Inclusión, discapacidad y educación

Enfoque práctico desde las Tecnologías Emergentes

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Vladimir Robles Bykbaev y Paola Ingavélez Guerra
(Coordinadores)

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Towards software for measuring intelligence quotient of people with intellectual disabilities

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Abstract

This document explains the development of a web application to measure the Intelligence Quotient (IQ) of people with intellectual disabilities. For the development, prototyping was used. For the interfaces, User Experience Design (UX) was used.

Because it allows to create the application using the user as part of the development team, and with that, an application was obtained that comes closer to the reality of the solution of the problem.

The use of an IQ test to a person with intellectual disability has shown three important problems to be considered for the development approach of an application.

A person with an intellectual disability cannot be evaluated directly with a web application. This person has special needs, and may become stressed, angry, or distracted while completing the test. The American Association on Intellectual and Developmental Disabilities (AAIDD) and the fifth edition of the Diagnostic and the Statistical Manual of Mental Disorders (DSM-5) advise that to measure the IQ and to classify it, it is necessary to use scales that evaluate other aspects besides intelligence. Scales such as

Wechsler Intelligence Scale for Children (WISC) and Zazzo fulfill this criterion. Other scales, such as Raven's scale, are not advisable because they only focus on intelligence.

In the measurement of the IQ of people with intellectual disabilities, it is necessary the therapist. Because it generates an atmosphere of trust between the person with intellectual disability and the tool to measure the IQ, so it is necessary for the development of the application the interaction between the therapist, the person with a disability and application.

Keywords: Intelligence Quotient, prototype, user experience design, intellectual disabilities.

Introduction

The Intelligence Quotient (IQ) of people with intellectual disabilities need to be measured at least once a year to determine the progress that has been made depending on the therapies received. Therefore, in this work a web application to carry out IQ evaluations based on Wechsler Intelligence Scale for Children (WISC) and Zazzo is presented.

The intellectual disability is diagnosed using questionnaires and scales. The following examples are tests that measure the IQ:

- The Raven Progressive Matrices (RPM) tests (of which there are several versions) are made up of a series of diagrams or designs with a part missing. Those taking the tests are expected to select the correct part to complete the designs from some options printed beneath (Raven, 2000).
- The Stanford–Binet Intelligence Scale is a cognitive ability and intelligence test that is used to diagnose developmental or intellectual deficiencies in young children. The test measures five weighted factors and consists of both verbal and nonverbal subtests. The five factors being tested are knowledge, quantitative reasoning, visual-spatial processing, working memory, and fluid reasoning (Becker, 2003).
- The Wechsler Intelligence Scale for Children (WISC) is an individually administered assessment containing fifteen subtests that provide a comprehensive assessment of intellectual ability. The

WISC-IV can be used with individuals aged 6–16 and contains normative tables for this age group.

- The Zazzo scale is a test that evaluates intelligence in a global way in children under 12 years. The test consists of verbal questions, logic and practical reasoning (Zazzo, 1984).

These are the most frequently used scales in the world. It is important to mention that all the scales are applied manually by using their manuals and tools. There are web and mobile applications that measure the IQ through different scales. For example, the Organization MENSA has a web test to measure the IQ through the scale of Raven and only focuses on intelligence (Mensa International, 2017). Another application is the test of Stanford–Binet. It concentrates on verbal questions of logic and mathematical reasoning (Stanford Binet, 2017). It is important to highlight that there are other applications, but they only focus on intelligence.

The most important aspects to evaluate people with intellectual disabilities are intelligence, adaptive behavior, behavioral problems, curricular competence, motivation to learn, learning potential, and family environment (Thompson et al., 2009). These aspects are considered in Psychopedagogy evaluation of light intellectual disability and limit retardation elements and modes of evaluation (Sánchez & Cárdenas, 2007), the DSM-5 Manual of the American Psychological Association (American Psychiatric Association, 2013), WISC III and Zazzo.

The American Association of Intellectual and Developmental Disabilities (AAIDD) defines intellectual disability as a disability characterized by significant limitations in both intellectual functioning and in adaptive behavior, which covers many everyday social and practical skills. This disability originates before the age of 18 (AAIDD, 2013).

There are currently 93,989 people with an intellectual disability in Ecuador (CONADIS, 2017). They are classified by the IQ score: mild, moderate, severe and profound. The measurement is diagnosed by the-

rapists who work in clinical centers and institutions of special education that are specialized in intellectual disability. The most used scales in Ecuador are WISC-III and Zazzo. The therapists evaluate with these scales and didactic materials, but the main problem is that the process is done manually.

