Design guidelines for self-assessment support for adult academic distance learning

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ABSTRACT

This contribution focuses on adult distance learning. Based on experiences at the Open University of the Netherlands we investigate specific problems that our students have with self-assessment and metacognition while studying. Starting from a literature review and complementing this with available student data from our teaching research center, we developed a conceptual framework that was iteratively adjusted and assessed by a questionnaire study and interviews. This allowed us to develop design guidelines for self-assessment support in distance learning environments. These guidelines were reviewed by experts. The input from the experts was used to modify the guidelines and iterate until they were considered complete. Tangible designs (i.e., mock-ups) for each of the self-assessment methods were proposed. These tangible designs were prototyped for later evaluation. Finally, we provide our conclusions and propose recommendations for actual application and systematic design.

KEYWORDS

Self-assessment, Metacognition, Distance learning, Design guidelines, Feedback, Progress tracking, Time management, Collaborative learning

INTRODUCTION

This chapter aims at providing grounded design-guidelines for self-assessment support for learners. The application domain, adult academic distance learning, is based on our context of work: The Open University of the Netherlands (OUN), a Dutch university for adult distance learning. Our university is funded by the government to make higher education accessible to anyone with the necessary aptitudes and interests, regardless of formal qualifications. Students can study at their own pace and at their own venue. Therefore, OUN students are a heterogeneous group of learners with diverse goals and needs. Flexibility and learning independence in study activities are among the main motivations for studying at the OUN. Lack of interaction and feeling of isolation are some of the disadvantages associated to distance learning, and OUN teachers generally consider this one of the main reasons for the low graduation rates in comparison to those at “traditional” Dutch universities.

In order to keep the type of students in mind, as well as to reason about their needs, we developed a set of personas, based on what our university statistics tell us about relevant student characteristics such as age, employment, family context, location, educational background, learning activities, and learning goals.

> Sonja
> Sonja is 23 years old and works as a waitress in a town in Flanders, Belgium. She started working when she finished high school. She works every day from noon until 10:00 PM which does not leave her too much spare time. Last year she decided that she would like to change her job and start working as a therapist in a help-center close to her town. That’s why she joined the OUN and started studying Psychology. She has been studying for ten months

and has successfully completed almost all of the courses in the first year of Psychology. She wants to obtain her Bachelor's degree in three years and maybe then continue to complete a Master's degree in Pedagogy.

Marta

Marta is 47 years old, is married, and has two young children. She works as a civil servant at the provincial level dealing with environmental regulatory policy who had studied environmental science but lacks the Law and Policy.
She is really good at her job. However, she has a weak point: legal issues. Although she had a class in Law during her secretarial education, she often lacks the necessary knowledge to understand the complex problems of the company and she has to ask her colleagues for help. Some months ago she decided to study Law at the OUN. It would be nice to obtain a Bachelor degree, maybe she could even get a better job, but her main priority is to obtain knowledge which she can apply to her daily work-related problems.

Peter

Peter is 76 years old. He used to work as a Professor of Math at the Technical University Eindhoven but now he is happily retired. He has plenty of free time and he likes to spend it taking care of his garden, going for walks in the woods, and growing vegetables and cooking them. He is very keen on natural sciences and would like to know more about so that he can better understand the physical environment that he so enjoys. That's why he decided to take some courses at the OUN. He does not want to obtain a degree, but he enjoys reading the texts sitting in the garden with a cup of tea.

Dirk

Dirk is 45 years old. He is married and has a little baby. He works in a large IT company in Amsterdam as a consultant. During the 15 years he has been working at the company, he has obtained extensive knowledge in Databases, programming and other IT skill, however he does not have a certificate which proves it. He would like to obtain an official document which shows his knowledge and that's why he decided to join the Computer Science Master's degree program at the OUN. Although he does not have a lot of free time, he tries to study as consistently as possible so as to graduate as quickly as possible. He thinks this is a good opportunity to improve his professional life by either looking for a better job or obtaining a promotion with his current company.

BACKGROUND

OUN students are adults with a broad age range (18 to 75). Most have full time jobs and families which take up most of their time. Among the most common motivations to study at the OUN are: obtain a promotion in one's current job, get a better job, obtain a degree to certify knowledge obtained through years of experience, or simply to become more knowledgeable on a subject of interest. But working on your own can also have drawbacks. Lack of interaction and feelings of isolation are often stated disadvantages associated with distance learning. Interaction between students and with the teacher is good for maintaining motivation, getting feedback, discussing ideas, and assessing one's knowledge. The self-assessment of knowledge is the focus of our study. In particular, we study how to support students' self-assessment by helping them to "know what they know" (i.e., metacognition). The problems we are attacking are generic for adult distance learning and, thus, solutions need to be

applicable in a broad variety of adult academic learning situations, as long as interactive systems, and, in some cases, internet connection, are available.

Our approach to design is based on an analysis of available relevant literature on self-assessment and metacognition, and on archival OUN student data, gathered by CELSTEC, the Center for Learning Sciences and Technologies (section 1). From the resulting insight we developed a conceptual model, refined this from a student survey study, and supported our results with additional interviews (section 2). Our design approach starts with the development of guidelines that were reviewed by experts in adult teaching. The input from the experts was used to modify the guidelines, allowing us to iterate until these were considered complete (section 3). The next step consisted of a tangible design (i.e., mock-ups as well as interactive prototypes) that was iteratively developed with empirical assessment (section 4). In the final section we provide our conclusions and suggestions for application in the context of adult distance learning environments.

1. SELF-ASSESSMENT AND METACOGNITION – A LITERATURE SURVEY COMPLEMENTED BY SOME OPEN UNIVERSITY DATA

Self-assessment is a broad concept which can be interpreted in different ways depending on what the focus of the assessment is. According to Boud (1995), self-assessment has two essential components. The first component relates to the identification of standards and criteria for judging the quality of the work. The second refers to the judgment of the extent to which the standards and criteria have been reached. A different approach by Paris and Paris (2001) considers self-assessment to consist of the learners' evaluation and appraisal of their competences and performance in the process of learning. This approach relates self-assessment to the concept of metacognition. Metacognition has been identified as one of the most important factors affecting learning (Mok et al, 2006). It can be defined as *thinking about thinking* (Wellman, 1985) or *knowing what you know*. In our design approach, we follow Paris and Paris, focusing on the development of a framework to support self-assessment in adult distance education by supporting the development of metacognition. The following overview shows the topics related to self-assessment and metacognition that we identified from our survey and selected as a start for our design.

Support Learners in their Self-reflection

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Self-reflection can be defined as the thinking reflexively or thinking about oneself. Self-reflection is related to metacognition in that it provides understanding of what one knows, and a way of improving metacognitive strategies through the examination of how a task was performed (Metacognition and reflection, 2006). Schön (1983) states that a reflective thinker is aware of her/his own knowledge and lack of knowledge. Supporting learners' self-reflection can also have collateral positive effects since it is related to performance improvement and learner motivational beliefs (Means et al, 2009).

Provide Instructional Guidance

Theoretical approaches like andragogy (Knowles, 1970) suggest that adult learning should be independent and self directed. It has, however, been proven that providing novice learners with support and guidance during the learning process is a more effective and efficient approach to learning (Kirschner, Sweller & Clark, 2006).

Teachers' support can be classified in metacognitive, procedural, contextual and technical. Metacognitive support includes presenting relationships between concepts, explaining rationale for

tasks and activities, and encouraging the development of relationships among participants. Students might need help in procedural support: searching, organizing, and representing the information provided as well as in clarifying the course contents. Teachers can guide learners by adding, elaborating and correcting information; content support. Finally, due to the special case of online education, learners might need technical support about the learning environment. The results of an empirical study with adult students in an online course show the importance of all of the kinds of support in the development of metacognitive skills (Rimor, Reingold, & Kalay, 2006).

At the OUN, student data are regularly collected. In a recent study (Puls & van den Munkhof, 2010) 786 respondents answered between 60% and 95% of each question. Of these, 60% registered in a Bachelor or Master degree curriculum, 40% taking one or more Bachelor or Master level courses), .students were asked to indicate their satisfaction with specific aspects of distance education. Aspects such as "content of written study material", "printing quality", and "course offering" were judged satisfactory by more than 80% of the respondents and "training content", "content consistency", "examination procedures", "examination content", and "electronic learning environment" by more than 60%. On the other hand, "guidance" and "study advice" were among the lower rated features, with only 40% scoring them as satisfactory. To determine which aspects need more guidance, students were asked to indicate if they would like to receive guidance in 13 different areas. The top three areas where students noted that guidance would be appreciated were "study coaching", "building their individual curriculum", and "monitoring the study" (each indicated by between 37 and 39% of the respondents).

Individualized Instruction

Individualized instruction is defined as a technique where the pace, content, and method are tailored to the individual needs of each learner (StateUniversity.com, 2010). Individualized instruction has been reported to have a positive effect in the performance and motivational beliefs of the learners (U.S. Department of Education, 2009).

