Designing Prototype User Interface Digital Library for Elementary School Based on Probability Bayesian

Agung Suprapto[a], Ridi Ferdiana[a], Rudy Hartanto[b]
[a]Jl. Grafika No.2 Kampus UGM, Yogyakarta, Indonesia

Corresponding e-mail: suprapto.agung@gmail.com

Abstract: Recently of digital library technology is not only developed on the aspect of the system, but also in the interface design, because it has a significant role to reach the level of usefulness and success as source of knowledge. Digital library's interface should be developed and can adapt to the needs of children, who have different of ability and expectation when interact the user interface design than adult. This research aims to design the interface prototype digital library for elementary school students, based on the analysis of chosen existing library. Tests performed limited on the interface "simple search" form on the ICDL, with field observation approach methods, and the 6 task were completed over 15 minutes. Layout space used a single room setup when doing the observation. Data were taken from 12 elementary school students (7-12 years old), who come from three different schools. Processed analysed by Bayesian probability methods. From the results obtained, it can be concluded that the certainty of children had a difficulty when accessed forms simple search ICDL at the first used. From the analysis of the design 1 login register on the form ICDL display showed the probability of students choosing Register / Login influenced by his perspective and the time given is 0.5.

Keywords: *Digital Library, Children, Bayesian Probability, Elementary School, usability*

1. INTRODUCTION

The new challenges of digital library in the 21st century is on the use of electronic protocol through computer network quickly, precisely and globally. The one of solution to address these challenges is to build a digital library[1]. In the development, there is a library of shapes and types because it has experienced several times evolution, from traditional libraries, automated libraries, electronic libraries, digital libraries or virtual libraries [2].In order to provide an effective digital library services, the designer and the programmer need to understand the factors of usability and user experience. In term of perception and satisfaction of the users, the principles of user-centered services should be compared with the data centered[3].

In the last view years, user interface digital library for children was rife developend[4].it based on research that most children today when learning, prefering to use computer than printed books or homemade flash card. Their goal is usually to use computer technology for learning or entertainment than productivity or work [5]. Digital library for children in need of interfaces and layout is the different design with adults[6]. Children aged 5 – 10 when accessing a digital library, the interface used is not enough if only text-based[4].

Evaluation of digital library is an essential component for designing effective. Most of the digital library evaluation phase, researchers apply with their own criteria and little is done by identifyng the criteria from user[7]. From this, it can be include that the aspect of interaction, especially the user interface, become the primary factor of the technology.

There are several digital library for children that already exist in the world[8]. One of their that belonging intensive to keep growing is the ICDL[9]. ICDL is the Internet web-based digital library devoted to accommodate children with a multi-lingual, multi-cultural, and multi-generational from different country. ICDL it the digital library have designed specially for children aged 3 – 12. Based on previos studies and existing digital library, it can not easily to be applied to the children [10].

In connection with the above, this study aims to evaluated the user interface design of ICDL to get the scores of level usability and user experience with user-centered design approach method. This study proposed of prototype model user interface digital library for children.

2. LITERATURE REVIEW

Research by Mardiah et al[10], developing digital library interface design for children who have full vision disorders (Fully sighted) and also children who have partial visual impairment (Partially sighted). This study focuses on the type, size and font color, background color (background) of a digital library. The purpose of this research is to create a digital library interface that can be easily accessed by partially sighted (PS) and fully of partially sighted children (FS) compared with the interface for normal children. Retrieval interface preferences and initiate ideas, this study uses the method UCD. Manufacture of prototypes using Microsoft Visual Basic 2008 Express Edition Development Tool. Results from this study stated that the participants need a font size between 30pt to 40pt to be able to read the text clearly. To read the simple text, font type Arial better and for brief readings Comic Sans better, whereas Type font Times New Roman and Courier New are not appropriate. For the font and background color, font participants better to use a black and white background and some participants preferred the text and background color for having high contrast. Disadvantages of this study is the number of font types in a test using only the four samples, the number of participants as many as 14 children who only represent four categories of diseases (cataract, cancer, albinism, and due to an accident). The study also does not create categories of age and gender of the participants.