The purpose of this paper is to offer a solution to the manual process of the measuring IQ for people with intellectual disability according to the social reality of Ecuador. Also, the automatization of WISC-III and Zazzo in the diagnose of IQ and the registration of scores will be a useful tool for the therapists.

The rest of this paper is organized as follows. Section 2 presents materials and methods including user experience design and prototype development. Section 3 presents results and discussion. Finally, section 4 concludes the paper with final remarks and future work.

Materials and methods

User experience design

User Experience Design (UXD) was used for the development of the application because the methodology centers in the solution of the problem by incorporate the end users to the development team and to enrich the application of their experience with the application (Garrett, 2011).

The application was developed with two prototypes in three iterations. The first prototype was designed for the interaction of the person with a disability and the application. Then, the second prototype changed to an interaction between the therapist, the person with a disability and the application. The development stages of the application are show in Table 1:

Table 1
Layers of UXD applied to the design and development of the application

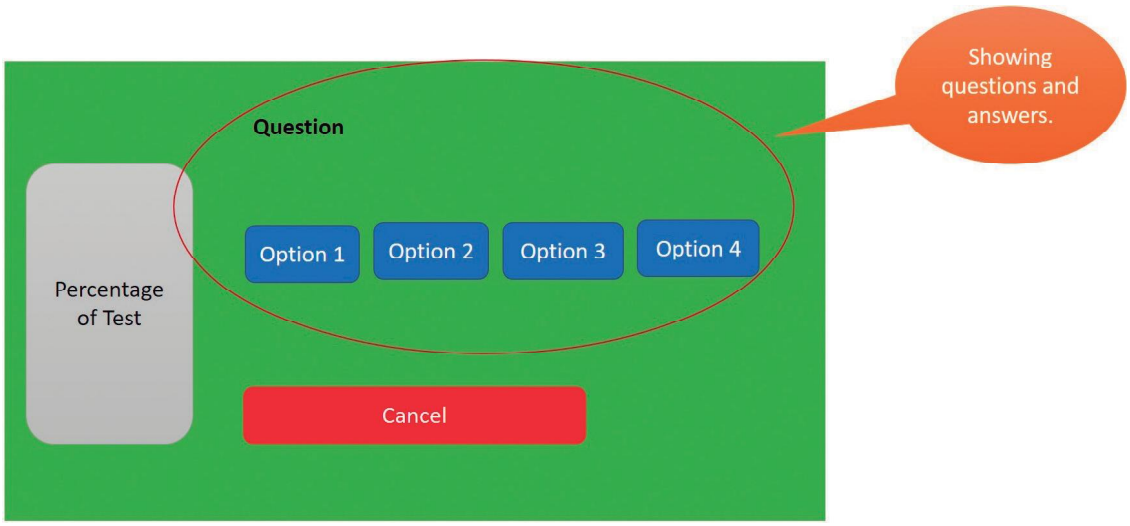
Elements	Description	Compliance
The Strategy Plane	The scope is fundamentally determined by the strategy of the site. This strategy incorporates not only what the people running the site want to get out of it but what the users want to get out of the site as well.	It was defined that the website will measure the IQ of people with intellectual disabilities. The first prototype was designed to evaluate the people directly with intellectual disabilities. The second prototype was changed for the interaction with therapists and the application.
The Scope Plane	The structure defines the way in which the various features and functions of the site fit together. Just what those features and functions constitute the scope of the site.	General Software features and functions: Measure the IQ of people with intellectual disabilities. First iteration: To whom the test is directed: child or adult. Show the questions and answers. Show the results calculated based on the results. After the first iteration: Register users. Register people with intellectual disabilities. Show questions, and register results. Show results based on the answers to the questionnaire. Save the results of the questionnaires of people with intellectual disabilities. Show history of the results of people with intellectual disabilities.
The Structure Plane	The realm of the structure is the third of the five planes, and appropriately it is the point at which our concerns shift from the more abstract issues of strategy and scope to the concrete factors that will determine what users finally experience.	Navigation First iteration: questions and answers pages After the first iteration: user registration and login. Session after logging: Register person with intellectual disabilities. Take the questionnaire. View evaluation history.

Elements	Description	Compliance
The Skeleton Plane	The skeleton plane defines what form that functionality will take. In addition to addressing more concrete issues of presentation, the skeleton plane deals with matters that involve a more refined level of detail.	The navigation and buttons were defined for all the pages. "Start Test" on the home page, "Cancel" in the question and answer page. The text of the questions and answers and the test results are placed as shown in Figure 1 y 2.
The Surface Plane	The surface plane defines the design visual of the elements of the information on the interface, through attention to information design is determinate how to group and organize the information elements of the page.	The logo, text, and images were specified to determine the application appearance. The elements were placed in the interfaces: home, question and answer and the test results page.