The role of individualized instruction in the development of metacognition has been studied by Azevedo et al (2005). In their research, they discuss the use of scaffolding methods in Computer Based Learning Environments (CBLE) as a metacognitive tool for enhancing student learning. This research provides the empirical basis for the design of CBLE as metacognitive tool to foster students in their learning of challenging science topics (Means et al, 2009).

According to the definition above, tailoring the method used in the learning environment is also linked to the concept of individualized instruction. It deals with how instruction is structured and managed for different learners. The different instructional structures can, for example, be designed by based upon the learners' different learning styles: "the composite of characteristic cognitive, affective, and physiological factors that serve as relatively stable indicators of how a learner perceives, interacts with, and responds to the learning environment" (Keefe, 1979, p. XX). Learning environments which address different learning styles can influence learner performance, satisfaction (Dunn et al, 1995; Kirchen, 2007), and metacognitive skill development (Shannon, 2008).

Collaborative Learning

Collaborative learning can enhance the development of metacognitive skills (Sandi-Urena, Cooper & Stevens, 2010). Larkin (2006) explains this in that "asking questions to oneself can begin by being questioned by others" (p. 23). Researchers have found evidence of metacognition development during collaborative work (Larkin) and through the practice of collective metacognitive activities (Case,

Gunstone, & Lewis, 2001; Georghiades, 2006). There is evidence (Sandi-Urena, Cooper and Stevens) that metacognition skills obtained through collaboration with peers can be transferred to the individual solution of an unrelated and independent task.

Although collaborative learning has great potential, some researchers are skeptical about using asynchronous discussion groups, especially in the way these are managed by teachers and the participation rates.

Puls and Van den Munkhof (2010) report on the current situation regarding collaborative learning at the OUN. Asked about the expected value of discussion groups, students indicated that they were a way to acquire additional insight, additional explanations and share educational experiences. However, concerns regarding the usefulness of discussions groups surface at the OUN because most of the students do not use the discussion groups, and other students experienced that discussion groups did not fulfill their expectations. To better understand this, student coaches and teachers from different faculties at the OUN were asked why discussion groups fail. They reported that they felt that there is not enough intervention from the teachers and, due to the lack of time and difference of timetable among students, discussions were not as smooth as they wished and did not provide immediate feedback that the students feel they need.

Plan and Monitor the Learning Process

Planning and monitoring are regulative processes. They do not directly yield knowledge, as do transformative processes, but are necessary to manage the discovery process (de Jong and van Joolingen, 1998).

Planning strategies relate positively to success in learning (Azevedo, 2005), perceived control of time, job satisfaction, and health, and relate negatively to stress (Claessens et al, 2007). Planning and monitoring is also related to the development of metacognitive skills because metacognition occurs when learners plan, monitor, and evaluate their own cognitive behavior in a learning environment (Sandi-Urena, Cooper, & Stevens, 2010). Students appreciate support in planning and monitoring their learning process (Alexander, 2001).

Time management is an important planning and monitoring strategy. Although it has been reported that adult students have better developed time-management skills than younger students (Trueman & Hartley, 1996), lack of time is still an important issue for them (Dunn et al, 1995). Helping adult students to profit most of their available time can positively influence their learning.

Strengthen Learner's Self-efficacy

Bandura (1977) introduced the concept of self-efficacy, which refers to a person's perceived ability to attain a desired outcome (i.e., the feeling one has that she/he can do what is asked of her/him). People with high levels of self-efficacy focus their energy on analyzing and resolving problems. People with low self-efficacy get worried about evaluation, doubt their skills and abilities, and anticipate failure before investing effort in problem solving (Bandura & Wood, 1989).

A study on the relationship between self-efficacy, metacognition and performance revealed that metacognition and performance are mediated by self-efficacy. This suggests that students with effective metacognitive strategies also have strong beliefs about their ability to successfully perform a task (Coutihno, 2008). Supporting learners in the development of their metacognitive skills will help them increase their levels of self-efficacy and improve learning outcomes.

2. A CONCEPTUAL MODEL FOR THE SUPPORT OF METACOGNITION

After choosing topics related to self-assessment and metacognition, we developed an online questionnaire to investigate possible relationships between the topics (e.g., Is the level of self-reflection related to the level of guidance needed?) and other potentially relevant variables (e.g., Is the level of guidance needed related to the previous level of education?).

The questionnaire consists of three parts. Part 1 dealt with background variables such as age, previous level of education, hours of study and faculty of study. Part 2 referred to the selected topics. Each topic was mapped to one or more questions. The variables from the questionnaire can be classified in three groups according to their role in the metacognitive process:

- Facts, skills and behaviors variables, containing: time available for study, level of education, student attitude, and time management skills. These variables can not be influenced externally.
- Means variables that hypothetically can influence the development of metacognitive skills: teacher feedback, resources offered, and adapted exercises. These variables can be externally influenced, e.g., by design.
- Goal variables, selected as indicators of metacognitive skills.

The final part was an open-ended question where students were asked to write any further comment they might have.

Table 1 shows the variables in Part 2 along with actual questions (translated from Dutch). Figure 1 shows how these variables feature in our original hypothetical conceptual model to support metacognition.

Table 1 about here

Figure 1 about here

The questionnaire was sent to 288 bachelor and master students and was completed by 102. Goodman and Kruskal's gamma (1979) was used to determine the correlation between variables. The upper right half of Figure 2 shows the significant correlations (95% confidence level) between the answers from the questionnaire. The height of a correlation coefficient is visualized by the saturation and diameter of the circle. The only significant negative correlations are between job time and study time, between time management skill and procrastination, and between procrastination and know criteria.

Figure 2 about here

The correlation structure challenged us to reconsider our hypothetical conceptual model.

Facts, Skills and Behaviors

These variables depend directly on the situation and state of the student and are the input of our metacognition model. *Time available* is a set of variables which includes the variables *study time* and *job time*. Understandably, the number of job hours is negatively correlated to the number of study hours. Students who spend more time working have less time to study. The variables *study time* and *job time*, together with the variable *level of education* are facts that can not be influenced.

This turns out not to be a serious problem because no significant correlations were found between *study time*, *job time* and *level of education* and any of the other variables. The means required by the learner to develop metacognitive knowledge and metacognitive skills do not strongly depend either on the hours spent in studying or working, or on the previous level of education. As these variables are not significantly correlated with any other, they can be removed from the model (Figure3).

Figure 3 about here

Student attitude, *time management skills and procrastination* are variables and sets of variables which can be indirectly influenced. *Student attitude* refers to the learner's attitude towards collaboration in the learning environment. It is composed of a set of variables which includes: *I collaborate*, *preference for teacher*, *preference for real-time* and *preference for non-real time*. *I collaborate* relates to the participation of students in discussion groups and forums. This variable is positively correlated with *preference for teacher* and *preference for real time*; γ is .39 and .55 respectively. There is a significant correlation between *I collaborate* and the variable *teacher feedback (*γ= .34*)*. Students who collaborate in the discussion groups and forums think that the level of teacher feedback is enough.

As stated earlier, students at the OUN complain about the low level of feedback from teachers. This along with the results from our questionnaire show that most students do not participate in the discussion groups. As collaboration is positively correlated with teacher feedback, redesigning the current way of collaboration into a tailored service which supports collaboration among learners can help to solve the problem of perceived low feedback.

From the results of the questionnaire it is not clear whether the positive correlation between *I collaborate* and *enough feedback* is due to the interaction of students with teachers in the discussion groups and forums, or because collaboration among students decreases the amount of feedback needed from the teacher.

Time management is a set of variables which includes *time management skills* and *procrastination*. *Time management skills* is positively correlated to *know strength and weaknesses* (γ=.57) and negatively correlated to procrastination (γ=-.41). *Procrastination* is not only negatively correlated to *time management skills* but also to *know criteria (*γ=-.33*)*.

Means Variables

The 'means' variables are *teacher feedback*, *offer resources*, and *adapted exercises*. These variables are ways (i.e., the means) to influence learners' metacognition. Significant correlations were found between means and goals variables, which will be further explained.

Goals Variables

The 'goals' variables are *known strengths and weaknesses*, *know criteria*, *know sources location* and *self-assessment*. These variables are metacognition indicators and need to be supported to develop metacognition. *Know sources location* is positively correlated with *know criteria* (γ=.72) and with *know strengths and weaknesses* (γ=.6). The correlations between 'means' variables and 'goal' variables give insight into how the development of metacognitive knowledge can be supported. The positive correlations between these variables were:

- *Teacher feedback* is positively correlated to *know source location (*γ=.53*)*, *know criteria (*γ=.4*)*, and *know strengths and weaknesses (*γ=.35*)*.

- O*ffer resources* positively correlates to *know source location (*γ=.60*), know strengths and weaknesses (*γ=.51*),* and *know criteria (*γ=.38*).*
- Providing *adapted exercises* correlates positively to *know strengths and weaknesses (*γ=.64*)* and *know source location (*γ=.38*).*

In conclusion, the results from the questionnaire show that the attitude towards learning, behavior in learning, the need for material, teacher feedback and adapted exercises, and metacognition knowledge do not depend either on the level of education, or on time spent in studying or working. Time management skills help avoid the tendency to postpone exams and to support metacognition knowledge development. The metacognition indicators are correlated with the level of feedback provided by the teacher, the offered material and the exercises adapted to the individual needs of the learner. These results indicate that the metacognition in learners can be externally supported.

