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Usability
Evaluation Methods

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- Usability is, according to ISO 9241-11:

“the extent to which a product can be used by specified users to achieve specified goals with effectiveness, efficiency and satisfaction in a specified context of use”

- How to measure it??

Standards evolve:

- ISO 9241-11's three factors of usability have become five in by ISO 25010's quality in use factors:
- Effectiveness
- Efficiency
- Satisfaction
- Freedom from risk
- Context coverage

https://www.iso.org/standard/35733.html
https://www.interaction-design.org/literature/book/the-encyclopedia-of-human-computer-interaction-2nd-ed/usability-evaluation

(Cokton, 2013):

"Put simply, **usability evaluation assesses the extent to which an interactive system is easy and pleasant to use"**.

Things aren't this simple at all though, but …:

- Usability is a measurable property of all interactive digital technologies

- Evaluation methods determine if an interactive system or device is usable

- And the extent of its usability, through robust, and reliable metrics

- Evaluation methods and metrics are thoroughly documented …

http://www.interaction-design.org/encyclopedia/usability_evaluation.html
https://www.nngroup.com/articles/which-ux-research-methods/

Evaluation Methods

- **Analytical** (without users)
  - Heuristic Evaluation ✓
  - Cognitive Walkthrough ✓
  - Model based methods
  - Review methods
- **Empirical** (involving users)
  - Observation
  - Query
  - Controlled Experiments

  > usability tests ✓

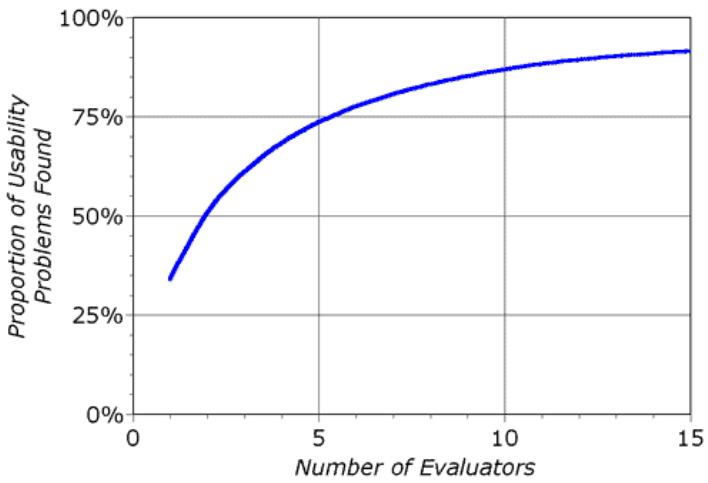
(✓ - have used in Lab classes)

Heuristic Evaluation (Nielsen and Molich 1990)

- A "**discount usability engineering method**" for quick, cheap, and easy evaluation of a UI design
- The most popular of the usability inspection methods
- It is a systematic inspection of a design for usability
- Meant to find the usability problems in the design so that they can be attended to as part of an iterative design process.
- Involves a small set of analysts judging the UI against a list of usability principles ("heuristics").

- Is difficult for a single individual to do; one person will never be able to find all the problems
- Involving multiple evaluators improves the effectiveness of the method significantly
- Nielsen generally recommends to use three to five evaluators
- not much gain by using larger numbers

https://www.nngroup.com/articles/how-to-conduct-a-heuristic-evaluation/

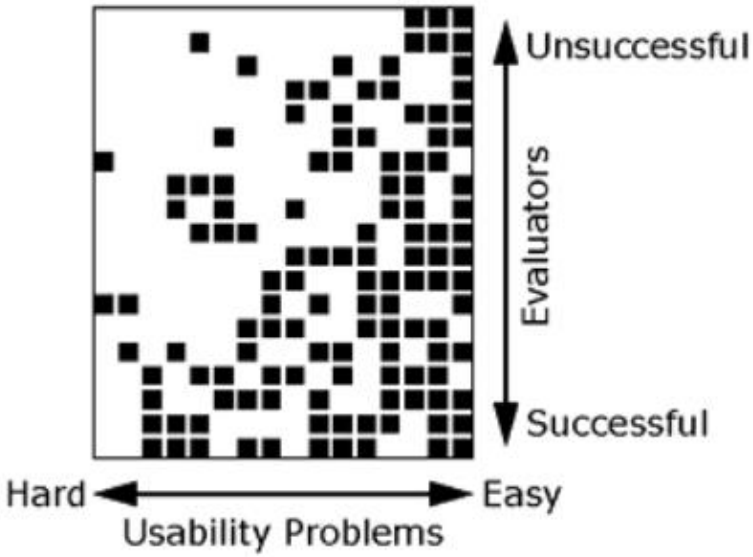


Example:

- Heuristic evaluation of a banking system:
  - 19 evaluators
  - 16 usability problems

black square - problem found

white square – not found



http://www.nngroup.com/articles/how-to-conduct-a-heuristic-evaluation/

This suggests that in general 3 to 5 evaluators may be reasonable…

How to select the number of evaluators for a specific case?

- Consider the following criteria:
  - **Complexity** of the user interface
  - **Experience** of the evaluators
  - **Expected costs** /benefits
  - **Criticality** of the system (cost of user errors)
  - …

How to perform HE

- Should be performed by **several evaluators**
  (one person will never be able to find all the problems)

- **Evaluators should work independently**:
  - First get **a general idea** of the UI
  - Then perform a **detailed inspection using a set of heuristics**
  - List usability problems (**heuristics not followed and severity degree**)

- Findings of all evaluators should be **integrated in the same report**

The report should help the development team to prioritize problem fixing!

https://www.nngroup.com/articles/how-to-conduct-a-heuristic-evaluation/

- Nielsen proposed **10 general usability heuristics**,

- yet **there are other sets, e.g. for**

  - different types of applications
    (web, mobile, visualization … applications)
  - different types of users
    (for seniors, children…)

http://www.interaction-design.org/encyclopedia/usability_evaluation.html

How to perform Heuristic Evaluation

Each evaluator:

- First **make a general analysis** to get to know the UI
- Then, make a **systematic analysis** having in mind **the heuristics**
- **Take note of each potential problem**, the heuristic and the severity grade

Finally, compile all the potential problems and discuss with other evaluators

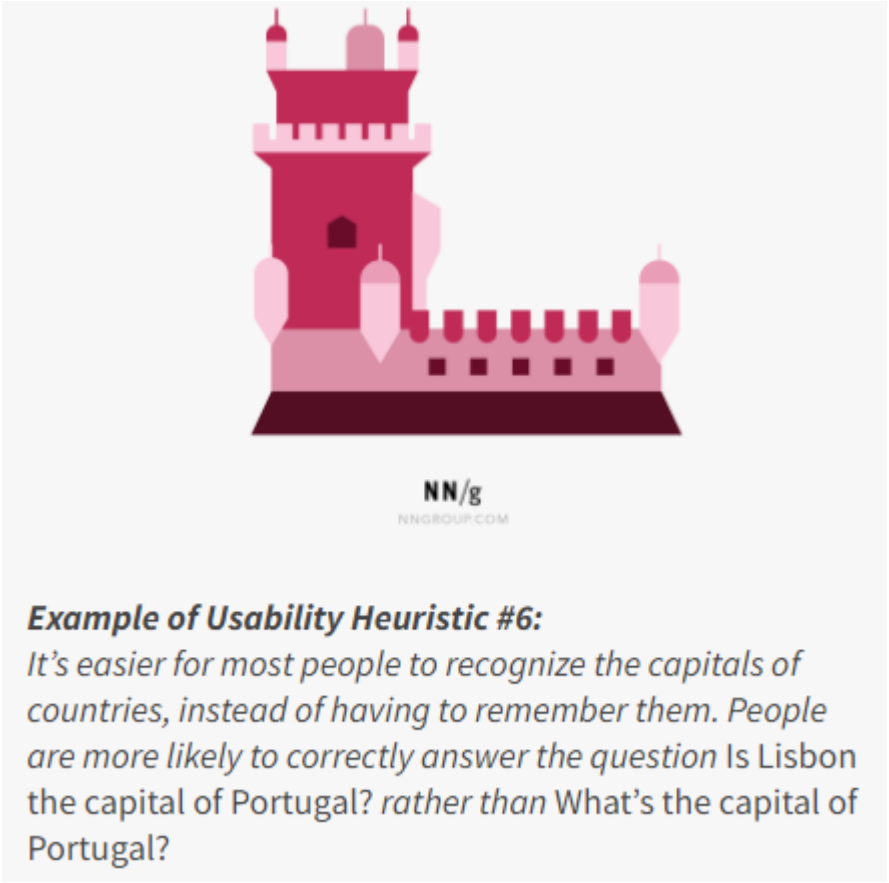
http://www.nngroup.com/articles/how-to-conduct-a-heuristic-evaluation

