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Designing a User Interface in HCI for predicting the performance task using Keystroke Level Model and Cognitive Complexity Theory

[1] D. Kalpanadevi, [2] Dr. M. Mayilvaganan
[1] Research Scholar, [2] Associate Professor
[1][2] Department of Computer Science, PSG College of Arts and Science

***Abstract*— In this research focuses on Human computer Interface system gives better performance of the student usability based on Keystroke Level model and cognitive complexity theory. A task performance can be measured by the goal factor of evaluating the user interaction when responds to the question. To conduct laboratory test by user interface design for determines the exact task in the test plan, based on cognitive model with usability metrics. Usability testing can be processed by the suggestion of evaluating usability metrics under in terms of effectiveness, efficiency and satisfaction..**

Keywords— Key Strokes Level Model, Cognitive Complexity Theory, Efficiency, Efficiency, satisfaction, usability testing, Usability metrics

I. INTRODUCTION

In cognitive model, scope of knowledge is this research to accumulated information, problem solving schemas[1-4], performance skills[5], expertise, problem representation ability, and categorization abilities (Numerical Ability, Logical Reasoning and Perceptual Speed) as refer in fig.1 motivation, efficiency and accuracy.

Fig. 1Cognitive Structure

From fig 1 represents, assessments encourage effective use of cognitive structures when students integrate and attend the activity to formulate question content. It helps true level of understanding is evident in the kinds of questions students attend.

In this research work, an analytic evaluation method such as Key Stroke Level Model in GOMS model and Cognitive complexity which has to be evaluating the task performance of the students based on usability criteria [6-8].

II. FRAMEWORK FOR DESIGNING A USER INTERFACE IN HCI

From fig. 2 represents the frame work of cognitive skill evaluate through HCI system. The following steps give the working in the frame work architecture consist as follows,

A. Register and fill the background details of Students

To register the details of Students.Design methodology in HCI aims to create a user interface that is usable i.e. that can be operated with ease and efficiently. The role of the interface design can create software device that organizes the multimedia content, that lets the user access or modifies that content and that presents the content on the screen.

The interaction between the users and computers occurs at the user interface which includes both hardware (input and output device) and software.

B. Students Learn the Instruction

After register the student details, give an instruction of the test before session start, when the user press the start button, session can be start.

C.Session Start

Set time as 45 minutes to start and each second reduced leads to end task in order to attend the test, specifically to

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measure the time task and result scoring for analysing the cognitive skill of the students.

D. Maintained Data in Database

To examining the student's skill factor who answers the exact task in the test plan, the responses of all data can be stored in data base.

III. COGNITIVE MODEL

A. Keystroke-level model (KLM)

KLM (Keystroke-Level Model) [7] is derived from Goal Operators Methods Selection rules (GOMS) and describe the time taken to execute sub-task using the systems facilities. Total time taken for an action is arrived at by simply adding together the times of each component task. It is basis for detailed predictions about user performance. It is aimed to

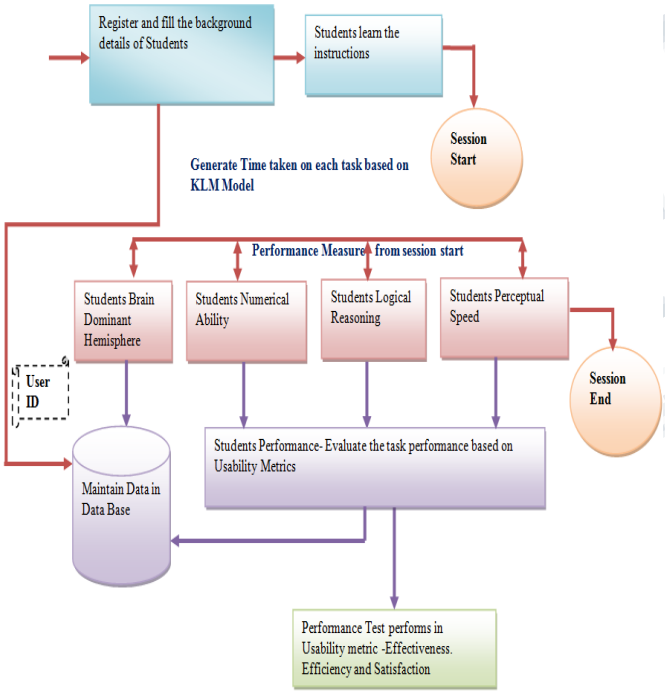

Fig. 2 Work Flow for Designing a User interface in HCI for Predicting task performance

get a unit tasks within interaction – the execution of simple command sequences. Keystroke Level model in GOMS can be implemented for analyzing the cognitive process of students through computer interfaces. Based on Usability criteria, to measure the goal factor of evaluating the user interaction when answer the question.