Developing Deeper Insight

The student questionnaire yielded useful information about OUN students and the relationships between variables. However, it also triggered questions such as: "What are the desired features of a time-management tool?", "What are the reasons for choosing between practice exams and online quizzes?", and "How can we support collaboration among students?" Interviews were conducted to obtain further insight on those topics and qualitative data on self-assessment practices. Based on availability we interviewed two Master's students in Computer Science, one participant of a single course (on Databases) and a student in Psychology. These extensive interviews consisted of three parts. First, the students were asked to identify the main challenges faced by OUN students. Then, they were presented with four scenarios showing personas studying at the OUN using a new interface which integrates some of the features discussed in the previous sections (i.e., time management, collaborative learning, self- assessment through quizzes, practice exams with teacher feedback, and progress tracking). The students were asked to give their opinion for each of the new features. Finally, students were asked to share their own personal self-assessment methods.

Time management, personal circumstances which interfere with the study, concentration, and motivation are the main challenges identified by the students. It became clear that time management is not a problem because of a lack of time-management skills but because there is little time available. Students are not positive about a time-management tool which is considered more of a burden than a help. It seems the students get annoyed by having to switch tasks because it hinders task completion. However, were positive about using management tools when working in groups. Setting milestones, allocating tasks and keeping track of the group members' holidays are some of the suggested features.

The interviews revealed that collaboration is important. Discussion groups are useful for the students, even if they almost never participate (i.e., vicarious learning). The students really appreciate face-to-face meetings, and participate in the classes organized in the Study Centers (i.e., physical locations spread around main cities in The Netherlands where students can meet with other students and teachers, take exams, and/or use the OUN library). Students told us that teacher feedback can be helpful but is not really necessary. One student pointed out that teachers can be overwhelmed if they are asked to be really involved into the learning process. Some students prefer to collaborate with colleagues who they already know. One student liked studying with colleagues because he is not "*alone with the book*".

Students identified practice exams as the most valuable self-assessment method. They point out that the level of difficulty of the exams should be aligned with the level of difficulty in the actual test.

They commented that the current practice exams only show whether the answer is right or wrong but do not provide further information.("*you can just see what its wrong and you can not learn from it*", "*what you do not understand you can not find it out*"). Quizzes were also identified as useful. They would use the quizzes to assess their knowledge after a set of chapters. Some students proposed providing extra credit to those students whose performance in the "after chapters" quizzes is good. All students were positive about adaptive quizzes that provide instantaneous and personalized feedback.

The students also reported other ways of self-assessment that they developed through experience. Some ask other students to review their reports; others initiate face-to-face meetings which they find useful to "*know what you know*". Some students reported that when they have to deliver a report they wait a few days after finishing it before delivering. In the mean time they spend time on unrelated things such as sports and after a few days they read it again.

All students were positive about having a service which allows them to see their progress. They described such a service as "*nice*" and "*useful*". Currently, few courses allow this. Some students reported that they use third-party applications to track their progress when the service is not provided. Most reported that they kept track of the hours spent to complete a course. While courses provide an indication of the time needed to complete the course, students complained about underestimation. One student suggested including a feature which would point out the weak points ("*The best thing would be that the system could warn you by some Artificial Intelligence: Please look at this kind of equations because you have a problem with them*").

From Model to Design

From the questionnaire and interviews we learnt that OUN students are self-directed learners. Most of them claim to have good self-reflection skills and that they are able to accurately assess their knowledge. OUN students' main challenges are lack of time, personal circumstances which interfere with study, concentration and motivation. While they are aware of the usefulness of time management, , in practice it is hard to keep up with the schedule because of individual circumstances which interfere with study. The platform used to schedule their tasks should not influence their time availability. They would appreciate a service which allows them to set the schedule when working in groups. Some of the options suggested are: set milestones, allocate tasks and set availability.

Procrastination is not an issue for most of the students. Only minority tends to postpone exams for a "good" reason: they are not sure whether they are able to pass though they would appreciate a service which allows them to follow their progress and identify their weak points.

Students appreciate practice exams and quizzes. The exams are a good method to assess global knowledge on a subject. However, the current way of presenting the answers does not take advantage of its potential. The exams should not be a mechanical way to assess knowledge but a supportive tool which promotes learning and reasoning. Quizzes are seen as a useful way of assessment "on the go". Most students would like to have a quiz after each, or at least after a set of chapters to assess their knowledge development.

Collaboration has been identified as successful for developing metacognition and is an important issue at the OUN. Discussion groups, which are one of the current ways of collaboration provided by the OUN, are not successful; students think that discussion groups are useful but do not participate. Some of the reasons why students do not use discussion groups are:

- Fear to fail: Some students think that their level of knowledge is lower than the active participants of the forums.
- Preference for alternative ways of interacting with peers: Some students prefer other ways of collaboration such as face-to-face meetings with peers, on-campus classes, phone or e-mail.

- Preferences for known peers: Some students prefer interacting with known colleagues.

In the on-line questionnaire, students requested enhancing collaboration. Some students are proactive in creating support groups and reported alternative methods to collaborate. Most of the interviewed students have alternative ways, not provided by the OUN, to collaborate with peers. Collaboration with the teacher is also important, though it is not considered as essential as collaboration with peers. We conclude, thus, that meetings with the teacher could be reduced to on-campus classes every few months, to exchange of e-mails or to specific appointments to solve problems if peer contacts exist.

The information gathered from literature and the conclusions from our field research were input to the creation of a set of guidelines to support self-assessment. The starting point was the initial list of six topics related to the development of metacognition and self-assessment:

- Support learners in their self-reflection
- Provide instructional guidance
- Individualize instruction
- Support collaborative learning
- Plan and monitor the learning process
- Strengthen learner self efficacy

We consider these topics "initial clusters". After reviewing all the information gathered (literature, reports by CELSTEC, answers to the questionnaire, and interviews with experts and students), we identified topics, practices and recommendations related to self-assessment and metacognition. If the practice was related to one of the existing clusters, we added it into the cluster. If it did not, we created a new cluster and iterated. When all sources were reviewed, each cluster was labeled by a sentence which described the topics, practices, and recommendations it contained. Finally, each cluster became one guideline and the topics, practices, and recommendations included in the cluster were recorded as information related to the guideline.

3. GUIDELINES TO SUPPORT SELF-ASSESSMENT

These guidelines aim to help professionals in adult education design distance learning environments which support self-assessment and development of metacognition. In our opinion, these guidelines are a valuable contribution since they are a compilation of good practices obtained through a combination of theoretical research and supporting empirical data. Obviously, every course and group of learners is different. Education professionals use their expertise to adapt our guidelines to the individual needs of the specific course. Notice that each guideline is supported by references which point to existing literature, interviews, and/or reports by CELSTEC.

1 Create a Safe Learning Environment.

1.1 Provide students with a safe environment where they feel free to express themselves, to ask questions (Hamilton, 1996; Porter, 1997), to experiment, and to fail (Chen, 1997; Spitzer, 1998; Interviews with OUN students and experts).

2 Provide Easy to Learn/Use Interfaces.

2.1 Mental fatigue and lack of time are the main challenges identified by students and education experts (Interviews with OUN students and Experts; Mok et al, 2006). These characteristics

make time and effort optimization a priority in adult distance education, and do not make learners struggle with the interface.

3 Thoughtfully Design the Learning Environment.

3.1 Provide structured and clear learning context. A good design can improve the quality of the learning environment by structuring the visual and interactive display of learning contexts to facilitate metacognition (Kirsh, 2005).

3.2 Adapt the content, format, infrastructure and strategy to the individual needs of the course (Pahl, 2003).

3.3 Create a flexible learning environment which can be used by learners with different learning styles.

- Address different learning styles by presenting material in multiples modes such as text, graphics and audio (Cercone, 2008; Bangert, 2004; van der Veer, 1989).
- Learners struggle to develop metacognition skills due to lack of awareness of their own learning process (Shannon, 2008). Proving learners with material presented in multiple modes can help them find out which presentation style fits them best (e.g. book versus text and pictures on screen versus video, icons vs. words, pre-structured data vs. searchable data collections).
- Learners' achievements and satisfaction benefit from learning environments where their learning style is addressed (Dunn et al, 1995; Kirchen, 2007).

4 Provide Feedback/Guidance Throughout the Learning Process.

4.1 Provide meaningful and in-time feedback.

- Appropriate teacher feedback in online courses helps students develop metacognitive skills (Reingold and Rimor, 2008). Also, feedback is more effective when delivered near the time a task is performed (Kluger & DeNisi, 1996). Immediate feedback can be a motivation factor in online education (Danchak, 2002).

4.2 Provide guidance during the learning process.

- Teacher's support is related to the development of metacognitive skills in learners (Rimor, Reingold & Kalay, 2006).
- Minimally guided instruction is less effective and efficient than instructional approaches that support learners during the learning process (Kirschner, Sweller and Clark, 2006). The level of support can be reduced as the learner's level of expertise increases.
- Keep timely contact with learners. Learners need support and appreciate teachers following their progress (Puls & van den Munkhof, 2010; Interviews met OUN students and experts.