Meanwhile, Hutchison, Rose, et al[11], designing digital libraries used by children around the world, the application is called ICDL (International Children's Digital Library). The digital library used a variable state (country), language (language), culture (culture) and different generations of each child. The purpose of this research is (i) made a collection of 10,000 books to children in 100 different languages, (ii) collaborate with children in designing the interface for searching, browsing, reading, and sharing books, (iii) evaluate the influence of cultural differences in children, schools, and libraries. The method is used to retrieve data with UCD or the participatory design approach. ICDL is a major research project involving many elements. Results from this study is the ICDL able to accommodate differences in language, culture, and generations worldwide. Disadvantages of this study are the lack of language support, and books that can facilitate Indonesian children to access it. This research is still in need of some parties from countries that have different cultures to provide ICDL proposal to the development of these in achieving its objectives.

Hourcode Druin, et al,[12] Search Kid present, a digital interface library devoted to children aged 5-

10 years. SearchKid offers an interface querying, browsing and reviewing the search results. Digital Library is not dependent on the text and visual metaphor alone. SearchKid digital library interface divides into three areas, namely Zoo Area, World Area, and Search Area. The method used is by involving children (participatory design). The study included children and teachers at Yorktown Elementary School in Bowie, MD. This research requires financial support from various parties. The focus of this study is to present SearchKid, so not tested how the level of Usability and UX of this interface. The study also does not consider the uncertainty aspect of the child when accessing interface.

Based on the state of the art, this research will be to design a prototype Digital Library for children of primary school (SD) using the method of participatory design in an attempt to get the data UID that is expected by the child, based on the measurement results Usability and User Experience Digital Library already available. The interface will be studied here focus on 1 digital library functions, namely: the registration form and the registration.

3. RESEARCH METHODOLOGY

This research focus to test the register and login form in the ICDL digital library. This study measured the level of usability by using field observation method, which involves 36 students in Indonesia. This observation test using test comparison approach, that comparing the elements above the ICDL with new prototype, so we will get the most desirable form by the participants with a parameter value of
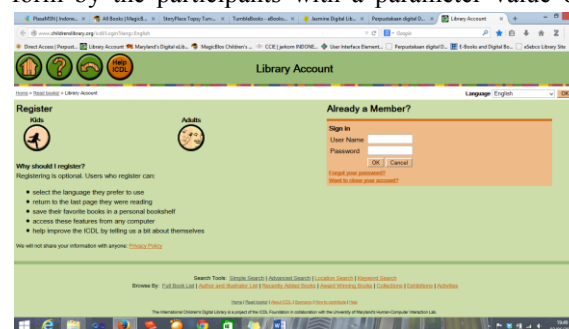
usability and user experience.

Figure 1. User Interface form Register and Login on ICDL

The data will be drawn from three schools, namely SD N 1 Gemolong, MTA Gemolong SD, and SD Aisyah Gemolong, Central Java, Indonesia, with the number of children a total of 36 students, with the division such as in table 1:

PROSIDING ICTTE FKIP UNS 2015
Vol 1, Nomor 1, Januari 2016
Halaman:

ISSN: 2502-4124

ICTTE
FKIP UNS 2015

Table 1.Distribution of participants from three schools and 36 participants by grade and gender.

SD Aisyiah Gemolong			SD MTA Gemolong			SD N 1 Gemolong		
L	P	Kelas	L	P	Kelas	L	P	Kelas
2	2	1 – 2	2	2	1 – 2	2	2	1 – 2
2	2	3 - 4	2	2	3 – 4	2	2	3 – 4
2	2	5 - 6	2	2	5 – 6	2	2	5 – 6
6	6		6	6		6	6	

The data collection method used field observation method, by directly involving children. At the time of observation, children are given tasks that amounted to 14 tasks are structured with 8 task for accessing the register form, and 6 task for the login form. Table 2 is a list of tasks to be awarded:

Table 2. Task list and the code of the UI construct form Register

Construct	code	Task
	R1	Students choose the category kids or adult according to his perspective
	R2	Students fill in the name on the form available
	R3	Students fill in the password twice in the fields provided
Form UI Register	R4	Students choose the option of age
	R5	Students choose gender
	R6	Students select a language
	R7	Students choose how to use ICDL
	R8	Students choose the location of the use of ICDL

To complete each task in Table 1, the participant is given a time for 20 minutes. As for the observation text login form consisting of six tasks, can be seen in table 3.

