when researchers review each other's publications. Digital examples can be found in most writing software, which lets multiple users add comments to documents (such as in Microsoft Word [41] and Apple's Pages [42]) or social bookmarking sites that allow users to share interesting websites and their notes on the websites (e.g. Delicious [43]). Until recently, Youtube even offered collaborative annotations on their videos [44] [45].

Collaborative annotation is said to support *active reading*, the combination of reading with critical thinking and learning. Critical thinking and learning was supported by not only reading the text, but also by interacting with it, through making notes and annotations or highlighting and underlining, either on the text itself or in a notebook [46]. The theory of active reading has been applied to create several collaborative annotation tools for e-learning. For example XLibris (Figure 3.5) by Schilit et al. [47], a software application for e-readers, allowed freeform writing on documents and communicated that to other XLibris users through a wireless protocol. Other such tools were *Memo Note* and *AnnForum* by Azouaou and Desmoulins. [48]

Figure 3.5. The Xlibris prototype.



3.3.3. Collaborative strategic reading

Active reading later evolved into the concept of strategic reading, where the learner is able to learn better and more efficiently by employing specific reading strategies. Examples of these strategies are looking for words in the text that specify the relations between subjects in the text, or reading the first and last sentence of every paragraph before reading the whole text [49]. Employing these strategies significantly increases the reading comprehension of the learner.

Because of the benefit of strategic reading and the fact that collaboration also positively impacts learning, people have been developing collaborative strategic reading (CSR) [50]. The strategies for CSR are as follows:

1. *Preview*
   Preview the text by reviewing your group's existing knowledge about the topic and trying to figure out what the text will say.
2. *Click and clunk*
   Every few paragraphs, figure out which pieces of text were difficult to understand (a 'clunk') and spend some time resolving this clunk.
3. *Get the gist*
   Every few paragraphs, spend time identifying the most important idea of the text.
4. *Wrap up*
   Answer questions to check whether the text in its entirety is understood.

These strategies are being used in several educational areas, such as teaching exceptional students to increase their reading ability, and even when teaching children with reading disabilities, giving them extra tools that might help them understand the text better. This versatility makes these strategies a powerful tool that should be incorporated into our own design.

However, CSR was developed with group learning in mind, and does not incorporate the spontaneous collaboration that might take place when individual students work by themselves. Even so, the timeline which the students adhere to can still apply, though some of the parts do not have to be done cooperatively.

In a normal day of a PABO student during which the he has to read study material, the four strategies usually unfold as follows:

- The *Preview* strategy is when the student figures out what the text might be about and what he already may know about the topic. This is usually done during class of the course for which they have to read their texts. The teacher covers the course topics and assigns the reading material. The student has a pretty good idea what the text will be about, since the topic of the course is known.
- *Click and clunk* is where students see what they understand about the text. Usually this happens after reading the entire assigned text. Clicks are normally stored and only retrieved when necessary. Clunks either stay unclear or the students ask a peer or his teacher to help him to understand it.
- *Get the gist* often goes hand in with click and clunk, though it may come at a later stage. The clunks usually have to be resolved first before a student gets the gist. This can also happen in concurrence with resolving clunks, for example when a peer helps the student make sense of the clunk by highlighting the basic idea of the text.
- *Wrap up* often comes in the form of using the text in practice. For example when preparing lessons or when asked questions about it in a written or oral exam.

Preview and *Wrap up* normally come up during formal class hours, which are not interesting for our design. *Click and clunk* and *Get the gist* occur at two possible moments. First is during group work, where others immediately help the student if necessary. The other is when the student is reading individually and gets stuck with his clunks. These have to be resolved later.

Incorporate the strategies for CSR into our design, gives us a great way of ensuring that the design encourages collaboration during reading. As mentioned above, the most promising way to approach this is by ensuring that the design encourages to fix their clunks by *asking questions*. *Answering these questions* is a good way to make sure that students got the gist.

To conclude, CSR has given us an excellent mechanic to focus our design on, namely *asking questions and giving answers* **(C3.7)**.

3.4. PaboCommunity

Communities of Practice provide a good basis for an education enhancing tablet application, provided the barriers to success for the PABO context are overcome. Luckily, most barriers that have been found were less crucial for the PABO, leaving only three major barriers to be solved; *collegiality and lack of face-to-face communication, electronic delivery of content and experiences, legal and intellectual property rights issues* (C3.1).

These barriers are alleviated greatly by the physical proximity of students to their peers and teachers (C3.2), the inclusion of study material (C3.3), though the legal issues that surround this will become one the biggest barriers when realising the design (C3.4).

The exploratory concepts *Notes* and *Proximity* were created and presented to a focus group. This gave valuable insights, though *Proximity* proved to be unworkable in a practical setting. Students are not willing to interact overly much with people they may not know (C3.5). *Notes* however proved to be very workable in the sense that the quick notes one makes become available for others to read. This gives a low barrier for sharing and a good capability for people to show their progress (C3.6).

And finally, we have found our mechanic that the design may focus on, namely *asking questions and giving answers* (C3.7).

Taking all this into account, we can now move towards designing *PaboCommunity*, our final design that will enable collaboration between students through facilitating CoP's.

3.4.1. PaboCommunity design considerations

The goal is to create PaboCommunity, an application in which a community of practice for PABO students can manifest itself and enable more collaboration between students. PaboCommunity has to be *practical, swift and intuitive* (C1.5), and has to motivate students to share (C3.6). It also has to give the students a good idea of what others peers are doing and how they are progressing in their education as well (C2.7, C2.8). This will give the students incentive to strife higher.

And most importantly, it has to incorporate the notion of questions being very much related to experiences and not just to 'yes' or 'no' subjects (C2.11).

3.4.1.1. Practical versus experiences

An issue is for PaboCommunity to be practical and still deal with experiences; two very different ideas. Practical for PABO students means that they can use the tablet to access study material they need for their classes and internships. Thus, it makes sense that showing this material and allowing them to ask questions about it makes perfect sense.

However, this does not take into account that questions may arise about things besides study material. Explicitly, questions about the student's experiences *during his internship* do not have a natural place within an area meant for study material.

To achieve this, PaboCommunity has to be split into two parts. One part would be a type of e-reader where *study material can be accessed and read*. It will also serve as the place where questions about the material can be asked and answered. The second part will be a more forum-like part, where *questions can be asked about any topic*, though the topic must be indicated. This forum would also contain the questions from the material, but it also gives a good opportunity to include questions about experiences as well.

3.4.1.2. Awareness of progress and activity

The application also has to give the students a sense of activity. They are motivated to collaborate if they know they are not the only

ones and that it is effective. Thus, showing what others, especially peers they are close to, are doing, gives them a sense of accomplishment by proxy. So it's important to not only see one's own questions and activity, but to also see other's questions and how their activity evolves over time.

Taking this a step further, if a student can get an *overview of the progress* people are making, he could also see which students are developing expertise or check how far along his own expertise is when compared to others. Expertise in this sense is when a student is interested in a particular subject and thus collaborates more often on that subject.

Seeing questions and answers pop up while reading study material, or seeing the forum grow as more questions and answers are added are probably a very good indicator of progress. Seeing such activity will motivate students to collaborate, since they can see that it actually works.

However, getting a sense of which students are developing expertise is still somewhat more difficult. A third part can be added to PaboCommunity, where the people that have to do with the student are displayed, along with the activity they show in certain topics.

3.4.1.3. Swift and intuitive

Of course, PaboCommunity has to motivate students to collaborate more often. We have already seen that this can be accomplished through lowering the barrier of sharing. In this case, making sure that students can quickly ask and answer questions about certain topics without much hassle, ascertains they will do so more often.

A way to achieve this is by guiding the students to use short, but sweet questions and answers. Services like status messages on messenger services, social networking sites and Twitter show that small messages are something that people use quickly. To leverage this, we can make the text areas where questions and answers can be asked small, to guide the students into keeping their collaborations small and quick.

3.4.2. Pabocommunity as an ubiquitous educational tool

To design PaboCommunity, we also should take into account its role amongst e-learning tools. There are already quite some ubiquitous applications available and already proper guidelines have been established on how to design them and what requirements they should fulfil to be viable as educational tools. For digital annotation tools, such as PaboCommunity, Azouaou et al. [48] proposed the following requirements:

- *Usefulness*
  The application has to be useful in the domain and context of the user and should adapt itself to the specific activities of the user (C3.7).
- *Shareability*
  The users should be able to share notes by means of a visual indicator, while using the semantics of the learning context (C3.8).
- *Usability*
  Creating annotations should not disturb the user's learning activities and annotators should be held in their learning context while annotating (C3.9).

We can take this further by looking at models for how the PABO students experience studying and homework (the situation in which we want to establish more collaboration) and compare this against a model for ubiquitous educational tools.

3.4.3. Studying and homework

The need for collaboration become most apparent when the PABO student is studying or is doing homework and has a question about the material. By creating a model of the actions taken during studying and homework, we can determine the most important parts of the student's interactions during these activities (Figure 3.6).

The PABO student has to view all kinds of study material, be it study books or articles from a variety of sources. Most of this study material can either be found in the library of the educational institution or at home

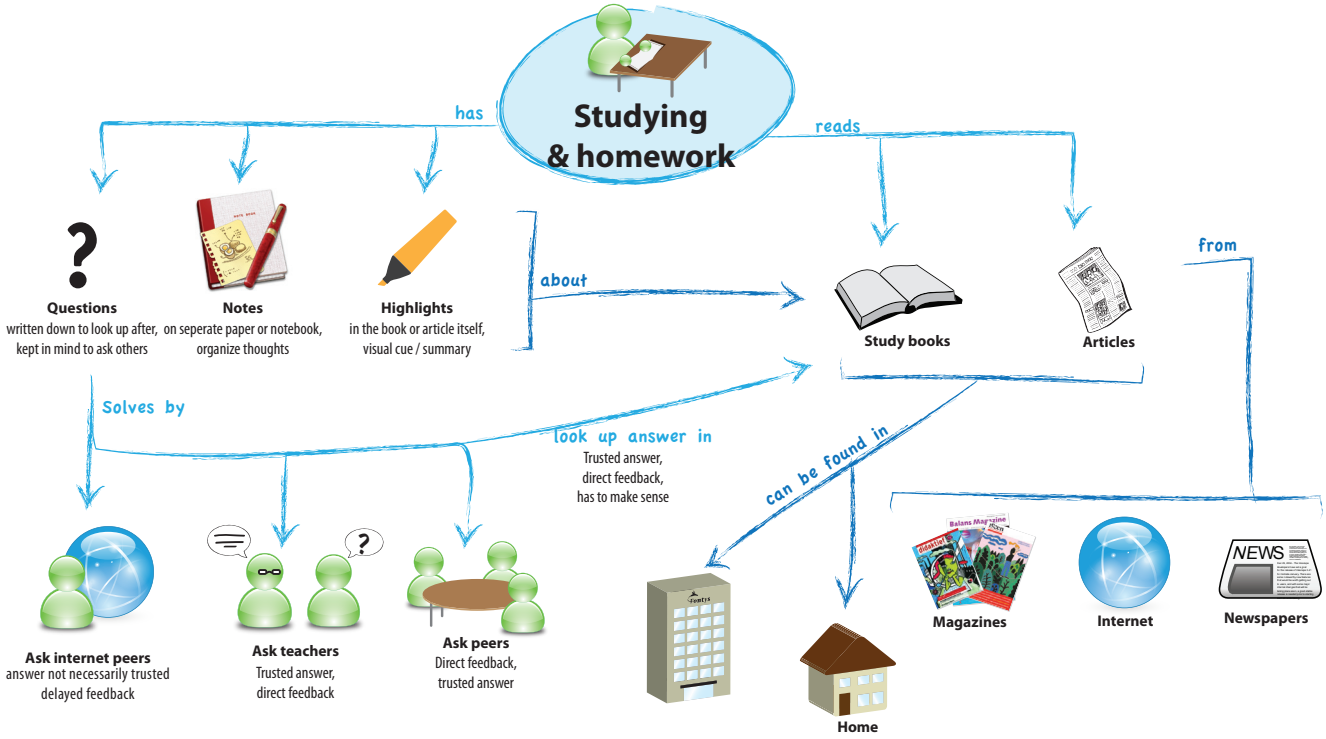


Figure 3.6. A model of the PABO student studying and doing homework.

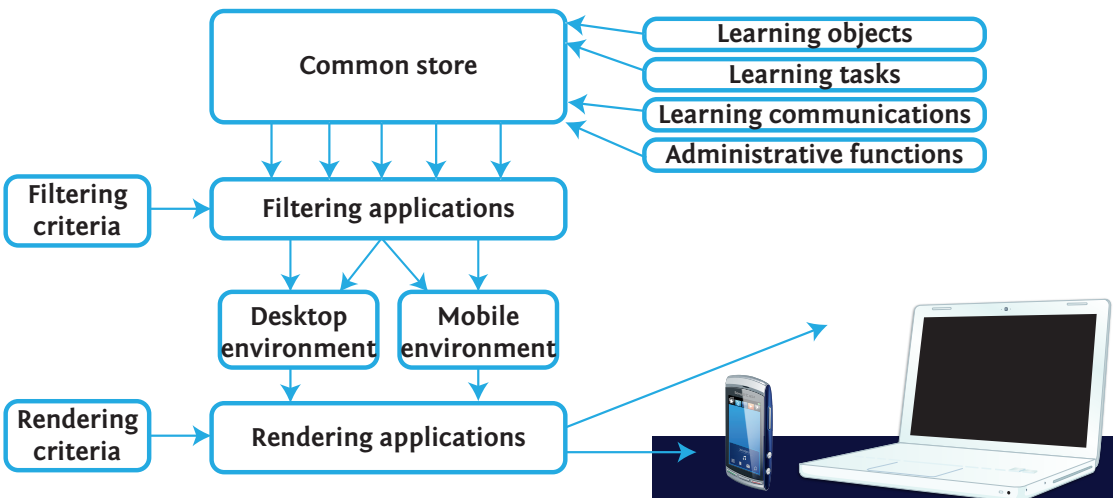
(where it was bought from educational suppliers).
In order to complete this work, the students highlights text in some way for faster visual recovery of the material, makes notes in either the book itself, paper, or notebooks. And of course a lot of questions arise, which are usually *asked to peers, teachers or perhaps even the internet* (C2.4).

3.4.4. U-learning model

The above model gives a good representation of most aspects that should be covered in the final design and the prototype. However, these should be placed into the context of u-learning, in order to see if PaboCommunity will be able to perform well as a ubiquitous educational application. Fraser [51] provides us with a model for u-learning, which covers most of the ingredients needed to create such an application (Figure 3.7).

One of the main considerations that have to be made is, as we have stated once before, the delivery of electronic content and experiences. Most of this is handled through the '*common Store*', (the repository for all common tasks, regardless of context or platform) in the u-learning model, which takes all the material (i.e. '*learning objects*') and provides them. '*Learning communications*' determines the necessary communication between users, which in this case are the PABO students and their peers and teachers.

Figure 3.7. U-learning model from Janet Fraser.