5 Promote Self-Assessment.

5.1 Self-assessment is related to developing of metacognitive skills (Ibabe & Jauregizar, 2010) as well as to other skills such as critical thinking, self-reflection, and problem solving (Dochy, Segers, & Sluijsmans, 1999; Segers & Dochy, 2001; Thompson, Pilgrim, & Oliver, 2005).

5.2 Provide self-assessment throughout the whole learning process. Continuous self-assessment yields better outcomes than post course self-assessment or no use of self-assessment (Lopez & Kossack, 2007).

5.3 Provide different ways of self-assessment to cover all stages of the learning process.

- Using computer based-quizzes as formative self-assessment method benefits learners (Wellman, 1985; Brusilovsky & Sosnovsky, 2005; Hunter, 2007). Quizzes can be proposed at the end of a chapter or set of chapters.
- Practice exams have been identified as a good method for self-assessment before a summative evaluation (Interviews with OUN students and experts).
- Collaboration among learners and with teachers can help students assess their knowledge throughout the whole learning process (Interviews with OUN students and experts; Sandi-Urena, Cooper, & Stevens, 2010).
- Real-life cases. Presenting examples that represent real-life problems helps set goals and supports development of metacognition that helps learners evaluate future applications of knowledge and skills (Lim and Moore, 2002).

6 Promote Collaborative Learning.

6.1 Collaboration is an effective way of enhancing metacognition (Interviews with OUN students and experts; Sandi-Urena, Cooper, & Stevens, 2010) and can affect learning effectiveness of distance adult learners (Rovai, 2001; Ragan, 1999).

6.2 Provide learners with different ways of collaboration.

- Discussion groups and forums (asynchronous). Teachers can participate in the discussion but it should also be possible for learners to discuss without teacher's intervention (Interviews with OUN students and experts).
- Chats (synchronous).
- Choose between asynchronous and synchronous collaboration depending on the nature of the course and learner preferences (Interviews with OUN students and experts).
- Facilitate setting up face to face meetings among students and/or with the teacher (Interviews with OUN students and experts; (Mok et al, 2006)).
- Provide the infrastructure required to set up video conferences.

6.3 Do not promote competition among learners (Sheridan, 1989).

6.4 Facilitate the creation of small collaborative groups (de Jong & van Jolingen, 1998). Students are generally unwilling to use discussion threads to collaborate (Interviews with OUN students and experts; Mok et al, 2006; Dunn et al, 1995; Kleinman & Enting, 2002), regardless of their experience with electronic communication (McDonald, Dorn, & McDonald, 2004). Students feel more comfortable and find it safer to ask, answer, contribute and discuss within small groups (Interviews with OUN students and experts).

6.5 Collaboration is good for motivation which also influences the cognitive process (Danchak, 2002).

7 Promote Time Management.

7.1 Lack of time, mental fatigue, and individual circumstances which interfere with the study are aspects affecting study (Interviews with OUN students and experts; Mok et al, 2006). Time management relates positively to perceived control of time, job satisfaction, and health, and negatively to stress (Claessens et al, 2007). Helping learners manage their time can have a positive effect in the learning process.

7.2 Specify the goals of the course and highlight the important issues (Mok et al, 2006).

7.3 Provide learners with estimations of time needed to solve an exercise or understand a chapter (Interviews with OUN students and experts; Mok et al, 2006).

7.4 Provide learners with time management and task allocation services when working in groups (Interviews with OUN students and experts).

8 Progress Tracking

8.1 Visualize the learner's progress in the course. Learners' capability of monitoring what they do and modifying their learning strategies according to it is related to metacognition knowledge (Boud, 1995). Furthermore, using monitoring strategies in online course can help maintain motivation (Chang, 2007).

8.2 Set milestones. Progressive calendar deadlines help avoid procrastination and improve self-fulfillment (Liu et al, 2005; McLoughlin, 2002). It also helps self-reflection (interviews with OUN students and experts).

9 Keep up Motivation.

9.1 In distance education, it is often difficult to maintain motivation because learners might feel isolated or feel that their effort is not recognized (Interviews with OUN students and experts). As motivation influences behavior (Malhotra, Galletta, & Kirsch, 2008), it is desirable to maintain motivation to have a positive attitude for learning.

9.2 Creating a sense of community can help maintain motivation (Rovai, 2002).

9.3 Recognize learners' effort. Rewarding effort and persistence helps in the learning process towards mastering a subject (Schraw & Dennison, 1994).

9.4 Use real life examples. Adult learners need to learn "in order to cope more satisfyingly with real-life tasks or problems" (Knowles, 1980). Providing real cases can raise motivation as well as prompt discussion and support self-reflection.

4. TANGIBLE DESIGNS

In this section we provide an example of how to use the guidelines by creating tangible designs which use them. The most learning specific guidelines related to self-assessment, collaboration, time management and progress tracking (guidelines 5 – 8) were directly mapped into four tangible designs or services (sections 4.1 – 4.4). The rest of the guidelines were considered generic recommendations to be applied whenever relevant during the design of the services.

To place the tangible designs in context, we created an imaginary course. The nature and content is irrelevant here because - at this stage - we are interested in understanding how to apply and transform the concepts in the guidelines into tangible designs.

Tangible Designs to Support Self-assessment

Self-assessment is a broad concept which refers to the involvement of learners in making judgments about their own learning, their achievements and the outcomes of their learning (Boud & Falchikov, 1989). Formative assessment is a way of assessment which contributes to student learning (Roberts, 2006), usually by using feedback (Sadler, 1989). Based on the interviews with students and experts we selected two types of formative assessment: training exams and quizzes.

- Practice exams are sets of questions which refer to information about any part of the material. We identified two approaches to this kind of formative assessment:
  The first can be called an iterative formative assessment. Students take the exam at any time, identify weak points, study those weak points and retake the exam. Theoretically, the number of correct answers will increase as the student iterates, indicating progress.

A second approach, more popular with students, is to use such exams, without iteration. After each practice exam, learners have the option to check the correct answers.
We created a flexible design that allows students to take both types of practice.

- Quizzes are sets of questions which refer to a particular piece of the material. Based on the questionnaire and interviews, we determined that learners have a strong preference for taking quizzes after a set of chapters. Our services are designed to prompt learners to complete quizzes after a set of chapters.

Based on learner preferences, the practice exams and quizzes provide elaborate answers, links to further material and information about which part of the course the question refers to. Relevant types of questions found in the literature[1] are:

- Multiple Choice (MC)
- Multiple Response (MR)
- Alternate choice, a two items MC
- True-false
- Multiple true-false
- Matching, a set of options followed by a set of matching statements, questions or phrases
- Context dependent item set: a scenario, vignette, table, chart, graph followed by a single item.

Some question types might be stronger related to the development of metacognition than others. Experts' opinions and previous studies (Crips and Ward, 2005) suggest that questions which have multiple right answers depending on the context might help in the development metacognitive skills because answering such questions requires critical thinking which is related to developing metacognitive skills.

In a previous study (Hunter, 2007) students reported problems with a system that simply reported that their answer was wrong. We attempted to mitigate this effect by explicitly indicating when the learner's answer is right. If the answer is wrong, the system provides an explanation of the correct answer, links to further material and a link to which part of the course the question refers to (Figure 4).

Figure 4 about here

In the interviews with experts and students, two other kinds of self-assessment exercises worth mentioning were offered, namely "real-life case exercises" and "worked-out examples". Real-life examples present situations from the real world and can be approached either individually or together with peers. This kind of exercises should prompt critical thinking and student discussions. Worked-out examples consist of the formulation of a problem and the steps needed to reach a solution. In some cases, learning from stepping through worked out examples can be more effective than be left alone solving a problem (Renkl, Atkinson, & Mier, 2000). Such exercises can also prompt discussion among students and with the teacher since there can be multiple correct answers depending on the assumptions. We propose that these kinds of exercises should be embedded into the material.

