Fundación ONCE

UNIVERSITAT POLITÈCNICA DE CATALUNYA
BARCELONATECH
Accessibility Chair

JACCES

JOURNAL OF ACCESSIBILITY AND DESIGN FOR ALL

Volume 5 - nº1 (2015)

www.jacces.org

DOI: 10.17411/jacces.v5i1

Journal of Accessibility and Design for All

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www.jacces.org

ISSN: 2013-7087

EDITOR'S LETTER

This volume 5, number 1 is composed of three articles where the researchers explain their findings of accessibility in the fields of engineering and education.

First investigation contributes to a better understanding of how users with motor and dexterity impairments confront accessibility barriers when are accessing to websites. Thanks to user tests researchers have analysed user's mood about different accessibility barriers comparing accessible and non-accessible webpages.

The second study evaluates which are the benefits of captioned online courses among American, international, and deaf or hard of hearing students from two California universities. Research conclusion was that captioned online courses provide benefits for all users and indicate the possibility of expanding them as Universal Design model for postsecondary educational institutions.

The last article describes an intensive design exercise conducted in a graduate course on Universal Design with professional architects as students. They developed a design project for a public-service center. The goal of the Charrette was to understand the effectiveness of this type of teaching method to increase the designers' sensitivity toward Universal Design issues and gain knowledge on participatory processes. The Charrette involved potential users with various disabilities who evaluated the design.

What all these papers have in common is the importance of taking into account diverse user experience to achieve a more accessible world.

We hope this number has an interesting and stimulating reading for all our readers.

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Editorial

Articles

Journal of Accessibility and Design for All

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IMPACT OF ACCESSIBILITY BARRIERS ON THE MOOD OF USERS WITH MOTOR AND DEXTERITY IMPAIRMENTS

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Received: 2014-10-03 | Accepted: 2015-05-13| Published: 2015-05-25

Abstract: With the aim of knowing the impact of accessibility problems on persons with motor impairments, we did a user test with this user group. The focus of the test was the analysis of this collective user's mood relative to different accessibility barriers comparing two parallel web pages: one accessible and another non-accessible. The study identified web forms and Flash elements as the most important aspects for this kind of users. On one hand these elements are useful to users, meanwhile, on the other, they raise many accessibility issues. The analysis of results indicates that persons who use assistive technologies are more efficient and effective interacting with web pages, than users who do not use them independently of the severity of their disability.

Overall, users had a positive mood while navigating the accessible website, and were more negative when interacting with the non-accessible website. Our investigation contributes to a better understanding of users with motor impairments confronting accessibility barriers.

Keywords: web accessibility barriers, motor impairments, user mood, user test, users with disabilities, real-world data collection.

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Introduction

Nowadays, a large number of websites present accessibility barriers and people with disabilities have difficulties accessing the contents. Different studies show that one fifth of the working age population has a disability and almost 60% of the population would be likely to benefit from web accessibility [62][13]. Some studies have discussed that there is a high variability regarding the accessibility level of Web pages and that few pages reach a high accessibility level [34][33]. Taking this into account, web content usability and web content accessibility deserve special attention in order to improve the quality of websites. An interactive system is more usable as it is easy to learn, understand and use under context-specific conditions [24]. We will use classical user tests [38] evaluation method, which take into account efficiency, efficacy and satisfaction as attributes conforming usability [25], in our research with people with disabilities (PWD). Web accessibility means that PWD and older people can perceive, understand, navigate, interact and contribute to the Web [22].

This article evaluates the mood of a group of users with motor disabilities while they interact with two websites (A-site, an accessible website, and NA-site, a non-accessible website). The final objective is to measure the severity of different accessibility barriers through this group of users' moods when confronted with them. In the framework of our research collected data will be used to communicate accessibility errors to non-technical web content authors in an empathetic way [42]. Web authors will confront persona characters depicting a negative mood when they fail to create accessible content and get the characters mood changed when they repair problems [43]. The failure of legal requirements to date suggests that other means should be considered in transmitting accessibility criteria, and the authors believe it will be easier to get an attitude change by means of empathy with final users. Other articles have suggested similar reasoning [11][49][52].

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Related work

Web Content Accessibility Guidelines (from now on, WCAG) [10][12][28], published by the World Wide Web Consortium are commonly used to evaluate the accessibility of websites. To avoid fragmentation they have been repurposed as an ISO standard [26]. Their adoption as a unique method to evaluate accessibility has raised much criticism [46][21][45].

The term "accessibility barrier" refers to any obstacles that make it difficult or impossible for people with disabilities to achieve a goal while they are using an interactive system (in our case, when they are navigating a website) using specific assistive technology [8]. A site without barriers will offer better usability, and will increase people's self-determination and autonomy, two key aspects of their welfare and quality of life [50]. Cited by WebAIM experts as the main accessibility barriers to people with motor impairments are small clickable elements, mouse-dependent actions, and time constraints in user answers [56]. Common assistive technologies (from now on, AT) used by this collective are alternative keyboards, pointing devices, eye-tracking equipment, voice-recognition software and screen scanning options. Some authors have observed that users with motor impairments are forced to do complex movements with standard mouse devices, while they do better with trackball devices. These authors observed also that the use of speech-recognition software presents its own problems, sometimes worse than the problems presented by the content itself [60][24].

Some authors in the accessibility field, such as Lazar [30][31][32], have thoroughly studied the effects of accessibility barriers on websites and desktop applications. Other researchers derive the needs of users with disabilities from user test results [45][23][53]. However, no studies have analyzed the mood of users with motor disabilities while confronting barriers while browsing the web.

Emotions can be classified into three continuous dimensions [44] valence, which takes values from nice to nasty; activation, going from calm to excited; and power, characterized by strong and weak ends. Primary

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emotions have positive (joy, happiness ...) or negative (anger, fear, sadness ...) valence and, depending to the emotion's intensity, its activation degree will go from "calm" (boring) to "excited" (tense).

There exist several techniques for measuring emotions classified into objective and subjective techniques. The objective techniques are mainly designed to analyze the bodily changes of a person, by means of studying facial expressions or measuring reactions of the human body, such as heartbeat or dilated pupil. According to James-Lange theory [56], different emotions produce changes in the body that cannot be controlled.

The subjective techniques measure the moods of a user through questionnaires, interviews and self-report. They provide information about user experience when performing a specific task. Nevertheless, they are based on a subjective perception and the result may be biased by the user own interests and desires. Related with this technique, we find two different types of self-reports: verbal and non-verbal. In verbal reports the participant use words to indicate the perceived mood, as for example in [57] and [48]. In non-verbal reports, a set of images representing the variety of moods are shown to the users, whom only have to point out which image represents the particular perceived mood, as for example in [28][15][16][14]. Because this last option is easier, in our study we have chosen a subjective technique based on non-verbal language.

In fact, this document presents the results of phase 3 of a more complete research divided into four phases, each involving the same websites being evaluated by users with different disabilities: cognitive (phase 1) [41], impaired sight (phase 2) [40], motor (this article, phase 3) and impaired hearing [39] (phase 4). Phase 2 showed very mild emotional responses to common visual accessibility pitfalls, while phase 1 the importance of readability of texts. Phase 4 is still ongoing at the moment of writing.

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Study Context

The purpose of the study was to analyze how an accessibility barrier could influence motor impaired user groups, and try to learn the emotional effects of such difficulties on users, in order to communicate them to content authors.

Experiment configuration

Two sites were created for the experiment: An accessible-site (A-site) [4] and a non-accessible website (NA-site) [37]. Wordpress Content Management System (CMS) [61] was used to develop them. Each site contained touristic information of a city, divided into four html pages: the city, monuments, accommodation, contact.

To grant maximum accessibility in the A-site, we follow the methodology proposed by López [35]: use an accessible template [54] and [1]; review generated code in HTML view; use of plugins such as CCPlayer plugin [9] to enable video accessibility and AAP plugin [2] to enable audio accessibility.

In the NA-Site we use the standard Wordpress configuration: use of a standard template (Twenty Twelve), code generated by the web editor, and without installing any additional plugin. Moreover, several accessibility barriers were created intentionally.

We verified both sites' accessibility following the suggested W3C methodology [55]. This included an automatic evaluation with two online tools: TAW [51] and eXaminator [18], and a human revision with the support of the Firefox Web Developer toolbar [19] and WAT [59] on IExplorer.

A-site does not present any accessibility problem, while NA-site presents problems related to content, template and HTML and CSS code. Table 1 details the content characteristics of each site and the WCAG 2.0 accessibility problems affecting the NA-site.

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Table 1. List of web elements and WCAG 2.0 success criteria with errors. (Pages: All–All pages, 1–The city; 2–Monuments; 3–Accommodation; 4–Contact)

Pages	NA-Site	A-Site
All	No web map (2.4.5) Page without titles (2.4.2) Skip links not implemented (2.4.1) No page headings (1.3.1, 2.4.10) No visible focus (2.4.7, 2.1.2) Source HTML not validated (4.1.1, 4.1.2) Keyboard non-operable (2.1.1, 2.1.2)	Web map Pages with appropriate titles Skip links implemented Page headings Visible focus Correct spacing Source HTML and CSS validate Access to functionality with Keyboard
1	Audio player non-accessible (2.1.2) Video player non-accessible (2.1.2) Video without subtitles and audio description (1.2.1, 1.2.2, 1.2.3, 1.2.5) Google Maps standard (1.1.1, 2.1.2)	Accessible Audio Player (AAP) Accessible Video player (CCPlayer) Video with subtitles and audio description Google maps with accessible features
2	Generics links (2.4.4, 2.4.9) Table layout (1.3.2, 1.3.1) Skip links not implemented (2.4.1) Link opens a new window (3.2.1, 3.2.5) Links/buttons that are too small	Informative text on links Layout without tables Skip links implemented Link opens the same windows Links/buttons cover a sufficiently large clickable area
3	Links/buttons that are too small	Links/buttons cover a sufficiently large clickable area
4	Form controls (1.3.1, 4.1.2, 2.4.6) Form with information (3.3.1, 3.3.2) Image of button without contrast (1.1.1, 1.2.1, 1.2.9, 1.3.1, 1.3.2, 1.4.1, 1.4.4, 1.4.5, 2.4.7, 1.4.8 and 1.4.9) Order focus (2.4.3)	Form controls identified Image of button with contrast Focus without order

Participants

Eight participants took part in the experiment and it was carried out from June to October 2013. Five out of eight users had a spinal cord Injury, one of them had multiple sclerosis which caused him fatigue after tasks of long duration, one interacted with only three fingers (thumb, index and ring) of the left hand, and the last one had cerebral palsy, with a mild cognitive disability that was not relevant to the fulfillment of tasks. This one was the only person with a disability from birth, while the others had become disabled as adults. The users belong to several organizations: ASPID [3], ATADES [5] and Virgen del Pilar [6]

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In the users with a spinal cord Injury, there were different degrees of severity in how their upper limbs were affected: two users with very low mobility in hands with stiff fingers were able to use a standard mouse and keyboards with difficulties; two users had almost no mobility in hands (they only could move one or two fingers) and used a special mouse with TrackBall and an onscreen keyboard; finally one user had mobility only with her head and used speech-recognition software as the means of interaction. The user with cerebral palsy used the onscreen keyboard and a joystick. The user with multiple sclerosis and the user who could only move his left hand used a standard mouse and keyboards. All users had more than five years' experience with their AT. Table 2 summarizes these details.

Table 2. User characteristics in the case studies.

Id	Sex	Health Condition	Schooling	Functional	Device
U1	M	Multiple sclerosis	High school	NO AT	Standard Mouse and Keyboard
U2	W	Only three fingers of left hand	High school	NO AT	Standard Mouse and Keyboard
U3	W	Spinal Cord Injury (hands low mobility)	University degree	NO AT	Standard Mouse and Keyboard
U4	W	Spinal Cord Injury (hands low mobility)	Elementary school	NO AT	Standard Mouse and Keyboard
U5	M	Cerebral Palsy	Elementary school	AT	Joystick and on screen keyboard
U6	M	Spinal Cord Injury (hands low mobility)	High school	AT	TrackBall and on screen keyboard
U7	M	Spinal Cord Injury (hands low mobility)	University degree	AT	TrackBall and on screen keyboard
U8	W	Spinal Cord Injury (Only head movement)	University degree	AT	Speech recognition software

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Equipment and software

A personal computer with Windows 7 Operating System (Service Pack 3), standard keyboard and 2-button mouse with scroll wheel was used. Each task was recorded with Morae software, version 3.1 [36], and we used a webcam to record gestures and comments of users.