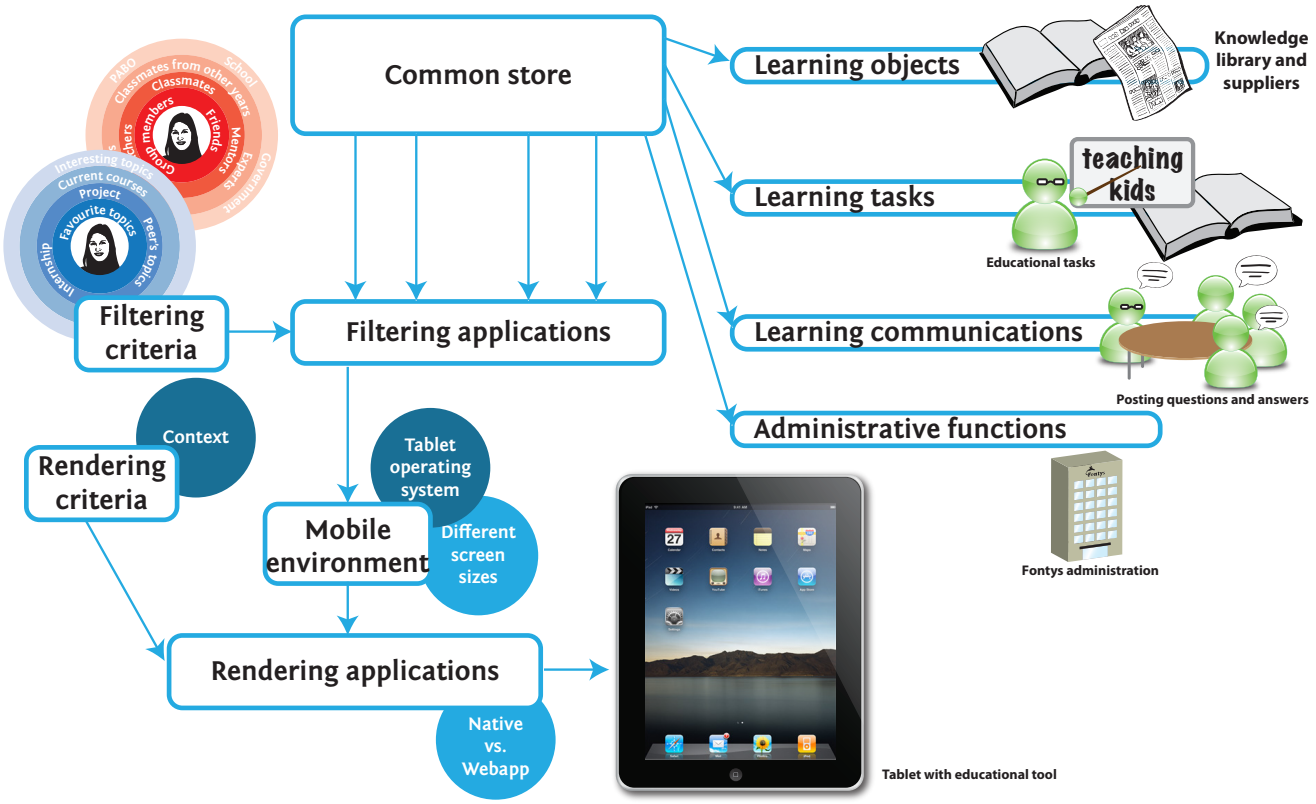


Figure 3.8. The u-learning model and its most important considerations for PaboCommunity.

'*Learning tasks*' signify the educational tasks given to the user, usually by the teacher, in college or by study material (assignments). Finally we have the '*administrative functions*', which manages details such as information about the different users and their roles and privileges.

Everything from the common store contains a large amount of data which has to be presented on the screen. In our case (Figure 3.8), this means that it has to be '*filtered*' for the three different areas of PaboCommunity. Disregarding the desktop environment (since that has no further consideration for this project), the *mobile environment* has to be considered. In this case, we are talking about tablets, of which different models are remarkably similar. Two major differences can be found between all the different models, namely screen size and operating system.

Taking this further, not everything has to be rendered immediately, since it is not relevant to the context. Also, this is where the user interface of the tablets come into consideration. Tablets usually have the choice between native applications (native apps) and web applications (web apps). For PaboCommunity, native apps are a better fit. We will discuss this later in section 4.3.1.1.

3.4.5. PaboCommunity and stakeholders

The different stakeholders will all use PaboCommunity in slightly different ways (Figure 3.9). The PABO student will use it most extensively, as all of the areas are designed around their needs. They will have to read study material, ask and answer questions, be able to enrol for new study material, courses and projects and keep track of their network. The other stakeholders will use PaboCommunity less extensive, but they still play a major role and they have to be designed for as well.

One of the more important stakeholders, the suppliers of study material for educational institutions, control most of the available material's distribution. PaboCommunity has to make it attractive for these stakeholders to provide material that can be included. For example by providing statistics about PaboCommunity's use that will convince the suppliers to invest in the design.

3.4.6. Solving the CoP barriers

PaboCommunity can become quite valuable for enabling student collaboration. It provides many of the major strong points of CoP's, and tries to enable students to participate in these.

Looking back at the major barriers for this application in regards to enabling a CoP, one of them has a large potential to be solved, namely *collegiality*. It integrates the idea of peers, with both study material and questions and answers quite closely. Since these peers are available from the entire environment of the PABO student, the connectivity is enhanced (C2.5). Allowing communication between all these peers also aids in fulfilling the u-learning requirement of *usability* (C3.7) **(C3.10)**.

The *electronic delivery of content and experiences* hinges on making the PABO student more aware of what is happening in the community. By providing visual cues (C2.7, C2.8, C3.8), such as in the e-reader for questions and answers, or in the network for the closer peers, the user stays engaged with the application and gets a better experience **(C3.11)**.

The *legality and copyright of material* is trickier. Making sure that PaboCommunity has sufficient practicality to succeed as an e-learning tool, it should integrate most of the study material which a PABO student will need for their education. However, educational suppliers are still notoriously scared of electronic delivery, which may hamper the adaptation of material in the application. Deals should be made with them to make this possible, though this may be very hard. Legality is a large consideration, to which PaboCommunity may only serve as a convincing tool during negotiations **(C3.12)**.

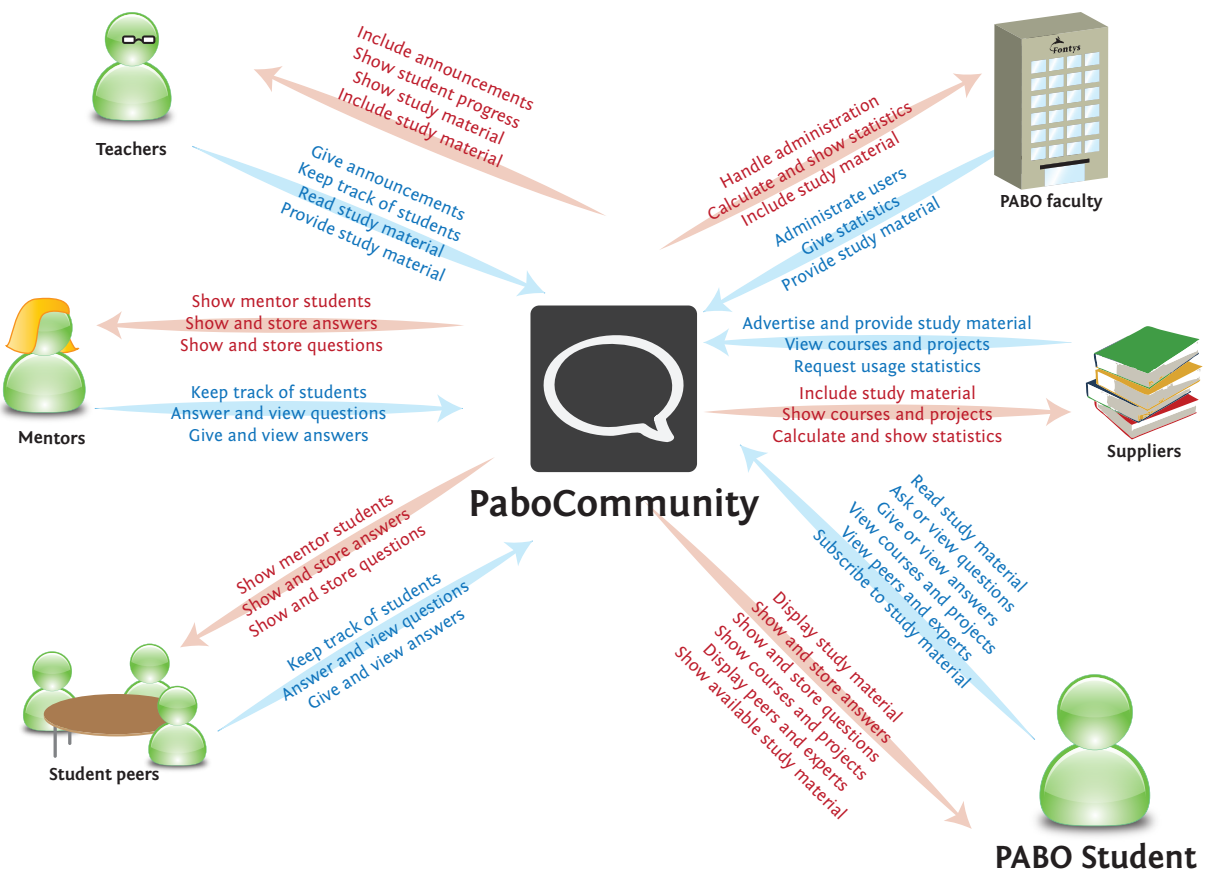


Figure 3.9. Context diagram of the different PaboCommunity functions for the several stakeholders.

3.5. A community in three parts

In section 3.4.1 we have established that the final design for PaboCommunity should have three parts (Figure 3.10):

1. *An e-reader area*
   Study material can be read and questions about it can be asked and answered.
2. *A forum area*
   Both questions about the study material and about free topics can be asked here, providing a place for questions about experiences. It also serves as a more compact way to see the activity over all the questions.
3. *A peer network area*
   The peer network of a PABO student is important for them. In this area, student's may see if someone's will be able to help them with their specific question.

A design that incorporates all three of the above areas, can have a great impact in the development of a community of practice and thus a beneficial impact in students' education. We will discuss the three aspects and their considerations for PaboCommunity.

Due to time constraints and considering the need for implementing a more elaborate user test, only the e-reader area has been designed and developed more thoroughly.

3.5.1. PaboCommunity e-reader

The first part of PaboCommunity is the e-reader area. We have mentioned above that this area has to adhere to the practicality of the application, that it should serve a purpose in making the student aware of the progress others are making and of course that it has to be intuitive to use (C3.9).

PaboCommunity's validity as an e-learning tool, and more specifically as an application that supports CSCL, depends nearly entirely on the amount of users that it will have. There are plenty of collaboration tools that completely fail to get active users and therefore are completely forgotten (an example of this are the 'Group tools' of Blackboard [52]).

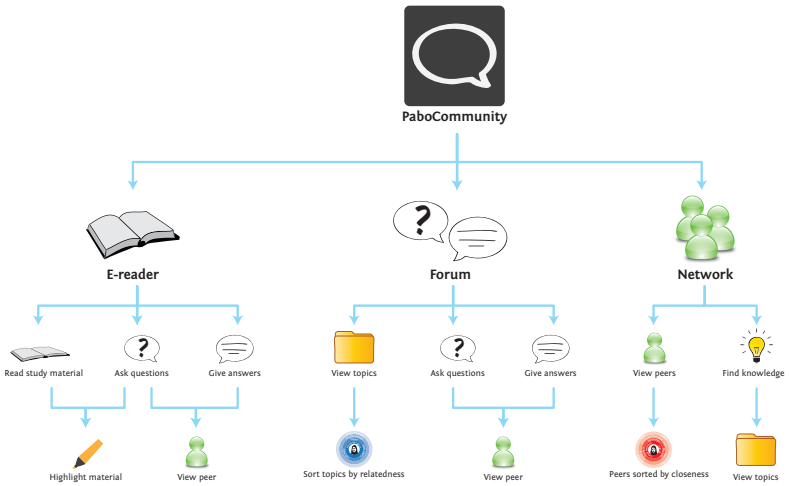


Figure 3.10. An overview of the different areas of PaboCommunity and their general functions.

3.5.1.1. Study Material

Looking back at the wishes of the PABO students, we return to the large amount of study material that the PABO student has to come into contact with (C2.4). There is an abundance of books, articles and readers that they have to read and it's both expensive and cumbersome to own and carry them all.

Tapping into this issue, if PABO-community can provide the student with all this study material, we immediately get a very valid reason for the student to use the application and obtain a good solution for PaboCommunity's practicality and usefulness (C1.5, C3.8).

3.5.1.2. Communication

Merely providing an e-reader however does little to allow the PABO students to form a community. To achieve that, we have envisioned a method for asking and answering questions as well. Integrating these two

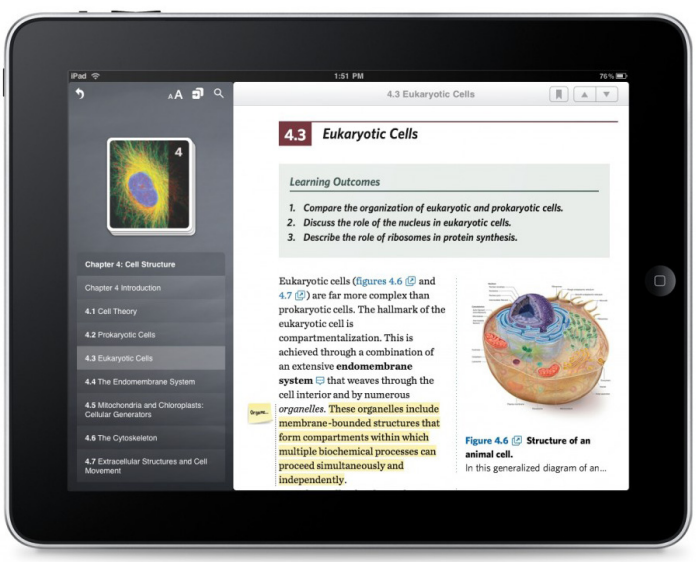


Figure 3.11. A screenshot of Inkling in practice. Of special note is the post-it icon in the left margin, indicating that a comment has been placed about the highlighted text.

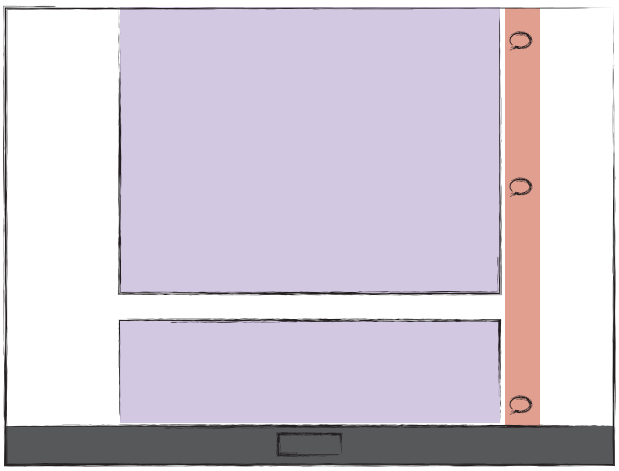


Figure 3.12. (left) Viewing study material in the e-reader.