Tangible Designs to Promote Collaborative Learning

Collaboration has been identified as a way to support the development of metacognition. Although the OUN provides ways to collaborate with other students and with teachers, the data gathered shows that participation is low. In spite of the low participation, students are aware of the potential benefits of

collaboration and request more support in promoting collaboration with peers, especially face-to-face. The current ways of collaboration provided by the OUN are not tailored to the needs of the students. Some of the possible flaws are:

- The discussion groups are experienced as impersonal
- They barely support setting up face-to-face meetings
- Students prefer collaboration with people they trust
- Students do not feel engaged and the discussion groups become static
- Most students have to log into the learning management system to see posts in the discussion groups
- Some students are afraid to participate in the discussion groups because they think they might ask something irrelevant

We propose redesigning the current way of collaboration by providing services which are easy to use, personal, make students feel safe, facilitate setting up of face-to-face meetings, facilitate creation of small groups, support dynamic collaboration, support synchronous and asynchronous collaboration, and engage learners. The proposed tangible designs are:

- Contextual discussions that appear at the bottom of each piece of learning material. Students can comment and ask questions about the material presented in that page. We feel that this is an easy and fast way to collaborate with other students. Also, because it is possible to make anonymous comments, students should not be afraid to comment. Teachers can take part in the discussion to resolve doubts or correct misunderstandings.
- General discussion groups aimed at solving questions about general issues such as doubts about the syllabus, examinations dates, and interface problems. This general discussion group could be introduced at the beginning of the course together with an introductory video. In the video, the teacher may give a brief explanation of what the course is about, what is expected from the students and what they can expect from the teacher. We expect this video will help engage students and make the interface more personal.
- Meeting point is a virtual space which provides various services to support student collaboration. The services proposed are:
    - Chat provides real-time (synchronous) collaboration. Students can chat with other students in their contact list. New contacts can be added by providing the email address or through the study-buddy service (explained below).
    - Sticky notes (see Figure 5) provide informal collaboration among students. It tries to mimic the situation of an on-campus class where students stick notes on a memo-board. Similarly, students can add sticky notes to a canvas. The notes have a color code which indicates the nature of the note: question, material, comment or other. Furthermore, it improves the functionality provided by the physical memo-boards by allowing students to attach files to the sticky note. This way of collaboration aims at providing an informal, fast, and intuitive way to leave short messages and prompt students to share their interpretations and summaries of the material.

Figure 5 about here

    - Study-buddy (see Figure 6) helps students to find other students to collaborate with. Users can look for buddies based on variables such as geographical distance, number

of common subjects, type of study (i.e., single course, Bachelor or Master), or kind of preferred collaboration (i.e., no preference, on-line or face to face). Students can decide whether they want to be found by others by indicating this in their settings. Students can check other students' profiles, send messages, and add them as buddies. New buddies are automatically added as chat contacts. This service was developed by a group of Bachelor students from the OUN Faculty of Computer Science.

Figure 6 about here

Tangible Designs to Promote Time-management

Lack of time is a major problem the OUN student faces. Based on the questionnaires and interviews we deteremined that this type of students have well developed time-management skills and would not appreciate a time-management tool to schedule static study plans. Instead, they want something to help them assess the time needed to reach their short-term goal (e.g., finish the chapter), and save time. We provide an estimation of the time needed for all the pieces of material, exercises, quizzes and practice exams. Also, we provide tools to highlight and comment on the text and save it (Figure 7). We expect students to highlight and comment on the material which will help them save time the next time they study.

Figure 7 about here

Finally, we also provide a calendar which can be used individually or in groups. Group members can set milestones, events, and tasks and share them with the rest of the group.

Tangible Designs for Progress Tracking

The questionnaire revealed that most students would appreciate a service which allows them to track their progress. Most of the interviewed students tracked their progress using external applications. A few courses provide services which allow students to track their progress. We propose two ways to track learner progress. First, the interface shows - in each piece of the material - how many single content items the student has studied and how many still need to be covered. Single content items are pieces of learning material which fit in one screenshot and contain information related to the course such as text, video clips, or images. The system keeps track of how many single content items the student has covered by keeping track of a check that a student may tick in the box "I have seen this slide" underneath the main content space on the screen.

Also, students can inspect their general progress by checking the progress tracker (Figure 8). Here they can find information about the material already covered, the practice exams and quizzes taken and how many hours they have spent logged into the system. Tracking hours spent logged in provides students with an estimation of their study time. However, this estimation might not be accurate because of idle-time where the students are logged in but are not studying. Also, students might study parts of the material by reading downloaded material or parts of books. If the concept evaluation shows that students appreciate this service, further research needs to be done on how to keep track of the time students have spent studying.

Insert Figure 8 about here

Prototype Assessment

After creating mock-ups for each of the tangible designs, we created a video prototype illustrating how the services work and what is possible in the interface. This video prototype was intended to help gain insight in conceptual issues of the tangible designs. For the prototype evaluation, we invited OUN students and people who fit the profile of an adult distance learning student. First, we showed them the video and then conducted semi-structured interviews where we asked about general issues of the prototype. The questions asked during the interview were related to visibility, acceptability, likeability, and understanding of the services as well as user opinions about the approach followed to map the concepts to tangible designs. The interview videos were analyzed and participant quotes were coded according to the service and area they were related. In this section we provide a comprehensive list of the results, with supportive quotes, arranged by service:

Self-assessment

Most of the interviewed users liked the practice exams and quizzes. They appreciated that the system provides elaborate answers, links to further material and information about which part of the course the question relates to. Some suggested including contextual discussions in the quizzes and practice exams (*"It would be interesting to put the forum inside the exams", "a place to go deeper than just the question and the answer, and that's important"*).

Collaboration

Contextual discussions were well accepted (*"I think it is better to have it there in the material, in the specific part because if you put everything together it gets kind of cluttered"*). However, depending on the context of the course, just text might be not enough (*"It would be nice if the amount of media that you can put in those forums would be a bit more sophisticated than just text"*, *"Maybe it would also be nice to be able not only to type text but also to sketch or draw to or put an arrow or a circle"*).

Contextual discussions are good to keep up motivation (*"It would be comforting for me if there was something that I didn't understand ,to know I was not the only one who had difficulties"," You can see if more people have problems with the same question or in the same topic"*).

Communicating with other students by chat can be distracting and time-consuming. (*"When I think about studying I first try to do it myself before looking if somebody else is chatting or posting questions. I may have to turn it off, but I probably won't do that so it's better if it's not there", "I have to work, I have got a husband, I have got many things to do (…) I'm not going to chat with other students"*).

Although users like the visual approach of the sticky notes (*"I thought the color coding was nice", "the post-it notes look nice", "with that way of presenting, using sticky notes, it's more realistic"*), there are some issues related to them:

- Organization:
  "It can be a bit fuzzy"
  "What happens when you have many sticky notes? They could be cluttered"
  "Maybe you could have a feature where you select several notes and you turn this into a forum, so you move them to another space".
- Relevance:
  "When you receive a lot of information but you don't know what to do with it because it is too messy and you don't know what relates to what and if it is relevant";

"You could have a kind of system where you can see what you want and hide what you don't want to see";
"It would be nice to give more preference to some notes than to others";
"Maybe I write something that people consider useless and it's taking the same space as something which may be very important".

- Development through time:
  "What happens when you are at the University for two years? How many of those sticky notes would you have? ";
  "I have some doubts about the organization: which ones are more recent, which ones should appear and how it will evolve over time".
- Misuse:
  "Sometimes these things get abused by people. Some people might use the sticky notes to have a conversation, while they should have this conversation through another channel".

Using sticky notes for two different purposes (i.e., commenting on your own material and posting messages in the common board) can be confusing. Some users thought that the sticky notes used to comment a piece of the material were somehow related to the sticky notes used to communicate with other students. This led to misunderstandings such as that the sticky notes used in parts of the material could be shared with other students.

The acceptance and likeability of the finding buddies service may depend on the needs of the students. (*"I would find it interesting and desirable"*, *"I would like people to find me more than I would like to find people"*, *"Usually I don't need other people to discuss the material"*, *"I don't see people, I just see names"*).

There were concerns regarding the role of the teacher in the collaboration and the trustfulness of the person they collaborate with (*"You cannot confirm whether that information is right or not"*, *"When I want to know something, I ask the professor. I don't ask another person because usually I think maybe I'm better than them"*). Most of the students like to collaborate with a small group of peers which they trust.

Reasons for not collaborating are lack of time (*"Maybe if I had more time, I would do that"*) or not knowing/trusting with whom you are collaborating with.

Time-management

Highlight and comment was broadly accepted among the interviewed users. Many users suggested adding a functionality which would allow them to gather the highlighted text and obtain a single document out of all the pieces. (*"I would like to click one button to save all the highlighted parts in the paper"*, *"There should be an option that allows me to grab only the marked things and to print those together, so I have a kind of summary"*).

Most users were positive about the calendar. Feelings of being observed or bother by constantly switching tasks was not an issue for the interviewed users (*"Even if the system does not tell you, you know that you are behind schedule anyway"*, *"I think it's a nice reminder, it's not a bother"*)

The teacher could also help by setting milestones in the calendar like exams and deadlines for exercises (*"It could be useful that the teacher himself puts some deadlines"* ,*"One thing is how you organize your time, other thing are the deadlines which are not up to you"*).

The acceptance and likeability of providing an estimation of the time needed were diverse. Some users thought that it would be very useful (*"Sometimes you are reading stuff and you do not know how long it will be"*, *"I have to stop and later it takes more time to try remember the stuff"*, *"I can set*

some personal goals for time to help time management") but others thought they were not appropriate (*"How many hours the teacher think you should spend and how many are spent, if I was a teacher I would never say that" "I would not give such expectations to people because maybe it is unfair"*).