Table 3. Task list and the code of the UI construct form Login

Construct	Code	Task
Form UI Login	L1	Students write down your username and password correctly
	L2	Students choose the language as you wish

L3	Students write down the password correctly
L4	students use the forgot password link facility, if feel username and password is lost or forgotten
L5	Students use the link went to a facility close your account
L6	Students accessing existing facilities in the footer

At each task in Table 3, the participant is given time for 5 minutes to complete.

2.1 Analysis Method

In the study in accordance with the above study, for analysis test registers observation form and login using Bayesian probability to the formula as below:

$$P(H|E) = \frac{P(E|H)P(H)}{P(E)}$$

Where:
P (H|E) : the probability of the hypothesis H if there *evidence* E
P (E|H) : the probability of evidence E if known hypothesis H
P (H) : the probability of the hypothesis H regardless of any evidence
P (E) : probability *evidence* E

Application of Bayes theorem to cope with uncertainty, if it appears if there are more than one written evidences as follows [35]:

$$P(H|E, e) = P(H|E)\frac{P(e|E, H)}{P(e|E)}$$

e : old *evidence*
E : new *evidence*
P (H|E,e) : the probability of the hypothesis H, if new evidence emerged old E of evidence e
P (e|E,H) : the probability of the link between e and E if the hypothesis is true H
P (e|E) : the probability of the link between e and E regardless of any hypothesis
P (H|E) : the probability of the hypothesis H if there *evidence* E

Road research is divided into two, namely the first stage of the test the digital form library, and the second stage, i.e. testing the digital library prototype form. The following is research flowchart:

```
                    ┌──────────┐
                    │  Begin   │
                    └──────────┘
                         │
    ┌────────────────────▼─────────────────────┐
    │            Literature Study               │
    │   ┌──────────────┐   ┌──────────────┐     │
    │   │   Digital    │   │     User     │     │
    │   └──────────────┘   └──────────────┘     │
    │   ┌──────────────┐   ┌──────────────┐     │
    │   │   Usability  │   │      UX      │     │
    │   └──────────────┘   └──────────────┘     │
    └────────────────────┬─────────────────────┘
                         │
    ┌────────────────────▼─────────────────────┐
    │            Need Assessment                │
    │   ┌──────────────┐   ┌──────────────┐     │
    │   │  Understand  │   │  Understand  │     │
    │   │ User Behavior│   │User Interface│     │
    │   └──────────────┘   └──────────────┘     │
    └────────────────────┬─────────────────────┘
                         │
            ┌────────────▼────────────┐
            │    Field Observation    │
            └────────────┬────────────┘
                         │
    ┌────────────────────▼─────────────────────┐
    │             Data Analysis                 │
    │   ┌───────────────────────────────────┐  │
    │   │  Probability Bayesian Method      │  │
    │   └───────────────────────────────────┘  │
    └────────────────────┬─────────────────────┘
                         │
            ┌────────────▼────────────┐
            │      Design High        │
            │       Prototype         │
            └────────────┬────────────┘
                         │
            ┌────────────▼────────────┐
            │    Field Observation    │
            └────────────┬────────────┘
                         │
    ┌────────────────────▼─────────────────────┐
    │             Data Analysis                 │
    │   ┌───────────────────────────────────┐  │
    │   │  Probability Bayesian Method      │  │
    │   └───────────────────────────────────┘  │
    └────────────────────┬─────────────────────┘
                         │
                    ┌────▼─────┐
                    │   End    │
                    └──────────┘
```
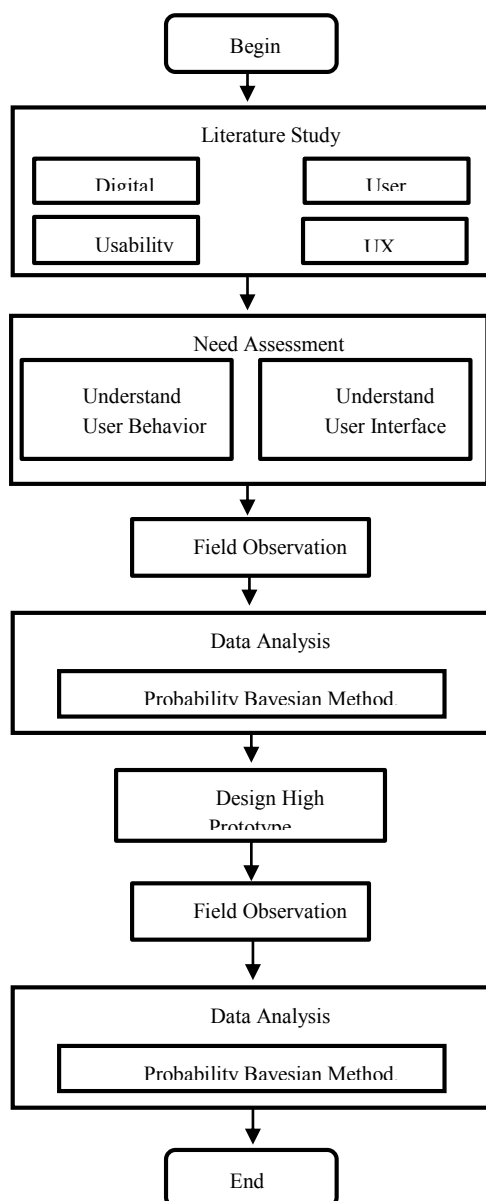
4. RESULT AND ANALYSIS