Following BS8878:2010 [7] we grouped the users according to their AT profile, so we differentiate participants which did not adapt any feature of the computer and participants who used their own ATs (Joystick or Oversized TrackBall mouse) and set the operating system on-screen keyboard. Due to the low number of users we included also in this later group the user needing speech recognition software. The exact speech recognition software used was Dragon NaturallySpeaking [17] with the MouseGrid option, which creates a numbered grid on the screen whose cells can be reached just saying its number.

Methodology

We followed the step-by-step approach to usability testing from Rubin [47] and Nielsen [38]. All user tests were carried out in the laboratory UsabiliLAB [20] (GRIHO research group's usability laboratory). The tasks were adapted focusing on barriers affecting users with motor impairments (see Table 3).

We measured efficiency, effectiveness and perceived difficulty, in addition to the user's mood, which was selected with the aid of emoticards [14].

Before the tasks, a pre-test questionnaire (see annex 1) was administered related to past experiences with web accessibility barriers. During the task time and task fulfillment were recorded. At the end of the whole test, a post-test questionnaire (see annex 2) was administered with questions that paralleled the pre-test questionnaire complemented with perceived difficulty of tasks, but related to the current experience. The average time spent on each test was 30 minutes in the case of users with no specific AT usage and 45 minutes in the case of users using personalized AT. In the test

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every user did task 1 to task 7 on A-site and also on NA-site. Tests were balanced across users, and tasks were randomly ordered to avoid learning or fatigue effects.

Table 3. List of tasks evaluated according to the profile of each participant.(Pages: 1–The city; 2–Monuments; 3–Accommodation; 4–Contact)

Task	Description	Page	Barriers
T1	Looking up a map	1	Opaque objects Keyboard Trap
T2	Playing a video file	1	Opaque objects Keyboard Trap
T3	Playing an audio file	1	Opaque objects Keyboard Trap
T4	Looking up a monument address	2	Internal links are missing Skip links not implemented
T5	Accessing links for more information	2	New Windows Links/Buttons that are too small
T6	Booking a room	3	Links/buttons that are too small
T7	Fill-in and Sending a form	4	Forms with no LABEL tags Links/Buttons that are too close to each other Links/Buttons that are too small

Results

Test results are detailed in the next sections: first we introduce the mood of the users from the pre-test followed by the efficiency, effectiveness and perceived difficulty during task execution, together with mood measurement. Finally, we describe the mood of users in the post-test questionnaire.

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Pre-test

On the pre-test, participants were asked about their user profiles and their moods on previous experiences interacting with either accessible or non-accessible websites. Figure 1 and Figure 2 show that all participants affirmed having a negative mood when they visited websites with accessibility problems (Figure 1), and a more positive mood when they interacted with websites without accessibility problems (Figure 2).

Figure 1. Emotional evaluation in pre-test questionnaire. (a) Non-Accessible website. Question: "How do you feel when you face a non-accessible website?" Source: Prepared by the authors.

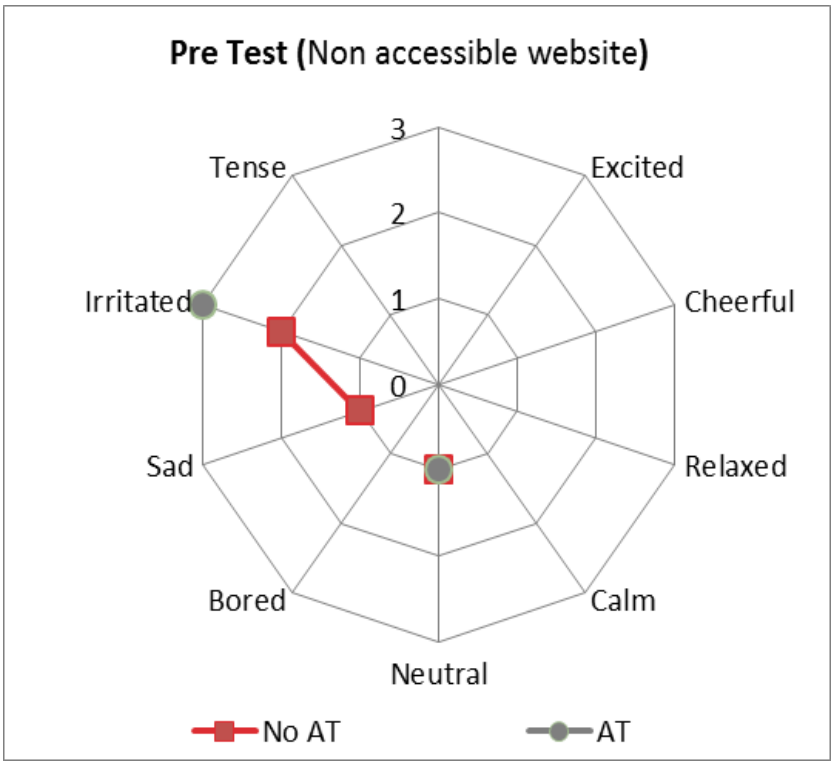

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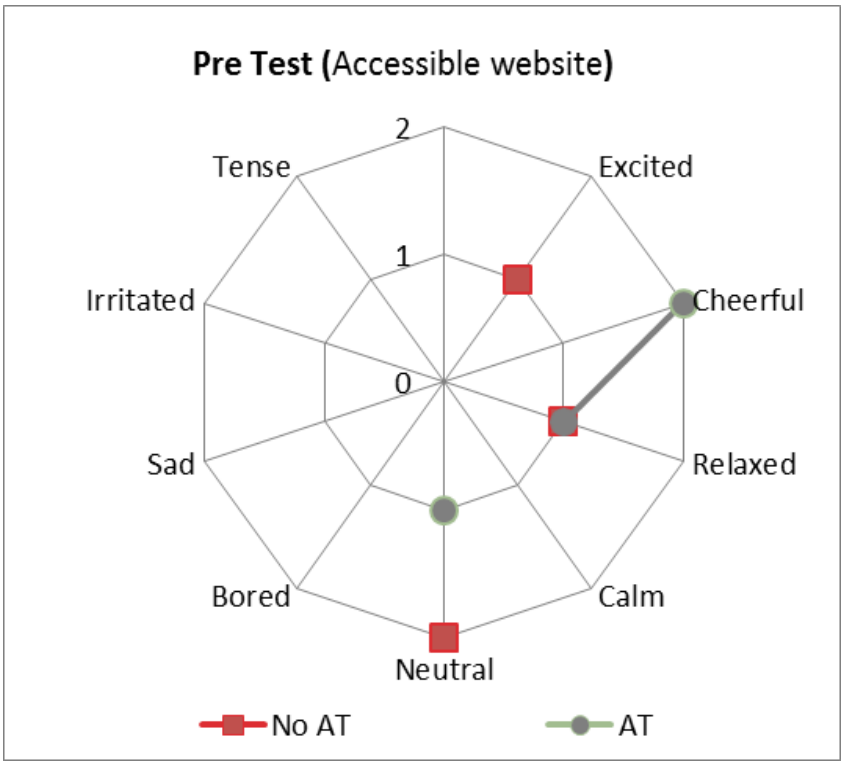
Figure 2. Emotional evaluation in pre-test questionnaire. (b) Accessible website. Question: "How do you feel when you face an accessible website?" Source: Prepared by the authors.



Efficiency

Efficiency was measured by the task completion time. Table 4 shows the average duration measured in minutes that each group of participants needed to perform each task. Although the 'thinking aloud' protocol was used during the test and the time should be considered with caution, the results provide enough information for comparison between the two websites. As can be seen in the "Total" column in Table 4, all users required less time (between 3-4 minutes) to perform the same set of tasks in the A-site than in the NA-site.

Users using specific ATs were quicker in task resolution in both webs than users with no specific settings, even when the severity of the disability was more severe in average in the first group.

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Table 4. Average task duration (in minutes).

Task	AT USER A-site	AT USER NA-site	NO AT USER A-site	NO AT USER NA-site	ALL USERS A-site	ALL USERS NA-site
T1	0,73	3,31	1,3	2,97	0,97	3,14
T2	1,01	0,42	0,46	0,67	0,68	0,53
T3	0,64	0,51	0,36	0,6	0,48	0,55
T4	0,33	0,34	0,32	0,6	0,32	0,45
T5	0,08	1,37	0,24	0,96	0,14	1,15
T6	1,97	1,46	3,97	5,2	2,80	2,76
T7	1,72	2,1	2,07	1,89	1,89	1,99
Total /average	6,48	9,51	8,7	12,88	7,28	11,07

Effectiveness

Effectiveness was counted as 1 if the task was completed, and as 0 otherwise. If 3 out of 4 users were able to complete the task, the final result was 75%. As expected, better results are observed on the A-site than on the NA-site. (See Table 5).

All users were able to successfully complete the proposed tasks, although interaction with maps, links and forms caused them several difficulties. In task 1, related to accessing an interactive map (similar to a Google maps), users had difficulties moving around and interacting with the different elements of the map. On the other hand, in A-site, with a keyboard-friendly map, users did not experiment difficulties. Task 5, consisting of accessing an external link, caused similar difficulties to all users, and initially we thought it was due to the size of the links, which was very small or to their target, which was a new window. A later review of the recordings showed that the difficulty was related to a usability problem, as it was difficult to differentiate and to visualize which text elements were links. In task 7, related to filling in and sending a form, only the user working with voice

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recognition software had difficulties in correctly writing within the form fields. This task did not present particular problems for the rest of the users.

Table 5. Percentage of users who completed the tasks.

Task	AT USER A-site	AT USER NA-site	NO AT USER A-site	NO AT USER NA-site	ALL USERS A-site	ALL USERS NA-site
T1	100%	50%	75%	100%	87%	71%
T2	100%	100%	100%	100%	100%	100%
T3	100%	100%	100%	100%	100%	100%
T4	100%	100%	100%	100%	100%	100%
T5	100%	50%	100%	75%	100%	61%
T6	100%	100%	100%	100%	100%	100%
T7	100%	50%	100%	100%	100%	71%
Total /average	**100%**	**74%**	**96%**	**96%**	**98%**	**84%**

Perceived difficulty

As the measure of mood is parallel to perceived difficulty we restrict the evaluation of this indicator to the perceived difficulty of interaction on a Likert scale. At the end of each task the participant should value it according to his/her perception as Impossible (0), Very difficult (1), Difficult (2), Easy (3) or Very easy (4).

Results are displayed in Table 6. Moreover, as expected, there is a clear correlation between the results in Tables 5 and 6.

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Table 6. Average perceived difficulty. 0–Impossible; 1–Very difficult; 2–Difficult; 3–Easy; 4–Very easy.

Task	AT USER A-site	AT USER NA-site	NO AT USER A-site	NO AT USER NA-site	ALL USERS A-site	ALL USERS NA-site
T1	3,7	2,5	3,2	4,25	3,44	3,26
T2	3,7	3,5	3	2,2	3,33	2,77
T3	3,2	3,2	3	2,7	3,10	2,94
T4	4	3,7	3,7	3,5	3,85	3,60
T5	4	2,5	3,7	2,5	3,85	2,50
T6	3,7	3,7	3,5	3,5	3,60	3,60
T7	4	3,2	3	3	3,46	3,10
Total /average	**3,75**	**3,15**	**3,29**	**3,03**	**3,51**	**3,09**

User's mood

User's mood was measured through an emoticard selection question [14]. Nine emoticards associated with different moods were shown: 1.Excited, 2.Cheerful, 3.Relaxed, 4.Calm, 5.Neutral 6.Bored, 7.Sad, 8.Irritated, 9.Tense.

Underneath we present the results of users' mood selection organized by accessibility barrier. In this case, the test was planned to obtain the user's mood grouped into three groups of tasks (T1, T2, T3), (T4, T5) and (T6, T7). The grouping of tasks was based on accessibility barriers:

Tasks 1, 2 and 3: Opaque objects and keyboard trap,

Tasks 4 and 5: Internal links are missing, Skip links not implemented and New windows, and

Tasks 6 and 7: Forms with no LABEL tags, Links/buttons that are too close to each other and that are too small.

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We proceeded like this because we found very difficult (if not impossible) to discriminate each barrier alone to obtain rich data to be analyzed.

As the selection was administrated as a post-task questionnaire, sometimes it was not possible to uniquely differentiate each barrier. Next paragraphs analyze every group tasks.