Ten Nielsen's heuristics

- Visibility of system status
- Match between system and the real world
- User control and freedom
- Consistency and standards
- Error prevention
- Recognition rather than recall
- Flexibility and efficiency of use
- Aesthetic and minimalist design
- Help users recognize, diagnose, and recover from errors
- Help and documentation

https://www.nngroup.com/articles/ten-usability-heuristics/

Example:
Heuristic #6 - Recognition rather than recall



Tips

- Let people recognize information in the interface, rather than having to remember ("recall") it.
- Offer help in context, instead of giving users a long tutorial to memorize.
- Reduce the information that users have to remember.

Learn more:

https://www.nngroup.com/articles/recognition-and-recall/

https://www.nngroup.com/articles/ten-usability-heuristics/

Severity rating of usability problems

Is a combination of **three factors**:

- The **frequency** with which the problem occurs
- The **impact** of the problem if it occurs
- The **persistence** of the problem

The following 0 to 4 **rating scale** can be used to rate the severity of usability problems:

0 = I don't agree that this is a usability problem at all (to be used in the discussion)

1 = **Cosmetic problem**

2 = **Minor usability problem**

3 = **Major usability problem**

4 = **Usability catastrophe**

http://www.nngroup.com/articles/how-to-rate-the-severity-of-usability-problems/

- **Main advantages of heuristic evaluation**:
  - May produce **useful results with modest investment**
  - **Simple to apply** even by not very experienced evaluators
  - May be **used along the development process from early phases**

- **Main limitations**:
  - **Subjective** (partially overcome with more and more experienced evaluators)
  - **Tends to find many small problems** which may not be very important
  - **Can't find all usability problems**

-> **evaluation involving users is needed!**

Cognitive Walkthrough (Wharton, et al., 1992)

- Usability inspection method **not involving users** (analytical)
- Based on the fact that users usually prefer to learn a system by using it (e.g., instead of studying a manual)
- **Focused on assessing learnability** (i.e., how easy it is for new users to accomplish tasks with the system)
- **Applicable at early phases**, before any coding

How to perform a cognitive walkthrough

1- **Task analysis**: sequence of steps or actions required by a user to accomplish a task, and the system responses

2- Designers and developers **walkthrough as a group**, asking themselves a set of questions at each step

3- Data gathering during the walkthrough: **answering the questions** for each subtask usability problems are detected

4- **Report of potential issues**

5- **UI redesign to address the issues identified**

CW Four questions:

- **Will the user try to achieve the effect that the subtask has?**
  (Does the user understand this subtask is needed to reach the goal?)

- **Will the user notice that the correct action is available?**
  (E.g. is the button visible?)

- **Will the user understand that the wanted subtask can be achieved by the action?**
  (E.g. the button is visible but the user doesn't understand the text and will not click on it)

- **Does the user get feedback?**
  Will the user know that they have done the right thing?

Common issues

- The evaluator may not know the optimal way to perform the task; the method involves the optimal sequence of actions

- Involves an extensive analysis and documentation and often too many potential issues are detected, resulting very **time consuming**

Thus:

Lighter variants of Cognitive Walkthrough were proposed to make it **more applicable** in S/W development companies

Streamlined Cognitive Walkthrough (Spencer, 2000)

- Only two questions:

  - Will the user know what to do at this step?

  comprises the 3 first questions of CW

  - If the user does the right thing, will they know that they did the right thing, and are making progress towards their goal?

- And a set of rules to streamlining the walkthrough and trade-off granularity for coverage

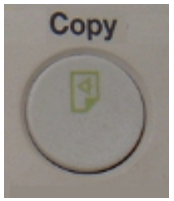
According to Spencer the method can be applied successfully if the usability specialist:

- takes care to prepare the team for the walkthrough,
- avoids design discussions during the walkthrough,
- explicitly neutralizes defensiveness among team members,
- streamlines the procedure by collapsing the first three questions into one question,
- and captures data selectively

Example: Evaluation of a desktop photocopier UI

- Machine UI:
  - numeric keypad,
  - "Copy" button,
  - push button on the back to turn on the power

The machine automatically turns itself off after 5 min inactivity



- Task: copy a single page
- User: any office worker
- Actions needed: turn on the power,
  put the original on the machine,
  press the "Copy" button

http://hcibib.org/tcuid/chap-4.html#4-1

- Story for action number one:

  “the user wants to make a copy and knows that the machine has to be turned on. So she pushes the power button. Then she goes on to the next action”

Not convincing!

- why shouldn't the user assume that the machine is already on? That is often the case

- Will the user figure out that the machine is off, and find the power switch?

  etc. etc.

Another example: Look for a person's phone number and email address at the University of Aveiro Web site
User: any student from the University

Task analysis:

- find the icon  (search);
- input part of the person's name and search in "Pessoas"
- get the phone number

But the defined user profile (any student from the University) includes foreign students, thus a previous action is needed:

- select the English version 

For each action we need to ask the two questions and put ourselves in the shoes of the user!

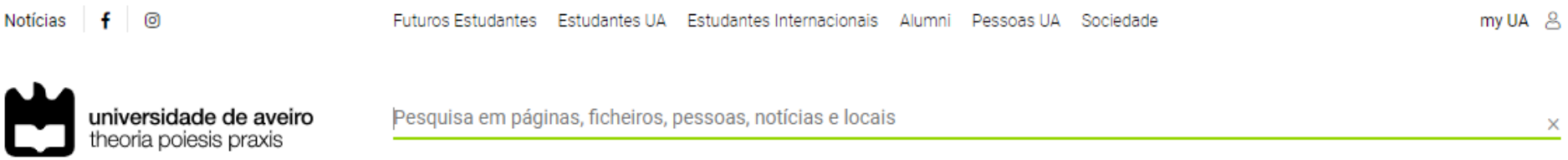
Previous action for foreign students: Select the English version seems easy (it is a "standard" way to do it in sites)

First action in the Portuguese version: find the icon 

Q1 - Will the user know what to do at this step?

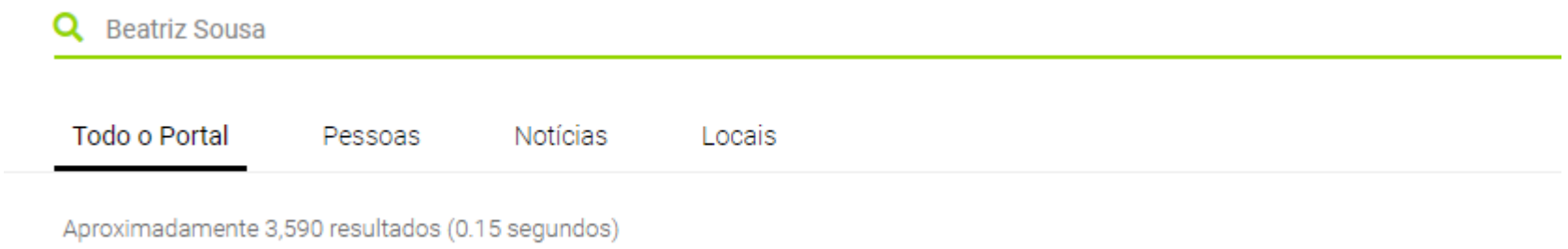
Even without tooltip the correct icon seems recognizable (it is "standard 

Q2 - If the user does the right thing (selects the icon), will they know that they did the right thing, and are making progress towards their goal?