Source: By authors.

The Skeleton question and answer page in the first prototype is shown in the Figure 1:

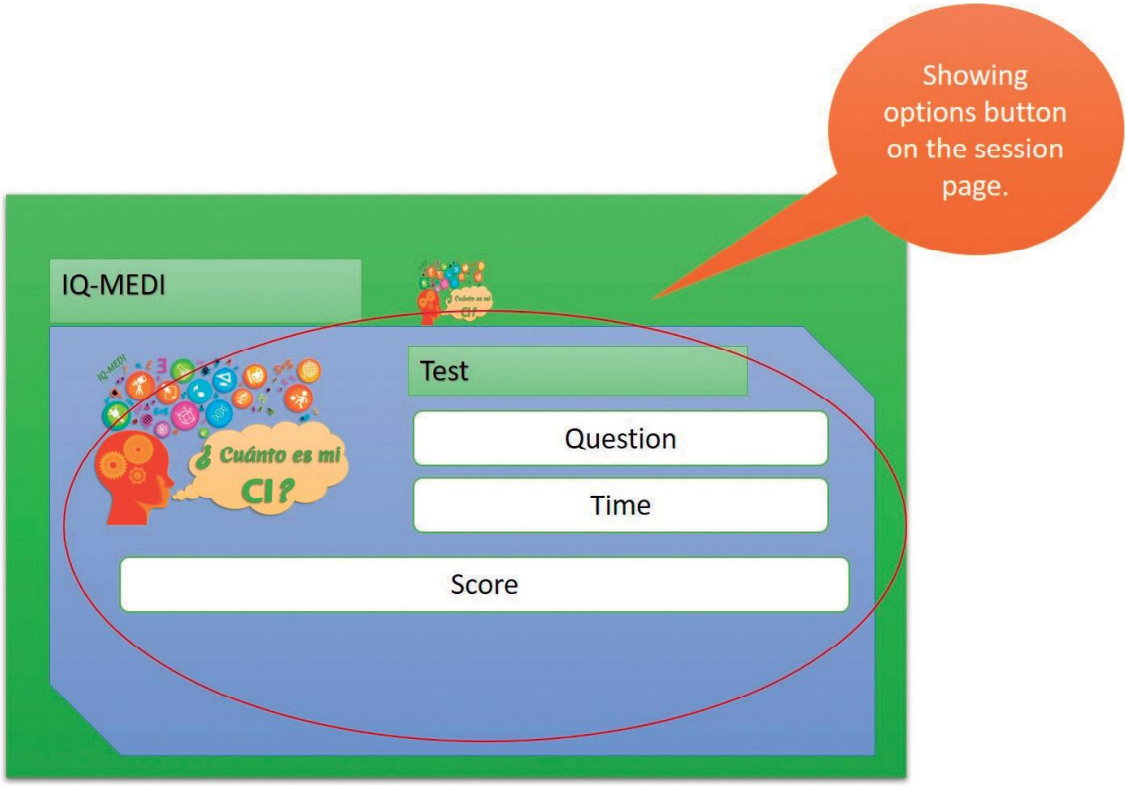
Figure 1
Skeleton question and answer page in the first prototype



Source: By authors.

The Skeleton on the session page in the second prototype is shown in the Figure 2:

Figure 2
Skeleton question and answer page in the second prototype



Source: By authors.

Prototype development

Prototype development was used especially for freedom that it has to modify the requirements drastically without losing the objective of the project (Sommerville, 2011)", and to complement some deficiencies of UXD on the requirements because these could change drastically in the development of the project.

Prototyping plan – Establish prototype objectives: In this phase the following activities were carried out:

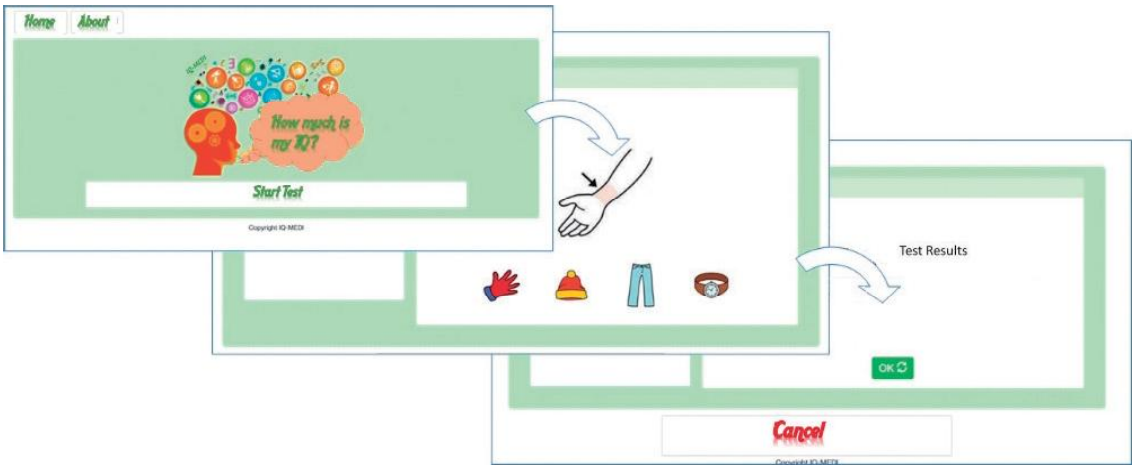
- The main objective of the project is to make an application that measures the IQ of people with intellectual disabilities. Use standard scales that measure the IQ, to generate the tests.
- Show the results of the test and classify the level of intellectual disability.
- After the first iteration:
  - ❑ Register the therapist and the person with intellectual disability.
  - ❑ Keep a record of the assessments made per person with intellectual disability assessed.

Outline Definition – Define prototype functionality: They are the same functions of the Scope Plan of Table 1.

Executable prototype – Develop prototype: For the development of the prototypes, UXD was used as a working framework to have a prototype that came closer to the reality of the solution of the problem.

The first prototype of the first iteration is shown in Figure 3:

Figure 3
First prototype - Homepage, Question page, and Results page



Source: Own elaboration.

Second prototype after of the first iteration is shown in Figure 4:

Figure 4
Second prototype - Homepage, and Register Form.

Source: Own elaboration.

Evaluation report – Evaluate prototype: The evaluation of the first prototype was carried out with a group of people who had an intellectual disability and did not have it. Moreover, it was carried out in a foundation of people with intellectual disabilities, in which information was obtained that the intellectually disabled needs help from a therapist to perform the IQ measurement and that therapists need to keep a record of the assessments to see the progress of the person with an intellectual disability over time. After it was implemented the new requirements, the second evaluation was made to the second prototype, with the help of the therapists and people with disability in which were obtained favorable results, and that the application only needed visual changes.

Results and discussion

Results

The application was evaluated in different aspects, and the results were as follows.

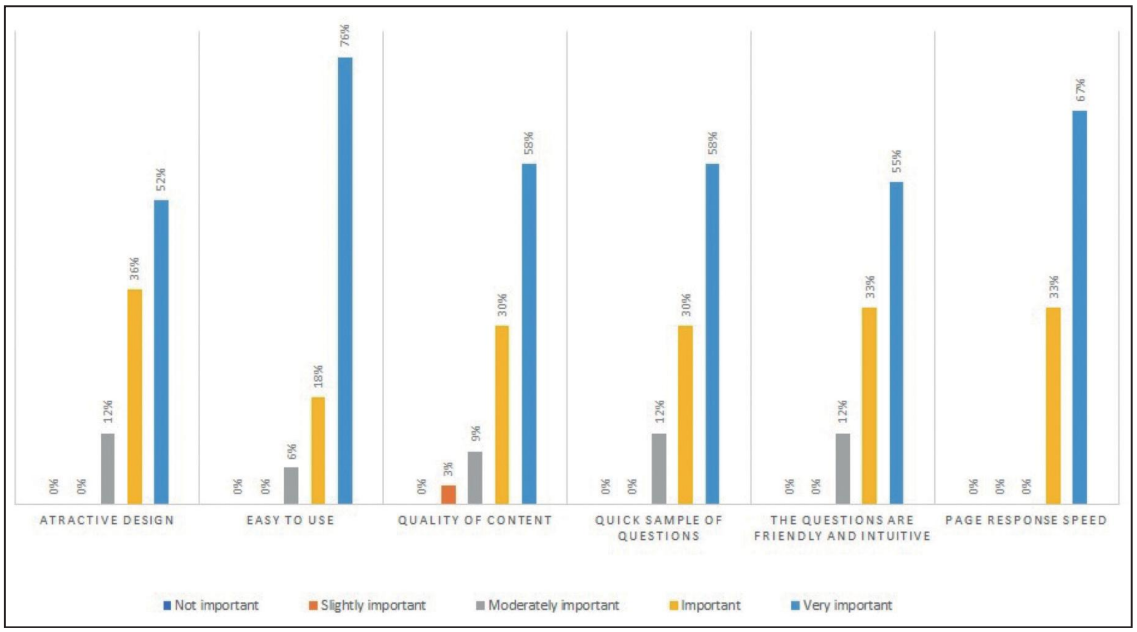
The questionnaire involved 33 people, including professionals in the field of intellectual disability and people with intellectual disabilities, and the results are as follows.