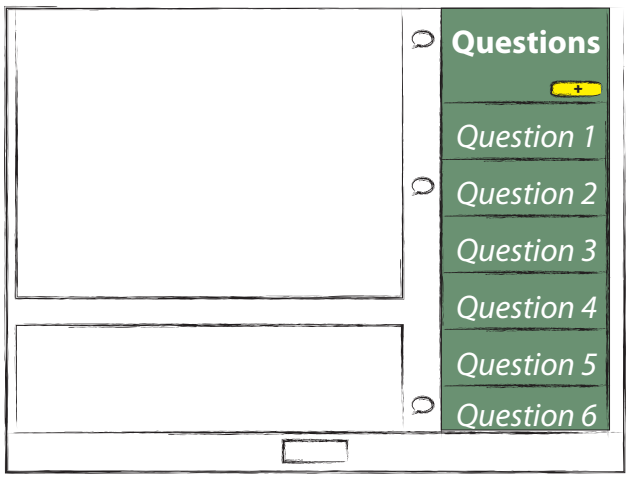


Figure 3.13. (middle) Viewing questions after pressing one of the visual indicators.

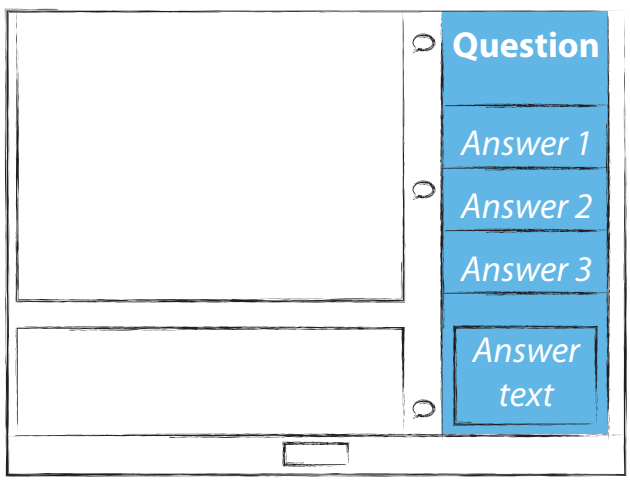


Figure 3.14. (right) Viewing the answers of one specific questions.

aspects has been done in the field before, for example with *ShowMe* [53], a tool which allows a student and a teacher to walk through the student's work together and *Inkling* [54] (Figure 3.11), which combines interactive study material with the ability to make notes about it and share these with your direct contacts.

ShowMe has realtime communication between, but only between a teacher and a student, and allows for annotating and highlighting as well. Inklings comments can be shared with a limited social network (direct contacts), though other cannot access the comments. The sharing is somewhat limited.

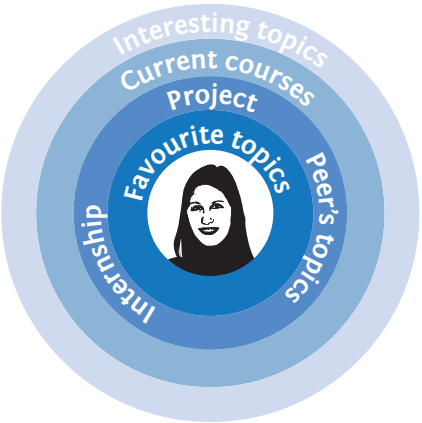
Using this sharing and real-time communication in PaboCommunity will help students to connect with their peers, solving the CoP barrier of collegiality (C3.10).

3.5.1.3. Functionality sketch

Taking a cue from both of applications, and checking to see what is necessary to achieve collaboration, even when students are studying individually, two features are key towards managing this. These features were quickly sketched to gain a sense of the functional screens and areas that would be included in the application.

Figure 3.12 shows the sketch where the e-reader provides functionality to read study material (purple area) and provides the user with visual cues (red area) on the presence of questions that are connected to the material. There is also a navigation bar, which is reserved for switching between application sections (grey area).

Interacting with the visual cues for the questions shows the user all the questions that are connected to the study material (green area), as shown in figure 3.13. The study material itself is still visible, allowing the user to keep it as a reference. A button (yellow area) provides a way for the user to add his own questions.



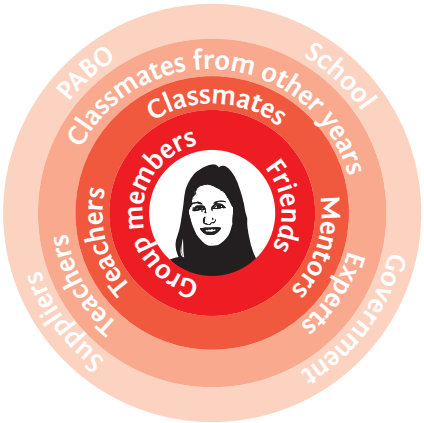


Figure 3.15. (left) Some topics are closer to the students than others.

Figure 3.16. (right) The network of a PABO student and their closeness to the student.

Finally, figure 3.10 shows how interacting with a question brings up its details. Most specifically it shows any answers to the questions by the user and his peers. Also, it allows for the user to add answers as well.

3.5.2. PaboCommunity forum

Creating an e-reader area for PaboCommunity will go a long way to enabling student collaboration. It provides a valuable tool for the students because of the integrated study material, and the functionality for asking and answering questions gives the students a practical way to collaborate.

However, it is limited to the topics that are covered in study material. Still, PABO students often discuss about their experiences as well, since feedback on that is just as important.

3.5.2.1. Categories

Experiences are often not confined within the strict categories that courses usually adhere to (which is the case when viewing study material). Rather, the experiences fall within a wider range of pedagogical topics. Therefore, this area should be able to hold multiple, changing topics. However, too many of these might be too confusing to the users.

A way to incorporate this properly will rely on efficiently making the user aware of the different topics that are available and which of those topics are important to him (Figure 3.15). Likewise, it is important for the practicality as well to allow quick access to important topics when incorporating the different levels of peers.

3.5.2.2. Functionality sketch

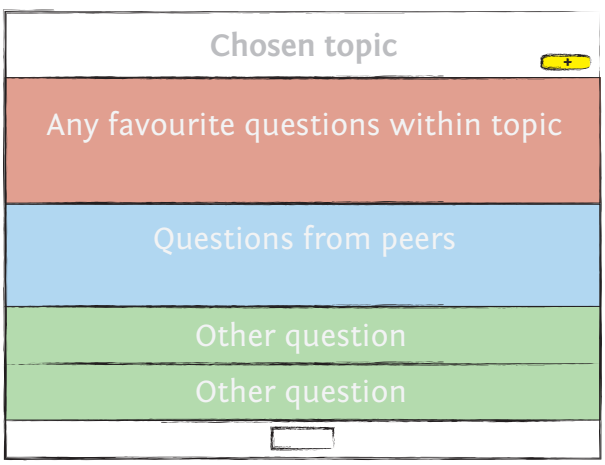
As with the e-reader area, we did an exploration on how a forum can show both topic activity and peer activity. (Figure 3.17). Activity in the areas closest to the user (blue area) are larger than those further removed from the user (green area). We also need to allow the user to ask questions himself (yellow area).

Two things are important for the user; knowing what questions there are on a certain topic, and knowing what questions of a topic are important to him (the ones he marked as important and the ones that his direct peers participated in).

3.5.3. PaboCommunity network

Finally, we come to the final area of PaboCommunity. PABO students have a great need for interaction, which means that they should have a good means to get a proper overview of how their peers are progressing within their education. This allows them to ask better questions or to give more valuable feedback to each other.

Figure 3.17. The network area of PaboCommunity.



3.5.3.1. Closeness

We have already determined that PABO students do not necessarily ask questions about the meaning of study material, but that most of the questions stem from the application of the study material in practice. PABO students want to relate their experiences about teaching and their study and also get feedback on them from their peers.

They preferably ask these questions of peers close to them. This first includes friends and group members, then moves on towards their classmates, teachers and mentors. Only afterwards will they ask other sources (Figure 3.16).

Figure 3.18. (middle) Viewing the activity of different types of peers.

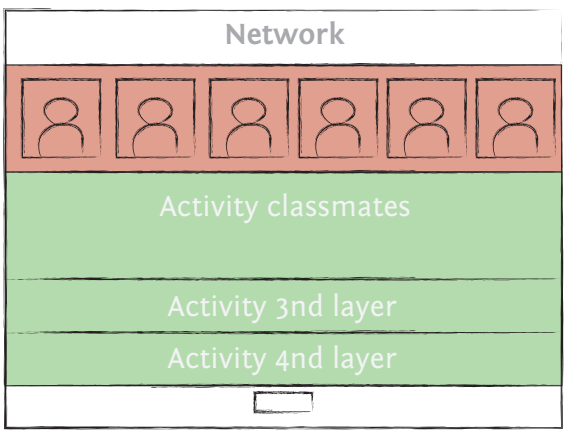
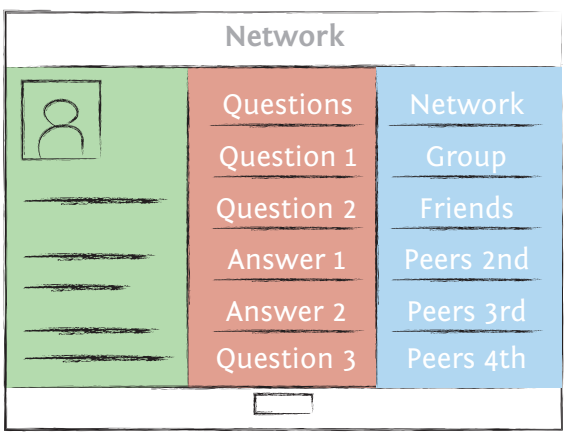


Figure 3.19. (bottom) Viewing a peer's details.



Because of this, a good overview of a student's peer network is important. It is important for them to realise what their peers are doing, especially their closest peers. They are the ones that have the most affinity with a specific student and therefore it is very valuable to quickly 'get a grip' and being able to contact them. This also improves communication between the peers, solving the barrier of *collegiality* (C3.10) of a succesful CoP (C3.13).

3.5.3.2. Functional sketches

This may perhaps be the hardest part to get into the application. Traditional social networks already have plenty of ways of filtering between different categories of networks. As an example, Live Messenger allows you to group your contacts into different categories as well as to select your favourite contacts. Favourites are shown at the top of your list, since those are the ones that the user perceives as the most important (i.e. closest).

In order to use this mechanic for multiple layers of closeness in our design, it needs a way to fit all the different categories in a smaller space (Figure 3.18). For instance, by using a visual hierarchy.

The first layer of peers (friends and group mates) can be put up top (red area). Their presence can be emphasised by showing more information about the peers than merely their name and activity. For example, photos can be used, so the user can distinguish them in a single glance. Likewise, since the other layers are not as important, visual information is less relevant (green area). So for example, names might do where photos were used before.

Since checking on the progress of peers (Figure 3.19) is something important, the student needs a more general overview of both his questions and his answers (red area), as well as the topics he is working on (blue area). Since we're viewing the information of a peer, some personal information (green area) helps create a stronger bond between the user and that peer, since they know a bit more about each other.

3.5. Conclusions

We have determined that enabling CoP in the PABO can be a good method to enable student collaboration.

Experimenting with the idea of a CoP, the two concepts, *Notes* and *Proximity*, were created. Submitting this to a focus group review yielded that Proximity was not practical enough to be used for a CoP (C3.5). Notes on the other hand was received well, providing a low barrier for sharing notes and communicating with peers (C3.6).

Trying to make use of the student's wish for a low barrier to collaborate, we searched for a mechanic on which PaboCommunity can focus, another literature study was held.

Looking at PaboCommunity as a ubiquitous educational tool, we came upon three requirements that it should fulfil:

- *Usefulness*
  The application has to be useful in the domain and context of the user and should adapt itself to the specific activities of the user (C3.7).
- *Shareability*
  The users should be able to share notes by means of a visual indicator, while using the semantics of the learning context (C3.8).
- *Usability*
  Creating annotations should not disturb the user's learning activities and annotators should be held in their learning context while annotating (C3.9).

Taking this further, we looked into the research area of computer supported collaborative learning (CSCL). Through CSCL we looked collaborative strategic reading (CSR) to enhance our design. Four strategies are involved in CSR, of which '*clicks and clunks*' and '*get the gist*' are the most important for PaboCommunity. Clunks are pieces of text that are not understood. The design should help the user to fix this by asking a question. Likewise, enabling students to show they 'got the gist', allows them to answer those questions.

Thus, we have found our mechanic; asking and answering questions (C3.7).

Finally, we still had our eyes set on enabling a community of practice (CoP), but still had three barriers to solve. Thankfully, most of these were taken care of by our context, which left:

- *Collegiality*; PaboCommunity has to make sure it is easy for students to communicate with all of their peers (C3.10).
- *Electronic delivery of content and experiences* hinges mostly on making the user aware of progress. PaboCommunity could achieve this by using visual indicators to show new activity (C3.11).
- *Legality and copyright* however is not something that can be solved by PaboCommunity, though it can be used a negotiation method with suppliers and authors (C3.12).

Using the above mechanic and guidelines, we started our design for PaboCommunity. Looking at the need for the design to be *practical, to increase awareness of the progress of the students and to be swift and intuitive* (section 3.4.1), we have designed the basic functionality that would be needed for PaboCommunity to succeed as an e-learning tool, an application that supports the forming of a CoP and that enables student collaboration.

The three areas that should make this work are:

1. An *e-reader* that combines study material and asking and answering questions,
2. A *forum* for questions not directly related to courses or study material (such as experiences of the PABO students) and
3. A *peer network overview*, which not only lists the chosen contacts of the user, but also all the other people that are relevant to his environment.

Functional sketches were made to explore how these areas could be made and to detail how the functions that they would minimally need would look like.

These sketches also showed how the two solvable barriers to CoP's would be solved by PaboCommunity:

- PaboCommunity promotes *collegiality*, by allowing instant communication to the PABO student's peers. This happens by sending any activity directly to all the peers. The network area also helps keeping PABO students connected by emphasising good connections between them **(C3.13)**.
- *Electronic delivery of content and experiences* is achieved by making the user aware of all the activity in topics that are relevant through the use of the forum area and by using visual indicators for activity, such as the visual indicators next to the study material **(C3.14)**.