Progress tracker

The progress tracker was generally well accepted among the students (*"I think the progress tracker is important for the discipline you need"*), although some students showed concerns about the privacy issues of this service (*"It might bother me if it was telling others also"*)

This service could be further developed by showing more detailed information (*"If I could get a journal of my activities rather than just a very general statistical overview then I would think this was quite useful"*) and using individual information of the learners (*"It could be useful but it has to be somehow related"*, "*maybe the system could suggest, you were supposed to read 40 pages and you read 30 and it gives you a kind of new schedule. From now on you don't have to read 10 pages per day but you have to read 12", "If I can see that I cover more material on Tuesday and more material on Wednesday then maybe I can also think why that was and correct stuff about my routine and the way I work with the site"*)

5. CONCLUSIONS AND SUGGESTIONS FOR DESIGN AND APPLICATION

Self-assessment is important for learning and particularly important for adult distance learning since studying at a distance might negatively influence in the ability to assess one's knowledge. "Knowing what you know" (i.e., metacognition) plays an important ole in self-assessment and is the focus of this research. The development of metacognition can be externally influenced by teacher feedback, resources offered during the course, and exercises adapted to individually acquired knowledge. No correlations were found between time available or level of education, and variables related to the development of metacognition, which suggests that the development of metacognition can be equally supported regardless of the time available or the previous level of education of the learner.

Quizzes and training exams are the most popular and appreciated self-assessment methods. Quizzes and practice exams with elaborated answers and further information about the topic targeted in the question are highly appreciated by students because they "*can learn from the answers*". Providing questions with multiple correct answers depending on the context is a valid and valuable method to support the development of metacognition.

Collaboration is an important issue in the development of metacognition. The interviews with users reaffirm what the literature suggests: development of metacognitive skills can be supported by collaborating with other students. The presented tangible designs aim to overcome this problem by creating dynamic, safe, and easy to use ways of collaboration as well as supporting the set up of face-to-face meetings. Users liked the proposed designs and perceived them as an added value to a web-based course. However, design issues arose related to sorting, storing, and visualizing the evolution across time with the sticky notes. We recommend systematic research and assessment on these issues to accompany actual design.

In general, the adult students have well-developed time-management skills but their lack of time makes them frequently run behind schedule. Some students use time-management tools. However, due to often interfering circumstances which force them to constantly modify their schedule, these tools frequently become more a burden than a help. The interviewed users did not perceive our time-management support (i.e., providing estimations of the time needed, highlighting and commenting on

the material, and calendar) as a bother. Instead, these were perceived as useful and convenient for time-management.

The progress tracker was broadly accepted among the interviewed students and during evaluation of the prototype. However, possible privacy issues were signaled during the evaluation. Students do not want other students to be able to see their progress. These results reassert that the guidelines suggesting “not promoting competition among students” and “providing a safe environment” are important when designing learning environments. It is important that students securely know which information they are sharing and how to modify their sharing options.

This research provides a base for the creation of self-assessment support in distance learning. Modern technology allows this support and facilitation even if the learners differ in learning styles, learning context, and learning goals. Our guidelines, based on literature and accumulated empirical research, can be implemented in usable support tools. Our current version of the prototypes for this should be considered only the start.

After this initial exploration and evaluation of the services, we should be aware not all issues are covered.
First of all, the current analysis is mainly based on self-report survey data. A next step has to be to validate our findings against additional data like analysis of graduation rates after implementation of our self-assessment support. We will also need to collect and analyze demographic correlations of grades / attrition / participation with survey responses.
Secondly, we suggest future studies on possible adaptations, among which could be:

- Provide a main navigation menu with a clear structure so students can easily identify the different parts of the course and the provided services: (1) Introduction; (2) Content; (3) Practice exams; and (4) Meeting point.
- Allow students to create a single file which contains all the highlighted parts of the material. This file can be saved and printed.
- Add contextual discussion groups to the quizzes and practice exams.
- Add more options to the contextual discussions, such as formulas, drawings, or audio files.
- Allow teachers to set milestones in student calendars.
- Develop the functionality of the progress tracker. Show a more detailed picture of the learning progress, provide recommendations based on the individual progress of the learner ,and relate the current and previous progress are some of the suggestions given by the users.
- Define a way to organize, manage through time and give preference to the sticky notes. The similarity between sticky notes used to comment on pieces of the material and sticky notes used as an informal way of collaboration led to misunderstandings about the functionality of both services. We think this is caused by, both, similar appearance and use of the same name to refer to different services. Changing the name and the appearance of the functionalities will prevent misunderstandings.
- Conduct further research on the “Find buddies” service. The current (working) prototype is developed by OUN students for a specific Bachelor project. Research has to be done on issues relevant to search-parameters for the context of application. Privacy issues also need to be addressed.

After new design like the ones suggested above, perform user testing - preferably interviewing students - and iterate as needed. Implement the prototyped services and test the new design

incorporated in an actual course. A feasible testing method is the Success Case Method (SCM), an evaluation technique developed by Brinkerhoff (2003). Initially, it was used to investigate why some practices were working for some individuals but not for others. SCM is particularly useful for assessing social practices, outcomes and impacts in areas which are difficult to quantify. SCM has been successfully applied in the evaluation of services developed for distance higher learning at the Open University in UK. It relies on the hypothesis that the majority of the data collected follows a normal distribution, with examples of 'absolute success' and 'absolute failure' at the extreme ends. The core of the distribution contains what the majority perceives as 'satisfactory'. However, the method focuses on the extreme ends to assess the main success and failures of the system. The SCM evaluation technique is based on five steps:

1. Developing models of what 'success' and 'non-success' mean. These models should be thoughtfully developed. Variables to measure success and non-success should be related to metacognition development indicators. To measure the development of metacognition it is important to have a control group.
2. Identifying the success and non-success cases by questionnaires to the students.
3. Identifying students at the extremes.
4. Interviewing those students.
5. Documenting the findings and providing recommendations.

This method is suitable even if it requires many respondents to answer a relatively long list of questions (which can be done through e-mail or web based tools), since it requires only a small group of students to be actually interviewed. We experienced that it is easy to obtain students' feedback from questionnaires, but hard to contact remote adult students face-to-face.

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TABLE AND FIGURES

Variable	*Question*
Time available	
Job time	*How many hours do you work per week?*
Study time	*How many hours do you study per week?*
Previous education	
Level of education	*Level of education*
Time management	
Time management skills	*While studying for a course, I know how to manage my time*
Procrastination	*I tend to postpone exams because I am not sure I am ready to pass*
Student attitude	
I collaborate	*I collaborate with other students during a course (through discussion groups)*
Preference for teacher collaboration	*I want teachers to participate in the collaboration*
Preference for real time	*When collaborating with students on-line I prefer to use real time collaboration (Skype, chats)*
Preference for non real time	*When collaborating with students on-line I prefer to use non-real time collaboration (discussion groups, forums)*
Means to support metacognition	
Teacher feedback	*I receive enough feedback from the teacher*
Offer resources	*While studying for a course the offered material (text, tutorials, examples) covers my needs*
Adapted exercises	*The exercises given during a course are adapted to my knowledge (they are neither too easy nor too difficult)*
Goals of metacognition in learning	
Know strengths and weaknesses	*While studying for a course, I can identify my weak and strong points in the subject*
Know criteria	*It is clear what I have to study to pass a course*
Know source location	*When I need further information on a topic, I know where to find it.*
Self assessment	*My expected score after finishing an exam matches the actual score I get*

Table 1: Variables (Bold face) and the actual questions (italic) in the questionnaire