Opaque objects and keyboard Trap

These barriers were evaluated in three different tasks: T1. Looking up a map, T2. Playing a video file and T3. Playing an audio file. In all cases, we used Flash components to show information on an interactive map, a video and an audio. In general, all users were able to complete the task and showed a neutral mood on the non-accessible page, with a more positive mood in the accessible page. (See tasks 1, 2 and 3 on Table 7).

Internal links are missing, Skip links not implemented and New windows

These barriers were evaluated in two different tasks: T4–Looking up a monument address, and T5–Accessing links for more information. None of them caused severe difficulties with links, and the users' moods were quite positive in both cases. (See tasks 4 and 5 on Table 7).

Forms with no LABEL tags, links/buttons that are too close to each other and that are too small

These barriers were evaluated in two different tasks: T6–Booking a room and T7–Filling in and sending a form. All users were able to complete the tasks without critical difficulties, although results show differences in execution time within the different tested groups. The user interacting with speech recognition software had the most significant difficulties while executing the tasks. In general user mood was positive (See tasks 6 and 7 on Table 7).

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Table 7. Autoevaluation of user's mood.

Task	AT USER A-site	AT USER NA-site	NO AT USER A-site	NO AT USER NA-site
T1 **T2** **T3**	Excited (1) Calm (2) Neutral (1)	Neutral (4)	Cheerful (1) Relaxed (1) Neutral (2)	Calm (1) Neutral (2) Bored (1)
T4 **T5**	Excited (1) Relaxed (1) Calm (2)	Relaxed (1) Calm (2) Neutral (1)	Cheerful (1) Relaxed (1) Calm (1) Neutral (1)	Relaxed (2) Neutral (1) Bored (1)
T6 **T7**	Cheerful (1) Relaxed (1) Calm (1) Neutral (1)	Cheerful (1) Calm (2) Neutral (1)	Cheerful (1) Relaxed (1) Calm (1) Neutral (1)	Relaxed (1) Calm (1) Neutral (2)

Post-test results

After testing both websites, users were asked again about their mood while interacting with accessibility barriers, in order to compare them with reported moods from the pre-test. Figure 3 and Figure 4 show that all participants tended toward a neutral or calmed mood when they had visited websites with accessibility problems (Figure 3), while they stated having experienced more negative moods with inaccessibility and more positive moods interacting with websites without accessibility problems (Figure 4). This difference could be related to critical incident technique because users tend to remind worst case scenarios.

In both questionnaires (pre- and post-test) the accessible page caused more positive results. Also in neither of them did any user report a very negative mood (sad, irritated or tense).

As the objective was to gather a first impression of the mood no further statistical analysis were done.

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Figure 3. Mood's evaluation in post-test questionnaire. (a) Non-accessible website. Source: Prepared by the authors.

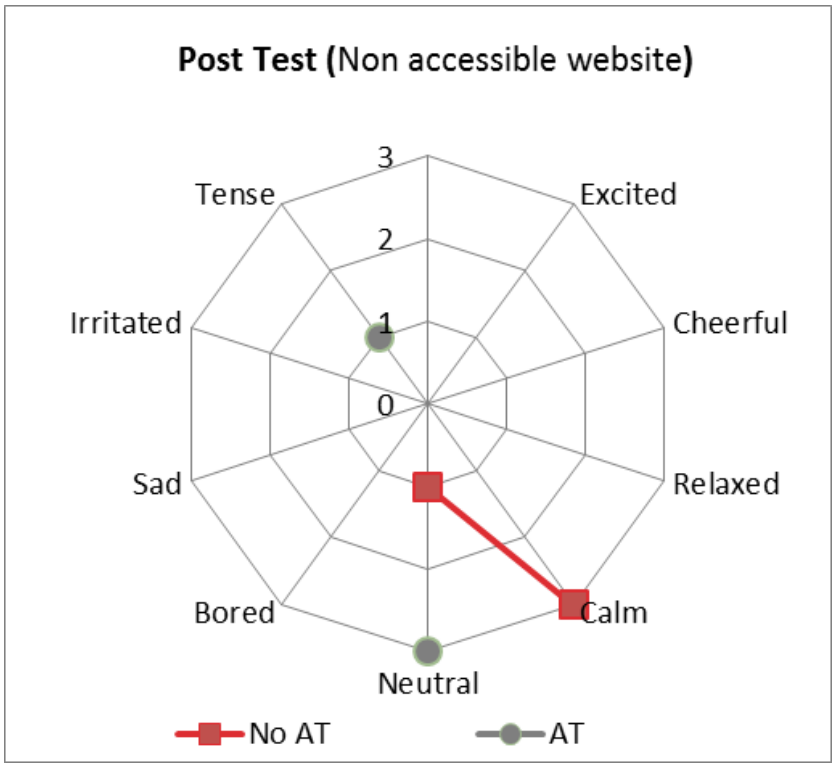
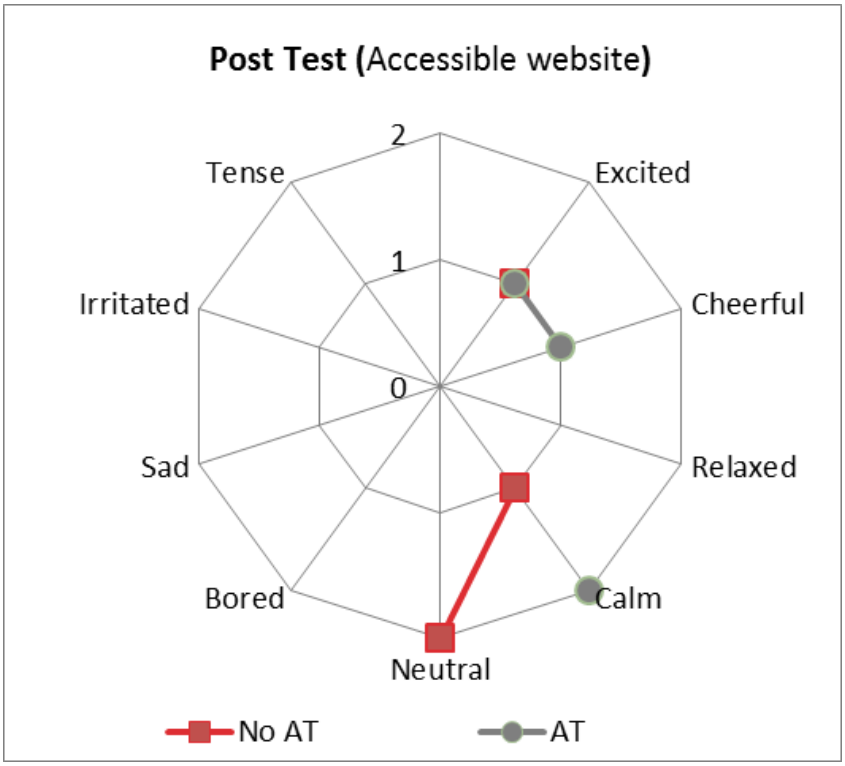


Figure 4. Mood's evaluation in post-test questionnaire. (b) Accessible website. Source: Prepared by the authors.



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Taking into account that the users' reported moods were not very intense, perhaps in order to communicate the need for accessibility to web authors, the message should be reinforced through the missed opportunities of users, such as "I could be cheerful and excited after visiting your web, but due to the difficulties I experience with (this barrier), I'm just neutral".

Conclusions

The purpose of the study was to analyze how some accessibility barriers could influence users with motor and dexterity impairments, and try to learn the effects of such difficulties on users' mood. This fits a bigger research framework and these results will be used to communicate these moods to content authors through persona characters. The study was done on a small-size sample of users, eight persons in total.

In reference to the users' mood results, in both tests more positive moods were registered in the accessible page, but in general, moods were not as negative as previously stated by participants in the pre-test questionnaire. A possible explanation for this change is, as previously said, the worst case memory. The habit of confronting different degrees of accessibility could have reduced their reaction to adverse experiences in web navigation, while softening their bad reactions. Another possible motivation is that in a lab setting with observers, due to social desirability, users tend to increase their emotional control in disadvantageous conditions [27].

The study has identified opaque objects and keyboard traps elements as the most important web elements affecting people with motor disabilities. Form elements negatively affect completion time and caused particular problems tot the user interacting with voice-recognition software. Those are the aspects related to motor disabilities that shall be communicated to content authors.

In the test we observed that users using specific AT (joystick, trackball, and screen keyboard, i.e. assistive technologies customized to their particular needs), often with severe impairments, got better results in all the usability

measures than users without any customization in the computer, even when some had mild motor disabilities. This is consistent with previous research findings [60] that stated that users with a common mouse require some combination of more complex movements than those using a trackball.

Acknowledgments

This research has been supported by the Spanish Ministry of Science and Innovation through the User Experience research project 'InDAGuS-UX: Towards the sustainable development of open government data infrastructures with geospatial features' (TIN2012-37826-C02-02), by the University of Lleida through the pre-doctoral fellowship of Afra Pascual, by the Official Agreement between the University of Lleida and ACTIVA MÚTUA 2008 to develop technologies and projects that enable the adaptation and reintegration of people with disabilities in the field of ICT. We would like to thank all of the people who participated in the survey and user tests.

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Annex 1. Pre-test survey

Pre-test survey was organized in various question groups:

A. Questions related to user profile: 1. Genre; 2. Age; 3.Schooling; 4.Current job; 5. Diagnosis

B. Questions related to web access of disability person: 1. Which device do they use; 2.Computer configuration; 3. Mobile configuration

C. Questions related to kind of use: 1.Time of use of assistive technology; 2.Frequency of computer use; 3.Usual tasks; 4.Web services used.

D. Questions related to accessibility barriers: 1.Assessment of difficulty of content access; 2.Accessibility barriers related with different web elements; 3.Assessment of the user's mood when navigating a web page without accessibility problems: □ Excited □ Cheerful □ Relaxed □ Calm □ Neutral. 4.

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Assessment of the user's when navigating a web page with accessibility problems: □ Neutral □ Bored □ Sad □ Irritated □ Tens

Annex 2. Post-test survey

Post-test survey was organized in a list of question:

1. Which web page seems to be more accessible?

□ Ávila □ Salamanca

2. What elements should you change of Avila web page to be more accessible? _____

3. What elements should you change of Salamanca web page to be more accessible? _____

4. Please, express your mood when you have been using Avila web page

□ Excited □ Cheerful □ Relaxed □ Calm □ Neutral □ Bored □ Sad □ Irritated □ Tense

5. Please, express your mood when you have been using Salamanca web page

□ Excited □ Cheerful □ Relaxed □ Calm □ Neutral □ Bored □ Sad □ Irritated □ Tense

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BENEFIT COMPARISON OF CAPTIONED ONLINE COURSES FOR AMERICAN, INTERNATIONAL, AND DEAF/HARD OF HEARING STUDENTS: FROM THE VIEWPOINT OF INDIVIDUAL VALUE AND TOTAL VALUE

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Received: 2014-09-09 | Accepted: 2014-12-05| Published: 2015-05-25

***Abstract*:** This study evaluated benefits toward Captioned Online Courses (COC) among American, International, and Deaf/Hard of Hearing (DHH) students from two California universities. As a result, COC were not just viewed as accommodations for DHH students, but also as providing benefits for American and International students. Study results indicated that international students showed higher individual value for COC than the other groups. American students had the smallest individual value but presented the larger total value toward COC than the other groups due to their comprising the largest population at both universities. The aggregate total value for all groups was approximately $2,000,000.00, which would represent the cost of conducting 370 classes at the lowest price of $2.00 per minute. These results indicate the possibility of expanding future COC as Universal Design model for postsecondary educational institutions.

Keywords: Universal design; captioned online courses; English as second language learners; deaf and hard of hearing; contingent valuation; economic value.

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Introduction

Statement of the Problem

The development of Information Technology has influenced Deaf and Hard of Hearing (DHH) people's social environment, even as DHH people have experienced a lack of access to voice information and communication (Shinohara & Wobbrock, 2011). Information Technology improvements, including cochlear implants, hearing aids, videophones, relay services and other technologies, have changed DHH people's lifestyles, while also producing a new issue; the lack of accessibility of electronic resources (Burgstahler, 2002; Hilzensauer, 2008). Human rights laws for people with disabilities, such as Section 508 of the U.S. Rehabilitation Act (U.S. Department of Education, 2013), and the Web Content Accessibility Guideline (WCAG) 2.0 (W3C, 2012), require accessibility services for electronic resources, such as adding captions to online videos. Section 508 of the U.S. Rehabilitation Act requires to access to electronic resources at federal educational institutions (U.S. Department of Education, 2013), while WCAG 2.0, an international guideline for federal and private educational intuitions regarding access to electronic resources for reference purposes (W3C, 2012).