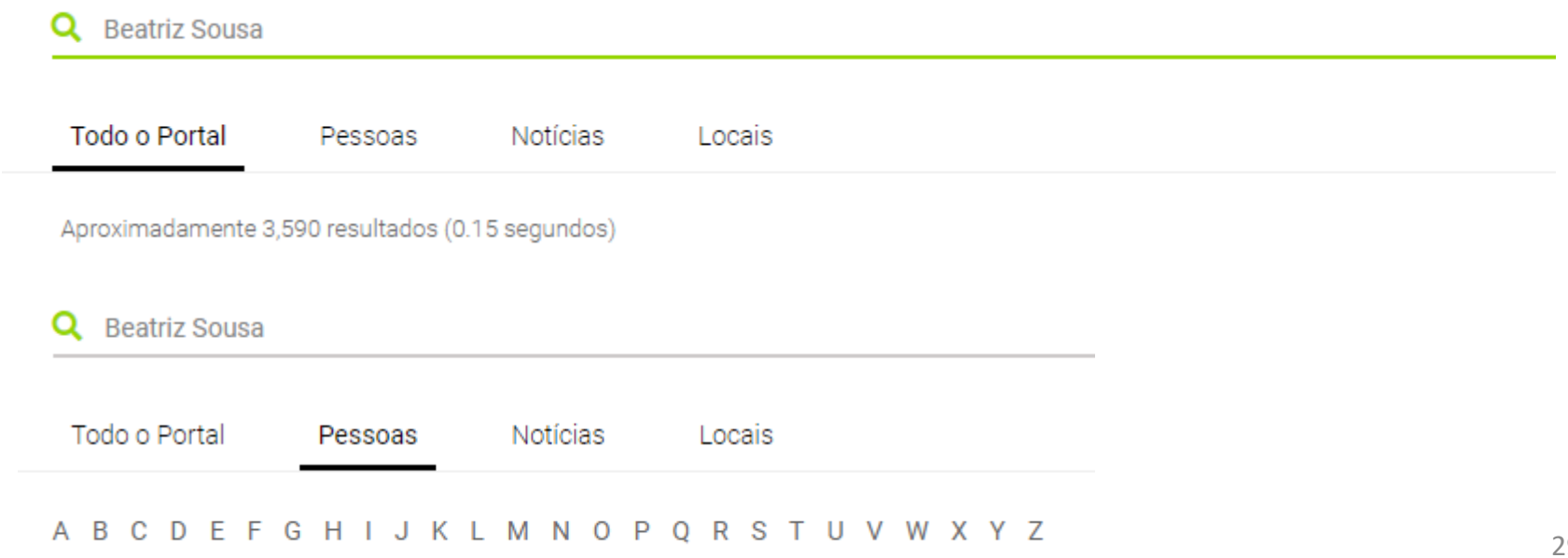
Probably yes; while it may not look a search bar, it is adequately labeled (Pesquisa em páginas, ...)

Second action: input part of the person's name and search in "Pessoas"

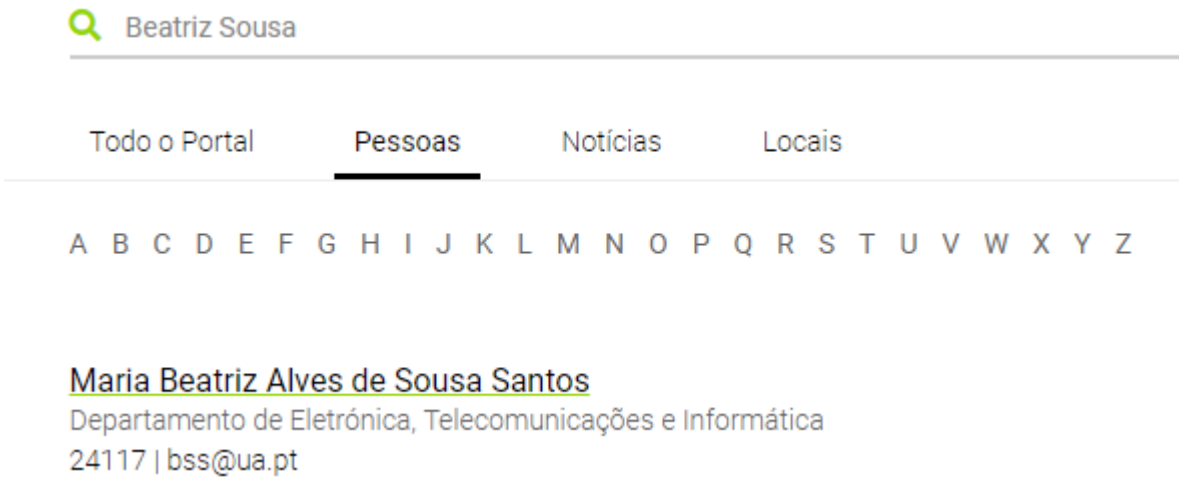


Q1 - Will the user know what to do at this step?

Probably yes; it is easy to recognize that s/he should input the person's name and select "Pessoas"



Q2 - If the user does the right thing (inputs the name and selects “Pessoas”), will they know that they did the right thing, and are making progress towards their goal?



Probably yes; however, some users may not recognize 24117 as a phone number (it only has 5 digits, as it is internal, and not 9 as possibly expected)

In conclusion:

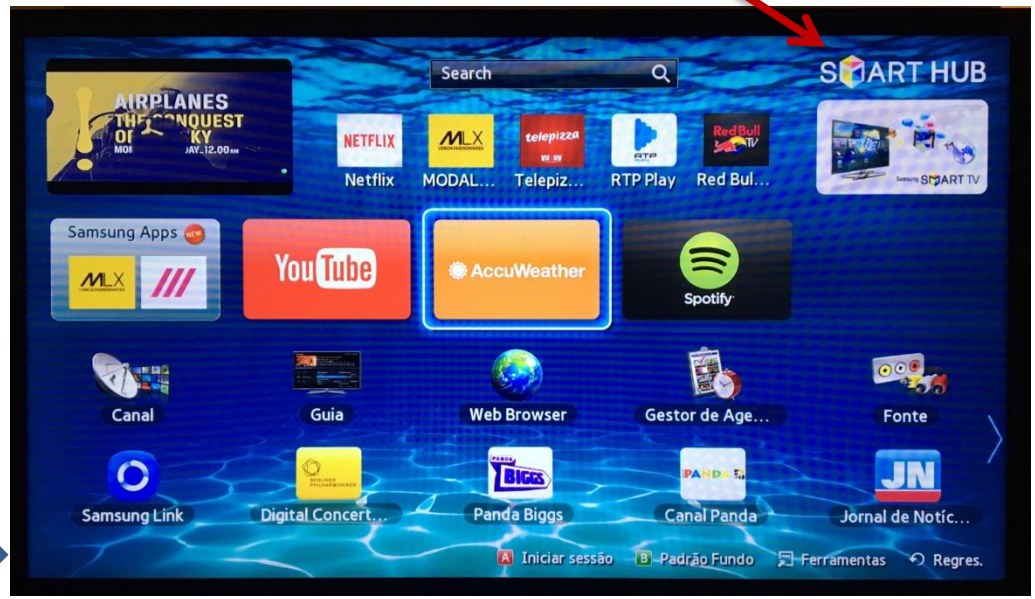
- it seems easy for the target users to reach the phone number and email address;
- however, the phone number may be not recognized as such

