

# Teaching the Next Generation of Universal Access Designers: A Case Study

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**Abstract.** This paper describes the development of the “Usability and Accessibility” course for M.Sc. students at the IT University of Copenhagen. The aim is to examine whether this course provides an effective and useful method for raising the issues around Universal Access with the designers of the future. This paper examines the results and conclusions from the students over 5 semesters of this course and provides an overview of the success of the different design and evaluation methods. The paper concludes with a discussion of the effectiveness of each of the specific methods, techniques and tools used in the course, both from design and education perspectives.

**Keywords:** usability, accessibility, universal access, education.

## 1 Introduction

It is widely accepted that there is a need to adopt user-centred [1] or user-sensitive [2] design processes when designing user interfaces. It is also widely accepted that there is a need to design for the widest possible range of users [3]. Design approaches such as Universal Design [4], Inclusive Design [5], and Countering Design Exclusion [6] have been developed as means of ensuring that user interfaces support the concept of Universal Access [7]. However, it is unusual to find any of these concepts taught explicitly within university Computer Science degree programs. Often they are taught within subjects such as Interaction Design, if at all.

This paper describes a combined Usability and Accessibility course for graduate students. It will explain how students with little to no background in either topic can gain pragmatic skills and experience in a comparatively short space of time.

## 2 The “Usability and Accessibility” Course

The purpose of the “Usability and Accessibility” course is to empower the students to be able to identify and design for the needs of the widest possible range of users once they enter the workplace. This is the future of Universal Access by doing, not solely by researching. Originally the course was called “Usability with Project,” but was re-named to reflect the actual course content more accurately in Spring 2010. The course is taught in the third semester of the 2-year M.Sc. degree within the Design and Digital Communication (DDK) line at the IT University of Copenhagen.

Students on the DDK line come from a wide variety of backgrounds. Approximately half of the students attending the course have received a traditional computer science education. The other students have had a more humanities-based education. The students are all typically mature and are either returning to education after a few years of work experience or are completing the degree as part of their on-the-job training. Almost all of the students describe their interest and motivation for taking the course as being to learn how to make websites more usable, even though websites are not explicitly mentioned in the course description.

The DDK line consists of a mix of mandatory courses and voluntary ones. The full course structure is shown in Table 1.

**Table 1.** The DDK study line for the M.Sc. degree at the IT University of Copenhagen

Semester	Courses
1 <sup>st</sup> Semester	“Interaction design” (15 ECTS) “Media and communication” (7.5 ECTS) “Web design and web communication” (7.5 ECTS)
2 <sup>nd</sup> Semester	“Innovation and concept development” (7.5 ECTS) “Introduction to coding, databases and system architecture” (7.5 ECTS) Elective 1 (7.5 ECTS) Elective 2 (7.5 ECTS)
3 <sup>rd</sup> Semester	“Digital rhetoric” (7.5 ECTS) Specialism (15 ECTS) Elective 3 (7.5 ECTS)
4 <sup>th</sup> Semester	Masters dissertation (30 ECTS)

The “Usability and Accessibility” course is a specialism option in the 3<sup>rd</sup> semester. Other choices include:

- “Digital culture and community”
- “Globalisation, organisation and communication”
- “Digital aesthetics: theory and practice”
- “Mobile communication: design-related, business-related and social context”

These are all 15 ECTS courses, constituting one-eighth of the 120 ECTS M.Sc. course and run twice every year in the Spring and Autumn (Fall) semesters.

### 3 Course Structure

The “Usability and Accessibility” course is 15 weeks long and is structured around the development of a web shop. In the first teaching session, the students are asked to interview each other and to complete a skills and interests questionnaire. Students are then placed into groups of 4 or 5 students with at least 2 experienced coders in each

group, although all students will have taken the mandatory course on Databases, which teaches the basics of PHP programming, and the course on Web Design, which teaches HTML, XML and the basics of Javascript.