The researcher conducted email interviews with six universities regarding universal design awareness, and 14 universities regarding universally captioning access on campus. Some major universities have found themselves unable to provide for DHH students' accommodations prior to the DHH students' enrolling in and registering for specific courses. Interpreters must have specifically-trained skills in order to translate technical terms on an academic level, so it is challenging to find an interpreter who fits a DHH student's need for all classrooms. Other DHH students may prefer captioning services, but, at times, captionists may not provide sufficient accessibility services due to the lag time when typing quick dialogs such as class discussions or films.

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Specifically for captions in online classes, the researcher obtained estimated prices for online lectures with captions from 10 captioning agencies. The cost of adding captions to online videos ranges from $0.62 to $8.00 per minute, and from $35.00 to $480.00 per hour. The cost depends on the duration of the video lecture, the speed and quality of sound, the type of media, the length of submission, the transcript request, and any discounts. As a part of federal educational laws, colleges and universities, which receive federal money are required to cover the costs of captioning services to make videos accessible to DHH students (U.S. Department of Education, 2013). Unfortunately, producing captioned videos requires higher per capita costs, even for only one DHH student. This issue may be a cause for the lack of popularity of online video lectures with caption since the costs for producing captioned online videos may be higher than the profits for those who produce them.

From another viewpoint, that of a Universal Design approach, the benefit of captioning is considered for not only those who are DHH, but also for International and American students who are English as Second Language (ESL) learners to provide materials without experiencing language barriers (Zanon, 2006). The concept of Universal Design is to design institutions, products, and technological information to ensure that all people have access to information without any barriers (Udo & Fels, 2009). Existing literature already indicates positive educational and learning outcomes for DHH and ESL students through the use of captioned videos or captioned televisions (Huang & Eskey, 2000; Bowe & Kaufman, 2001; Markham, Peter, & McCarthy, 2001; Lewis & Jackson, 2001; Danan, 2004; Rowland, 2007; Holmes, Rutledge & Gauthier, 2009). However, little research is available which presents the benefits of captioning services and the educational outcomes for American students who are hearing and native speakers.

Purpose of the Study

When considering the popularization of COC, a discussion regarding the high cost of captioning services is unavoidable. As a part of this consideration, the purpose

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of the study is to present a new perspective regarding the introduction of Captioned Online Courses (COC), defined as online video lectures with captions, for college students in the following four groups: (a) American Native Speakers, (b) American ESL Learners, (c) International Students, and (d) DHH Students.

As a matter of course, the individual value toward COC is expected to be divided between a group that has higher value toward COC and another group that has lower value toward COC. However, from the viewpoint of popularity of COC, a total amount gathered from individual values is more important than the individual value. The total value toward COC could be significantly affected by a number of individual values, rather than only the group that has highest singular value toward COC. If the results of this study reveal that the American groups which are hearing and occupy a majority of the total student population might have great value toward COC for better learning in English, this could become the catalyst and power to popularize COC.

Therefore, this study proposes taking two approaches: (1) estimating the individual value of COC for each group: American Native Speakers, American ESL Learners, International Students, and DHH Students, and (2) estimating the total value of COC for each cluster, which is measured as the individual value multiplied by the number for the group. In this way, the benefit of COC may be considered for not only the DHH group, but also for the American and International groups who can hear. To make this point clear, two hypotheses are presented below.

Research Question and Hypotheses

This study leads with one research question: Which group of American, International, and DHH students receives a large benefit from Captioned Online Courses? Two hypotheses are adapted as follows:

Hypothesis One: The International group has a higher individual value for COC than that of the other groups. The first hypothesis presents the ranking of individual values as International > DHH > American ESL Learners > American

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Native Speakers. The International students may have more personal value for COC because they want to improve their listening and reading skills in English. The DHH group may include two types: DHH students who are signers and who prefer to take an online class with an interpreter, and other DHH students who are non-signers and who prefer to take COC. The American group also includes two types: American ESL Learners and American Native Speakers. American ESL Learners may have more particular value for COC than American Native Speakers because they may prefer to watch captions rather than listening since their second language is English. Other American Native Speakers may prefer to listen rather than watching captions as their mother tongue. Both groups may place special value on COC for better learning opportunities.

Hypothesis Two: The American group's total value for COC is higher than the other groups. The second hypothesis presents the ranking of the total value as American > International > DHH. Due to limited data access, this study integrates the two types of Americans as one group for data analysis. Even if the individual value of the American group is less than that of other groups, the population of the American group is much larger than that of the other groups, so the total value of the American students for COC is expected to be larger than that of other groups. Even if the individual value of the International group is higher than that of other groups, the population of the International group is smaller than the American group, so the total value of the International students for COC is expected to be second after American group. The population of DHH group is much smaller than that of the other groups, so the total value for the DHH students is expected to be lower than the other groups.

If these hypotheses are accepted, COC should be strongly recommended, not just for the DHH group for reasonable accommodation, but also for the larger populations of the American and International groups for better learning opportunities.

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Methodology

Questionnaire

The target population consists of four categories: (a) American students who are native speakers, (b) American students who are ESL learners, (c) International students, and (d) DHH students attending a California Private University (CPU) and a California State University (CSU). All subjects are over 18 years old. An online survey link was forwarded to each of the groups via mass email.

The questionnaire was divided into three main parts: Part A, Introduction; Part B, Benefit Evaluation Questions; and Part C, Students' Backgrounds. In the questionnaire, Part B estimates each group's individual values and asks about their willingness to pay (WTP) for a captioned online course at their maximum rate of averaged tuition fees per year. This study uses Contingent Valuation Method (CVM), which is widely used for a majority of environmental economic research (Mitchell & Carson, 1989; Carson, 2000; Bateman et al., 2002). The theoretical framework of CVM was adapted to estimate the economic profits to be gained from these groups in regards to COC. CVM evaluates WTP to get better services, and this study examines WTP for taking COC. Check List CVM, which is used in this survey, is useful for a small sample population (Mitchell & Carson, 1989; Bateman et al., 2002). The Check List CVM presents a series of different values that users would be willing to pay, and asks participants to check the item in the values list that most closely resembles their opinions (Bateman et al., 2002). The Part B, Evaluation Question represents as follows:

> Imagine that your selected course has two optional online class choices: (a) a captioned video online lecture and (b) a non-captioned video online lecture. What percent would you be willing to pay for a captioned online class rather than for a non-captioned online class? Please remember that the payment for captioned online classes is withdrawn from our budget.

- Even if the two classes are given for the same fee, I do not want to take a captioned online class.
- If the two classes are given for the same fee, I want to take a captioned online class.
- If the percentage is under 2% in additional fees, I want to take a captioned online class.
- If the percentage is under 3%…
- If the percentage is under 5%…
- If the percentage is under 7%…
- If the percentage is under 10%…
- If the percentage is under 15%…
- If the percentage is under 20%…
- If the percentage is under 30%…
- Other ( ) %
- Don't know

ANOVA for Examining Hypothesis One

Survey questions for *Hypothesis One* such as the Part B, Evaluation Question sample above were analyzed using a one-way analysis of variance (ANOVA) and multiple comparisons in SPSS Version 20.0 (IBM, 2011). The statistical analyses were used to compare the differences in WTP for each of the four groups. This study used *WTP Rates* as a scale of individual value, defined as the increased tuition rate toward COC per alternative choice. In other words, *WTP Rates* refers to the percentage that students would be willing to pay for COC in additional tuition fees.

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Calculation of Total Value for Examining Hypothesis Two

The total value of WTP for each group is calculated by multiplying the mean of the WTP Rates by the amount of each of the target populations per campus, and by the return rates, in order to prevent overestimation of the responders' total values. This study estimates the respondents' total values by multiplying the return rates, which means the WTP of non-respondents is assumed to be $0. This study compared each group's total value toward COC, and ranking and estimating the total costs per campus as a whole.

Results

Overview of Survey

The researcher contacted all of the CPU's and CSU's departments for survey permission, and obtained permission from 16 out of 73 of the CPU's departments, and 10 out of 54 of the CSU's departments. As the survey link was sent via mass email, it is unknown how many students received the survey link from these departments. Excluding the 248 uncompleted responses, the total response rate consisted of 1,579 responses from the CPU, and 207 responses from the CSU. All data information of students was divided into four groups based on the answers of Part C, Student Backgrounds, for identifying how respondents' backgrounds influence their individual values toward COC. The return rates were: 8.30% at the CPU, and 3.10% at the CSU (See Table 1). Table 2 shows different characteristics of four groups: American Native Speakers (NATIVE), American English as Second Language Learners (ESL), International Students (INTL), and DHH Students (DHH) (See Table 2).

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Table 1. Summary of Survey.

University	CPU	CSU
Survey Method	Qualtrics Survey	Qualtrics Survey
Survey Period	08/25/11-11/11/11	08/25/11-10/25/11
# of Departments	73	54
# of Permitted Departments	16	10
Target Population	38,000	36,911
# of Students Sent Survey	19,028	6,674
Respondents	1,799	235
Total Effective Respondents	1,579	209
Return Rate	0.083	0.031

Table 2. Characteristics of Effective Respondents.

University	CPU	CSU
NATIVE	877	131
ESL	160	16
INTL	404	25
DHH	138	37
Total	1,579	209

Individual Value for COC

WTP rates for the four groups by combined campuses. The first approach is One-way ANOVA to compare with the single value for each of the four groups, combining the data from the CPU and CSU. WTP Rates is the increased tuition fee rate toward COC. Table 3 presents the differences among the means of the WTP Rates toward COC, as a scale of individual value, varied: American ESL Learners at 3.431%, International Students at 2.016%, DHH Students at 1.741%, and

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American Native Speakers at 0.942%. The result represents that at least one group has shown a different *WTP Rate* compared to the rest of groups' *WTP Rates* at a rate of $p < .01$ ***.

Table 3. One Way ANOVA: Comparison in Four Groups.

Descriptive Variables	NATIVE	ESL	INTL	DHH	*p* value
WTP Rates	0.942	3.431	2.016	1.741	0.000 ***
N	934	159	411	162	Not applicable

Therefore, to examine the full detail of the differences of *WTP Rates* for the four groups, Table 4 presents multiple comparisons for the *WTP Rates* for each of the four groups. The *WTP Rate* of American Native Speakers was statistically significant from that of American ESL Learners and International Students, at a rate of p <.01***. Also, the *WTP Rate* of American ESL Learners was statistically significant from that of International Students and DHH Students, at a rate of *p* <.01 ***.

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Table 4. Multiple Comparison: WPT Rate In Four Groups.

WTP Rates	ESL	INTL	DHH
NATIVE	0.000 ***	0.000***	0.131
ESL	Not applicable	0.003***	0.003***
INTL	Not applicable	Not applicable	0.902

From the above results, *Hypothesis One's* rank of individual values as International > DHH > American ESL Learners > American Native Speakers, is partly accepted. Comparing each of the four groups' *WTP Rates*, the rank of individual value is represented as American ESL Learners > International > DHH > American Native Speakers. The result indicates that American ESL Learners have higher personal values toward WTP than the other groups, even though International students are also ESL learners.

WTP rates for the three groups per campus. The second approach is to estimate the total value toward COC, and it requires getting an exact number for the student population for each of the four groups per campus. However, the study was unable to identify the exact amount of the student populations of American Native Speakers and American ESL Learners per campus. Thus, this study integrated the two groups in order to calculate the American students' total values as one group, and compared the *WPT Rates* for each of the three groups.

Therefore, the means of the *WTP Rates* toward COC was recoded into three groups: American students (USA), International students (INTL), and DHH students (DHH) for each campus (See Table 5). As a result, the means of the *WTP Rates* at the CPU were: 2.115% for International students, 1.793% for DHH students, and 1.291% for American students. The groups at CPU showed as being statistically significant at the level of $p < .01$***. Thus, the result from the CPU indicates that the ranking of individual value in the three groups should be presented as International students > DHH students > American students. On other hand, the means of the *WTP Rates* toward COC at the CSU were: 1.544% for DHH student,

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1.402% for American students, and 0.417% for International students (See Table 5). Although the International students' *WTP Rates* at the CSU was lower than the other groups, the groups at the CSU showed no statistical differences among the three groups at a rate of $p < .01$.