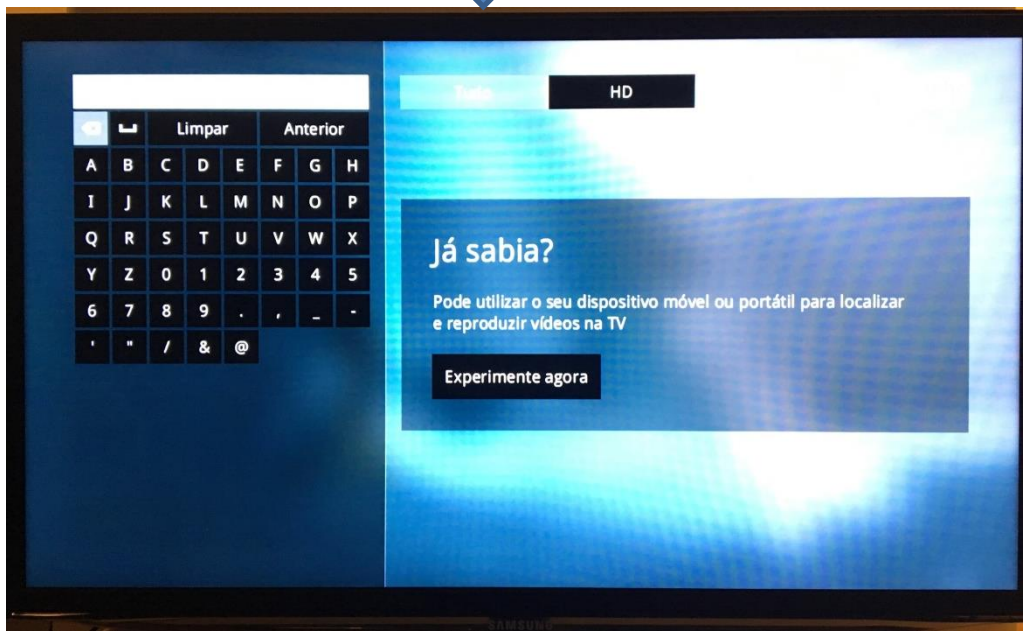
Another example: Smart TV

How to access the Internet?

(before reading the manual?)

(we see the symbol at the screen only after pressing it on the control!)





Practice the Streamlined Cognitive Walkthrough:

Analyzing interactive systems/applications that should be very intuitive (e.g. consumer electronics):

- Turn on and off the video projector in your Lab using the remote control or directly on the projector
  user: any student from the University

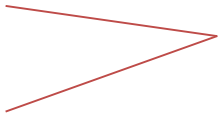
- Change the Channel using the box of your TV service (not the remote control)
  user: anyone having a TV box

Limitations of Analytical Methods

- Are subjective
- Involve several usability experts
- Cannot find all usability problems

Thus, empirical methods (involving users) are needed !!

observation
query
controlled experiments (scientific approach)



Usability test (engineering approach)

Evaluation Methods

- Analytical (without users)
  - Heuristic Evaluation ✓
  - Cognitive Walkthrough ✓
  - Model based methods
  - Review methods
- Empirical (involving users)
  - Observation > usability tests ✓
  - Query
  - Controlled Experiments ↙

(✓ - have used in Lab classes
↘ - have seen in papers)

Ethics in applying empirical methods

Involving users implies **specific cautions**:

- Asking for explicit consent
- Confidentiality
- Security (avoid any risk)
- Freedom (users may give up at any time)
- Limit stress

It's the system that is under evaluation not the user!

https://www.nngroup.com/articles/user-research-ethics/

Empirical evaluation styles

These methods may be performed:

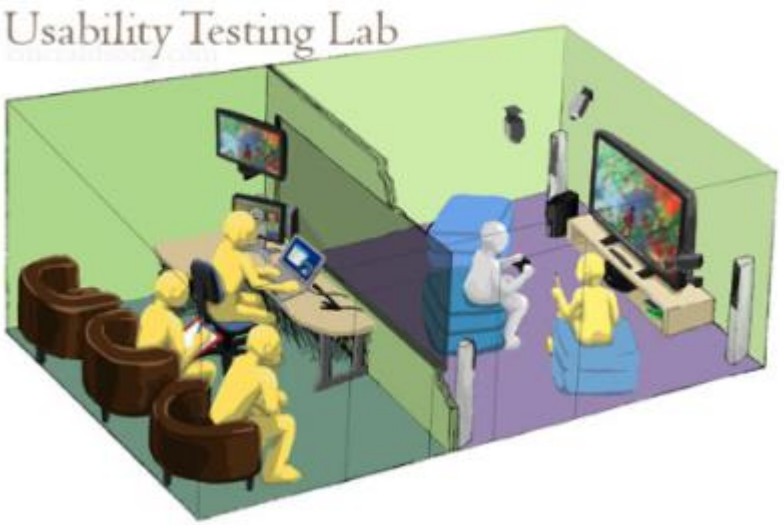
- In the laboratory (more controlled)
- In the field (more realistic)

They produce complementary information;

if possible use both!

https://www.nngroup.com/articles/field-studies/

Observation



Has many variants from very simple to very complex and expensive:

- Direct: observer takes notes
- Undirect: through audio/ vídeo – more complex and time consuming
- Think Aloud: users are asked to explain what they are doing
- Logging: users activity is logged by the system
- Combinations of the previous, etc

https://www.usabilitybok.org/usability-testing-methods

Think aloud Observation

Participants are asked to use the system while continuously thinking out loud (verbalizing their thoughts as they use the system)

Benefits:

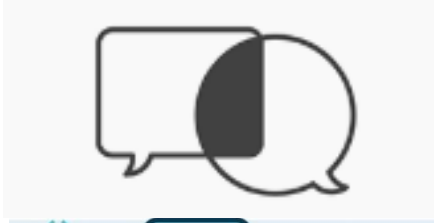
- Inexpensive
- Flexible
- Easy to learn and apply

Limitations:

- Unnatural situation
- Filtered statements
- Changing user behavior

https://www.usabilitybok.org/usability-testing-methods
https://www.nngroup.com/articles/thinking-aloud-the-1-usability-tool/

Query



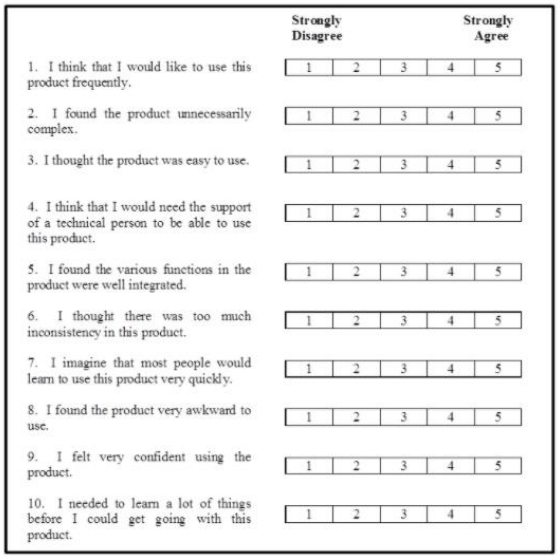
- Two main variants:
  - Questionnaire
    (reach more people; less flexible)
  - Interview
- **Should always be carefully prepared and tested**
- Collected data should be carefully analyzed

https://www.interaction-design.org/literature/article/useful-survey-questions-for-user-feedback-surveys
https://www.interaction-design.org/literature/article/how-to-conduct-user-interviews

Well-known usability questionnaires

- **System Usability Scale** (SUS)

- Questionnaire for User Interface Satisfaction (QUIS)



	Strongly Disagree				Strongly Agree
1. I think that I would like to use this product frequently.	1	2	3	4	5
2. I found the product unnecessarily complex.	1	2	3	4	5
3. I thought the product was easy to use.	1	2	3	4	5
4. I think that I would need the support of a technical person to be able to use this product.	1	2	3	4	5
5. I found the various functions in the product were well integrated.	1	2	3	4	5
6. I thought there was too much inconsistency in this product.	1	2	3	4	5
7. I imagine that most people would learn to use this product very quickly.	1	2	3	4	5
8. I found the product very awkward to use.	1	2	3	4	5
9. I felt very confident using the product.	1	2	3	4	5
10. I needed to learn a lot of things before I could get going with this product.	1	2	3	4	5

- SUS provides a “quick and dirty”, reliable tool for measuring the usability
- It includes 10 questions with five response options

- QUIS is a measurement tool designed to assess a computer user's subjective satisfaction with the UI
- It is designed to be configured according to the needs of each UI analysis by including only the sections that are of interest to the user
- It includes questions with ten response options

- Both questionnaires should be completed following use of the UI in question

System Usability Scale (SUS)