Students are tasked with building a simple web-shop from scratch in the first 2 weeks of the semester. The tight deadline is specifically to emulate the time pressure in most commercial environments. No explicit usability or accessibility goals are presented. This version of the web-shop is then frozen and the students are not allowed to modify it. A copy of the web-shop is made and over the next 10 weeks of the course, usability and accessibility theory are introduced. The students develop another version of the web-shop, with explicit consideration of the usability and accessibility requirements.

Students are introduced to usability and accessibility theories in an order to support the continuing development and refinement of their web-shops. The course is expected to take 20 hours per week of student time, with 2-hour lectures and 2-hour exercise sessions twice a week (Wednesday and Friday), giving 8 hours of direct tuition per week and the remainder of the time being self-guided tuition by the students, typically work on their projects. Usually, the first morning of lectures introduces new theory. The first exercise session is focused on applying that theory in an exercise that is unrelated to the project. The second morning of lectures then examines the application of the theory and introduces further theory. The second afternoon of exercises is then focused on applying the theory to the web-shop project.

At the end of the semester, the students are asked to prepare a 10-page project report in the ACM CHI publication format [8] along with a 5 page supplementary report, which can be formatted to their own choice. They are examined on a combination of the 10-page report, a 20 minutes group presentation and 20 minutes individual oral examinations. The students were told to focus on being able to justify quantitatively whether their revised sites were more usable and accessible than their original (frozen) sites.

### **3.1 Course Participants**

In total 116 students have enrolled in the course over the 5 semesters discussed in this paper (Autumn 2008 to Autumn 2010). Between them, they have developed 48 different web-shops – 24 original (frozen) versions and 24 revised versions.

### **3.2 The Design Brief**

Once students have been placed in their groups of 4, they are given a design brief, which states that:

- The students have been hired by a fictional company to produce a web-shop within 2 weeks that offers a list of specified British products to their employees as a reward for a record-breaking year of sales.
- The web-shop is to consist of a welcome/splash page explaining the offer, a product selection page, a delivery page and an order confirmation page.
- Each employee is to either choose a single product (Autumn 2008 and Spring 2009) or is to receive between 5 and 10 stars to spend (all other semesters). All stars must be “spent” to reduce delivery costs before the order can be completed.

The students are then given a list of between 60 and 75 British products to offer on their web-shop. A number of those products are deliberately chosen to be unfamiliar to non-British people, such as mince pies and Christmas crackers. The aim is to encourage the students to learn to research products for themselves and also to ensure that their web-shops communicate the nature of the products effectively, rather than simply relying on brand and product name familiarity to the users. Between 30% and 50% of the products on the list were changed each semester both to reflect the change between Christmas and Summer holiday rewards and also to minimize the effects of designs being passed down from semester to semester.

The change from selecting a single product to spending 10 stars was made because although the newer project is more complex to code, it offers a richer interaction and thus more data to analyse in the final reports.

Having developed a working web-shop, the students then have to improve the design through the application of usability and accessibility methods.

### 3.3 Usability Methods

The students are introduced to usability methods in both increasing complexity, but also in an order that makes sense for the re-design of their web-shop.

**Card sorting.** Card sorting was used by the students to decide on the best potential clusters for their products (e.g. Sweets, Healthcare products) and also to ensure that the products were in the correct cluster

**Personas.** Personas are usually developed from a known user group and are typically used to describe particular sectors of the target users that are of specific interest to the designers. In this case, though, since the target user group was fictional, the personas were developed to represent broad user types and were used to prompt the students to consider different user patterns of behaviour in conjunction with heuristic evaluation.

**Heuristic evaluation.** The students developed specific use cases based on the personas that they had developed and then performed a heuristic evaluation to identify potential usability issues with their “frozen” sites.

**User trials.** At the end of the semester the students performed user trial evaluations of their original (frozen) and revised sites. They had to recruit a minimum of 4 (later 6) users and a user who was blind. No assistance was given in finding the blind user to encourage the students to learn where to find such users. Before conducting the final set of user trials, they also had to perform a pilot study with at least one user. The students typically used screen-recording software, such as Silverback<sup>1</sup> and Camtasia<sup>2</sup>, to record the trials. They were encouraged to collect as much quantitative data as possible.