Table 5. Group Comparison of Three Groups Per Campus.

WTP Rates	USA	INTL	DHH	*p* value
CPS	1.291	2.115	1.793	0.006***
CSU	1.402	0.417	1.544	0.531

Total Values toward COC

At the CPU and the CSU, each group's total value toward COC was multiplied by the mean of the increased tuition rate per year, the means of *WTP Rates*, the total student population, and the return rates.

Total values at CPU. Multiplying the tuition average per year 2011-2012 of $42,818 by the mean of the *WTP Rate*, the individual value for COC at the CPU was estimated as $905.60 for International students, $767.71 for DHH students, and $552.73 for American students.

The CPU's total student population in the fall of 2011 was 38,000. International students were 7,226 of that total. DHH students were estimated to number approximately 200, as 10 DHH students were officially registered by Disability Services, but the rest of students who identified as DHH were possibly not yet registered. American students were estimated to be 30,574, which were subtracted from the International and DHH student populations.

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Table 6. Mean of Individual Value and total Value Toward Captioned Online Courses.

University	CPU	CSU
Effective Return Rate	0.0830	0.0310
Average of Tuition Fees	$42,818	In State Citizens: $5,076 Out of State Citizens: $21,312
Total of All Students	38,000	36,911
USA	30,574	34,422
INTL	7,226	2,489
DHH	200	200
Individual Values		
USA	$552.73	$71.14
INTL	$905.60	$88.87
DHH	$767.71	$78.37
Total Values		
USA	$1,402,630.86	$75,956.32
INTL	$543,140.84	$6,857.12
DHH	$12,743.98	$485.89
Overall Group	$1,958,515.68	$83,299.33

This study also calculated the return rates, dividing the respondent rate by the number of students who were sent the survey, calculating the total values multiplied by the return rates, in order to avoid overestimation regarding the total values for COC. The return rates were shown to be: 8.30% at CPU, and 3.10% at CSU (See Table 1's Recollection Rate section).

Overall, considering return rate and calculating the total value per group at the CPU revealed that values toward COC were: $1,402,630.86 for American

students, $543,140.84 for International students, and $12,743.98 for DHH students. The overall total value for all groups was $1,958,515.68 (See Table 6).

Total values at CSU. The in-state tuition average per year 2011-2012 was $5,076.00 for American and DHH students and the non-in-state tuition average per year was $21,312.00 for International students. In the same manner as the calculation for the CPU, the estimated individual values for COC at the CSU were obtained, resulting in: $71.14 for American students, $88.87 for International students, and $78.37 for DHH students.

The CSU's total student population in the fall of 2011 was 36,911, and International students represented 2,489 of that total. DHH students were estimated to number approximately 200 with 163 DHH students were registered by DHH Services, but the rest of students who identified as DHH were possibly not yet registered. American students were estimated to total 34,442, and were subtracted from the International and DHH student populations.

Considering return rate and calculating the total value per group for the CSU reveals that the values for COC were: $75,956.32 for American students, $6,857.12 for International students and $485.89 for DHH students. The overall total value for all groups was $83,299.33 (See Table 6).

Discussion

Individual Values of COC in the All Groups

First, this study combined the results from the CPU and CSU and compared them with the WPT Rates for each of the four groups: American Native Speakers, American ESL Learners, International, and DHH. This study assumed the original ranking of individual value as International > DHH > American ESL Learners > American Native Speakers. However, the actual rank of individual value was: American ESL Learners > International > DHH > American Native Speakers.

The results indicate that American ESL Learners have higher individual values toward COC than the other groups, even though International students are also ESL learners. American ESL learners and International students may have similar reasons for wanting to take COC in order to improve their listening skills in English, while DHH students may have other reasons, such as wanting full access to speech information. American Native Speakers had lower individual values than the other groups, as they may not need often to depend on captioning.

Second, the individual values for the four groups by combined campuses as a result of a one-way ANOVA were shown as being statistically significant. However, the individual values by dividing into three groups per campus in a one-way ANOVA was shown to be statistically significant at the CPU, but not at the CSU. The main cause for this was insufficient sampling size for data analysis: 147 for American students, 37 for DHH students, and 25 for International students at the CSU, as compared with a sufficient sampling size at the CPU: 1037 for American students, 404 for International students and 138 for DHH students (See Table 1's Effective Respondent section). Therefore, Table 1 and Table 2 represent a statistically significant difference for the group comparisons by combined campuses due to the sufficient sampling size of the CPU.

Furthermore, compared to the population rate of American Native Speakers, the population rate of American ESL Learners was smaller, comprising 15.40% of the

total American group at the CPU and 10.90% of the total American group at the CSU who were ESL.

As a result, integrating the two groups of American Native Speakers and American ESL Learners, this study found that the American group was affected by a vast majority of in population of American Native Speakers. In addition, 88% of the total respondent rate was occupied by CPU's student population. Therefore, the results from the four groups were affected by the large majority of the CPU's population. In summary, the data analysis for Americans was influenced by a majority of American Native Speakers and the data analysis for the combined universities was impacted by CPU respondents.

Total Values of COC

The American students' mean of the *WTP Rate* is lower than that of the International students and the DHH students. However, a large number for the American student population rate resulted in higher American students' total value regarding COC than for the other groups' total values. The population ratios of absolute values between American and International students from the two universities could apply to other California State Universities or all universities in the United States which have similar population ratio.

This study considered the return rates in order to avoid overestimation of the total values for COC. The aggregate total value for all groups from the CPU and the CSU was evaluated to be approximately $1,900,000.00 per year and $83,000.00 per year respectively, despite having a 91.70% no response rate at the CPU and a 96.90% no response rate at the CSU. In addition, the online survey was sent to only 16 of 73 departments at the CPU and 10 of 54 departments at the CSU. A higher collection would be realized if the online survey had been sent to all of the departments at both the CPU and the CSU. At that rate, the overall total values may be expected to be over $2,000,000.00 throughout year, and not just per year.

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Possible Offer of COC Lectures

The study calculated the number of conducting COC as a three-hour lecture per class by dividing the aggregate total values by the cost of offering COC, based on the lowest price of $2.00 per minute, or the average price of $5.00 per minute. Table 7 represents 370 classes conducted at the lowest price, and 148 classes held at the mean rate.

Table 7. Estimated Breakdown of Captioned Online Courses.

Price of Captions	$2.00 per minute	$5.00 per minute
Price of one class	$2 × 180min =$360	$5 × 180min =$900
Price of 15 weeks (one semester)	$360 × 15 =$5,400	$900 × 15 =$13,500
# of classes per year	$2,000,000 / $5,400 = 370	$2,000,000 / $13,500 =148

Overall, the information from this study contributes the idea that not only DHH students, but also International and American students would prefer to take COC. Therefore, it is essential that universities establish investigation committees to examine students' benefits for COC thoroughly, which will be of great value in developing a project tailored to increasing the number of COC offered.

Conclusion

In past studies, captioned videos have been viewed as a benefit primarily for ESL and DHH students. However, this study reveals that COC are not just accommodations for DHH students but can also benefit American and International students as well. International students were shown to have higher individual values toward COC than did other groups. Furthermore, American students have demonstrated the potential for higher benefits from COC than the other groups because of the large amount of student population. Assuming the WTP of non-respondents to be $0, regardless of the lower return rates of 8.30% at

the CPU and 3.10% at the CSU, the total value for the populations from all groups at both universities was estimated at approximately $2,000,000.00 per year, which would cover the cost of conducting 370 classes at the lowest price of $2.00 per minute or 148 classes at the average price of $5.00 per minute.

The effectiveness of this project contributes to the promotion of the Universal Design model for postsecondary educational institutions. Offering COC to International students in other countries, or to American students in other states, may help improve their academic achievement, as compared to students who do not partake in COC. The more American students who are interested in taking COC, the more tuition income supports the budget necessary for providing COC, which generates positive feedback. In addition, development of an online course curriculum that offers COC internationally may lead to COC becoming popular with a large number of International students.

More importantly, COC is an essential accessibility service for students who have slight or mild hearing loss and who are non-signers. Despite the fact, Disability Services at the CPU registered only 10 DHH students, the survey collection identified 138 students who reported slight or mild hearing loss. That is, DHH students who have slight or mild hearing loss may not register Disability Services at universities.

Unfortunately, although this research analyzed the expected educational and economic valuations toward COC, there were limitations. The survey collection rates were 8.30% at the CPU and 3.10% at the CSU, so a university would need to examine all of the students' values toward COC thoroughly. The online survey was conducted with college students, and most of the responders were possibly interested in taking COC, which represents the characteristics of these subjects. If most of the subjects were enrolled at California State Universities, the study may show different results. This study estimated the effectiveness of COC popularization economically, but whether the total value of COC is higher than the costs of captioning services has yet to be discussed.

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Journal of Accessibility and Design for All

(CC) JACCES, 2015 - 5(1): 47-76. ISSN: 2013-7087

A UNIVERSAL DESIGN CHARRETTE CONDUCTED IN AN EDUCATIONAL SETTING TO INCREASE PROFESSIONAL SENSITIVITY

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Received: 2014-07-13 | Accepted: 2015-03-04| Published: 2015-05-25

Abstract: This paper describes a design Charrette conducted in a graduate course on Universal Design (UD), in which students, here professional architects, developed a design project for a public-service centre. The goal of the Charrette was to understand the effectiveness of this type of teaching method to increase the designers' sensitivity toward UD issues and gain knowledge on participatory processes. The Charrette involved potential users with various disabilities who evaluated the design proposal using tactile maps and other communication media. The Charrette exercise included Wayfinding as an important topic in the design of buildings and urban spaces. Issues related to this aspect were translated into flowcharts as diagrams and tactile representations. The participation of users with disabilities was evaluated. The results showed that the Charrette, as a teaching method, was successful in making the student group examine questions regarding UD. However, the student group continued to be primarily concerned with the design's formal aesthetic issues, and the process differed little from the traditional "designerly" ways of doing things. An analysis of the participatory phase showed that potential users with visual disabilities had difficulties understanding the design and the wheelchair users criticized various questions of access and barrier-free Wayfinding. Recommendations to improve "design for all" education are presented. To increase the sensitivity of professional designers to

issues concerning UD, potential users with disabilities should participate early in the design process, to provide input as the proposal is developed. Introducing a multidisciplinary design team should also be tested to include a larger variety of viewpoints in design decisions. This approach may strengthen the concern for elements of an architectural and urban design that directly affect person-environment relationships.

Keywords: Universal Design (UD), Architectural Design Process, Design Pedagogy, Wayfinding, Design Charrette, Tactile maps

Introduction

This paper discusses the importance of Universal Design (UD) as a concept to be incorporated into the creative design process of the built environment. The principles of UD should be part of designers' repertoire. To achieve this result, UD should be present in appropriate pedagogies to increase designers' sensitivity towards the needs of others. Responding to different requirements and desires is an essential design attitude that must be learned and acted on in design decisions.

In this study, UD was the subject of a graduate class at the University of Campinas, which included a design Charrette. The students of this graduate class were all practicing design professionals, in this case, licensed architects who were engaged in graduate courses at the above-mentioned university. The topic of the Charrette was a Citizen Service Centre (*Poupatempo*) and the exercise emphasized not only UD, but also organizational issues concerning Wayfinding of this building type.

The creative process is continuously changing in the face of new design requirements. Technological advances and global, social and economic changes have directly influenced the design of the built environment, thereby increasing the complexity and functional requirements of buildings (Nicol & Pilling, 2000;

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Hadjiyanni, 2008; D'Souza, 2009; Kowaltowski et al., 2010). A new professional posture is required that is capable of a more responsible and sensitive approach to design solutions to address environmental impact, accessibility and humanization of architecture, among other design factors (Kowaltowski, 1980; Quayle & Paterson, 1989; Salama, 2005; Danko et al., 2006; Ryhl, 2009).

To contribute to the discussion on the preparation of designers to address the concepts of UD in their professional activities, this paper presents a building design educational experiment, as a design Charrette. This exercise followed a study where role-playing and user participation were shown to be significant collaborative factors in design education (Bernardi & Kowaltowski, 2010). The same research also showed that role-playing was insufficient to engage design professionals fully in the needs of users with disabilities, and that further efforts were needed to increase design professionals' sensitivity.