- Provides a "**quick and dirty**", reliable tool for measuring the usability
- It includes 10 questions with five response options
- It allows to **evaluate a wide variety of products and services**

  (H/W, S/W, mobile devices, websites and applications)
- Has become an **industry standard**, with references in over 1300 publications

Benefits of using a SUS

- Is a **very easy** scale to administer to participants
- Can be used on **small sample sizes** with reliable results
- **Is valid** – it can differentiate between usable and unusable systems

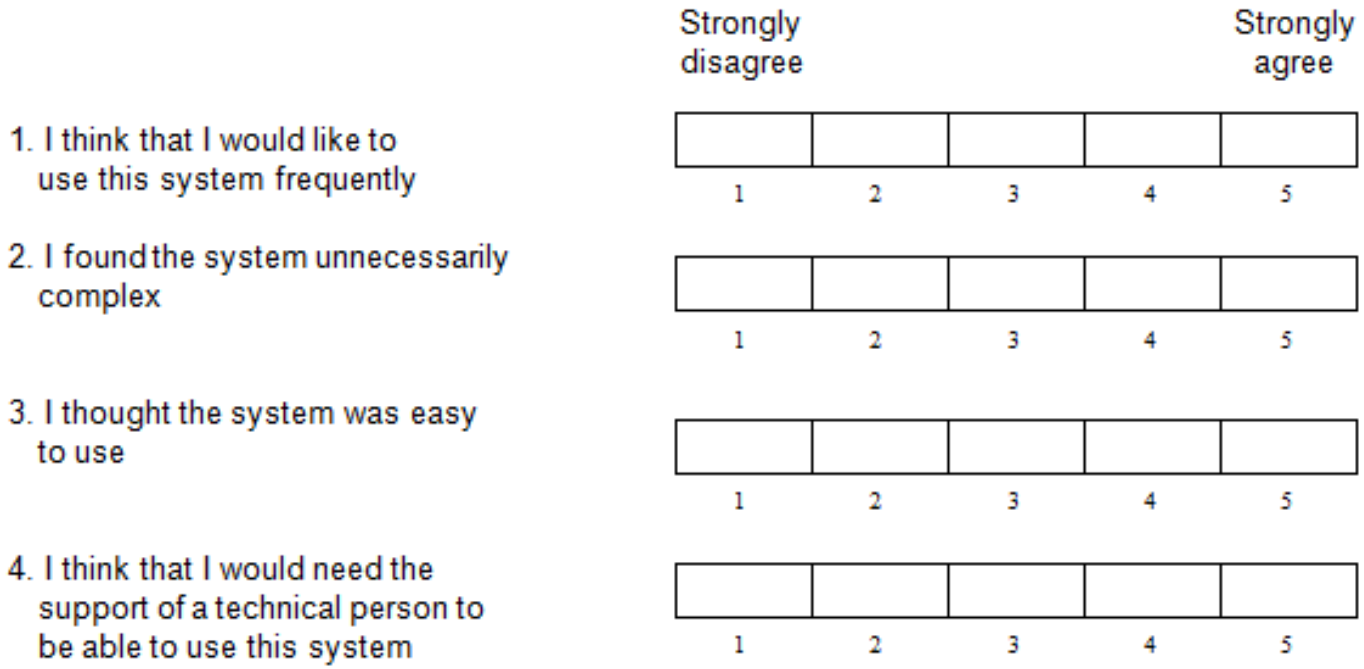
https://www.usability.gov/how-to-and-tools/methods/system-usability-scale.html

SUS Questions

- I think that I would like to use this system frequently.
- I found the system unnecessarily complex.
- I thought the system was easy to use.
- I think that I would need the support of a technical person to be able to use this system.
- I found the various functions in this system were well integrated.
- I thought there was too much inconsistency in this system.
- I would imagine that most people would learn to use this system very quickly.
- I found the system very cumbersome to use.
- I felt very confident using the system.
- I needed to learn a lot of things before I could get going with this system.

https://www.usability.gov/how-to-and-tools/resources/templates/system-usability-scale-sus.html

Scoring SUS



…

Let R(n) be the answer to Question n:

$$SUS = \left(\sum_{n=1}^{5} R(n)-1 + 5- R(n*2) \right) * 2.5$$

0… 100; SUS > 68 would be considered above average

QUIS - Questionnaire for User Interface Satisfaction

- The QUIS contains:
  - a demographic questionnaire,
  - a measure of overall system satisfaction,
  - a measure of specific UI factors (e.g. screen visibility, terminology and system information, learning factors, and system capabilities)
- QUIS has pen and paper and PC software versions for administration
- Uses a 10-point scale to rate 21 items relating to the system's usability
- These ratings produce data for the overall reaction to a system's usability on 6 factors.
- It is easy to use and analyse.

https://ext.eurocontrol.int/ehp/?q=node/1611

Example questions of QUIS

OVERALL REACTIONS TO THE SOFTWARE

terrible 0 1 2 3 4 5 6 7 8 9 wonderful

difficult 0 1 2 3 4 5 6 7 8 9 easy

frustrating 0 1 2 3 4 5 6 7 8 9 satisfying

inadequate power 0 1 2 3 4 5 6 7 8 9 adequate power

dull 0 1 2 3 4 5 6 7 8 9 stimulating

rigid 0 1 2 3 4 5 6 7 8 9 flexible

SCREEN

Characters on the computer screen

hard to read 0 1 2 3 4 5 6 7 8 9 easy to read

Highlighting on the screen simplifies task

not at all 0 1 2 3 4 5 6 7 8 9 very much

Organization of information on screen

confusing 0 1 2 3 4 5 6 7 8 9 very clear

Sequence of screens

USABILITY AND USER INTERFACE

Use of colors and sounds

poor 0 1 2 3 4 5 6 7 8 9 good

System feedback

poor 0 1 2 3 4 5 6 7 8 9 good

System response to errors

awkward 0 1 2 3 4 5 6 7 8 9 gracious

System messages and reports

poor 0 1 2 3 4 5 6 7 8 9 good

System clutter and UI “noise”

poor 0 1 2 3 4 5 6 7 8 9 good

Usability tests

- Involve **observation and query**

- Main aspects:
  - Participants
  - Tasks
  - Test facilities and systems
  - Protocol
  - Usability measures
  - Data analysis

- May have a **complex logistics**

- Standard: **Common Industry Format (CIF)** for usability test reports

https://www.usability.gov/how-to-and-tools/methods/planning-usability-testing.html
https://www.interaction-design.org/literature/topics/usability-testing

Participants

- The total number of participants to be tested
  (a valid statistical analysis implies a sufficient number of subjects)
- Segmentation of user groups tested, if more than one
- Key characteristics and capabilities of user group
  (user profile: age, gender, profession, computing experience, product experience, etc.)
- How to select participants
- Differences between the participant sample and the user population
  (e.g. actual users might have training whereas test subjects were untrained)

Tasks

- The task scenarios for testing
- Why these tasks were selected

  (e.g. the most frequent tasks, the most troublesome tasks)
- The source of these tasks

  (e.g. observation of users using similar products, product specifications)
- Any task data given to the participants
- Completion or performance criteria established for each task

  (e.g. n. of clicks < N, time limit)

Test Facilities and equipment

- The setting and type of space in which the evaluation will be done

  (e.g. usability lab, cubicle office, meeting room, home office, home family room, manufacturing floor, etc.)

- Any relevant features or circumstances that can affect the results

  (e.g. video and audio recording equipment, one-way mirrors, or automatic data collection equipment)

- Participant's computing environment

  (e.g. computer configuration, including model, OS version, required libraries or settings, browser name and version; relevant plug-in, etc.)