### 3.4 Accessibility Methods

The stipulation that at least one of the users in the final user trials had to be blind meant that each group had to explicitly consider the accessibility of their web-shop. To this end, the students were introduced to common accessibility evaluation tools.

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<sup>1</sup> <http://silverbackapp.com/>

<sup>2</sup> <http://www.techsmith.com/camtasia/>

**Cynthia Says**<sup>3</sup>. The students were first asked to use HiSoftware’s Cynthia Says Portal to identify how many Web Content Authoring Guidelines (WCAG) Priority 1, 2 and 3 errors [9] their sites had. Although WCAG is commonly accepted as the default standard for web accessibility in the Universal Access community, this was the first time almost all of the students had encountered it.

**Wave**<sup>4</sup>. As many students found the Cynthia Says Portal output to be very difficult to visualise, they were asked to repeat the WCAG evaluation using WebAIM’s Wave Web Accessibility Evaluation Tool, which produces a marked up version of the web page being analysed, with red, yellow and green markers indicating the location of potential problems (the yellow and red markers) or successes (the green markers).

**Vishceck**<sup>5</sup>. About 8% of the male population is colour blind, so to check whether this presents a problem to users of their sites, the students are instructed to evaluate their sites using Vischeck. The aim is to establish whether users with Deuteranopia (red/green colour deficit), Protanopia (red/green colour deficit) or Tritanopia (blue/yellow colour deficit) would experience difficulties using their sites.

**Screen reader**. While the WCAG compliance tools such as Cynthia Says and Wave are useful in identifying basic coding issues, simply conforming to those standards does not guarantee an accessible or usable website. To check this, the students are asked to use a screen reader such as WebAnywhere<sup>6</sup> or JAWS to browse their web-shops aurally.

**Exclusion calculator**. To evaluate the potential number of users that may be excluded from using their sites, the students are asked to perform a comparative exclusion analysis using either of the exclusion calculators from the Engineering Department at the University of Cambridge<sup>7</sup>. The calculators require the students to estimate the level of functional capability required to use a product and then report the total number of people within the British population who do not possess those levels of functional capability. The aim of introducing the exclusion calculators is to indicate prevalence of impairment in the general population.

## 4 Review of the Usability and Accessibility Methods

As discussed above, the “Usability and Accessibility” course introduced the students to a number of common design and evaluation methods and tools.

### 4.1 Consideration of Usability and Accessibility

None of the groups considered accessibility in their initial designs. Where the first versions of their web-shops were accessible, this was solely due to using valid HTML

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<sup>3</sup> <http://www.cynthiasays.com/>

<sup>4</sup> <http://wave.webaim.org/>

<sup>5</sup> <http://www.vischeck.com/>

<sup>6</sup> <http://webanywhere.cs.washington.edu/>

<sup>7</sup> [http://www.eng.cam.ac.uk/inclusivedesign/index.php?section=data&page=exclusion\\_calc](http://www.eng.cam.ac.uk/inclusivedesign/index.php?section=data&page=exclusion_calc) or <http://www.inclusivedesigntoolkit.com/betterdesign/downloads/exclusioncalc.html>

coding. This is both good in that it demonstrates that accessibility can be achieved by following standards, but is also concerning that no students considered accessibility until formally instructed to do so.

Comparatively few groups considered explicit usability goals either. When they were considered, the goals were vaguely formulated often making reference to “user experience,” but with no set targets or objectives.

By the end of the course, all groups had clearly defined usability and accessibility objectives. By far the most common usability definition adopted was that from ISO 9241:11 specifically the “*extent to which a product can be used by specified users to achieve specified goals with effectiveness, efficiency and satisfaction in a specified context of use.*” [10] The most commonly adopted definition of accessibility was broadly that the site must be “*usable and accessible to a blind user using a screen reader.*” While this definition does not meet the usual definitions for Universal Access – to be as usable and accessible by as many people as possible in as many contexts of use as possible – it is a major step in the right direction.

## 4.2 Usability Methods and Tools

The card sorting exercise is useful in helping the students to consider their product groups and especially to identify products that were in the wrong product group.