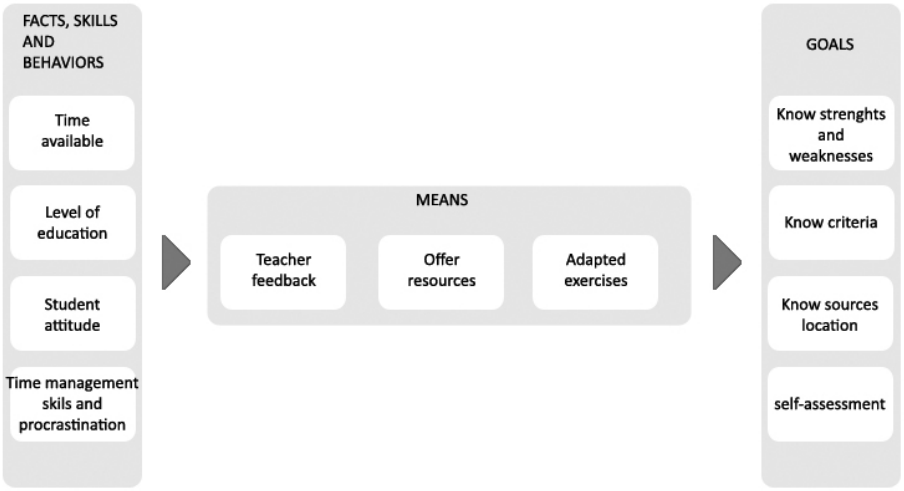

Figure 1: Original (hypothetical) model to support metacognition

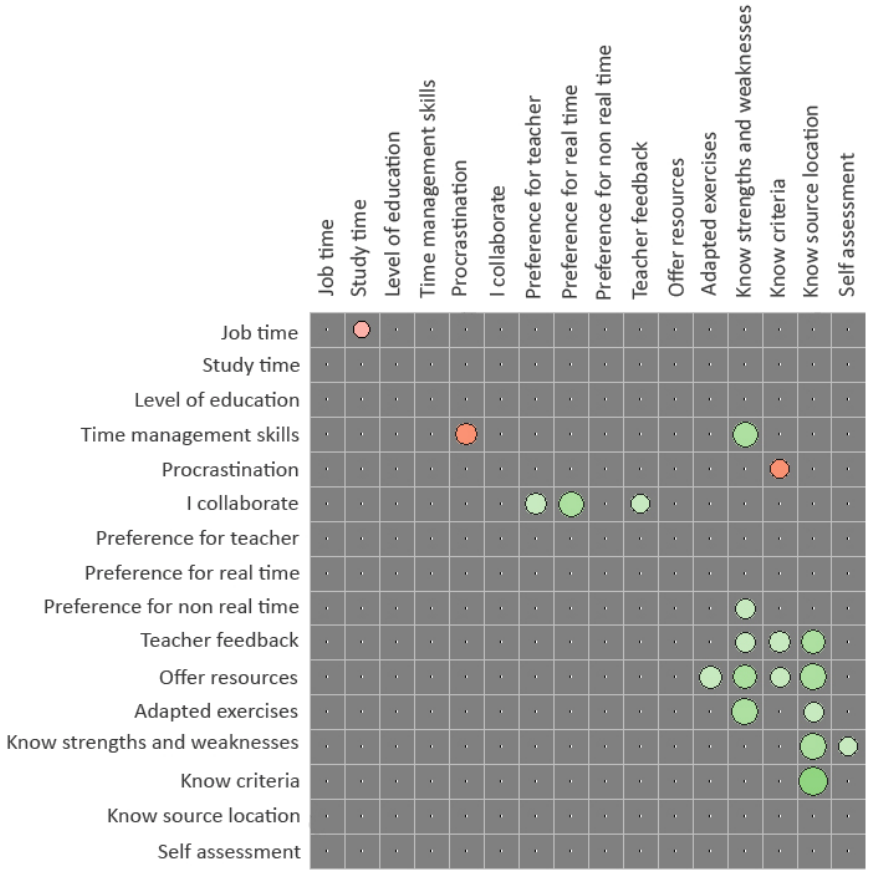

Figure 2: Significant correlations (size and saturation of circle indicate strength of correlation) between the answers to the questionnaire

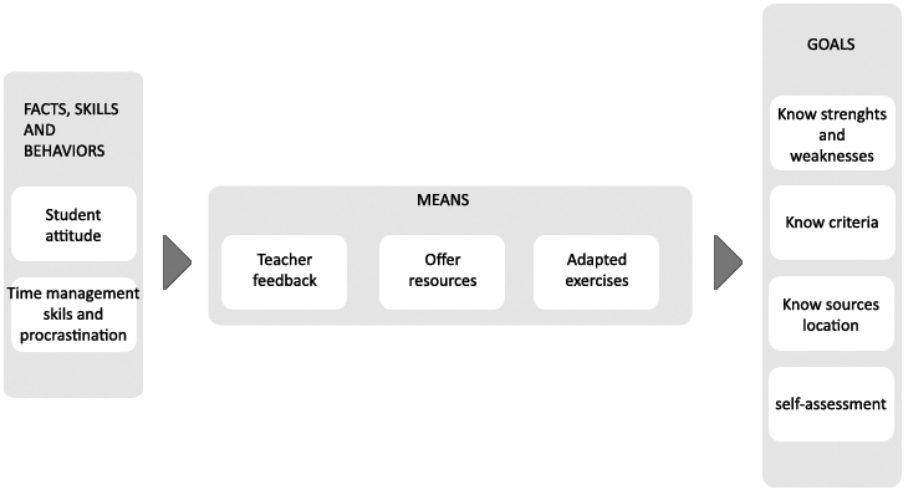

Figure 3: Simplified model to support metacognition

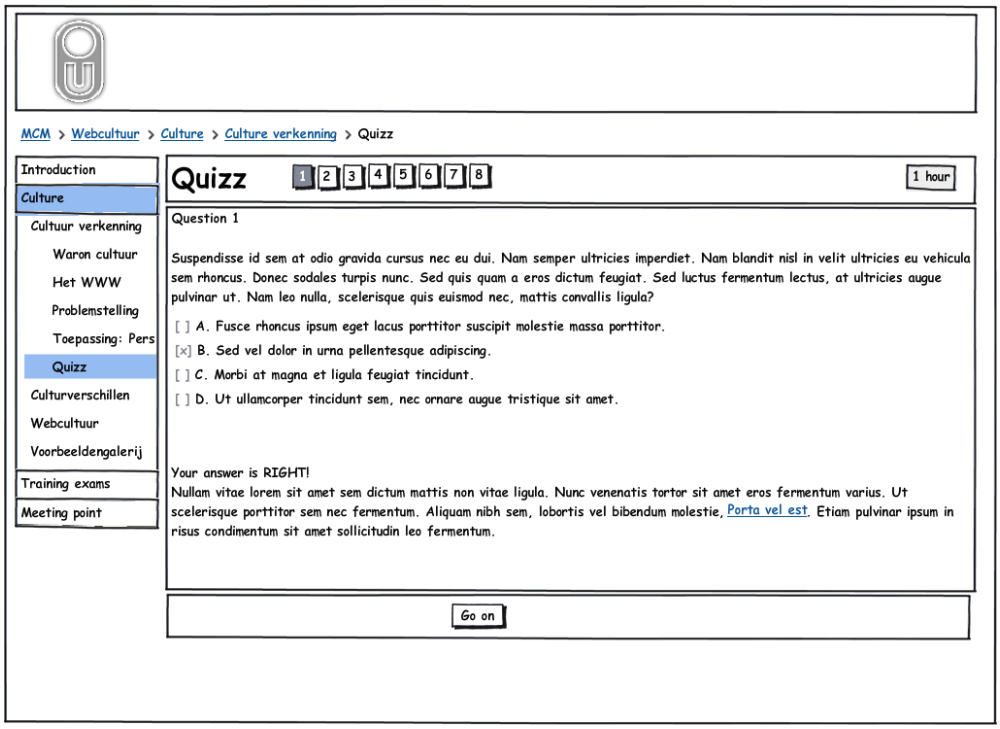

Figure 4: A quiz could be located at the end of any chapter in the course. After the student checked his choice of answer (B in this case) the system shows which answer(s) could be correct, explicitly indicating the conditions for teach answer to be correct. In addition, the system provides pointers to additional information.

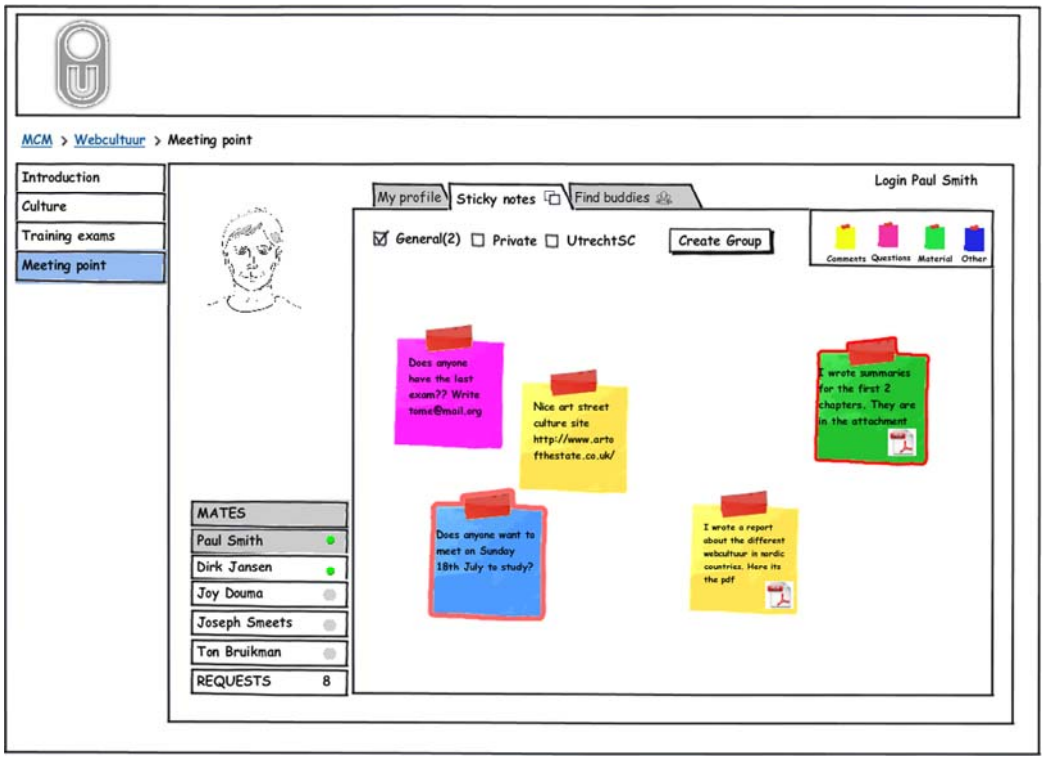

Figure 5: Whenever wanted, a student could go to the "meeting point" and choose "Sticky notes". Here the student can add color coded sticky notes indicating "comments", "questions", "material", or "other". With each new note the student can upload a PDF if needed. Also, for each new note the study should indicate whom should be allowed inspecting the note: "general" (meaning all buddies in his course group), "Private" (only the student herself), or any group the student has created (in this example there is a group "Utrecht CS"). New groups can be created by clicking on "Create Group".