Table 1. Target of Time for Keystroke level model

Task action in KLM	Target Time for KLM (in seconds)
Point mouse to target	1.10 seconds
Select or release target mouse	0.10 seconds
Move hand to mouse	0.04 seconds
User wait to respond the task	Depending on the system

The execution of tasks involves interleaved occurrences of the various operators. The target of time for KLM task analysis is furnished below on table 1.

In this research, keying time obviously depends on the pressing mouse skill of the user, and different times are thus used for different users. Pressing a mouse button is usually quicker than typing (especially for two-finger typists), and a more accurate time prediction can be made by separating mouse pointer action like Point mouse to target, Select or release target mouse, measure the time taken for respond to solve the question.

B. Cognitive Complexity Theory

The user's knowledge is modeled using production rules with general form:
IF <Condition> THEN <action>

Training time is calculated by the following formula:
Training time= t * n + c (1)

Where t represents the training time per production rule; n represents the number of new production rules to be learned to reach goal; c represents time required for already learned part of the task [1].

Cognitive complexity can estimates the task performance of students and learning time of response an answer by given question on the basis of production system for predicting the performance time, spending time for each task. These are the basic methodology of creating the designing tool for conducting the test based on experimental method by usability criteria.

IV. PSEUDO CODE FOR COGNITIVE SKILL ANALYSIS USING KLM MODEL AND COGNITIVE COMPLEXITY THEORY

1. To choose the task scenario of three representative ability test such as numerical ability, Logical reasoning and perceptual speed.

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2. Have a design specified to the mouse pointer to target is 1.10 seconds, select target mouse is 0.10 seconds, Move hand to mouse from keyboard is 0.04 seconds and task time measures depending on the user responds.

3. Insert mental operator ie. Running time is count down, when the students has to stop and think for solution.

4. To set an operator action of system for calculating the excecution time of each task using production rule system.

5. Measure the complete task time based on usability metric.

6. Log data maintained in database.

From the pseudo code, illustrate the time period which can be construct the rule by evaluation of analytic method for analysing the performance task of the students, collected by quantitatively. Set time as 45 minutes to start and each second reduced leads to end task in order to attend the test. When the time complete from 45 minutes to 0 minutes the session time out message can be displayed.

V. EXPERIMENT ANALYSIS

A. Usability Measurement Scenarios

From the following scenario is given as a procedure o the students to test in laboratory. Each Student follows the sequence below to accomplish the given task.

By defining the task to conduct the problem solving test like numerical ability, Logical reasoning and perceptual speed, these tasks that the cognitive walkthrough will examine for usability of student's exact task in the test plan. During the process, tasks are then divided up into a process as follow.

Step 1: Interface- Open browser in local host and Navigate to site
Step 2: User- Choose the category of Institution – Arts and Science graduate students (School/ Arts and Science/ Engineering)

- Fill the registration form required the students back ground. Click the submit button.
- See the instruction of the test plan and time given, then Select to start

Step 3: Task can start

- Set time as 45 minutes to start and each second reduced leads to end task in order to attend the test.

Identify the action sequence of task while answering the each question of numerical ability, Logical reasoning and Perceptual speed.

- When the students select the option button to answer, the query can match the choosing option with correct answer and make the result either right or wrong simalteneously.

Step 4: Performance recorded

- Recorded the time taken for each task when the students click the option to answer the question.
- The result of scoring for analysing the cognitive skill of the students and all collecting performance of each task of ability (Numerical, Logical and perceptual) and also brain dominant hemisphere questionnaire data maintain in the database.