The personas are not very useful in their traditional role in a user-centred design process. However, this is not surprising as they are entirely fictional and not developed in the correct way. They are useful, though, as a design tool in reminding the students that the users may exhibit a variety of browsing patterns and IT skills. The most successful strategy observed to date is a trio of personas that exhibited the following browsing patterns:

- *The quick user* – someone who wants to complete the process as quickly as possible
- *The careful user* – someone who wants to consider all of the possibilities to get the best possible value
- *The uncertain user* – someone who changes their mind frequently, might possibly visit the site multiple times before deciding and also possibly chooses products based on someone else’s recommendations

The heuristic evaluation often proves very useful in identifying many usability issues with the original (frozen) versions of the web-shops. However, this technique has also proven to be the most problematic for the students to use. In the final user trial evaluations of the original and revised web-shops, the times when the users expressed a preference for the original site can in almost all circumstances be traced back to the heuristic evaluation stage. Heuristic evaluation is known to identify many potential usability issues on a website. However, the method provides comparatively little information about the priority of each issue.

Consequently, the students often assign each issue the same priority and attempt to fix them all. In doing so, they sometimes end up with a revised site that is visually more complex than the original site through the addition of FAQs, contact addresses, more robust error-checking, etc. While the users often respond positively to the new additions to the site in terms of trustworthiness, for example, they also sometimes feel

that the flow of the interaction has become more cumbersome and less streamlined. Many of the students walk the fine line between providing a richer and more secure user experience without compromising the effectiveness of the site. Some groups, however, make their sites so complex that the user satisfaction is adversely affected.

Finally, the user trials at the end of the semester are generally regarded by the students as the most useful usability evaluation method and the user trials with the blind users are often the most interesting and personally rewarding. However, it is also accepted that user trials take much longer to perform and are more resource intensive.

### **4.3 Accessibility Methods and Tools**

The students typically find the visual presentation of WCAG violations from Wave to be extremely useful in identifying where the accessibility problems were on each page. However, the detailed analytical feedback from Cynthia Says is typically more useful in identifying where the problems lie in the coding. All groups to date have used a combination of both applications in developing the revised versions of their web-shops.

Vischeck is often harder for the students to interpret. A number of students have tried to adjust the colour schemes of their sites to still look visually appealing to themselves, while not appreciating that their colour preferences (with unimpaired colour vision) may not be the same for some with a colour vision impairment. Most students, though, use Vischeck to look for insufficient colour contrast for each of the three colour vision impairment types, which is usually more successful.

The exclusion calculators usually do not offer enough data resolution to be able to respond to the changes made between the original and revised versions of each site, with often only minor differences in exclusion reported between the two versions. This is because the limiting factors in the ability to use the web-shops are imposed by the hardware used in the interaction (the keyboard, mouse and screen) rather than the design of the web-shops themselves.

The accessibility tools that are most universally praised and used by the students are the screen readers. Trying to complete purchases using only the screen readers quickly makes it clear why the pages have to be well-structured and also why options such as “Skip to Content” are so important.

## **5 Review of the Course**

The “Usability and Accessibility” course is under constant review to keep it fresh and relevant to the students. The review process involves student feedback as well as setting new pedagogical and learning goals.

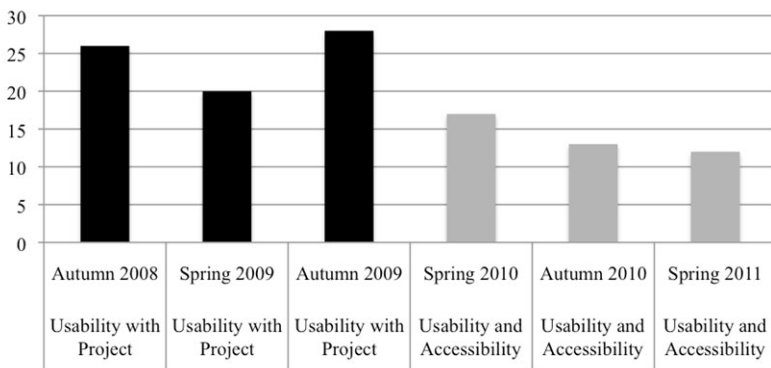
### **5.1 Student Response to the Course**

Midway through each semester, the students on the course are invited to provide anonymised feedback through an online questionnaire. Responses are rated on a Likert scale of 1 (*I completely disagree*) to 6 (*I completely agree*).