4

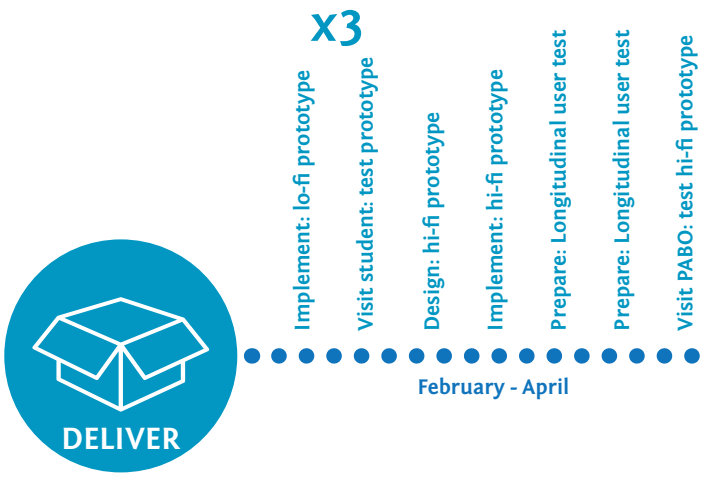
DELIVER

Deliver is about creating experiential prototypes to test and validate our design as detailed in section 3.4 and 3.5. In order to achieve this, an iterative design cycle was used. At the beginning of each cycle, a prototype for the design was made and tested with users. The results of these test are then used for the next cycle.

Due to time constraints we have focused exclusively on the e-reader area of Pabo-Community, since this was shown to be the most practical for the PABO students and it had the potential to enable communities of practice around certain topics to do something, centred around the study material in the e-reader.

The first three iterations took the form of low fidelity scenario's, which were presented to the user group as a user test. The fourth, and final iteration became a fully functional prototype of the e-reader, in which the act of reading study material and asking and answering questions was successfully implemented for high fidelity. We will discuss the decisions that were made in the three iterations, including the technical design, more extensively. Finally we will discuss the results of the user test done with the high fidelity prototype, which unfortunately went wrong.

Afterwards, we will provide the conclusions of the design and the graduation project and recommendations for research and implementation in the future.



Goal: Create a working pilot
Functional prototype
User test

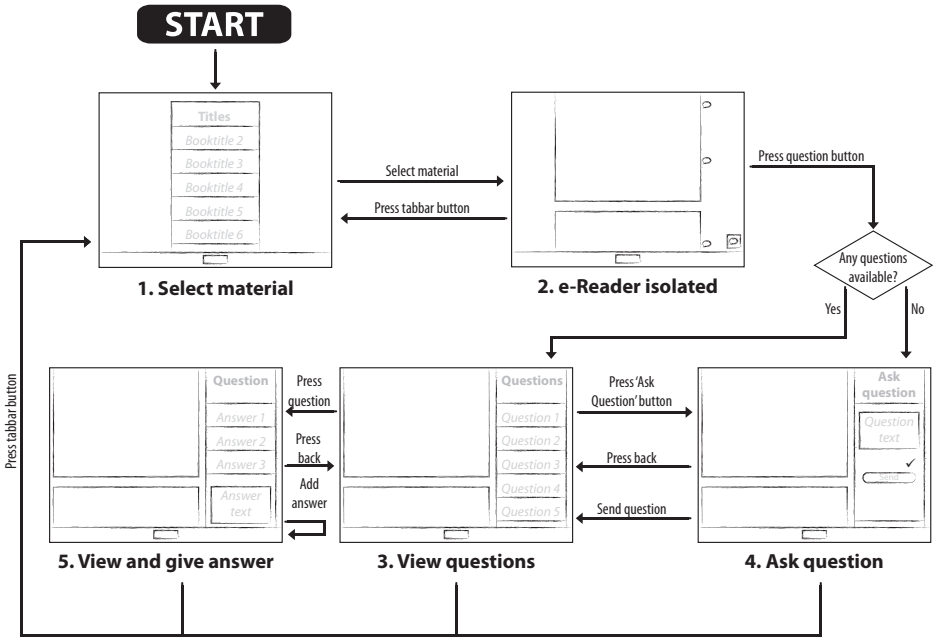


Figure 4.1. Flow diagram of the different application states.

4.1. Prototype requirements

As mentioned above, the prototype will only incorporate the e-Reader area of PaboCommunity. However, what should this e-reader area do? Looking back at the functionality sketches for the e-reader, we came upon the following required functionality;

- Show study material
- Allow asking questions about material
- Show questions about material
- Allow answering questions about material.

In order to achieve this, we have adhered to the layout as shown in the functional sketches (Figure 3.8, 3.9 and 3.10) for the creation of the low fidelity prototypes, which we will describe in detail. The functionality sketch provided areas of interest for all of the above functions and allowed us to create a flow chart of the different states that would be needed for the scenarios and the final high fidelity prototype. Figure 4.1 explains the flow of five different states:

1. Select material
2. E-reader isolated
3. View questions
4. Ask questions
5. Viewing answers

4.2. Low fidelity iterations

The first three iterations produced low fidelity prototypes to test the user interface of the e-reader area. We created a scenario for the user to navigate through by means of screenshots shown on an iPad (Figure 4.2), the tablet of choice for the target group of PABO students.

The user tests consisted of putting the graphics in order of the scenario in the iPad picture slideshow, so the users would think they were dealing with an actual application (Figure 4.1). They would be asked to walk through the scenario and think out loud. They were also encouraged to use any gestures they thought were necessary for specific actions, in order to gain a sense of how the user wants to navigate.

In order to create a realistic testing environment, a real chapter was chosen from study material for PABO students, in this case a text about different ways of letting children cooperate. This also had the added benefit that the users could immerse themselves better in the prototype, since an actual text is found to be conducive to testing.

4.2.1. First interface design

Starting an interface design for the above, Figures 4.3 to 4.6 show the most important screenshots used. This first prototype was to gain see if the user experienced a significant benefit to seeing questions next to his study material and to see if the visual language made sense.

The visual language that the prototype makes use of is the native language of Apple's iPad, and the one that Apple encourages developers to use in order to maintain a uniform user experience across multiple applications. This has the benefit that the PABO students, which are already walking around with iPads for some months, are accustomed to the visual language and less energy and time is wasted on figuring out interactions that are common to iPad applications.

Examples of the normal visual language is the use of a tab bar below the application to indicate which area of the application the user currently resides in, as well as the use of scrollable lists for data such as the questions, their answers and chapter titles for an index bar.

The questions marks in the margin of the study material were introduced specifically for this scenario, in order to indicate that that section of text was the topic of a question.

4.2.1.1. User test and conclusions

The above prototype was presented to a student user. Not a PABO student, but a student aiming to become a high school teacher instead. The test proved that the above idea has incredible merit, since the user wasn't at all aware that she was testing the interface, instead of the application. She became immersed in the prototype and indicated that reading the material like this was easy and gave comments on it.

Getting back to the user interface side of things, there were some negative aspects. The biggest negative aspect was that the question marks to indicate questions weren't at all clear. Instead, the student thought those were indicating assignments that were part of the text and avoided using them as button. After all, she wasn't going to work on assignments. After explaining what the

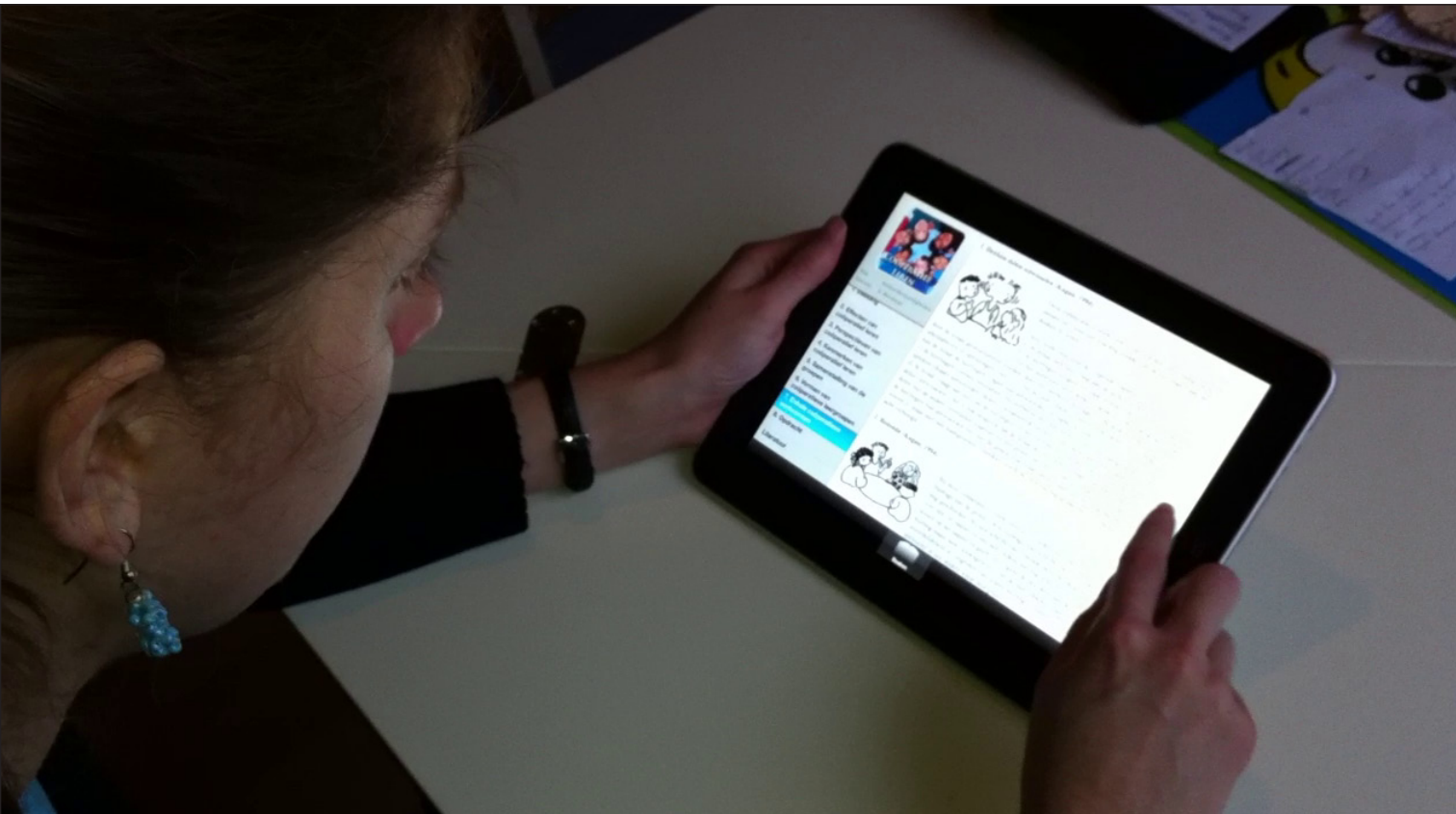


Figure 4.2. The interface graphics of the first interface design shown on the iPad to a tester.

Low fidelity prototype 1

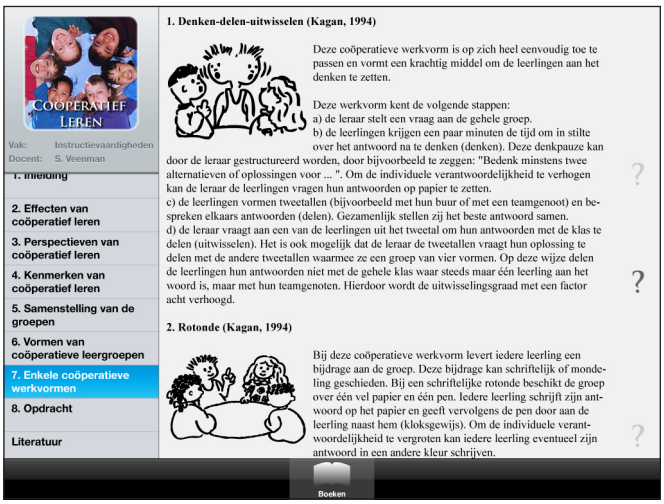


Figure 4.3. State 2 of the e-reader, shows the study material for reading to the right.
The question marks in the margin of the text indicate questions about the material next to them.
If a question mark is dark, it means that the question is new or that new answers have been added.
The left bar contains the index of the study material that is shown and points out which chapter the user is currently in.

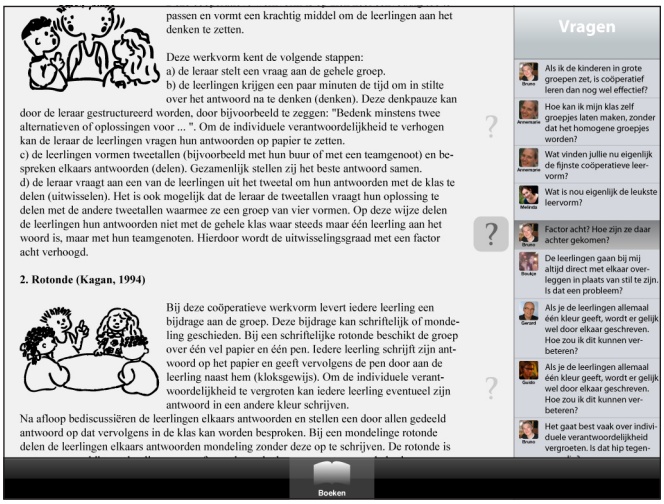


Figure 4.4. Once the user presses one of the question mark, we come into state 3. The specific mark highlights and the study material slides to the left, obscuring the index from view.
To the right the list of questions related to the entire study material appears, with the question associated to the question mark highlighted.
The questions are accompanied by the name and photo of the person that asked them.

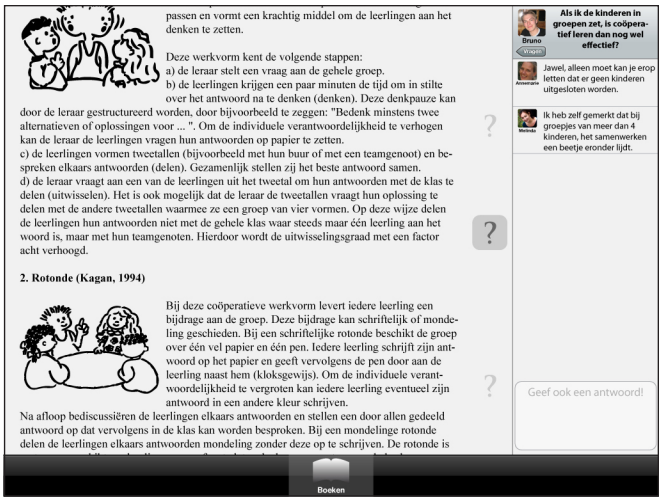


Figure 4.5. Pressing one of the questions removes the list of questions from view and brings us to state 5. The list of questions is replaced by a bar with the question in the header and a list of the answers given to that question below it.
At the end of the bar, the user gets an opportunity to add an answer as well by pressing the text area.

Figure 4.6. The answer can be added by using the virtual keyboard that comes into view as soon as the text area is pressed. We are still in state 5, since the keyboard is not part of PaboCommunity, but native to the iPad. The 'Ga' button is designed to send the answer for storage.
The answer will then also be available for other users of PaboCommunity to view.

question marks actually were, it still wasn't clear that the opacity of the question mark indicated new activity.

Another problem was that it was not clear which question belonged to which page and which part of the material. Because of this, redundant searching was required to spot the correct question with its text.

4.2.2. Improved question indicators

In order to remedy the aforementioned problems, two variations were created for indicating questions about the material in the second iteration. Also, since there were some remarks about the previous prototype being rather chaotic, the index bar was removed to let the reader area stand by itself.