Results of the first stage of analysis using Bayesian probability formula is described as below:

4.1 Form Register existing DL (ICDL)

4.1.1 R1: Students choose the category kids or adult according to his perspective.

From 36 students, 15 choose kids or adult categories in according with the perspective itself. 21 students can accomplish the task register without selecting a categories kids or adult according his perspective and time given:

$P(E|H)$: $15/17 = 0.75$
$P(H)$: $20/36 = 0.58$
$P(H|E)$: 0.04

2. R2: Students fill in the name on the form available

From the 36 students, 13 select the category name according with the perspective itself. 22 students can accomplish the task of selecting the name category in according with his perspective and time given:

$P(E|H)$: $14/22 = 0.64$
$P(H)$: $22/36 = 0.61$
$P(H|E)$: 0.04

3. R3: Students fill in the password twice in the fields provided

From the 36 students, 11 students select a category password twice in the fields provided appropriate if given the task by the given time, 25 students can complete the task of choosing a category password twice in the fields provided in accordance with the perspective of himself and the time given:

$P(E|H)$: $11/25 = 0.44$
$P(H)$: $25/36 = 0.69$
$P(H|E)$: 0.03

4. R4 Students choose the option of age.

From the 36 students 12 students select age category in accordance with the perspective itself if given the task by the given time, 24 students can complete the task of selecting the category in accordance with the perspective of her age and the time given:

$P(E|H)$: $12/24 = 0.50$
$P(H)$: $24/36 = 0.67$
$P(H|E)$: 0.03

5. R5: Students choose gender.

From the 36 students 12 students choose a category according to gender perspective itself if given the task by the given time, 24 students can complete the task of selecting the category of gender in accordance with his perspective and the time given:

$P(E|H)$: $12/24 = 0.50$
$P(H)$: $24/36 = 0.67$
$P(H|E)$: 0.03

6. R6: Students select a language

From the 36 students 17 students select a language category in accordance with the perspective itself if given the task by the given time, 19 students can accomplish the task of selecting the appropriate language category with his perspective and the time given:

$P(E|H)$: $17/19 = 0.89$
$P(H)$: $19/36 = 0.53$
$P(H|E)$: 0.03

7. R7: Students choose how to use ICDL

From the 36 students 17 students select the category in accordance with the perspective of how to use him if given the task by the given time, 19 students can accomplish the task of selecting the category in

accordance with the perspective of how to use him and the time given:
P (E|H) :17/19 = 0.89
P (H)   : 19/36 = 0.53
P (H|E) : 0.05

8. R8: Students choose the location of the use of ICDL

From the 36 students 13 students chose the location categories in accordance with the perspective itself if given the task by the given time, 22 students can accomplish the task of selecting a category according to the location of her perspective and the time given:
P (E|H) : 13/22 = 0.59
P (H)   : 22/36 = 0.63
P (H|E) : 0.05