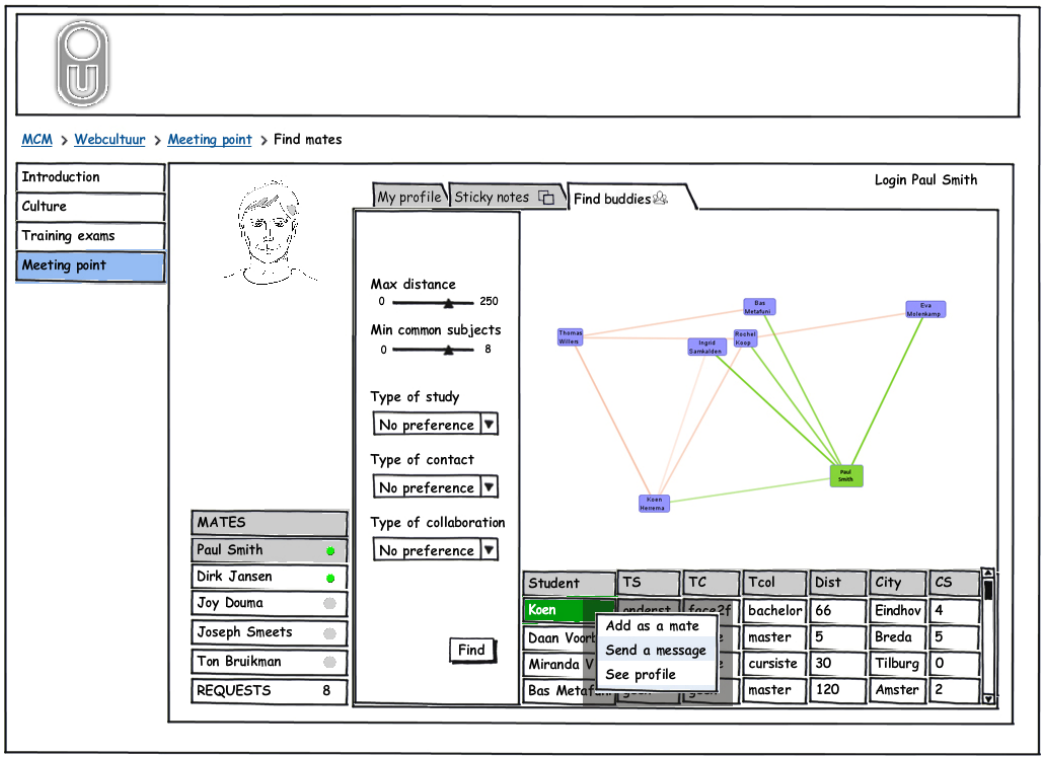

Figure 6: Another facility of "Meeting point" is "find buddies", where a student can identify members of his course group based on criteria like distance (e.g., in Miles), number of common courses or subjects, type of study (single course, Bachelor, Master), type of contact (on line, face to face), etc. The figure shows the student has just clicked "mates".

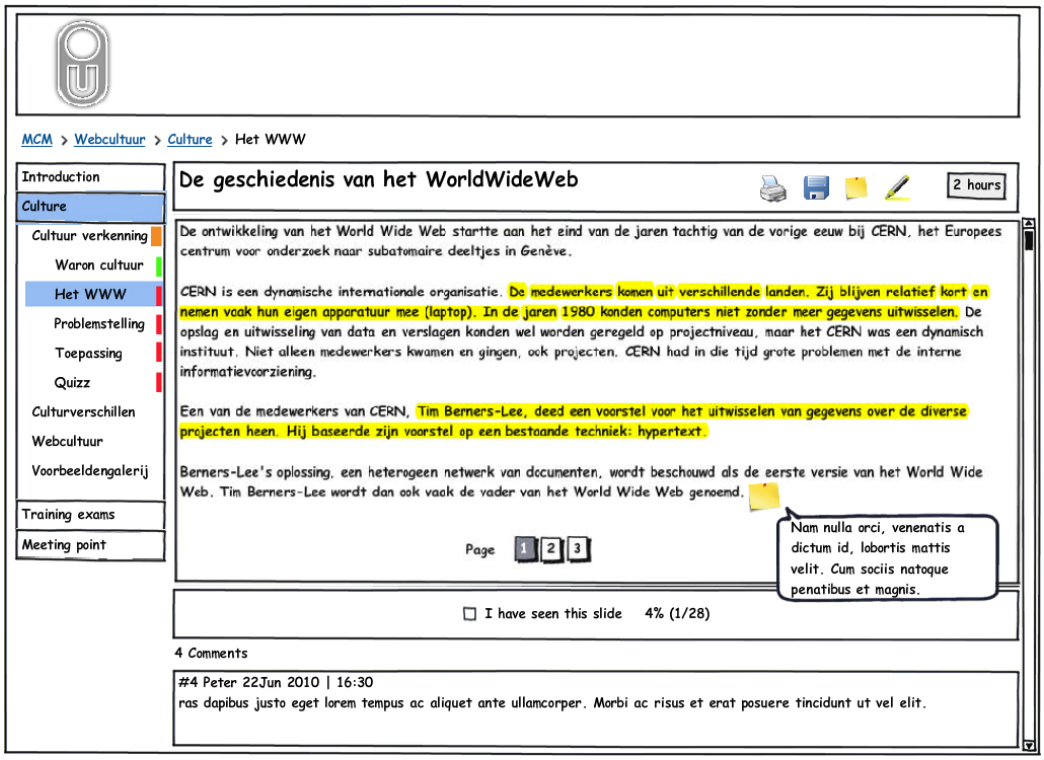

Figure 7: This example shows how a student has highlighted some parts of the content and added a comment. The student can decide to check "I have seen this slide" right under the content. In that case the indication of how much of the content of this section ("Het WWW") has been studied. In the menu on the left, for each content section a color code indicates the amount studied so far.

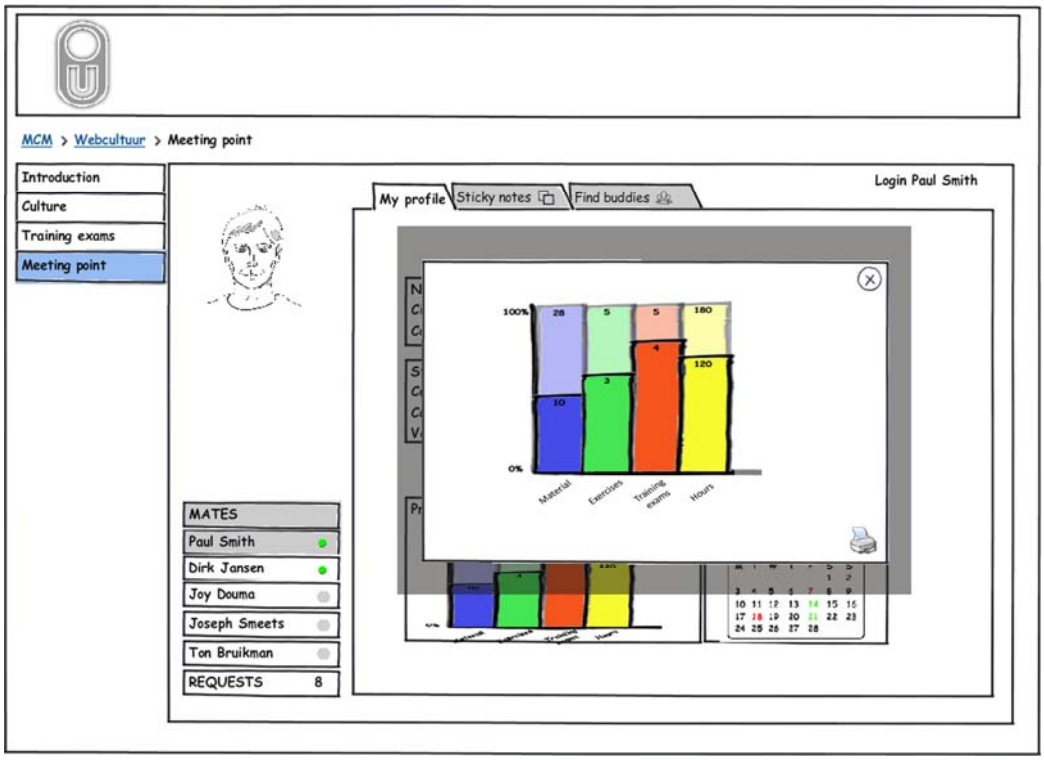

Figure 8: The Meeting point also allows students to manage "My profile". Here they are able to inspect their overall progress on Reading material, Quiz exercises, Training exams, each relative to the total amount available. In addition this overview shows the Hours spend online with the course so far in relation to estimated average number of hours needed.