The question marks were replaced by speech bubbles (Figures 4.7 and 4.8), which are more universally known to indicate discussion. And to show whether there is new activity, the variations changed between showing a numeral indicator with the amount of activity or a popped up question mark to indicate activity.

4.2.2.1. User test and conclusions

The reactions to removing the index were mixed. Some found it annoying, since the index was a great indicator for progress (again, this seems to be important in all aspects). However, others found it a relief, since it gave more peace while reading the material, allowing them to concentrate better.

The speech bubbles were very well received. The students immediately wanted to interact with them (Figure 4.9) and see what kind of discussion was taking place about the study material. This indicates that the speech bubbles invite more collaboration than question marks and that they make the intent clearer.

The numerical indicator for activity in a question was also well-received, better than the popped up version. A suggestion for combining them was made, but that may make the design chaotic once more.

Low fidelity prototype 2

Figure 4.7. State 2 showing the varation of the question's visual indicators. The question mark is replaced by a speech balloon and the amount of new answers is indicated by a number.

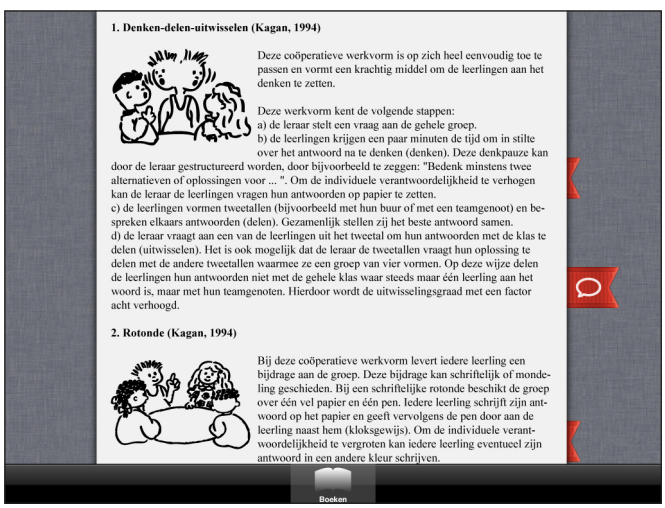


Figure 4.8. State 2 showing another variation. When a question is new or has new answers, the bookmark slides out, showing a speech balloon to attract attention to the question.

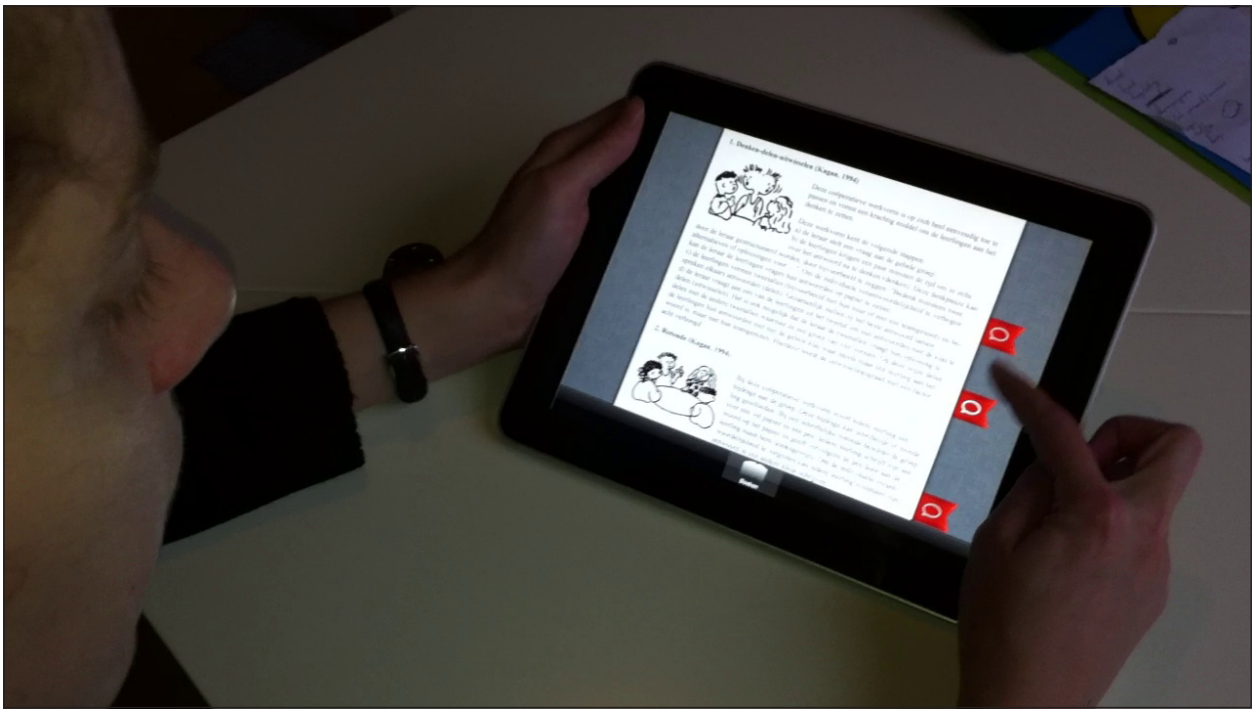


Figure 4.9. One of the test participants interacting with the speech bubbles.

Low fidelity prototype 3

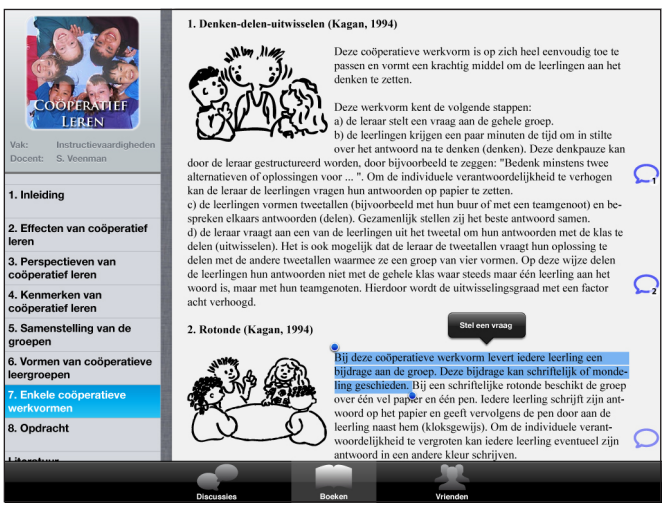


Figure 4.10. Again, state 2 is shown. The index bar was added see how much it distracts the user. Furthermore, functionality was added by adding an intuitive way of asking questions. User can select text and then a context menu appears asking if the user wants to asks a question.

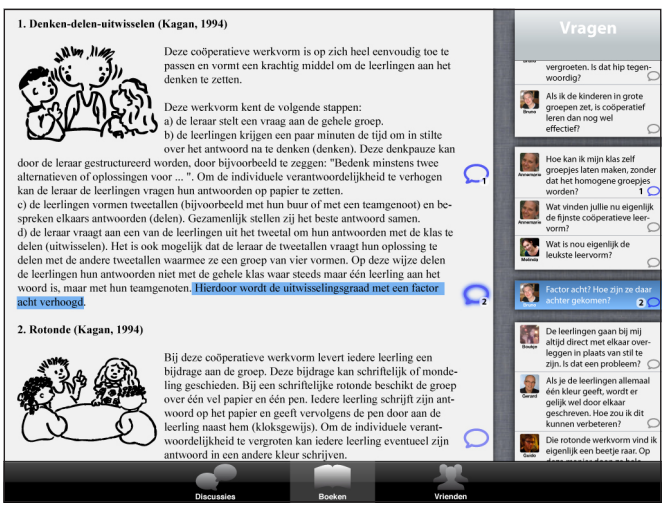


Figure 4.11. State 3 has changed as well, this time grouping all the questions that belong to a page together. This helps avoid confusion about which text the question is associated with and gives an extra indication of the uer's progress through the book.

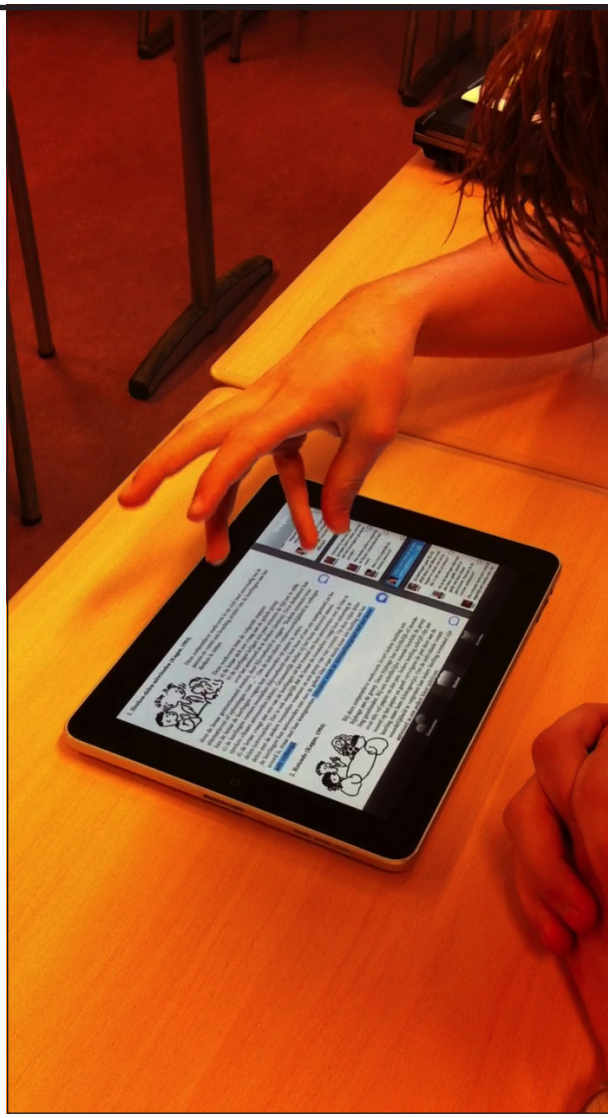


Figure 4.12. (right) PABO students interacting with the prototype.

4.2.3. New functionality

The third iteration took the feedback from the last two prototypes and added functionality to the scenario for asking questions as well. This one got closer to solving some of the issues and makes use of some solutions.

The index bar was brought back, just to see if its usefulness outweighs the chaotic impression it left on the students (Figure 4.10). The speech bubbles were moved to the margin of the material and given a different colour to stand out more. The questions now have divisions indicating that a single group of questions belongs to a single page of the material. We also incorporated that pressing a speech bubble brings up the question as well as highlights the material associated with the question. This allows for quick scanning of the text (Figure 4.11).

As for new functionality, a test was started on how to start questions. For now, selecting the text with a so-called 'long tap', brings up a context menu allowing the user to ask a question about selected text.

4.2.3.1. User tests and conclusions

For this prototype, we went back to Fontys Eindhoven to test with PABO students (Figure 4.12). The design held its own, with the students quickly managing to move through the screens and indicate what the functions were of all the interface elements.

They were especially praising the apparent intuitiveness and the fact that the small text boxes allow for swift answers. This validated the fact that swiftness has a huge factor in collaboration. Numerous remarks were made that it would allow for the feedback which was important throughout the entire PABO education.

There were still some negative aspects as well as some of the variations that could safely be removed;

- The students found it difficult to distinguish the questions and answers in the question area. At first they thought that the entire list was one huge discussion, with subsequent entries being answers and reactions to the previous one. An extra indication of the page numbers should clear this up.
- The speech bubbles in the margin gave some confusion as to whether it was part of the material or not. Moving them back outside of the margin should solve this.
- The index bar was found to be more distracting than was worth. Therefore, we will remove it in the coming prototype to cut down on visual clutter while reading the study material.

4.3. High fidelity prototype

For the last test and to conclude this project, a high fidelity prototype was made for the iPad (Figure 4.13). The prototype was designed to test whether prolonged use of the PaboCommunity e-reader would still enable collaboration between peers and to look for ways to enhance this.

4.3.1. Technology choices

In order to achieve this, several technology choices had to be made. Namely if we would allow PaboCommunity users to work with each other during the test and which development environment to choose. These choices were made considering the need for the users to feel immersed in the prototype and taking into account the need for fast development.

4.3.1.1. Native app or web app

There are three types of mobile applications; dedicated applications, native applications and web applications (web app).

Dedicated applications indicate applications on devices that are meant for one purpose, such as a radiation measuring system. These fall outside of the scope of our project.

Furthermore, there are *native applications* and *web apps* [55] (Figure 4.14). Native applications are applications that have been developed using the device's own development platform, usually adhering to the manufacturer's usability guidelines as well. One of the best known examples are iOS applications for Apple's mobile devices. The main advantage of these applications is that they appear uniform with the device's other applications and its operating system and are focused on a single task, allowing for a simplified learning curve for the user.

Web Apps on the other hand are written with web technology, such as HTML5, CSS and Javascript. They are made to be rendered through a mobile device's browser and with little else. A single web app is therefore capable of being rendered on multiple brands of devices, allowing them to be developed only once, which decreases development time and

Figure 4.13. PaboCommunity's high fidelity prototype.

Figure 4.14. Google Voice as both an iPhone native application (left) and a web app (right).

costs. However, minor differences that come with differing browsers also cause differences in how the applications are rendered as well. Because they are browser-based, they also focus less on a single task (the browser's own UI usually takes priority). This increases the learning curve that users may have when accostumed to their device of choice.

Taking this into account, a native application seems to be more suited for a high fidelity prototype, due to the decreased learning curve. This will hopefully lead to increased immersion in the prototype later on. The author's experience in C-like programming languages and background in computer science also made the step towards creating a native application easier. Since the prototype will be developed for the iPad, programming in Objective C should not come hard either, especially since the user interface is supported extensively by Apple's iOS libraries.

4.3.1.2. Communication between users

Another concern was the communication between users of the PaboCommunity prototype. Making the application as realistic as possible involves creating functionality that actually works. In the case of this prototype, allowing the questions that users ask and the answers that are given to be sent towards all other users of PaboCommunity. This also enables the progress to be checked on during the testing period. However, this involves creating a web protocol, something that usually takes quite a bit of development time.

This functionality can also be faked or ignored, in favour of speed. For example, to test whether users were triggered to collaborate in discussions, fake discussions could have been placed, perhaps even scripted to appear at later periods during testing. And of course, to see if questions were asked, all that's needed is to see whether the user used that functionality. Checking the progress of the test during the testing itself is complicated by this though.

Because of the expertise available with both the author and at Noodlewerk, we opted to implement direct communication between PaboCommunity users. Noodlewerk could provide their experience in creating the databases and web protocols, making the implementation of these parts easier.

4.3.2. Technical design

Now that the choices for a native application and for user communication have been made, a technical design is necessary to ensure smooth development. The design for PaboCommunity's prototype is heavily centred on development speed, which has been displayed in Figure 4.15.

It details the choices that have been made for PaboCommunity's prototype, such as how to deal with local and remote storage and how the different data objects are stored. In the centre is the application itself, which is supported heavily with Apple's own user interface libraries, collectively named Cocoa Touch.