Literature review

Design education with Universal Design in mind

Research continuously forms and refines principles and concepts on which to base decision-making for the design of the built environment. In this context UD has gained importance as a research area and as a subject in design curricula. Various teaching methods have been devised to increase future designers' sensitivity to the issues of UD. To permit a more autonomous use of built spaces for people with a variety of disabilities regulations and laws have been introduced over the last thirty years. These efforts should ensure that the planning, design and construction of buildings and urban places adequately provide for these users. (Duarte & Cohen, 2003, Preiser & Smith, 2010; Barnes, 2011; McGuire, 2011; Nussbaumer, 2011).

Afcan and Erbug (2009) showed that three critical issues challenge the integration of UD in current design practices. The first of these questions is a theory-practice inconsistency, with design professionals showing a lack of UD knowledge. The

second issue concerns user needs, as designers are typically not users of their own creations; therefore, eliciting, capturing and describing diverse user requirements through effective procedures is vitally important. Finally, the third issue is attributed to the interdisciplinary nature of design processes.

To increase the discussions of UD and address these three issues in higher education many strategies have been used. Among such strategies are the following: curricula expansion; faculty training; introduction of innovative new courses and new topics in design assignments. Recommended teaching methods include role-playing and Charrettes within participatory processes (Brent et al., 1993). The literature regarding design education with specific emphasis on UD is rich, presenting successes and some failures from which lessons can be learned (Lifchez, 1986; Quayle & Paterson, 1989; Stiffler, 1990; Welch, 1995; Morrow, 2001; Schermer, 2001; Christophersen, 2002; Duarte & Cohen, 2003; Paulsson, 2005; Salama, 2005; Luck, 2007; Hadjiyanni, 2008; McGuire, 2011; Dorneles & Bins Ely, 2012). These studies point out that students should learn the difference between accessibility and UD because accessibility is more concerned with a barrier free environment and an inclusive design based, in most countries, on legislation. In contrast, UD embraces the spirit of inclusion as a concept of design and, as a study subject, should emphasize the experiential and psycho-social qualities of spaces. Courses should therefore discuss and practice critical interpretive understandings of person-environment interactions (Franz & Lehmann, 2004; Souza, 2008). Cooperative projects between design schools and special user organizations are encouraged and appropriate UD pedagogy should apply methods such as creative problem solving, project-based teaching and evidence-based design (Nussbaumer, 2009).

Teaching methods

One of the more frequently used teaching methods in design courses is role-playing, where students will temporarily become users with disabilities. Role-playing was introduced in discussion groups in universities already in the 1980s and was shown to diffuse a student's close proximity to a project and engage

him/her in a more objective and creative mode of thinking (Lifchez, 1986; Radford & Stevens, 1988; Quayle & Paterson 1989; Duarte & Cohen, 2003; Altay & Demirkan, 2014).

The participation of special users in design classes has been a fairly long-standing pedagogical tool as well in architecture schools. Paulsson (2005) recommended this type of inclusion, to enhance empathy exercises in the studio setting, which should be coupled with lectures by experts on various disabilities to increase factual knowledge. Empowering design can then occur through the inclusion of profound knowledge about human capabilities and less on disabilities (Tyler, 2011). Participation of individual users may also bring to the design debates specific life endeavours, experiences and coping techniques. Thus, immersion in reality can stimulate creative solutions. Following people with disabilities on a daily basis is also recommended, to develop intellectual rigor and motivational skills in students who may find inspiration in the everyday lives of ordinary people (Gehl, 2011). After this immersion, innovation no longer tends to be a quest to be different but seeks to respond critically to everyday problems and challenges. Restrictions imposed on design by UD are no longer viewed as stifling creativity but can be instigators for new and fresh ideas (Stiffler, 1990; Morrow, 2001).

Preparing design professionals for interaction design with an emancipatory process, particularly when users with various disabilities are included, touches on several key issues of expertise. Ethics of conduct, representational and ethnographic skill development are necessary (Luck, 2007). Being able to adequately convey ideas, with respect for others and have insights into special needs can no longer be missing in pedagogical goals of colleges of design. Students should develop a questioning attitude, think in alternatives and engage in non-argumentative conversations (e.g., making deals, agreeing to disagree, etc..) (Morton, 2012). The new approach establishes an awareness and appreciation for diversity and design for society as a whole (Tyler, 2011; Christophersen, 2002).

Emancipatory processes occur primarily in professional practice, with users as active members of a design decision-making process (Luck, 2003; 2007; Sanoff,

2011). In this scenario, the professional designer must learn to act ethically and responsibly in serving the needs of others (Schermer 2001; Woolner, 2009). The introduction of users with disabilities in such processes usually transcends the dialogue between designers and potential users. Reading of a design proposal to obtain a perception of the future built environment occurs essentially through graphic documentation, which may present difficulties. When users with visual impairments participate, one must go beyond the usual two-dimensional drawings or 3D presentation models. Tactile maps are recommended, because they address richer sensorial values (Dischinger, 2000; Howell & Ionides, 2008; Bernardi et al., 2011). For this reason these new communication techniques should be part of the formal education of designers.

Universal Design in a specific context

In a previous teaching experience by the authors involving role-playing and the participation of users with visual impairments, students increased their awareness to accessibility and UD issues (Bernardi & Kowaltowski, 2010). However, this study showed that students often revert back to their normal abilities when difficulties arise and the combination of role-playing and user participation was recommended. This previous example also showed that a gain in real-life experience might come at a cost because frustrations can occur during participatory design. Further studies were recommended to achieve a more inclusive design process in both teaching and practice.

The case study presented below concerns issues of UD education and design practices in a specific context. Because the teaching experience is situated in Brazil, some historical facts on accessibility and UD in design education in this context are presented.

A university undergraduate degree in Architecture and Urban Design is the traditional degree for professional designers in Brazil. The graduates from these courses can work in various areas of design, such as architecture, interior design, product and landscape design and urban planning. To date, most design education in Brazil has only touched on the concepts of UD and Wayfinding, and

there is a need to expand the necessary and specific knowledge of designers (Preiser & Smith, 2010). In the USA design Charrettes, with a focus on UD, were considered important vehicles to discuss vital questions and increase designers' sensibility in their decision-making process soon after the signing of the Americans with Disabilities Act (ADA) (Brent et al., 1993). In Brazil, such concentrated workshops are a more recent introduction to design education (Cohen & Duarte, 2010).

The discussions on the topic of UD increased in the 1960's in Brazil. In the mid-1980s, a long debate culminated in laws, decrees and technical reports that sought to ensure the right of access in the physical environment for disabled persons, with an emphasis given on people with reduced mobility. In 1985, the first Brazilian technical codes were published. In the revised 2004 version, these codes are now a standard, applied throughout the country (Brasil, 2000; ABNT, 2004, Prado et al., 2010). Physical barriers pose problems for a significant number of Brazilians. In developing countries, not only physical barriers but also cultural and economical hurdles affect questions of accessibility. Attitudes play a role, among other important factors, to make a society barrier free in the widest sense (Sassaki, 1997). The 2010 general census in Brazil found that 23.9% of the population possesses at least one kind of disability (IBGE, 2012). This information emphasizes the importance of the topic of UD in a society where the demand for universally accessible spaces exists and is growing.

Methodology

Design Charrette

Charrette, meaning "cart" in French, is said to originate from the *Ecole des Beau Arts*, where, after long days and nights designing and drafting, students' projects were collected and placed in carts *en route* to their final review (Sanoff, 2011). The basic idea of the Charrette, putting students under pressure, so to speak to catch the last train, is prominent in design education. Typical Charrette protocols are the following: a short time period, multidisciplinary participants, focus on a

single design problem and group isolation in a specific place (Lennertz & Lutzenhiser, 2006).

In current design studios, the term Charrette usually refers to an intensive design exercise developed by groups of students in a short period of time ranging from one day to two weeks. Many subjects, including building safety and security, ADA, community planning and sustainability have used Charrettes (Brent et al., 1993; Onayngo & Noguchi, 2009; McLaughlin, 2013)

The effectiveness of Charrettes can be linked to the fact that interdisciplinary teamwork can be practiced (Clayton et al., 1998). There are authors who question the use of Charrettes because they may involve gruelling workloads for students (Bachman & Bachman, 2009). However, Staub and Lulo (2011) show that Charrettes can be productive in establishing dialogue between designers and user groups. Participating laypersons may provide initial design information and help define the parameters for the further exploration of solutions.

Case Study

In the case study described in this paper the design Charrette did not have all the protocol elements. The Charrette group was not isolated for a specific short time period in a single space. Users only participated in specific phases of the process, namely during the presentation and design “crits”.

The focus of the Charrette was to design a building for a particular purpose and to test whether students are able to include UD as a principal design-guiding element. The seven principles of UD and Wayfinding, as an aspect of design, were considered the focus of the exercise (Connell et al., 1997). The Charrette also paid attention to presentation and communication techniques to improve the design process, considering users with various disabilities. Motivating students to imagine more conceptual solutions that follow UD principles was a primary goal of the case study. The proposed building, its relation to the urban tissue, architectural forms and details, interior spaces and their organization should be naturally inclusive.

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The topic of the Charrette was the design of a municipal Citizen Service Centre building, called "*Poupatempo*" ("Save Time" in Portuguese). In the State of São Paulo, these centres exist in all medium and large cities, where the State Government offers essential services to the population. The centres have the following goals: concentrate public services in a single physical space; provide fast, efficient citizen services and apply advanced information and communication technology (Painelli, 2008). The most sought-after *Poupatempo* services include ID cards, work permits, unemployment insurance and driver's licenses, which are all important documents that people need in everyday life. The site for the design proposal was located close to the main university of the city of Campinas and local residents were considered the target population.

The challenge of designing a *Poupatempo* considering UD was assigned to eight graduate students of the School of Civil Engineering, Architecture and Urban Design, of the University of Campinas. All students were professional architects with several years of experience. The exercise was part of a course given on UD in the master's and doctoral program of the School. The course was structured as a design Charrette and as a participatory process. The student group was given instructions to include users with a variety of disabilities in the design phases. The actual organization of these stages was transferred to the students, and they were asked to document their specific means of achieving a participatory goal. Students were also invited to observe difficulties and gains.

Theoretical discussions on accessibility and UD in the design process were a component of the course work. The following four topics were part of the syllabus: Universal Design; UD and its impact on design quality; Post Occupancy Evaluation (POE); and Wayfinding. The required reading included manuals and POE studies of *Poupatempos*, references on UD principles (Connell, 1997) and Wayfinding as a guiding aspect for the organization and legibility of architectural spaces. The primary reading included the following: Luck et al., 2001; Preiser & Smith, 2010 and Welch, 1995. Additional supplementary readings were required for each topic. Design analysis exercises occurred prior to engaging in the design Charrette.

The Charrette group included eight architects and two instructors, who were also professional architects. Five female and three male designers participated, each with more than five years of professional practice, and all were enrolled in the architecture graduate program of the School of Civil Engineering, Architecture and Urban Design of the University of Campinas.

Five design stages were present in the exercise: briefing, preliminary design, design development, participatory design presentation and evaluation. The Charrette was developed in the four-hour weekly course meetings, and the students met off-campus and on-line between classes. Students prepared pre-design material and drawings individually at home or in their offices. The group divided these activities in two parts: urban access to the site and the building design proposal. The activities lasted six weeks. After the participatory presentation, the group met for a feedback debate. A report was made, and a conference paper was presented and published.

While concentrating on the principles of UD (equitable use; flexibility in use; simple and intuitive use; perceptible information; tolerance for error; low physical efforts and size and space for approach and use (Connell, 1997)), the Charrette group gave special attention to the task scenarios as presented in Afacan and Erbug (2009). The scenarios were used to structure the design process as a whole and to pay attention to detail. Elements were specified as presented by Afacan and Erbug (2009): entering and exiting; the circulation system as a whole; Wayfinding; obtaining services; and the location and design of the public amenities. In a *Poupatempo* building, spatial orientation is essential. A coherent layout, referential elements, clear zoning and the placement of objects with obvious functions are important (Ribeiro, 2004). To enable people with disabilities to use such spaces, the path leading to all areas should be accessible (Dischinger et al., 2012). This path should be free of obstacles from origin to destination and display a range of access possibilities. Orientation should also be enhanced through maps and their tactile versions, located in strategic places (Cohen & Duarte, 2010; Bernardi et al., 2011).

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To begin the Charrette, the group of students established an urban access route to the site, coming from the local bus terminal and ending at the proposed building site. This route was translated into a tactile map (Figure 1).