Step 5: Get the feed-back of student's suggestion
From fig. 3 represents, the part of the training data set maintain in the database, the performance of usability time can be measured from the running time of the system as referred by the equation 1.

logical_id	num_questionid	num_answ	log_table	Log_running	log_each_task_timing	user_id	mgt_type
1	1	a	logical	23.9	0.02	73	arts
2	2	a	logical	22.01	1.89	73	arts
3	3	a	logical	21.93	0.08	73	arts
4	4	a	logical	21.63	0.3	73	arts
5	5	c	logical	20.95	0.68	73	arts
6	6	b	logical	19.64	1.31	73	arts
7	7	a	logical	18.13	1.51	73	arts
8	8	a	logical	17.46	0.67	73	arts
9	9	b	logical	16.28	1.18	73	arts
10	10	a	logical	15.17	1.11	73	arts
11	11	d	logical	14.48	0.69	73	arts
12	12	b	logical	13.45	1.03	73	arts
13	13	b	logical	12.26	1.19	73	arts
14	14	a	logical	11.6	0.66	73	arts
15	15	d	logical	10.02	1.58	73	arts
16	1	b	logical	22.61	1.7	72	arts
17	2	d	logical	21.24	1.37	72	arts
18	3	c	logical	21.07	0.17	72	arts
19	3	c	logical	20.79	0.28	72	arts
20	4	d	logical	20.51	0.28	72	arts
21	5	c	logical	19.01	1.5	72	arts
22	6	b	logical	18.46	0.55	72	arts
23	7	b	logical	17.23	1.23	72	arts
24	8	b	logical	16.04	1.19	72	arts
25	9	b	logical	15.13	0.91	72	arts
26	10	a	logical	14.06	1.07	72	arts
27	11	d	logical	13.26	0.8	72	arts
28	12	c	logical	12.36	0.9	72	arts
29	13	b	logical	11.86	0.5	72	arts
30	14	c	logical	10.87	0.99	72	arts
31	15	d	logical	10.12	0.75	72	arts

Fig. 3 Performance of Logical Reasoning Test

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Efficiency is measured in terms of task time. that is, the time (in seconds) the participant takes to successfully complete a task. The time taken to complete a task can then be calculated by simply subtracting the start time from the end time,

Task Time = End Time – Start Time (1)

Usability testing performed for evaluate the effectiveness, efficiency and satisfaction. The ISO/IEC 9126-4 metrics recommends that usability metrics should include:

•Effectiveness: The accuracy and completeness with which users achieve specified goals
•Efficiency: The resources expended in relation to the accuracy and completeness with which users achieve goals.
•Satisfaction: The comfort and acceptability of use. From this analysis, 81.1% of the test attendants commended in the favor of and 18.9% comments are unfavorable.

Usability metrics are attempts to establish objective criteria for usability evaluation. The following checklist suggest to measures as a starting point for establishing a suitable set of metrics.

1.To measure an Effectiveness for task completion rate using,

$$Effectiveness = \frac{\text{Number of tasks completed successfully}}{\text{Total number of tasks undertaken}} \times 100\%$$

i.e.,

$$\overline{E} = \frac{\sum_{j=1}^{R}\sum_{i=1}^{N} n_{ij}}{RN} * 100\% \quad (2)$$

2. Efficiency can then be calculated by two way such as time based efficiency and overall relative efficiency as given below,

$$Time\ Based\ Efficiency = \frac{\sum_{j=1}^{R}\sum_{i=1}^{N} \frac{n_{ij}}{t_{ij}}}{NR} \quad (3)$$

$$Overall\ Relative\ Efficiency = \frac{\sum_{j=1}^{R}\sum_{i=1}^{N} n_{ij}t_{ij}}{\sum_{j=1}^{R}\sum_{i=1}^{N} t_{ij}} \times 100\% \quad (4)$$

B. Effectiveness- Percent of task completed

All students have completed the test procedure. Procedure applicability is measured by taken FOUR scenarios such as Numerical Ability, Logical Reasoning, Perceptual Speed and brain dominant hemisphere. In each Scenario, there are 1000 students have to complete their task.