The storage has been dealt with twofold. Offline all the data and content is stored for fast retrieval and online it will be stored for communication with peers. Because both had to be implemented in the simplest way possible, we opted for a simple, but expensive archiving for the local storage. The online storage would be done with CouchDB [56], a simple database scheme that stores text dictionaries.

As far as different objects go, PaboCommunity keeps it simple by focusing only on the bare essentials;

- Books (i.e. all the content) stored in the application, which contains Pages.
- Pages contain all the Questions, linked to their respective page.
- Questions have an Owner and zero or more Answers.
- Answers also have an Owner.

The prototype will use naive object association, which causes everything to be stored in everything else. Furthermore, the actions by the user also create a large amount of application actions, which are detailed in appendix F.

4.3.3. User test

The user test for the high fidelity prototype (Appendix G) was designed as a longitudinal test, allowing the PABO students to work with the prototype over the course of a week. This would enable us to look past the stage where everything is new for the users and thus get a better picture of prolonged exposure to the system.

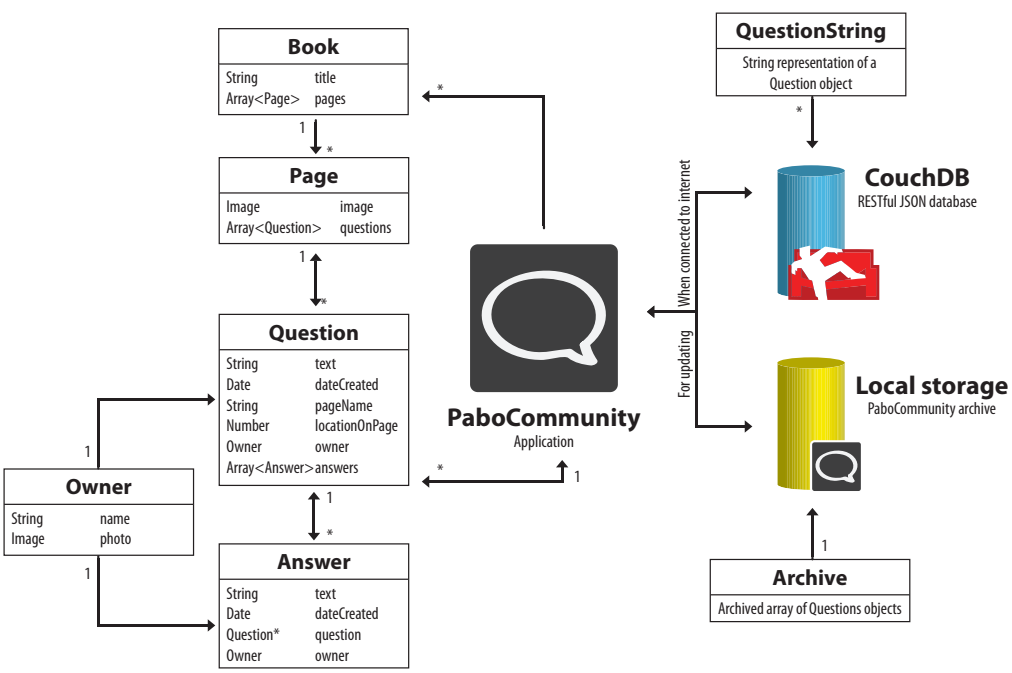


Figure 4.15. Object diagram for the PaboCommunity prototype.

4.3.3.1. Research question

The project up to this point has shown that PaboCommunity is a very promising design for enabling student collaboration by using u-learning to facilitate communities of practice. The PABO students have already indicated that they are enthusiastic about viewing their all their study material in one application and that the ability to ask and answer questions would motivate them to collaborate more often.

In section 2.2 we established, thanks to Terval et al. [34] that collaboration is indeed an effective way to improve education, especially when giving and receiving solicited advice. So, in order for PaboCommunity to be effective in achieving this goal, we want the students to ask and answer more questions than they usually would. In short, we want them to interact more with each other during the perusal of study material. This brings us to the following research question:

"Does combining the mechanic of asking and answering questions with digital study material improve the interaction between students?"

To answer this question, the following subquestions were of importance:

- While studying material, does seeing questions associated with the currently studied content invoke interaction with other users through...
  - ... reading the questions?
  - ... answering them?
- While studying material, do users feel encouraged to ask questions themselves which will reach every other reader of the material?
- Do the users gain a better understanding of the material with this method than without?

4.3.3.2. Preparation

In order to create an immersive prototype, three things have been accomplished;

- Preparing study material and documents relevant to the PABO students.
- The creation of an immersive and functional prototype.
- Holding a preparatory meeting with the PABO students to get initial impressions and to explain any questions they had beforehand.

The study material and documents were prepared in cooperation with both PABO students and their mentor, in order to ensure that the students were motivated to use the prototype. If the study material provided is useful, it increases the chance that the prototype is useful to them and thus that it will be used more naturally. In addition to normal study material, also assignment texts for upcoming projects were included.

To create a more immersive environment, pre-prepared questions were created for the study material, to make it seem as if PaboCommunity was already in use. This also would act as an ice breaker for the PABO students to ask and answer questions.

The creation of the immersive prototype took longer than expected, which has resulted in a delay in the testing. This has sadly caused the assignment texts to become less relevant. However, the end result was very positive, with all of the necessary functionality in place and working properly.

A bigger problem during the creation was the inactivity over mail with the PABO students. Apple's policy for testing applications makes it necessary that all details on the devices that will be testing the prototype were known beforehand. However, while this was communicated to the PABO students beforehand, only two have presented this before the preparatory meeting.

The preparatory meeting went well. Half of the potential test group was present and the prototype was met with praise. The PABO students mentioned they could really see themselves using this application and start exploring it on their own (Figures 4.17, 4.18 and 4.19).

As mentioned before, we took care of ensuring that the students could run the prototype on their own iPads, during the meeting, which always takes some time. And because not everyone was present, the others would have to do this remotely with me afterwards, which caused another delay.

The meeting ended with an agreement with the mentor and students that they would check one of the texts provided in the application, namely Veenman's '*Cooperatief leren*' [57] and that the rest of the students and the mentor would instruct the rest of the test group in the installation of PaboCommunity.

4.3.4. Results

Sadly, the user test went wrong. During the testing period, there was no activity on the prototype at all. This coincided with a sick leave of the mentor, who was the author's main means of communication with the student's as well. The student's themselves did not reply to mail sent directly by the author, nor did they activate any of the licenses delivered to them a second time.

Furthermore, another meeting with the students to repeat the test was next to impossible to arrange, since they had all entered a period where they were only doing internships in several locations, including outside of the country. However, in order to gain insight on why the test failed, the students' mentor was contacted to learn more about the causes.

The end result was that the prototype has not been used, despite the promising preparatory meeting and the students' apparent enthusiasm about the project during its course. This had several causes:

- The PABO students entered a rather busy period in their education, causing them to focus only on their projects and internships and leaving no time to invest time into the prototype. Before the delay, they would have been able to spend

Figure 4.17, 4.18 & 4.19. (right) Three of the PABO students working with the PaboCommunity prototype.

more time with the prototype, however that time window was passed when the test started.

- The testers which were not present during the preparatory meeting had an additional barrier to participating, in that their iPad details were necessary for them to participate. However, they were reluctant to cross this barrier and therefore could not access the application at all.
- The prepared assignment texts were no longer as relevant, as the delay in creating the immersive prototype has caused the students to use the paper or online version instead of the one in PaboCommunity. Any initial questions they might have shared through the prototype were dealt with already and later questions were easier to ask with the help of their own paper versions, since they had added annotations and notes on them physically.
- The PABO students had too little motivation to use PaboCommunity and to invest in this graduation project. Any product that would have resulted from it would probably have been too late for them and there was no additional incentive for them to participate.

Summarising, the biggest cause of the test failure was the delay in creating the prototype. This delay caused all the PABO students to miss the time window in which they could participate properly. Also, the need for preparation during the testing period itself and the lack of incentive or reward didn't encourage them to enough spend time on the test.

In hindsight, a longitudinal study may have been too ambitious. A series of smaller, more focused tests with less functionality might have yielded the same valuable data, while being faster to implement. This would have prevented the delay during the implementation of the high fidelity prototype.

A longitudinal test might have been more valuable afterwards, but the participants will have to be better prepared and rewarded as well.

4.3.5. Conclusions

While the user test failed, it did give some more insights into the behaviour of PABO students and the functionality of PaboCommunity.

The initial reactions during the preparatory meeting were very positive. This indicates that, despite the lack of interaction during the test, the students do see the use of PaboCommunity and it would make a valuable e-learning tool for them.

Also, their preference for the paper assignment texts, indicates that they want to be able to rapidly create notes. This again underlines the importance of swiftness and low barriers for creating notes. Promoting short questions and answers through the physical limitations was a correct move in this sense. And the interactions with PaboCommunity during the preparatory meeting were swift and intuitive, indicating that the interface and visual language of the prototype were sufficient.

Trying to answer the subquestions of the user test, we come with the following:

- *While studying material, does seeing questions associated with the currently studied content invoke interaction with other users through...*
  - *... reading the questions?*
    Yes. The student's were triggered during the preparatory meeting to interact with questions that were already there and to see what the discussions were about.
  - *... answering them?*
    Yes. The prepared questions were relevant to the text and after two students took the time to write down a proper answer to it, waiting for others to respond as well.
- *While studying material, do users feel encouraged to ask questions themselves which will reach every other reader of the material?*
  Inconclusive. The students did ask questions during the preparatory meeting,

however their questions and demeanour indicated that this was more to test the functionality of the prototype.

- *Do the users gain a better understanding of the material with this method than without?*
  Inconclusive. Because the test itself did not finish properly, no information could be gathered about the student's understanding of the prepared study material.

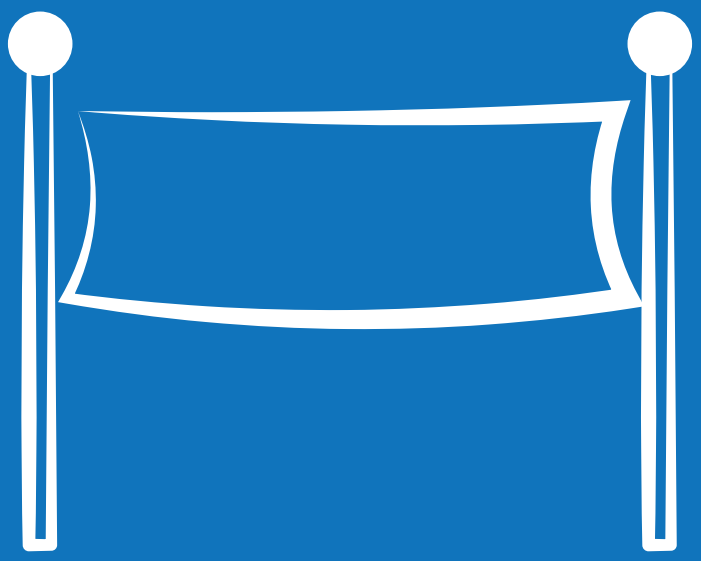
And finally, answering the research question;

"Does combining the mechanic of asking and answering questions with digital study material improve the interaction between students?"

has also become impossible, since there is not sufficient data to conclude anything about the improvement of their interaction.

However, the early success of in getting the students to interact with questions and to answer them, indicates that PaboCommunity does have the potential engate the student and in that way enable collaboration. The enthusiasm displayed during the low fidelity user tests and the preperation of the high fidelity user test suggests this as well.

5



FINISH

This project started with the following design goal;

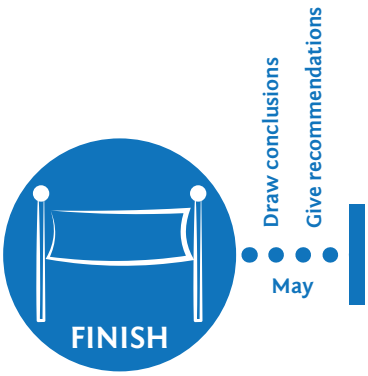
"To design a mobile software concept that makes use of tablets that can enhance education for students."

During the course of this project a lot of time and effort was spent on both research and user testing, which culminated in the creation of PaboCommunity.

In Finish, we will look back at the major conclusions of this project and relate how these conclusions were placed into PaboCommunity's design and how PaboCommunity fulfils our original design goal.

Finally, we will go over the recommendations for the continuation of this project. Some conclusions have not made it into PaboCommunity's design yet and there is still a lot of room for extra testing the concept and fleshing out the whole of the application.

Considering the future of PaboCommunity, we will also look at some options to create acceptance for the application within the educational community.



Goal: Conclusions and recommendations
Gather results
Draw conclusions
Give recommendations

5.1. Collaboration

In order to understand how we incorporated the conclusions of this project, we look at what PaboCommunity has become:

"PaboCommunity is an educational tool, which aims to improve education by enabling collaboration between students with multitouch tablet computers."

As stated above, the design places heavy emphasis on collaboration, using it as the main method of improving education.

We came to this method by our research in the beginning of the project (section 1). We found that in the current educational market, there are a lot of technological, educational tools. However, there was a great lack of *collaborative software that was specifically aimed at students* (Figure 5.1) (C1.6).

Along with this fact, we used the many features of tablets which were beneficial to education (C1.4, C1.5) to strengthen collaboration as a starting point for our design.

This choice was quickly validated by frequent visits to our target group, the PABO students of Fontys Hogeschool Eindhoven (Figure 5.2). In a series of meetings and brainstorm sessions, they emphasised the need for PABO students to collaborate extensively with their peers.

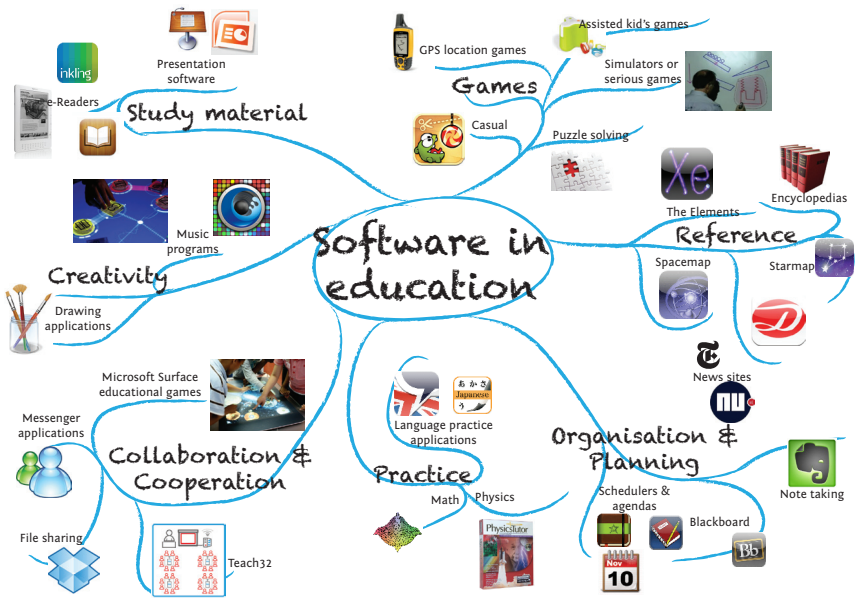


Figure 5.1. Different examples of software in education and their categories

Thanks to this choice, we narrowed down our design goal to the following:

"I want to design something that improves education by allowing students to collaborate more often and effectively, by making use of the capabilities of tablets."