Figure 5. Tactile map of route from bus terminal to proposed Citizens Service Centre

In the programming phase, the Charrette group structured design information and created a checklist according to the Problem-Seeking method (Peña & Parshall, 2012). Facts were collected and a wish list of goals was created, with specific design requirements that included UD and spatial orientation. The feasibility of the project was studied and users were characterized. Semi-public and private spaces were defined. Main access points and circulation flows for Wayfinding were outlined, and local codes were analysed. Design requirements included good indoor-outdoor connections and a project with aesthetic impact. The proposal's design principles were the following: good organization of services and integration of spaces; environments appropriate for employees and users; accessibility to all areas and finally comprehensible and attractive spaces that promote social inclusion. Providing users with humanized spaces, which include views of gardens, were concepts discussed during design development (Kowaltowski, 1980; Danko et al., 2006).

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Each member of the design group prepared an individual interior space-zoning proposal that considered spatial orientation and the legibility of circulation flows. After extensive design debates, a preliminary flowchart was agreed on and translated into a tactile map, as shown in Figures 2 and 3. The special tactile legend of this map defined the services offered, where information can be found and the choices users have to reach their destinations. The waiting area gained special design attention. The flowchart map played an important role during presentation of the design proposal to potential users with disabilities.

Figure 6. Flowchart of services for the design of a Citizens Service Centre (Poupatempo) with numbers indicating: 1 - information panel, 2-information and service desk, 3 – non-official services (food, copying, public toilets, etc.), 4 – waiting area, 5 – specific services offered by the centre

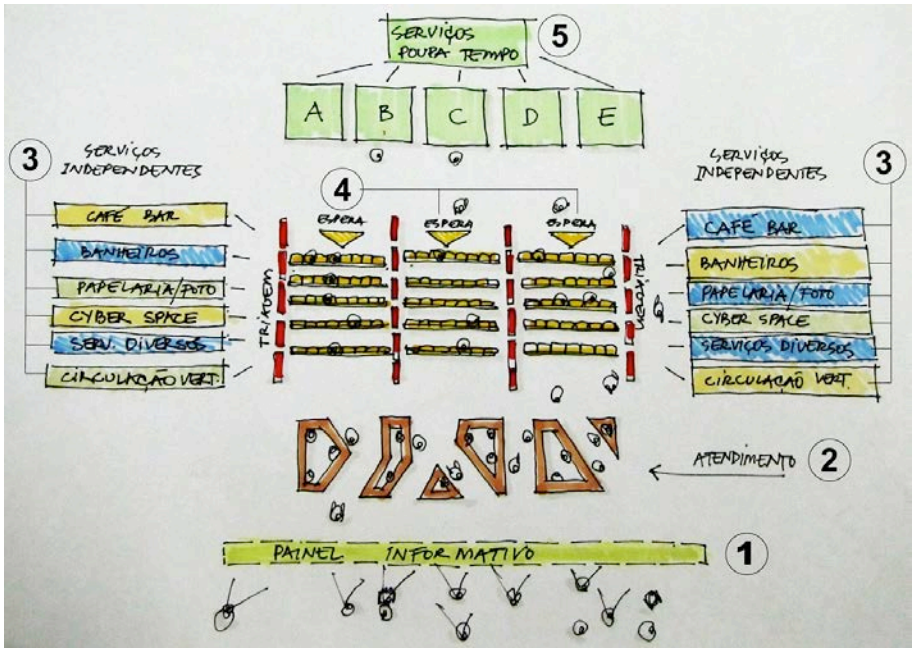

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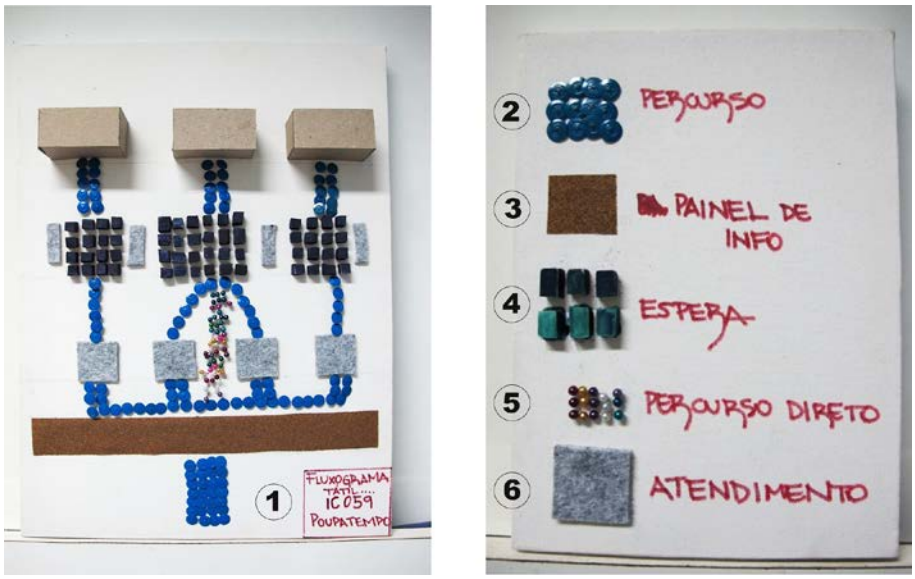
Figure 7. Tactile map of flowchart of services for the design of a Citizens Service Centre (Poupatempo) and legends read: 1 - flowchart for the service centre, 2 - path to obtain information, 3 - information panel, 4 - waiting area, 5 - direct path on return visits, 6 - customer service desk



Design sessions began with intense discussions and "crits" by the two instructors (Figure 4). The final design proposal (Figures 5) was in the form of four simple buildings, joined by a marquise. These buildings formally represented the major internal uses and services offered. Because the site has a topographical level difference of three meters between the front and back streets, parking could be accommodated underground. Stairs, ramps and elevators connect the two levels vertically.

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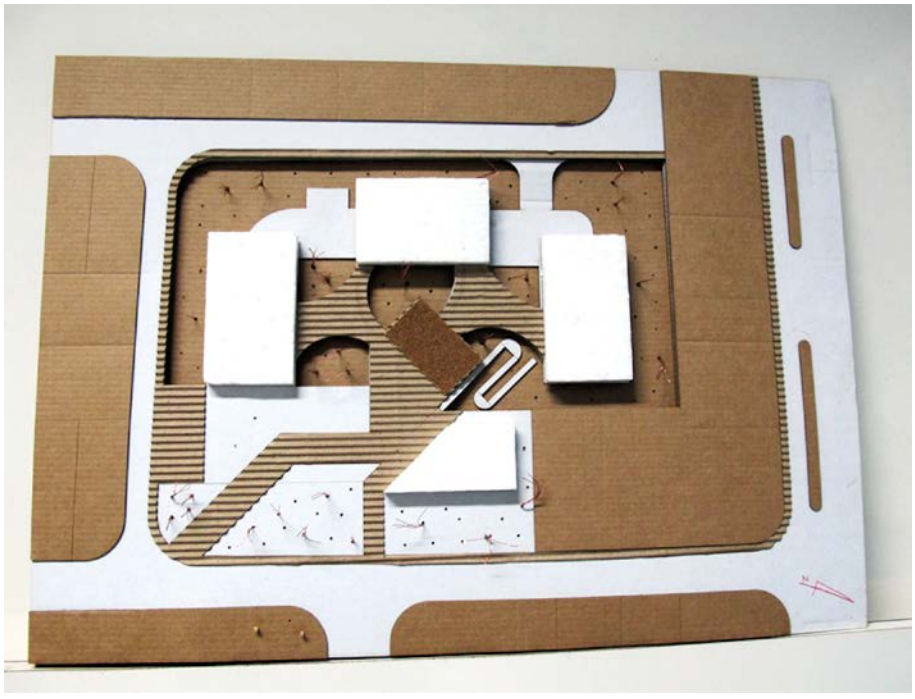
Figure 8. Design "crit" with students and instructors, of the case study Charrette

Figure 9. 3D physical model, with some tactile elements, of Citizen Service Centre design proposal



After follow-up research, the design group was convinced that traditional design presentation techniques would be insufficient to adequately communicate the design proposal to potential users with disabilities. Some questions emerged on

how to present the project to potential users. These questions were debated by the student group, in relation to Heller's observations on haptic perception of blind people (Heller, 2000; Herssens & Heylighen, 2008). The design group asked themselves several questions. Do blind people think about objects in the same way as people without visual disabilities? Are images created from tactile experiences? Are mental images necessary for spatial understanding? The type of materials to be used for models and tactile maps also raised questions concerning safety of touch and the legibility of maps. These types of questions are part of research on UD. In this case study they were raised during design "crits" and demonstrate that the student group became aware of such fundamental questions. To answer some of the more specific queries, the literature on design communication in a multi-sensory environment was studied (Howell & Ionides, 2008). After this, the Charrette student group made a concerned effort to rethink their design communication, to adequately include users with visual impairments.

For the final design stage, a participatory strategy was adopted in which designers and potential users discussed and evaluated the proposal. During this phase, a slideshow, containing graphs, charts and a virtual model of the design proposal was presented. The history of *Poupatempos* was briefly outlined. Tactile tools, included in the design presentation, were a physical 3D model with some tactile elements (Figure 6) and the organizational chart of the proposal (Figures 2 and 3).

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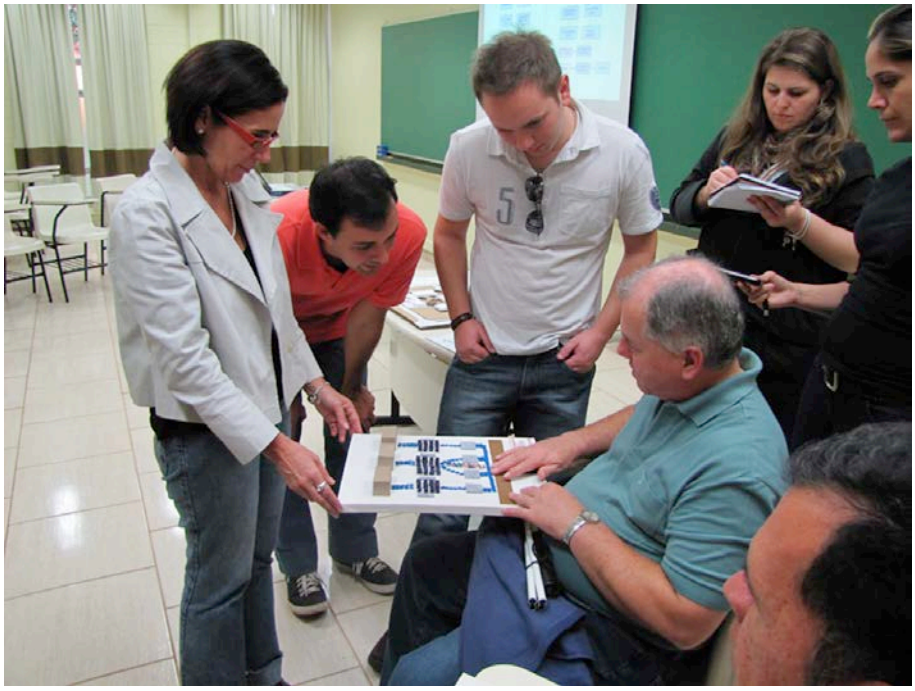
Figure 10. Presentation of Citizen Service Centre design proposal with the participation of potential users with disabilities, using the tactile flowchart



A small group of five potential users participated in the presentation and evaluation phases of the Charrette. This group consisted of individuals with some degree of disabilities, such as being confined to a wheelchair or having visual impairments. These users were students enrolled in a course of the School of Physical Education given at the University of Campinas, therefore not all types of users with disabilities participated in this phase. For example, users with cognitive problems were absent.

During the initial slideshow, the user-participants with visual impairments asked to touch the tactile material to be able to follow the rationale of the talk (Figures 7). After the formal presentation, many questions were asked. Where in relation to the university is the new building going to be? How do I get there by bus? Why is there a level change between the parking garage and the main functional spaces of the proposed building? The ramp seems to be long with of a complicated shape; is it sufficiently low in grade to allow autonomous wheelchair use? Can I park in front of the building and avoid the ramp? Can I, as a blind person, easily find the main information desk? Where will I be sent if I want to

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obtain my work permit? None of the potential users asked questions regarding the formal aspects of the design, its attractiveness and the site plan or landscaping features.