The age of the participants:

- 0 to 15 years = 0%
- 16 to 18 years = 12%
- 19 years and over = 88%

The participants evaluated the different characteristics of the application in the level of importance, and the results are shown in Figure 5:

Figure 5
Importance of characteristics in the evaluation



Source: By authors.

Participants were asked if they would use the application and the results were the following:

- Yes 90.6%
- No 12.5%

Participants were asked how they would like the order of the questions and the results were the following:

- First the questions for the relative of the person with intellectual disability: 33.3%
- First the questions for the person with intellectual disability: 69.7%

Participants were asked what they liked, and the results are as follows:

- Ease of use, and little dynamic.
- The formulation of the questions for the companion was a bit confusing.
- The questions are a difficulty, and the color is missing.
- There must be more variety in the questions.
- Some questions did not show the correct answer.
- Questions from parents should be better written.
- Intelligence categorizes the users, and the tricky questions.
- Some questions were unclear. Everything seemed very well designed.
- The selection frame is very confusing. Use of the standardized test.

Participants were asked if they had any advice to give and the results are as follows:

- Keep improving. The user liked the app.
- Apply more questions from other areas (not just logical reasoning).
- The suggestion would be to help print the results. Be more didactic.
- Measure the IQ based on different tests. Correct the answers.
- More ways to measure their mental capacity. You should have more questions.

- Make an agreement with some faculty of psychology, since the usual tests usually fail.
- The measurement of the IQ level is not the most relevant, it must be complemented by other ten areas of social skills.
- Be more colorful to get people's attention.

Discussion

The results were favorable in the first prototype, although some comments were that the questions were confusing, this was because some scales were used to create the first prototype and a scale was the Raven scale. Moreover, this scale by the generality creates confusion in the user. Moreover, that the application had to be more dynamic, it was because the prototype was simple. However, many participants said that the prototype lacks questions: in quantity, other areas of knowledge, and other standardized tests. These type of answers were expected of the first prototype, because the prototype was designed with few questions, and simple design, with the objective of that the application was easy to use for all people.

Although the application was designed with the help of an end user, it was not completely applicable to people with intellectual disabilities. Because people with intellectual disabilities had several disadvantages: tired, stressed, distracted trying to finish the test with satisfaction, due to these, an investigation was made of how the therapists performed the measurement of IQ in people with intellectual disabilities. Moreover, although the method is manual, therapists had basically the same problems as the first prototype, but they solved it with the interaction of the therapist with the person with disability. And with an atmosphere of trust between the two, then to solve the problems of the prototype, it was concluded that the therapist has to interact with the application, and this generated new requirements in the prototype that were implemented in the second and third iteration.

Finally, a prototype was obtained, and this one has the interaction between therapists, people with disabilities and application, of this prototype obtained better results than the first prototype.

Conclusions

Although the first prototype was developed with UXD and specifically with the help of an end user, it was not 100% applicable to people with intellectual disabilities because a person with intellectual disability has special needs and differs from one another. When a person with a disability Intellectual interaction with an electronic device is not concentrated, in the case of trying to complete the prototype were angry and had difficulty completing the test.

In conclusion, a person with an intellectual disability cannot evaluate directly with any application, because people with intellectual disabilities have special needs.

It was discovered that the therapist is needed in the interaction between the person with intellectual disability and the application because it creates an atmosphere of trust with the person with intellectual disability to perform the IQ measurement. In conclusion, it is necessary a third party that is the therapist, because it creates an atmosphere of trust between the person with intellectual disability and the application.

AAIDD classifies intellectual disability in: mild, moderate, severe and profound, but the type of disability cannot be assessed by all scales accurately, in the case of the Raven's scale is not 100% reliable in the case people with intellectual disabilities, because the scale only focuses on intelligence. In conclusion, to measure the IQ of people with intellectual disabilities, it is necessary to use scales that focus on other factors such as scales: WISC, Zazzo, K-ABC that are recommended by the AAIDD, or the DSM5.

For future work, we plan to assess the IQ test web application in other educational institutions that help people with intellectual disabilities.

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