Figure 5.2. The five PABO students participating with the group session.

5.2. PaboCommunity requirements

Having determined our new design goal, we had to create the set of requirements that PaboCommunity has to fulfil in order to become a valid educational tool.

The tablet's features (C1.5) gave us a strong link to *ubiquitous learning* (u-learning) (section 1.1.2) and provided the following set of requirements for PaboCommunity to be a useful u-learning tool:

- *Seamless integration* of the different networks used for communicating with the learning environment (C1.1).
- *Context-aware adaptation of the learning environment,* where the information of the user is used to alter the material presented to him [9] (C1.2).
- *An intuitive user interface,* which allows the user to communicate flawlessly with the learning environment (C1.3).

Later on, we delved further into *ubiquitous educational tools* (section 3.4.2), which gave us similar requirements to consider for PaboCommunity as an educational tool.

Through a series of exploratory concepts (section 2.3.2) and sacrificial concepts (section 3.2), we were able to narrow down these requirements further. To help us with this, we created *Christine* (Figure 5.3) (section 2.5), a persona of the PABO student with a tablet.

Christine helped us by telling us the needs and wishes of the PABO student. The most important ones of these for PaboCommunity were:

- *Collaboration and feedback* is something that is emphasised in her study (C2.2) and therefore the wants to be able collaborate efficiently.
- She needs a good *overview of her peers and teachers,* since those are her primary source for help with her questions (C2.2).
- The tablet should contain most of her study material (C2.4).

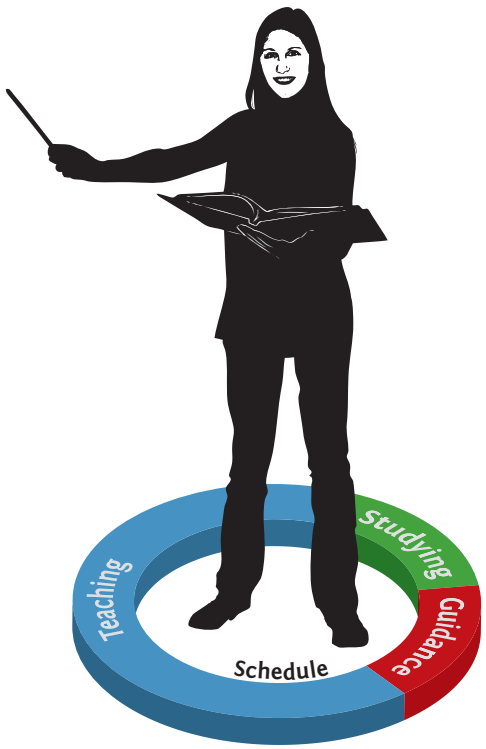


Figure 5.3. The persona 'Christine', who is a summary of the average PABO student with a tablet.

- *Confirmation of tasks and work* well done is important to them, so she can keep track of what is happening around her as well (C2.7, C2.8).
- Giving *positive rewards* encourages the student to collaborate (C2.9).
- Collaboration is mostly centred around *asking and answering questions*. Taking this further, it's one of the base requirements for PABO students, since they are very dependent on relating their experiences and getting feedback (C2.11).

In addition to these needs and wishes, we came across the difference between group collaboration and spontaneous collaboration. S*pontaneous collaboration* (C2.10) (section 2.3.1) was found to be a more effective method of motivating students to collaborate more often.

5.3. Communities of Practice

The emphasis on study material and enabling spontaneous collaboration helped us to look into *communities of practice* (CoP's) (section 3.1):

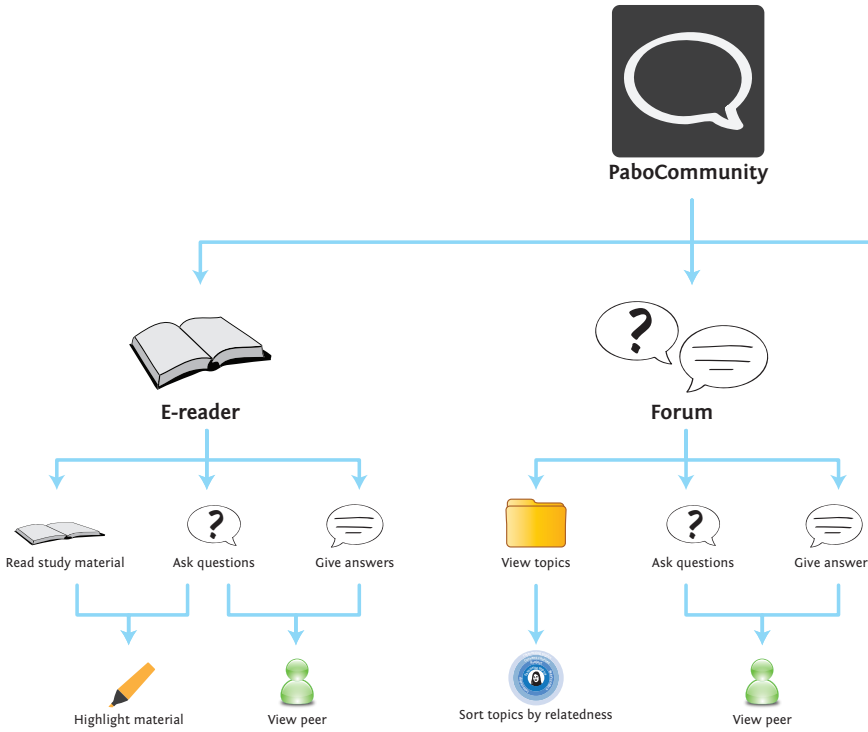
"Communities of practice are groups of people who share a concern or a passion for something they do and learn how to do it better as they interact regularly."

Because the goal of PaboCommunity is to improve education through collaboration, we took CoP's as the base for our application. PaboCommunity would try to facilitate the forming of a CoP within the PABO study for the PABO students and their peers.

Several barriers existed that had to be overcome to ensure the success of a CoP, but a lot of them had little influence within the context of the PABO student. Three however would have to be solved:

- *Collegiality*; PaboCommunity has to make sure it is easy for students to communicate with all of their peers (C3.10).
- *Electronic delivery of content and experiences* hinges mostly on making the user aware of progress. PaboCommunity could achieve this by using visual indicators for new activity (C3.11).
- *Legality and copyright* however is not something that can be solved by PaboCommunity, though it can be used a negotiation method with suppliers and authors (C3.12).

In addition to this, the concepts 'Notes' and 'Proximity' gave us extra directions that we could use to make PaboCommunity facilitate a successful CoP. The main direction here was that a *low barrier to sharing* notes or questions (C3.6) enabled students to collaborate more often.



Due to this, we investigated similar educational applications and came across the area of *collaborative strategic reading* (CSR) (section 3.3.3). By incorporating CSR into our design, we were able to find the most important mechanic aorund which PaboCommunity would function to facilitate a CoP, namely the mechanic of *asking and answering questions* (C3.7).

5.4. PaboCommunity's design

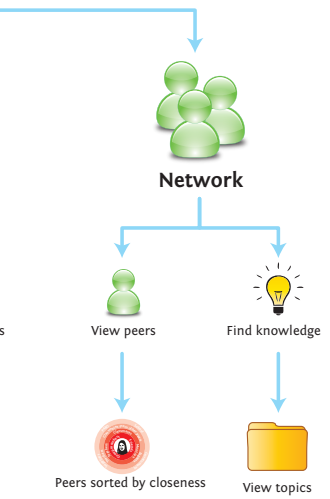


Figure 3.10. An overview of the different areas of PaboCommunity and their general functions.

In section 3.4.1 we have established that the final design for PaboCommunity will have three parts (Figure 5.4):

1. *An e-reader area*
   Study material can be read and questions about it can be asked and answered.
2. *A forum area*
   Both questions about the study material and about free topics can be asked here, providing a place for questions about experiences. It also serves as a more compact way to see the activity over all the questions.
3. *A peer network area*
   The network that PABO students have is important, especially if they're looking for someone to help them with something. In this area, students can look for expertise and see if they can contact someone they might need.

Functional sketches (section 3.5) (Figure 5.5) were made to explore how these areas could be made. And ways past the solvable barriers to a CoP's success were sought;

- PaboCommunity promotes *collegiality*, by allowing instant communication to the PABO student's peers. This happens by sending any activity directly to all the peers. The network area also helps keeping PABO students connected by emphasising good connections between them (C3.13).
- *Electronic delivery of content and experiences* is achieved by making the user aware of all the activity in topics that are relevant through the use of the forum area and by using visual indicators for activity, such as the visual indicators next to the study material (C3.14).

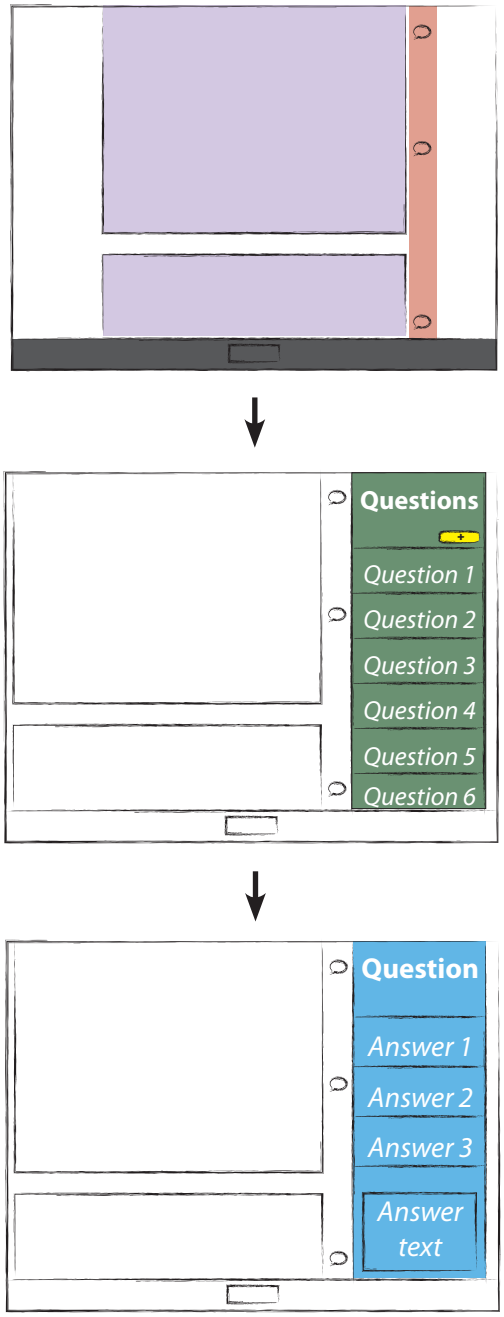


Figure 5.5 (right). The functional sketches of the-reader area of Pabo-Community.

By taking care of these barriers, we have also taken care of most of Christine's needs and wishes (C3.13, C3.14):

- PaboCommunity centres around *collaboration and feedback*. Christine can contact her peers quickly and easily merely by asking questions with the same ease as when she would make an annotation and receives feedback in the same way.
- The network area provides a good *overview of her peers and teachers*, altered to her respective situation, so she always has the best peers for her problems.

- *Confirmation of tasks* is done in PaboCommunity through indicating any activity visually. In addition, the network and forum area provide an overview of all peers and topics, so Christine can see any relevant activity quickly.

As the above shows, PaboCommunity's design goes a long way in solving many of the problems that we encountered and fulfils most wishes and needs of our target group, the PABO students

5.5. Low fidelity prototypes

In order to validate PaboCommunity as an effective means of enabling collaboration between PABO students, a series of low fidelity prototypes and on high fidelity prototype was made. All of these prototypes were put to a user test (Figure 5.6) to obtain insights from the PABO students and see if the design was accepted by the target group.

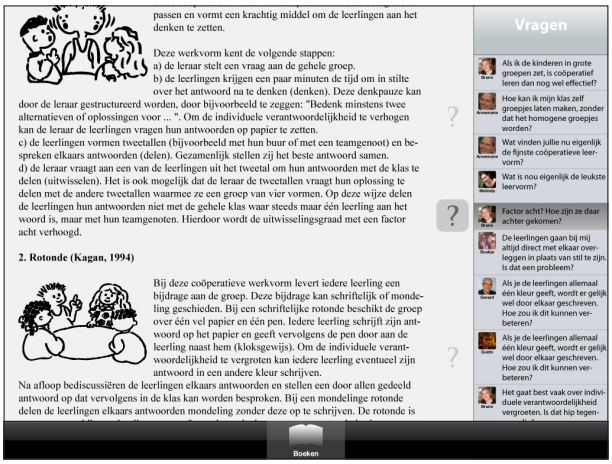
Because of time constraints, only the e-reader area of PaboCommunity was developed. This specific area was chosen for its practicality in taking care of most of the PABO students' wishes, especially concerning the amount of study material and not being able to ask questions at certain times and locations.

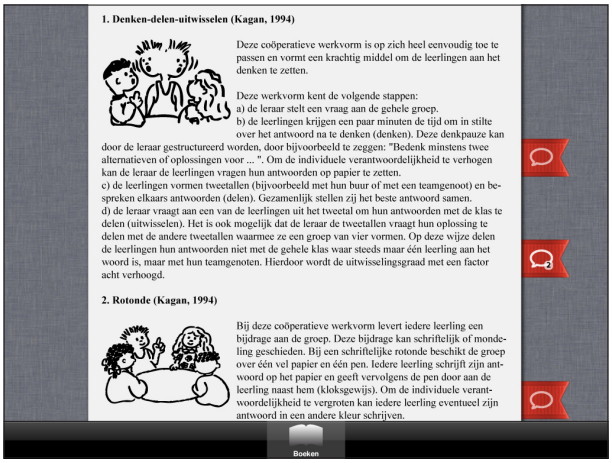
The low fidelity prototypes focused on the intuitiveness and the visual language of PaboCommunity. Their evolution can be seen in Figure 5.7. We strove to meet the wishes and needs of the target group, as well as the requirements of ubiquitous learning and communities of practice. This can be seen in the differences between the prototypes.

The biggest examples of this are:

- *Increasing the collegiality* of the PABO student with his peers, by adding the photo and name to the person associated with the question or answer (C3.13).
- Steering towards *discussions about experiences*, rather than merely questions, through the use of speech bubbles instead of questions marks (C3.6).
- Encouraging PABO students to use *short questions and answers* to enforce the low barrier of sharing them. This is done through only giving the students small text areas where they can type their answers and questions in (C3.6).
- Adding *awareness of the current activity* is done through the numerical indicators of the speech balloons, indicating activity in that specific question (C3.13, C3.14).
- *Highlighting the text* is associated to the question, adds more awareness about the difficulty of the study material as well.

Figure 5.6. (left) PABO students interacting with a low fidelity prototype.