Figure 11. Presentation of Citizen Service Centre design proposal with the participation of potential users with disabilities, with students helping to explain the 3D physical model

Following the slideshow, all users had access to the models, tactile maps and drawings. The urban map (Figure 1) was presented first, followed by the organizational chart (Figure 6) and finally the 3D model of the building complex (Figure 7). During this session, the students of the Charrette were actively explaining design elements, their goals and answered questions. They also helped blind users to touch specific places on the tactile maps, when doubts arose (Figures 9 and 10). The potential user group made polite remarks on the design, considering the proposal inviting and attractive. However, these users noted that functional concerns are more important to them than formal issues. For example, users with restricted mobility consider distances a prime concern. The Charrette group debated these concerns and concluded that compact solutions need generous circulation spaces, and to enhance Wayfinding simplicity in the organizational structure of a building is recommended.

Discussion and recommendations

The Charrette exercise presented in this paper demonstrated that the design of an accessible building could surpass UD standards established by local codes. Additionally, design proposals with UD in mind must consider functional layouts and the clarity of circulation flows in buildings, which in this case reflected the organizational chart of *Poupatempos*.

The feedback phase of the Charrette showed that the graduate students considered the experience a rich exercise in design with UD in mind. The course and its Charrette convinced them that UD should be a guiding concept in the first stages of design and that the appropriate introduction of UD principles in the design process is not a simple prescription of code requirements. The student group was unanimous in their positive evaluation of the graduate course as a whole, and the Charrette as a productive exercise for a practical application of concepts and principles. For several students, this was the first time that UD was considered a more comprehensive design goal than accessibility. The design theme, *Poupatempo,* was found appropriate for the exercise, because it is a building offering services to all citizens, regardless of their needs or capabilities.

The development of a group project united students around common goals, such as: spatial organization based on function; perception of architectural space by users; Wayfinding and accessible routes. Using the Charrette model made the division of labour possible, according to individual talents and abilities and increased productivity. Most students were impressed by the capacity of participating users with visual impairments to comprehend essentials of the design proposal. However, a certain frustration was expressed regarding the lack of anticipation of many of the communication problems that occurred. The Charrette group considered that an exercise of this type should allocate more time to develop the design proposal and the fabrication of tactile maps and models. For the most part, this Charrette was the students' first contact with these tools. More time was also considered important to better understand a

specific user group so that students could be better prepared to answer to typical questions raised.

The graduate students of the Charrette were sufficiently mature and interested in environmental psychology and its application to design practice. User-centred investigations are well known, through POE studies. However, the final design proposal (*Poupatempo*) was mainly based on the formal aspects of design. Each part of the building represented a particular function, as a formal volume, and emphasis was given to the aesthetic composition of these volumes. These aspects had little or no impact on the participating users, and the Charrette students had to rely on verbal communication to explain the more psycho-social qualities of the proposal. Form and dimensions of spaces, views of outdoor areas, effects of light and shade, as well as colour are some elements designers address. How to explain physical space qualities to individuals with sight impairment brought doubt to the minds of the Charrette group, and many problems identified by the potential users with disabilities were not fully anticipated.

Potential users with disabilities mentioned several problems they face in everyday tasks, which reflect expectations of new designs. Because this Charrette example did not include all types of users with disabilities, such insights could not be completely compared to results of other studies. The observations of Afacan and Erbug (2009) are important however, as representing typical problems found in user accounts. These accounts include the following: unnecessary complexity of circulation systems; non-legibility of location of elevators, extensive distances of stairs and ramps from entrances; indirect access to important amenities; unclear paths to travel through buildings; long distances; difficulty of finding information desks; insufficient daylight to guide and direct users; inconsistencies caused by identical colour and decoration schemes; symmetrical layouts causing Wayfinding problems and insufficient distribution of restrooms for disabled persons. Other problems mentioned in Afacan and Erbug (2009) are the following: lack of smooth minor level changes (e.g.. small steps at entrances); too few maps, lack of information directories, signs and displays; total lack of tactile and sonorous maps and no auditory systems in elevators;

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difficulties in Wayfinding in car parks; fear of Wayfinding in case of emergencies (e.g.. fire, bomb threat); unusable door handles; insufficient seating in customer service centres; bad finishing and inappropriate material selection in restrooms and lack of tactile information in restrooms. This collection of problems must be transformed or translated into qualitative design data and must be made readily available to professionals and design students. Interpretation should be minimized and designers should be free to find creative solutions. The integration of theories and guidelines in design practice can then be achieved (Ostrom et al., 2010).

Further studies are necessary. Some research should be related to the way designers communicate with a variety of users and their diverse needs. Symbols used in design communication are not necessarily understood by participating users. The question of Wayfinding and the legibility of the functional organization and accessibility are also not directly visible or perceived through an analysis of drawings and models (Hunter, 2010). Experiences of the real world are absent and must be represented or discussed by other than graphic means. Full-scale mock-ups may help, and virtual reality coupled with visits to similar places could be tested.

To increase the sensitivity of professional designers to UD issues, potential users with disabilities should participate in the design process from the beginning as active, equal partners in design decision-making. Introducing a multidisciplinary design team, as recommended by Afacan and Erbug (2009), should be tested as well, to increase the variety of viewpoints. This may strengthen the concern for elements of a building design that directly affect users and their person-environment relationships.

In the teaching studio, establishing the meaning of space is mostly hypothetically discussed and unconnected to realities in use. Specific indicators are needed to test the abstract concepts recommended for briefing, such as the hierarchy and character of spaces, communications and relationships, indoor/outdoor connections, internal and external views, flows of people and goods, spatial organization and orientation, finishing materials, texture and colour, layouts of

furniture, facility and flexibility of use, fixtures and fittings, safety and security, and feelings of comfort (e.g.. glare, light and shade, drafts, reverberation of sound, etc..) (Hunter, 2010; Peña & Parshall, 2012). Typically, design education may introduce these concepts to students but often unconnected to specific design problems. Design "crits" will mostly debate spatial aspects such as dimensions, proportions, light, shade and sound, form and volume and the composition of facades, to mention only a few aspects. Discussions that question the perception of a proposed space by users with varied disabilities are still rare in the design studio.

To ensure that a designer can increase his/her observational abilities, think outside the box, test ideas and propose more consistent indicators for the subjective aspects of architecture, design pedagogy must include issues raised in this paper. As a result of the Charrette case study, diverse and dispersed information on "design for all" was organized and structured. Thus, concepts must be introduced and discussed in context. Methods must be applied and refined, and guidelines should be used during design development. Design concepts should include UD and Wayfinding, and a participatory process should be conducted in the design studio (professional and educational). Students must have contact with a multidisciplinary team and users with specific psycho-social requirements. The varying needs and desires of users may then enrich design "crits". In order to encourage design pedagogy and practice to become more inclusive, the value of multiple skill-sets could also be explored (McGuire, 2011). For example, the framework of Gardener's (1990) multiple intelligences could have a place in design education. This framework consists of the following eight skills: spatial, interpersonal, intrapersonal, logical, verbal, natural, kinesthetic (tactile learning) and musical (D`Souza, 2009).

To improve orientation (especially for users with impaired vision) organizational issues in indoor spaces also need guidelines. Solving Wayfinding issues in the interior of buildings is related to the absence of wider views and landmarks, where other elements must come into play to enable and enhance the legibility of the built environment.

A summary of recommendations for UD and Wayfinding pedagogy is outlined below. In the first place, **Concepts** must be established on three topics: Design, UD and Wayfinding. In relation to Design different phases demand specific attention:

- At the programming stage designers must address: User needs (physical, social and cultural); Qualification and Quantification of needs; Desires; Performance Indicators; Personal Interests and Ambitions; Design for society as a whole and Ethnographic concerns.
- Data collection should include: Goals; Facts; Concepts; Necessities and Location of Problems, therefore conditions that affect a design project.
- Analysis of repertoire is essential and includes: Theory - practice consistency evaluation and research results from Environmental psychology
- First design ideas need to concentrate on: Established Design Concept, Goals and Principles.

In architectural programming discussions the participants of this phase of the design process must reflect on a number of UD questions as outlined: 7 principals of UD; Human capabilities; Generosity; Empathy; Humanization; Equity; Cognitive abilities; Human senses and sensory experiences (Ryhl, 2009); Coping techniques; Psycho-social qualities; Person-environment interaction; Haptic perception; Ethics; Diversity as well as Serving the needs of others. Data collection in relation to UD must include Codes and Legislation according to location, Public policies and Technological developments. A thorough analysis of existing repertoire can also foster the introduction of UD as a design principle.

Where Wayfinding is concerned the design process must pay special attention to questions of Articulation of spaces (Zoning with coherent grouping of functional relationships); Routes; Circulation of users and goods; Legible circulation systems (paths, markers, nodes, intersections, edges, links and approach from street); Parking; Connection to mass transportation and Intuitively perceptible paths. Furthermore the legibility of spaces must take priority in design proposals through: Ease of users in organizing visual information; Defining boundaries; Clear

separation between indoor and outdoor spaces; Clear articulation; Clear routes and Markers. Wayfinding necessarily depends as well on an Integrated Signing System, Integrated Communication Systems, Maps and Models as well as Audible Visual Information.

Once concepts are established the design process needs support from **Methods and Tools**, especially when the process is participatory and includes a multidisciplinary team and users. To establish user requirements the following can be used: Observations; Questionnaires; Case studies; POEs; Cognitive maps; Testimonies; Walkthroughs; Focus groups; Eliciting, capturing and describing user needs; Problem Seeking (Peña & Prashall, 2012) and Codes and Regulations. To make sure that Psycho-social qualities are present in the design proposal such tools as Immersion in reality; Role playing; User participation; Narratives (Danko et al., 2006); Lectures of experts; Observation on a daily basis and Non-argumentative conversations are useful.

To proceed in the development of a proposal architects can be helped at the synthesis stage through problem solving methods such as: Thinking in alternatives; Holistic thinking; Evidence based design, Application of specific results from POEs; Checklists; Charrettes; Collaborations; a Multi-disciplinary team; DQI (Design Quality Indicator) (Gann et al., 2003) and CFA (Comparative Floor Plan Analysis) (Voord et al., 1997). Some common practices should also be present to further design ideas. Thus, models and tactile maps are important and students should be encouraged to develop their visual communication and motivational skills to convey their ideas. Design methods should be tested in the studio setting, to provide students with a sense of security in tackling their decision-making process.

Finally, **Guidelines** for design decisions are important. Hunter (2010) divides these in two parts: the building proximity and the interior. For the surroundings questions such as an Accessible route, Urban mobility and Barrier free urban design must be addressed. The building also needs identification through: Building form, Volumes, Physical separation, Clustering of components, Roof design, Location of openings, Cladding, Textures, Materials and Colours as well as

Ornamentation. Site planning must pay special attention to shaping of the site and the buildings setting through Landscaping, Berms, Roadways, Pedestrian paths and the placing and detailing of Entrances and Exits. When the design is completed Hunter (2010) recommends the use of GPS to check the proposal in detail.

In relation to the building interior Hunter (2010) gives special attention to: Indoor outdoor connections; the placing of Orientation tactile maps; Identifiable circulation spaces (paths, markers, nodes intersection, edges, links entrances and exits, elevators, staircases, escalators); Mobility aids (people movers, fixed rail systems); Ramp and elevator location; Ramp design; Visual identities (environmental graphics, sign systems, orientation devices, "you are here" maps, real-time information devices, colour schemes); Hierarchy of places and spaces; Proxemics; Sensorial perception (sound, smell, touch, ventilation, temperature, light, colour); Layout (Furniture: type, quantity, distribution); Finishing and Furnishing materials; Ergonometric and anthropometrics; Fittings and accessories; Usability and flexibility of space and finally Variability of Wayfinding by building type.

These recommendations are extensive but provide the design instructor with a pallet of ideas and tools to test in the studio setting. Students can also profit from a better-structured design process and develop their attention to detail, when becoming aware of the large number of issues involved in designing with UD and Wayfinding in mind.

Conclusions

The teaching experience, as a Charrette exercise described in this paper, demonstrates that design professionals could increase their UD awareness by considering universal design a challenge beyond the mere incorporation of code requirements. However, the example made clear that a new design process is necessary for professionals to understand more profoundly the needs of others,

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question traditional ways of doing things and be humble enough to accept participatory criticism during the design process.

For these changes to occur, design education must also change. The studio must open its doors more frequently to potential users with disabilities. The analytical phase of design must gain structure. Tools to understand various viewpoints, requirements and difficulties of users must be available.

Finally, the results of the teaching experience outlined several recommendations. These ideas provide guidance for a "design for all", which should be tested in innovative practices both at the professional and educational levels. Collective learning can then be achieved through the sharing of experiences and the addition of insights to a more inclusive design process.

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