4.2   Form Login existing DL (ICDL)

1.   L1: Students write down your username and password correctly

From the 36 students 16 students write down your username and password correctly in accordance with the perspective itself if given the task by the given time, 29 students can complete the task of writing down your username and password correctly according to his perspective and the time given:
P (E|H)   : 16/29 = 0.80
P (H)   : 20/36 = 0.56
P (H|E)   : 0.04

2.   L2: Students choose the language as you wish

From the 36 students 16 students select the appropriate language properly in accordance with the desire of perspective itself if given the task by the given time, 20 students can complete the task of selecting the appropriate language properly in accordance with the desire of her perspective and the time given:
P (E|H)   : 16/20 = 0.80
P (H)   : 20/36 = 0.56
P (H|E)   : 0.04

3.   L3: Students write down the password correctly.

From the 36 students 13 students write down passwords properly in accordance with the perspective itself if given the task by the given time, 25 students can complete the task of writing down passwords properly in accordance with the perspective of himself and the time given:
P (E|H)   :13/25 = 0.57
P (H) :25/36 = 0.64
P (H|E)   :0.03

4.   L4: students use the forgotten password link facility, if feel username and password is lost or forgotten.

From the 36 students 11 students feel username and password is lost or forgotten, the students use the facilities forgot password link correctly in accordance with the perspective itself if given the task by the given time, 25 students can complete the task feel username and password is lost or forgotten, the students use the facilities link forgot password correctly according to his perspective and the time given:
P (E|H)   : 11/25 = 0.44
P (H)   : 25/36 = 0.69
P (H|E)   : 0.03

5.   L5: Students use the link went to a facility close your account.

From the 36 students 11 students use the facilities link want to a close your account properly in accordance with the perspective itself if given the task by the given time, 25 students can complete tasks using the facilities link want to a close your account properly in accordance with the perspective of himself and time which are given:
P (E|H)   :11/25 = 0.44
P (H)   :25/36 = 0.69
P (H|E)   :0.03

6.   L6: Students accessing existing facilities in the footer

From the 36 students 8 students accessing existing facilities in the footer properly in accordance with the perspective itself if given the task by the given time, 28 students can complete the task of accessing existing facilities in the footer properly according to his perspective and the time given:
P (E|H)   : 8/28 = 0.29
P (H)   : 28/36 = 0.78
P (H|E)   : 0.02

4.3   New Prototype User Interface Digital Library

After going through the process of data analysis 1, the researchers obtain a prototype model of user interface design a new digital library. In this design, there are several good differences of colour, layout, icons, backgrounds, and headers.

Once the design process is complete, the next step is to test a new prototype with the method, time and the same participant. The following sequence of results from the second phase of testing:

The second stage of analysis results using Bayesian probability formula d is described as below:

4.3.1 New prototype User Interface Digital library (user Register)

1.   R1: Students choose the category kids or adult according to his perspective
P(E|H)   :20/36 = 0.56

PROSIDING ICTTE FKIP UNS 2015
Vol 1, Nomor 1, Januari 2016
Halaman:

ISSN: 2502-4124

ICTTE
FKIP UNS 2015

P(H)   :16/36 = 0.44
P(H|E)   :0.08

2. **R2: Students fill in the name on the form available**,
    P(E|H)   :25/36= 0.69
    P(H)   :11/36 = 0.31
    P(H|E)   :0.07

3. **R3: Students fill in the password twice in the fields provided**
    P(E|H)   :24/36 = 0.67
    P(H)   :12/36 = 0.33
    P(H|E)   :0.07

4. **Students choose the option of age,**
    P(E|H)   :16/36 = 0.44
    P(H)   :20/36 = 0.56
    P(H|E)   :0.08

5. **Students choose gender,**
    P(E|H)   :24/36 = 0.67
    P(H)   :12/36 = 0.33
    P(H|E)   :0.07

6. **Students select a language**
    P(E|H)   :20/36 = 0.56
    P(H)   :16/36 = 0.44
    P(H|E)   :0.08

7. **Students choose how to use ICDL**
    P(E|H)   :19/36 = 0.53
    P(H)   :17/36 = 0.47
    P(H|E)   :0.08

8. **Students choose the location of the use of ICDL**
    P(E|H)   :18/36 = 0.50
    P(H)   :18/36 = 0.50
    P(H|E)   :0.08