The students are very satisfied overall with the course (response mean = 4.8 out of 6.0 to the statement “*Overall conclusion: I am happy about this course*”). They also feel that the quantity of work on the course is about right (mean response = 3.4 out of 6.0 to the statement “*My time consumption for this course is above the norm of about 20 hours/week*”) and that the course is highly relevant to their future employment (response mean = 5.1 out of 6.0 to the statement “*I think this course is highly relevant for my future job profile*”). These results indicate that the students respond positively to this course. Qualitative feedback demonstrates very clearly that the students respond most positively to the very practical and applied nature of the course, with the focus on learning pragmatic skills rather than simply classroom theory.

## 5.2 Course Name and Student Enrolment

In Spring 2010, the name of the course was changed from “Usability with Project” to “Usability and Accessibility”. Figure 1 shows the student enrolment on the course before and after the name change. It can clearly be seen that the student enrolment decreased from a mean of 24.7 students to 14 students per semester with the change in name of the course. This shows that the concept of “accessibility” is still problematic in persuading students that this is a topic worthy of their attention. It is worth noting, though, that Denmark does not have a formal anti-discrimination law along the lines of the 1990 Americans with Disability Act [11] or the 1995 UK Disability Discrimination Act [12]. Thus it is not clear whether the student response to the course name change would be the same in countries where there is a clear legal imperative to consider accessibility in the design of websites.



**Fig. 1.** The number of students enrolled for each semester of the Usability with Project and the Usability and Accessibility courses

It is worth noting, though, that in their final exams the students are usually the most excited by the work that they have done with the blind users. So, it is not that they are prejudiced about the work, simply that they do not see the relevance of “accessibility” to their own careers and shows that there is still work to be done in making accessibility and Universal Access more mainstream concepts.



### 5.3 Experimental Design and Analysis Pre-course

It became clear during the first semester of the “Usability with Project” course that the students from a non-scientific background were struggling with the quantitative analysis elements of the project. It was clear, for example, that many of them had never been introduced to fundamental concepts such as probabilities and could not make the connection between a probability of 0.5 being the same as a 50% chance.

As such, a new pre-course was introduced – “Experimental Design and Analysis.” This course runs in the second semester of the degree programme and teaches basic statistics assuming no pre-knowledge. It covers basic probabilities all the way up to multivariate analysis of variance.

Since the introduction of this course, the overall quality of reports submitted for the “Usability with Project” and “Usability and Accessibility” courses improved substantially, with the students able to better understand the role of the statistical tests and spontaneously performing Kolmogorov-Smirnov or Q-Q plot analyses to ensure that the data is normally-distributed before applying a paired Student *t*-test or ANOVA. If the data is not normally-distributed, they usually perform a Wilcoxon signed-rank test.

This is remarkable in students that have often had no statistical training prior to the “Experimental Design and Analysis” course. Since the introduction of that course, no students have lost marks because of incorrect statistical analyses in their projects.

## 6 Conclusions

Overall, the “Usability and Accessibility” course provides a model for teaching both usability and accessibility theory and practice within the later stages of a Bachelor programme or in a Masters programme. It shows that students from a wide variety of backgrounds can respond positively to the challenges presented by this course. The student response is overwhelmingly positive to the course.

However, there is still room for concern over the tailing off of the number of students enrolling in the course since the name change and this suggests that “accessibility,” and thus Universal Access, is still widely perceived as a niche interest rather than a mainstream activity within the student community. Since the students on the DDK course are mature students and have experience in industry before enrolling in the programme, this suggest that this attitude is also widespread in Danish industry. This is clearly a challenge that needs to be met.

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