- Display and input devices characteristics

- Any questionnaires to be used

Protocol

- Procedure: the logical design of the test
- Participant general instructions and task instructions
- The usability measures to be used:
  a) for **effectiveness** (completeness rate, errors, assists)
  b) for **efficiency** (times)
  c) for **satisfaction**

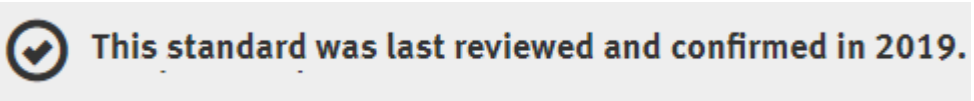
Common Industry Format (CIF) for usability test reports ISO/IEC 25062:2006

- Specifies the format for reporting the results of a **summative** evaluation
- The most common type of usability evaluation is **formative**, (i.e. designed to identify problems that can be fixed)
- A summative evaluation produces usability metrics that describe how usable a product is when used in a particular context of use
- The CIF report format and metrics are consistent with the ISO 9241-11

https://www.iso.org/standard/43046.html

https://www.userfocus.co.uk/articles/cif.html

Software engineering -- Software product Quality Requirements and Evaluation (SQuaRE) -- **Common Industry Format (CIF) for usability test reports**

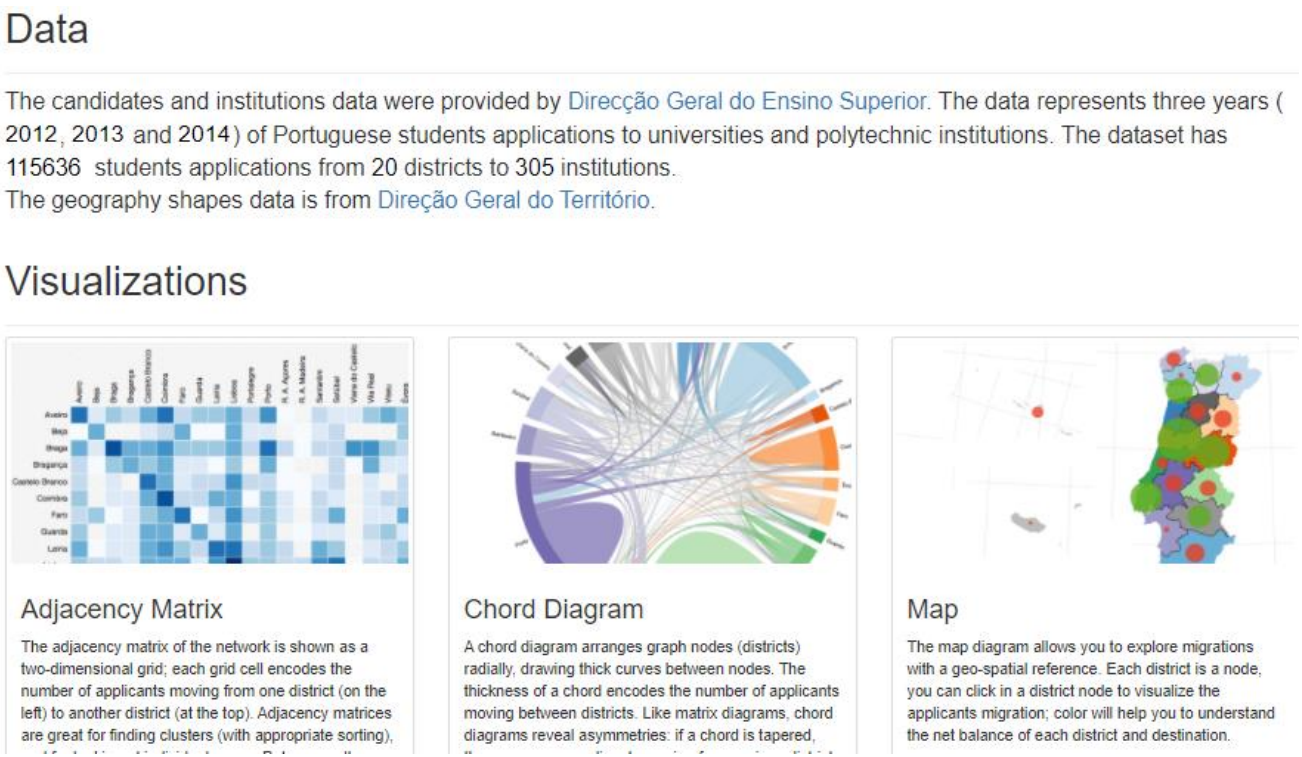


The format includes the following elements:

- the description of the product,
- the goals of the test,
- the test participants,
- the tasks the users were asked to perform,
- the experimental design of the test,
- the method or process by which the test was conducted,
- the usability measures and data collection methods, and
- the numerical results.

Example of a usability test of a visual data exploration application

based on a web questionnaire including tasks to be performed and questions to be answered by a user while observed by an experimenter



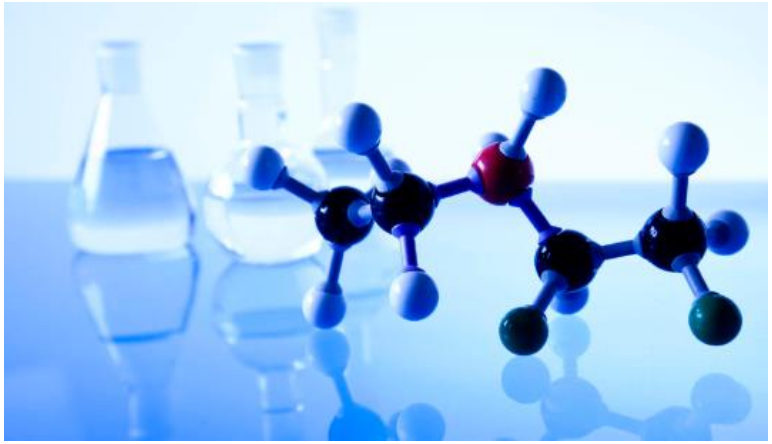
https://forms.ua.pt/index.php?r=survey/index&sid=489227

Evaluation Methods

- Analytical (without users)
  - Heuristic Evaluation ✓
  - Cognitive Walkthrough ✓
  - Model based methods
  - Review methods
- Empirical (involving users)
  - Observation > usability tests ✓
  - Query
  - Controlled Experiments ↙

(✓ - have used in Lab classes
↘ - have seen in papers)

Controlled experiments



- The **“work horse” of experimental science** ...

- Important issues to consider:
  - Hypothesis
  - Variables (input or independent; output or dependent, secondary)
  - Experimental design (within groups; between groups)
  - Protocol
  - Participants (number, profile)
  - Statistics

https://www.interaction-design.org/literature/book/the-encyclopedia-of-human-computer-interaction-2nd-ed/experimental-methods-in-human-computer-interaction

Controlled experiment

- Define **hypotheses**
- Define input (independent), output (dependent) and secondary **variables**
- Define **experimental design** (within-groups / between groups)
- Define **protocol**
- Select the **participants**
- Prepare all the **documentation and data gathering mechanisms**:
  - list of tasks and perceived difficulty
  - final questionnaire

  To the user
  - list of tasks for the experimenter to take notes

  To the experimenter
- Run a **pilot test**
- Take care of the **logistics** … and after the experiment **analyze data**

Controlled experiment

Variables:

- **Independent or input variables** – what is controlled
  (e.g. interaction method)

- **Dependent or output variables** – what is measured
  (e.g. times and errors)

- **Secondary variables –** not controlled but may influence the result
  (e.g. age, previous experience)

Controlled experiment

Experimental design:

- **Within-groups or within-subjects** – all participants use the same conditions (usually in randomized order to avoid bias)

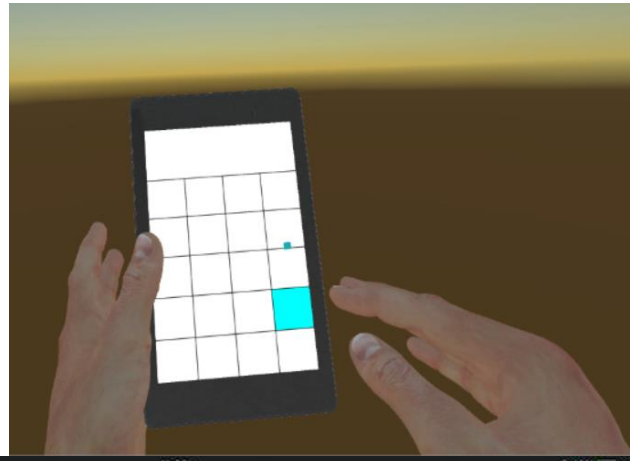
  advantages – a smaller number of participants
  same profile
  disadvantages – prone to fatigue or learning bias