4.3.2 New prototype User Interface Digital library (user Login)

1. **Students write down your username and password correctly**,
    P(E|H)   :20/36 = 0.56
    P(H)   :16/36 = 0.44
    P(H|E)   :0.08

2. **L2: Students choose the language as you wish**
    P(E|H)   :20/36 = 0.56
    P(H)   :16/36 = 0.44
    P(H|E)   :0.08

3. **Students write down the password correctly**
    P(E|H)   :24/36 = 0.67
    P(H)   :12/36 = 0.33
    P(H|E)   :0.07

4. **Students use the forgot password link facility, if feel username and password is lost or forgotten**
    P(E|H)   :20/36 = 0.56
    P(H)   :16/36 = 0.44
    P(H|E)   :0.08

5. **Students use the link went to a facility close your account,**

P(E|H)   :10/36 = 0.28
P(H)   :26/36 = 0.72
P(H|E)   :0.06

6. **Students accessing existing facilities in the footer**
    P(E|H)   : 10/36 = 0.28
    P(H)   :26/36 = 0.72
    P(H|E)   :0.06

Results of the probability of students choosing Register / Login influenced by his perspective and the time given was 0.61.

4   CONCLUSIONS

From the analysis of the design 1 login register on the form ICDL display showed the probability of students choosing Register / Login influenced by his perspective and the time given is 0.5.

From the analysis 2 of the register design logged in prototype form results showed the probability of students choosing Register / Login influenced by his perspective and the time given is 0.61. From the results obtained both the difference in 0:11, which means the level of a child's response to the results form Register / Login prototype there is an increase of 11%.

5   ACKNOWLEDGEMENTS

6 REFERENCES

[1] R. S. Wahono, "Digital Library: Chalenges and Roles Toward 21 st Century," *Proc. Tekno'98 Sysmposium*, 1998.

[2] F. Abbasi and S. Zardary, "Digital libraries and its role on supporting E-Learning," *Glob. J. Technol.*, vol. 1, 2012.

[3] S. Chiasson and C. Gutwin, "Design principles for children's technology," *interfaces*, vol. 7, p. 28, 2005.

[4] A. Druin, B. B. Bederson, J. P. Hourcade, L. Sherman, G. Revelle, M. Platner, and S. Weng, "Designing a digital library for young children," in *Proceedings of the 1st ACM/IEEE-CS joint conference on Digital libraries*, 2001, pp. 398–405.

[5] T. S. M. T. Wook, N. Sahari, S. F. M. Noor, N. A. H. M. Zin, and A. Jaafar, "Framework of visual interface for children's digital library," in *Electrical Engineering and Informatics (ICEEI), 2011 International Conference on*, 2011, pp. 1–4.

[6] A. Druin, B. B. Bederson, A. Weeks, A. Farber, J. Grosjean, M. L. Guha, J. P. Hourcade, J. Lee, S. Liao, K. Reuter, and others, "The International Children's Digital Library: Description and analysis of first use," 2003.

[7] H. I. Xie, "Users' evaluation of digital libraries (DLs): Their uses, their criteria, and their assessment," *Inf. Process. Manag.*, vol. 44, no. 3, pp. 1346–1373, 2008.

[8] "Harford County Public Library." [Online]. Available: http://hcplonline.org/childrensdigital.php. [Accessed: 11-Oct-2015].

[9] "ICDL - Mission." [Online]. Available: http://en.childrenslibrary.org/about/mission.shtml. [Accessed: 29-Sep-2015].

[10] M. Madiah and S. Hisham, "User-interface design: A case study of partially sighted children in Malaysia," in *User Science and Engineering (i-USEr), 2010 International Conference on*, 2010, pp. 168–173.

[11] H. B. Hutchinson, A. Rose, B. B. Bederson, A. C. Weeks, and A. Druin, "The international children's digital library: a case study in designing for a multilingual, multicultural, multigenerational audience," *Inf. Technol. Libr.*, vol. 24, no. 1, pp. 4–12, 2013.

[12] J. P. P. Hourcade, A. Druin, L. Sherman, B. B. Bederson, G. Revelle, D. Campbell, S. Ochs, and B. Weinstein, "SearchKids: a digital library interface for young children," in *CHI'02 Extended Abstracts on Human Factors in Computing Systems*, 2002, pp. 512–513.