In first scenario, Numerical ability complete the task is 908
Second, Logical reasoning it complete the task is 961
Third, Perceptual Speed it complete the task is 826
Fourth, Brain dominant hemisphere, it complete the task is 954
Let N - be the total number of scenarios (goals)
R - is the number of respondents (users)
nij – is the result of coming through scenario i by respondent j; nij=1 if the scenario has been completed successfully and user goal has been achieved, and nij=0, if the scenario is unsuccessful and user failed to achieve the goal.
Then, overall integral product effectiveness E will be calculated according to the following formula 2:

$$\overline{E} = \frac{908 + 961 + 826 + 954}{4 * 1000}$$

$$\overline{E} = 91.225\%$$

Effectiveness statistic error:

$$\sigma_E = \sqrt{\frac{\overline{E}(100 - \overline{E})}{R}} \quad (5)$$

Overall product Effectiveness:

$$\sigma_E = \sqrt{\frac{91.2(100 - 91.2)}{1000}}$$

$$\sigma_E = 0.895 \quad (6)$$

C. Efficiency- Percent of task completed per unit time

Take FOUR scenarios such as Numerical Ability, Logical Reasoning, Perceptual Speed and brain dominant hemisphere. In each Scenario, there are 1000 students attended the task. Here 1000 students' works with four Scenarios,
Let N - be the total number of scenarios (goals)
R – is the number of respondents (users)

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nij – is the result of coming through scenario i by respondent j;
nij=1 if the scenario has been completed successfully and user goal has been achieved, and
nij=0, if the scenario is unsuccessful and user failed to achieve the goal.
tij – is the time spent by respondent j to come through scenario i. In case of unsuccessful scenario completion, measured till the moment of scenario quittance by the respondent as a result giving up the goal or logging off the system.
Then, overall time-based user Efficiency of a product Pt will be calculated according to the following formula of 3:

Time-based Efficiency calculated so in fact is the speed of work with the product with effective users vs. all users
Here 1000 students works with Three Scenarios, In first scenario, Numerical ability Second, Logical reasoning and Third, Perceptual Speed it complete the task.

$$\bar{p}_t = \frac{\frac{0}{12.31}+\frac{1}{13.5}+\frac{1}{4.21}+\frac{0}{11.6}+\frac{1}{13.5}+\frac{1}{4.43}+.....+\frac{1}{11.59}+\frac{1}{13.5}+\frac{1}{2.04}}{4*1000}$$

$$\bar{p}_t = \frac{0.3116+0.2998+.....0.7603}{4000}$$

$$\bar{p}_t = \frac{468.66}{4000}$$

$$\bar{p}_t = 0.1171$$

goals per minutes

A task completion time of each scenario as follows,
•Brain dominant test is 0.107 minutes in average
•Numerical ability test is 0.078 minutes in average
•Logical reasoning test is 0.071 minutes in average
•Perceptual speed test is 0.21 minutes in average

To Calculate overall relative time- based Efficiency of a product including time spent by ineffective users give the ratio of effective users' work time to all users' work time by formula 4 :

$$\bar{p} = \frac{(0*12.31)+1*13.5)+(1*4.21)+(0*11.6)+(1*13.5)+(1*4.43)+.....+(1*8.14)+(1*9.35)+(1*9.11)}{12.31+13.5+4.21+11.6+13.5+4.43+.....11.59+13.5+2.04}*100$$

VI. RESULT AND DISCUSSION

From the analysis satisfaction measures, 81.1% of the test attendants commended in the favor of and 18.9% comments are unfavorable.

•Percentage of complete a task as per unit time is 0.117 minutes as per goal.
•Relative time based- efficiency of students is 92.85%. By the effectiveness measures for analysing the percentage of goal achieved to complete the task is 91.225%.
•The statistical error of effectiveness is 0.89.

Usability testing can be followed for usability metrics under the terms of effectiveness, efficiency and task and test satisfaction.

CONCLUSION

In this research, it can be concluded that the Human computer Interface system gives better performance of the student usability based on Keystroke Level model in GOMS can be implemented for analyzing the cognitive process of students through computer interfaces. It can measure the goal factor of evaluating the user interaction when answer the question. It gives accuracy and completeness of user goal achievement successfully.

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