- **Between-groups or between-subjects** – each participant uses only one condition

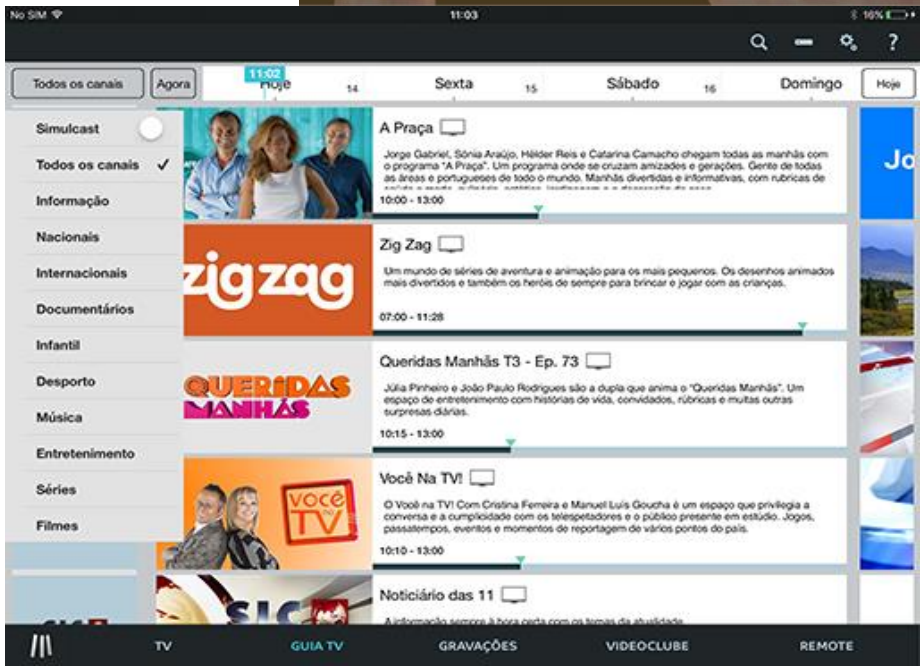
  advantages – less fatigue or learning bias
  disadvantages – higher number of participants needed
  different participants' profile

Examples of Controlled Experiments performed @ HCI - DETI

- Study of the Effect of Hand-Avatar in a Selection Task using a Tablet as Input Device in an Immersive Virtual Environment



- Comparing two alternative versions of Meo Go



“Effect of Hand-Avatar in a Selection Task using a Tablet as Input Device in an Immersive Virtual Environment”

L. Afonso, P. Dias, C. Ferreira, B. Sousa Santos
IEEE 3D UI, Los Angeles, March 2017

- Research question: How does the virtual representation of the user's hands influence the performance on a button selection task performed in a tablet-based interaction within an immersive virtual environment?

- Method: Controlled experiment

- 55 participants used three conditions:
- no-hand avatar,
- realistic avatar,
- translucent avatar.

- Participants were slightly faster but made more errors with no-avatar

- Considered easier to perform the task with the translucent avatar

Experimental Design

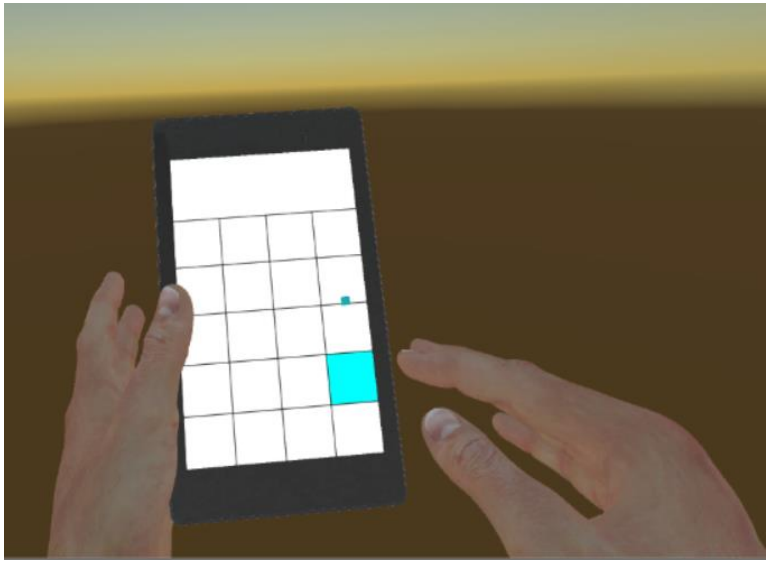
Null Hypothesis: usability is independent of the hands representation

Independent (input) variable (with 3 levels): representation of the hands

Dependent (output) variable: usability (performance + satisfaction)

Within-groups: all participants used all experimental conditions (in different sequences to avoid learning or fatigue bias)

Task: selecting as fast as possible a highlighted button from a group of twenty buttons (repeated measures)

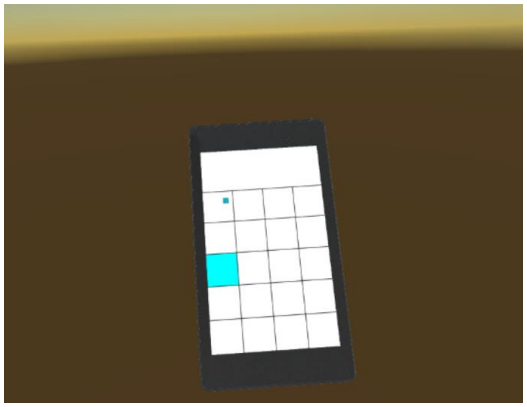


Experimental Conditions

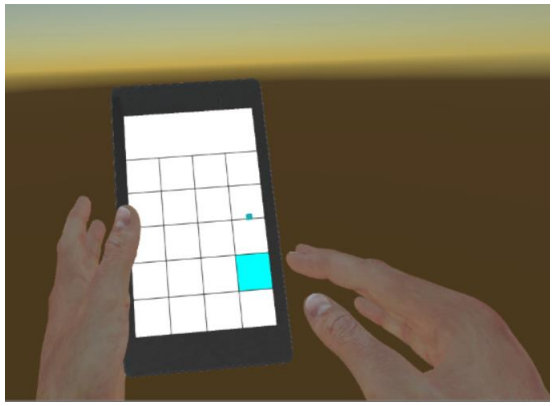
1- **No avatar**: the user only sees the virtual tablet;

2- **Realistic avatar**: a realistic representation of the hands movement is shown

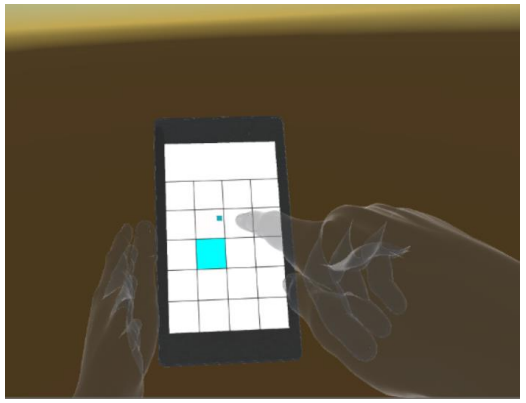
3- **Translucent avatar**: a translucent hand model is used (to alleviate occlusion)