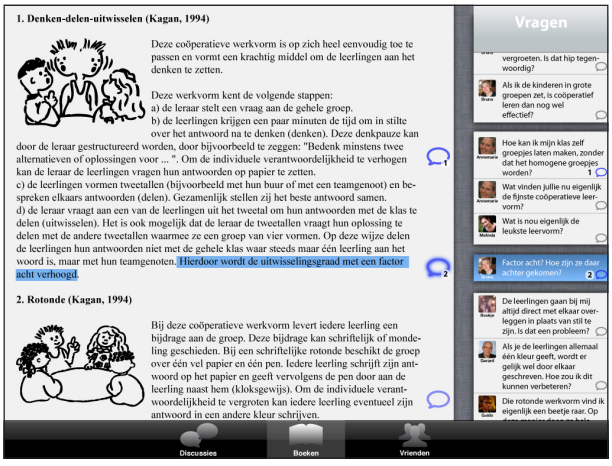


Figure 5.7. The evolution of the visual language in the three low fidelity prototypes.

The low fidelity prototypes were met with enthusiasm and PABO students indicated that they could really see this work. Especially the inclusion of study material and being aware of the other student's questions and progress were deemed to be useful.

5.6. High fidelity prototype

For the final user test, a high fidelity prototype was developed (Figure 5.8).

The prototype was designed for a longitudinal test, during which multiple PABO students with tablets would be able to view study material and ask questions, as designed in the e-reader area of PaboCommunity and further developed in the low fidelity prototypes.

In order to achieve the best result for the user test, the prototype was designed with implementation speed in mind as can be seen in the simple state diagram (Figure 5.9) and technical design (Figure 5.10).

Figure 5.8. PaboCommunity's high fidelity prototype.

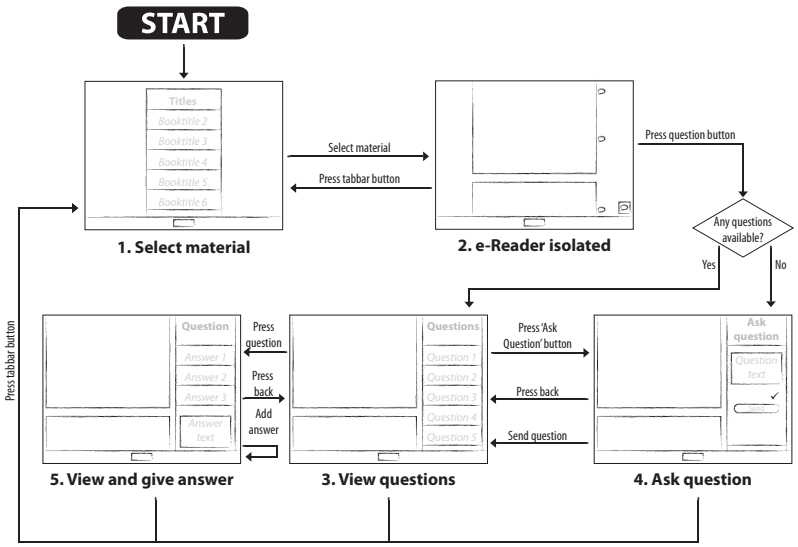


Figure 5.9. Flow diagram of the different application states.

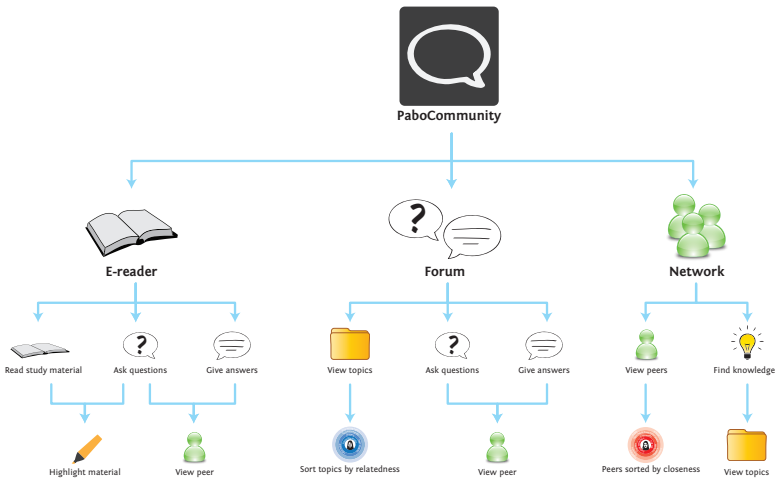


Figure 5.10. An overview of the different areas of PaboCommunity and their general functions.

To ease the implementation process further, we have chosen to use the Apple iPad's visual language and navigation style exclusively and implement PaboCommunity's high fidelity prototype as a native iPad application. The development tools provided for this made a lot of the implementation easier and faster.

A preparatory meeting (Figure 5.11) was held with the PABO students that would participate in the test to ensure they understood the prototype, its design and its purpose, as well as making sure they would have no problems with installing and using it.

However, due to delays during the implementation phase and some mishaps during preparing the PABO students for the application's usage before the preparatory meeting, the user test went wrong.
None of the PABO students showed any activity on the prototype, indicating that they did not use it at all.

While this was a great setback for PaboCommunity's validation, we still could garner some conclusions from all the tests together and the reactions to PaboCommunity at the preparatory meeting.

- The students were triggered by PaboCommunity as a tool to read study material and to easily be able to collaborate with other PABO students as well.
- PaboCommunity's design solves most of the problems and barriers to success that are associated with u-learning tools as well as with CoP's. This indicates that potential to be a valid e-learning tool.
- In addition to solving the above barriers and problems, PaboCommunity takes great care to respond to the target group's wishes and needs. Making PaboCommunity suitable for the PABO students will help in creating the large active user base required to make the design succeed.

Figure 5.11. (right) A PABO student working with the PaboCommunity prototype.

5.7. Conclusions and reflection

This graduation project has as its final goal to enable student collaboration with multitouch tablet computers. PaboCommunity is the result of seven months of work in trying to fulfil this goal. In order to see if we succeeded, we will look back at our guidelines and see if they are fulfilled.

We make us of the tablet's benefits for PaboCommunity, by using its mobility (being able to use the design at any place), the convergence (combining reading study material with asking and answering questions (C2.10, C2.12) and by focusing on communities (by enabling a community of practice) (C C1.2, C2.2, C2.3, C2.4). We also take advantage of the gap in student collaboration applications to ensure that the design has its own place amongst other educational software (C1.3).

There were constant reminders that the barriers for using PaboCommunity should be as low as possible. We also provided the students with the ability to see what was happening in their community. Visual indications of activity were incorporated in the design (C2.5).

We solved the major barriers to creating successful CoP's (C3.6, C3.7, C3.8) and incorporated the strategies that were needed to enable collaborative strategic reading (C3.5).

Taking all of this together, we have come a long way in validating PaboCommunity as a design that can enable student collaboration on tablets and can improve education by doing this. However, the failed user test with the high fidelity prototype has made it impossible to see if the validation holds when users have a prolonged exposure towards PaboCommunity.

5.7.1. Process review

Finally, we come towards the review of our design process. We have used an altered version of IDEO's human centred design approach, Hear-Say-Deliver, prefixing it with an analysis phase called Start.

This approach itself gives a very valuable method of structuring the project. However, while this structure was there in hindsight, the approach was only formalised in the final stages. This showed in a lack of planning and a lack of a reporting schedule, which made the final stage of the project, Deliver, very hard to accomplish properly and on time.

In the end, this has caused the user test on our high fidelity prototype to fail, which was our main method in validating PaboCommunity as a design that fulfils our design goal. The test itself failed due to delays in implementing the prototype in the most realistic way possible, which again shows that planning is crucial. Giving a very strict deadline beforehand would have been a good way to and collaborate with the PABO students more effectively.

Finally, creating a proper report also should not be done at the end. Adhering to the the design approach also gives the designer moments in which he can reflect on everything that he's done and link it towards his future efforts. Forgetting these reports and creating it all in the end, ends up in a very chaotic workflow, which can still be entirely complete, but very hard to defend against reviewers.

In the end, this project has been both a success and a failure on the part of the author. The importance of project planning, especially when working alone, is something that has now been hammered into significance quite thoroughly, and will be remembered in future efforts. But the final result and the positive reactions towards the prototype and design are still a great success. Noodlewerk has expressed their interest in continuing this research, which is encouraging as well.

5.8. Recommendations and future work

The design for PaboCommunity is sound and has a large potential to succeed as an educational tool.

However, the failed user test at the end of the project indicates that more testing and designing is needed before starting to search for acceptance within the educational community.

Furthermore, not all the barriers and problems to its success as an educational tool have been solved yet. Foremost in this are the legality issues that an application like PaboCommunity will have to deal with.

5.8.1. PaboCommunity's content

The design functions best when there is a healthy amount of educational material available for the application. However, this also includes study material such as study books, work books and other copyrighted material. This brings us to the Legality and intellectual property rights issues that we could not solve within PaboCommunity itself.

Suppliers of educational material are stringent about digitising this material, preferring to let clients, such as educational institutions and students, buy the physical copies.

Without a sufficient supply of digitised material, students themselves will also have little reason to use PaboCommunity, since it does not replace the heavy and expensive books they need currently.

Future work in PaboCommunity should therefore be focused on either gaining acceptance and material from suppliers or on convincing educational institutions to release study material suitable for PaboCommunity on their own. Both of these require a very convincing proof of concept to show at the negotiations.

5.8.2. Other studies and contexts

Another thing that has not yet been determined is how other studies and contexts may benefit from PaboCommunity and if they design changes are required.

A good example is comparing the PABO study with the study of Computer Science. In both cases, there are a lot of books and other study material needed and both studies thrive heavily on student collaboration.

However, while PABO students are better served with small questions and answers, Computer Science students will often have questions about pieces of their own programming code. This code can quickly become very large, which PaboCommunity should also take into account if it wants to be successful for those students as well.

In short, other studies and contexts may have very different needs for PaboCommunity to fulfil. More research should be on how it should be changed or supplemented, if PaboCommunity will have to cater to these studies as well.

5.8.3. Validating PaboCommunity

And most importantly, since we have not validated PaboCommunity to fulfil the project goal yet, a longitudinal user test still has to be completed. This is needed to show that the design still has value after prolonged exposure.

However, given time and interest, pursuing this validation is worthwhile to see if PaboCommunity has further promise as an educational tool.

Additionally, this graduation project makes some assumptions which have to be accounted for during any future work:

- *All students have tablets*
  PaboCommunity works best if the user base is large. Therefor, most students should have access to a tablet with PaboCommunity. At the moment is not the case. Therefore, PaboCommunity should

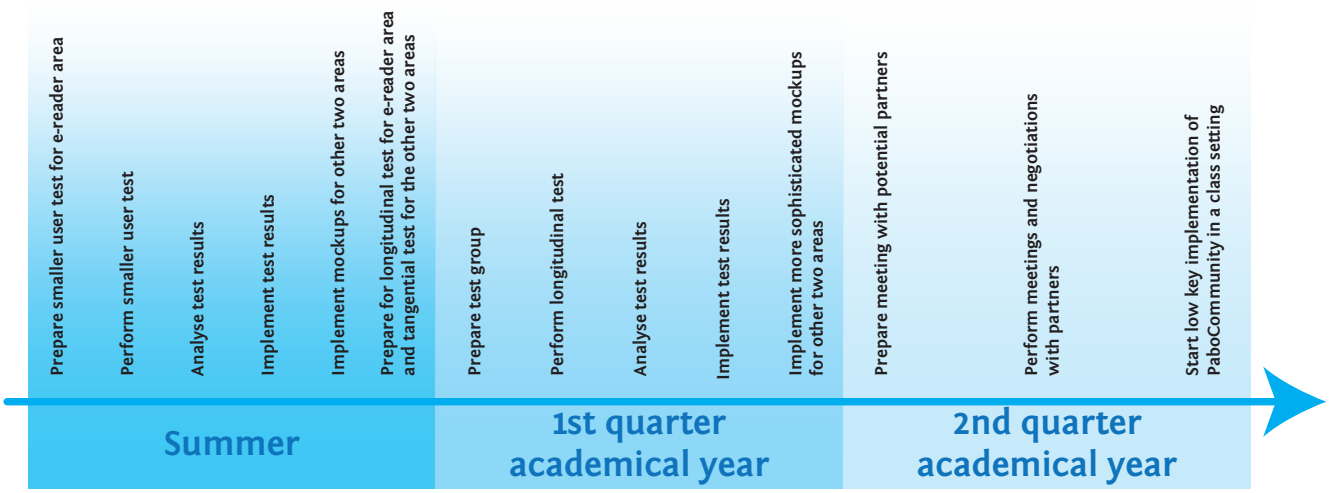


Figure 5.12. A potential time schedule for future work on PaboCommunity.

be created with the objective of convincing stakeholders to provide these tablets to students as well.

- *PaboCommunity is aimed towards PABO students*
  Since PaboCommunity is aimed towards Pabo students and its design fulfils their needs exclusively. However, other groups of students have different needs, which may have significant impact on the design. For example, Computer Science students discuss computer code heavily, something which is very cumbersome in the current design due to the small text boxes. More research needs to be done in order to see where the design has to be altered to fit multiple contexts and different groups of students.
- *PaboCommunity is used by everyone the same time*
  The design currently anticipates that everyone can use and see all questions regarding certain study material. However, this can be cumbersome during later in its lifetime, since students refresh every year, but their questions do not. Do we show all questions indefinitely? Or do we create filters based around the closeness of peers of the user?

The design for the remaining two areas of PaboCommunity also have to be improved:

- The *forum area* centres around questions about experiences, that have no clear link in study material. However, we have not yet researched how these questions manifest themselves in the application. For example, who chooses the categories to which the questions belong? The students themselves or the teachers? Is any category allowed or only a preselected group of them which are relevant to the study?
- The *network area* also has to be thought out better. While it is a valuable part of PaboCommunity, it still has no guidelines on how peers should be shown to the user and what information is important. Are only the closest peers important for the user? Or does the user also gain access to more people, such as from teachers an experts in the field as well? Do they gain access to the students or does privacy prevent this at all times?

The current test as detailed in Appendix F is still possible. The fact that the PABO students for which is was meant didn't use it due to lack of time, indicates that it may still be very valuable to the them if they would use it.

Getting the PaboCommunity tested completely requires that all three areas are implemented to a degree that the entire design can be shown to potential partners, such as a supplier willing to produce digitised material for it, or an educational institution that believes in it sufficiently to bring it to all their students.

Figure 5.12 shows a possible time line in which this could happen, taking Noodlewerk, this graduation project's company

sponsor, as the company what will continue to invest both manpower and expertise to this project.

The time line starts from the beginning of the summer period for academical year, making use of the fact that no appropriate testing group is available to represent the target group of PABO students.

Using the summer period to perform a smaller test to improve the e-reader area and to properly prepare the longitudinal test should be sufficient.

Afterwards, preparing a proper testing group and performing the longitudinal test would probably take at least an entire quarter (i.e. ten weeks).

During the above two periods, the remaining two areas of PaboCommunity can be created as visual prototypes next to the high fidelity prototype of the e-reader area. When, in the second quarter of the academical year, Noodlewerk starts preparing partner meetings, they will help convince the potential partners to take part in this project.

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