No-avatar



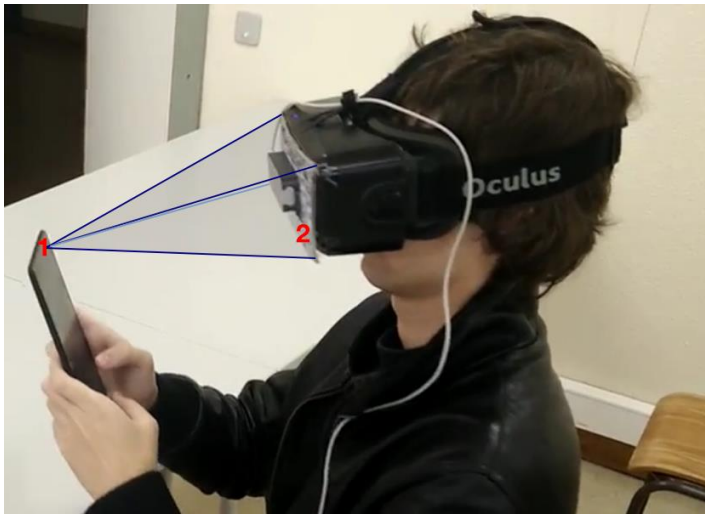
Realistic avatar

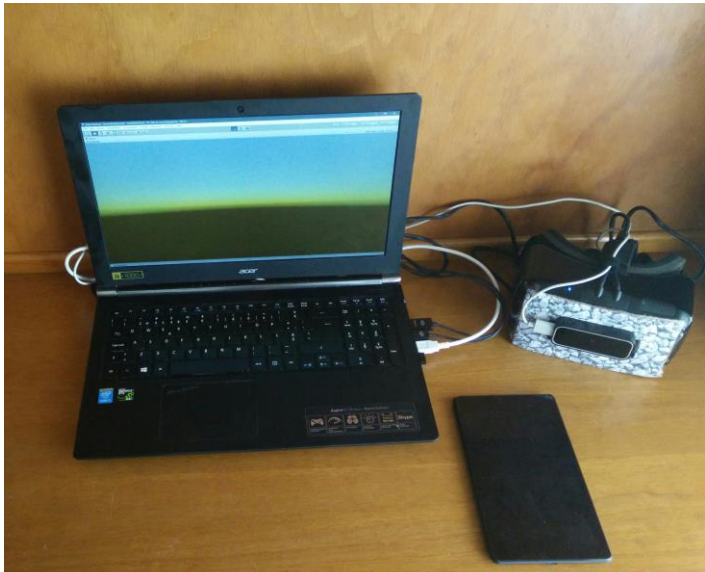


Translucent-avatar

Experimental Set-up

- Laptop running the main application (in Unity)
- HMD (Oculus Rift DK2) providing head tracking
- Tablet (Google Nexus 7) as input device running the controller application (in Unity)
- Leap Motion (mounted on the HMD) to track the user's hands
- Tablet camera tracking the position and orientation of an AR marker on the HMD to map tablet position in the virtual world (using Vuforia)



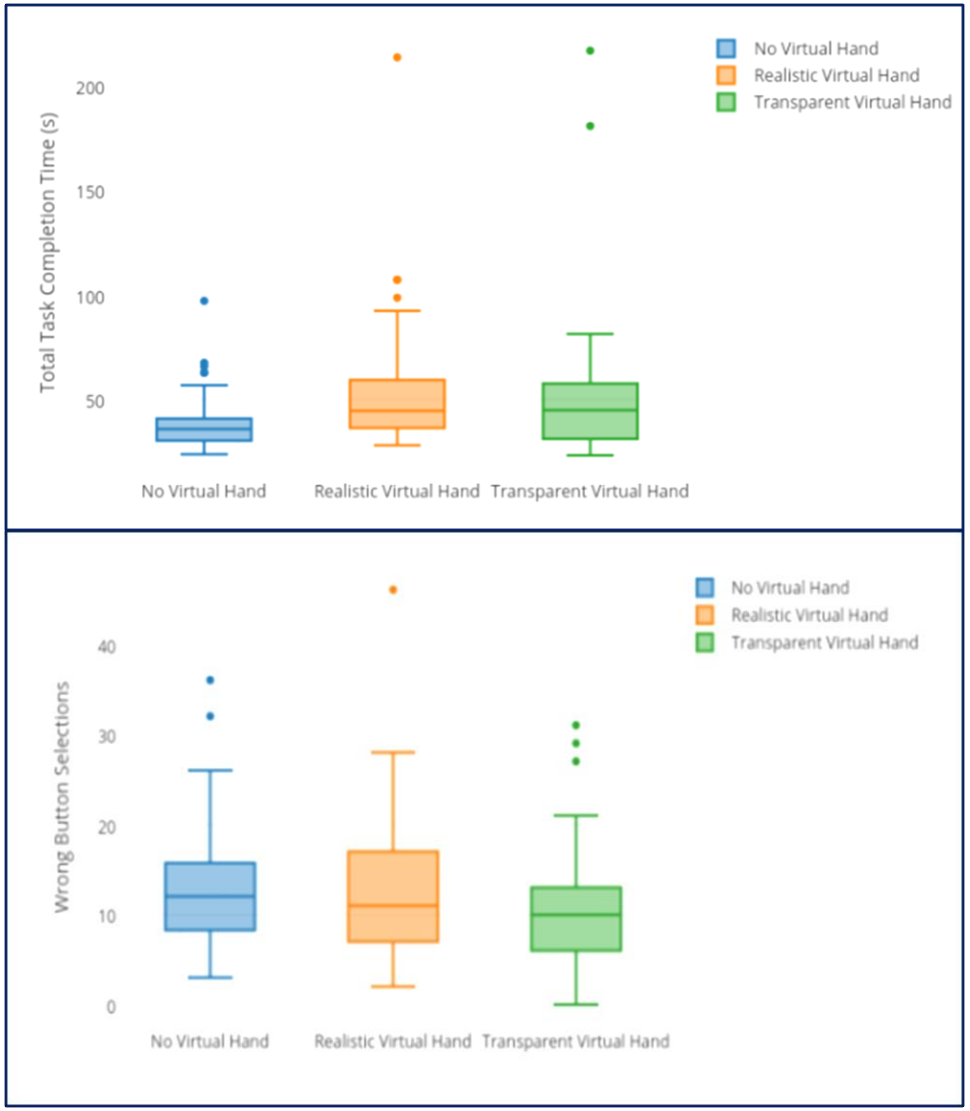


Main Results

Selection time:
Participants completed the button selections in average **faster with no-avatar** (**statistically significant**)

Selection errors:
Participants made slightly less errors with avatar - realistic or translucent- (**statistically significant**)

Participants' opinion:
The translucent avatar:
- was more often preferred
- was considered as better than the realistic avatar (statistically significant)



Now available in Moodle:

Test exam

Questions to help prepare exam

Bibliography for Usability evaluation – Books and links

- **Alan Dix, Janet Finlay, Gregory Abowd, Russell Beale, *Human-Computer Interaction*, 3rd edition, Prentice Hall, 2004**

- Jackob Nielsen, Usability Engineering, Morgan Kaufmann, 1993

- **Peter Mitchell, *A Step-by-step Guide to Usability Testing*, iUniverse, 2007**

- Gilbert Cockton, Usability Evaluation. In: Soegaard, Mads and Dam, Rikke Friis (eds.), The Encyclopedia of Human-Computer Interaction, 2nd Ed, 2013, Aarhus, Denmark: The Interaction Design Foundation. (2018)

http://www.interaction-design.org/encyclopedia/usability_evaluation.html

- Norman/ Nielsen Group site - http://www.nngroup.com/articles/
- Usability.gov site - https://www.usability.gov/index.html
- User focus site - https://www.userfocus.co.uk/articles/

Epilogue of this course

- We will have the Human in the loop for long in most situations …
- And even when/if they are no longer in the loop

Technology shall serve the Human

(and not the other way around…)

Preparing the Exam

- Study the Slides
- Study the mandatory readings
- Answer the Exam preparation questions available in Moodle

Mandatory Readings for the Exam

- Slides available at Moodle and at the course web page:

  http://sweet.ua.pt/bss/disciplinas/IHC-ECT/IHC-ECT-home.htm

- Alan Dix t al., *Human-Computer Interaction*, 3rd ed., Prentice Hall, 2004
  (at the Library)
  - Chapters: 1 to 4 (for the topics addressed in the slides)
  - Chapter 9 (for the topics addressed in the slides)
  - Chapters 12, 14 and 16 (for the topics addressed in the slides)

- Ian Sommerville, *Software Engineering*, 9. Ed., Addison Wesley, 2009
  (Chapter 29, available at Moodle)