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Analysis of the Effectiveness of IC Tester Demonstrator Tools in Accelerating the Diagnosis of TTL Logic Gate Damage: A Quasi-Experimental Study at UMK

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Abstract - In the practicum process for testing the condition of the TTL IC, it is still done manually and requires time to complete. With class conditions where students who participate have different levels of understanding. The smooth implementation of digital electronics practicum activities will be hampered if the ICTTL (Integrated Circuit Transistor Transistor Logic) components used in the experiment do not have normal operating functions. This study analyzes the effectiveness of the *IC tester teaching aid* in accelerating the diagnosis of TTL logic gate damage through a *quasi-experimental study* at UMK. Data were taken from 9 students grouped by ability (*Good*, *Sufficient*, *Less*) by comparing the time of manual testing and testing using the teaching aid. From the results, it was found that the teaching aid provided good effectiveness in the TTL IC testing process, namely 60-72% by reducing the average from 121-159 seconds (manual testing) to 45-58 seconds/student. The consistency of the time required to check the IC for all groups of student abilities became the same after using this teaching aid.

Keywords - Demonstration Tools, IC Tester, Effectiveness, Quasi-Experiment

1. INTRODUCTION

The success of Indonesia's national development in all areas will depend heavily on human resources, the nation's assets. Optimizing and maximizing the development of all available human resources is achieved through education [1] . Undeniably, the development of digital technology has completely transformed the face of engineering education—particularly in the realm of digital electronics. Practical activities are one of the important factors in supporting student success in participating in the teaching and learning process. Some practical courses, in addition to having to understand basic concepts and supporting theories, also require conducting experiments/trials in the laboratory to understand a particular concept or basic theories that have been studied in order to have a broader level of understanding [1] [2] .

For electrical engineering students, this course is like the main foundation for mastering the application of logic gates, microprocessors, and digital systems. The digital electronics practicum course is one of the compulsory courses that must be completed by electrical engineering students. In the practicum module used in the practicum process, there are 3 points of the practicum chapter that use TTL ICs. In the practicum process for testing the condition of the TTL IC, it is still done manually and takes time to complete. With class conditions where students who participate have different levels of understanding. The smooth implementation of digital electronics practicum activities will be hampered if the ICTTL (Integrated Circuit Transistor Transistor Logic) components used in the experiment do not operate normally [3] . The manual process is carried out by checking each IC leg using a multimeter and comparing the results with

the IC's truth table. The IC itself is an Active Electronic Component consisting of a combination of hundreds or even millions of Transistors, Resistors and other components that are integrated into an Electronic Circuit in a small package. The shape of the IC (Integrated Circuit) also varies, starting from 3 (three) legs to hundreds of legs (terminals) [4] [5] . The IC legs on a digital IC are electronic points in the form of a conducting wire that can be used as input or output, and can represent one of two logic states, namely logic '0' (zero, low) or logic '1' (one, high) is represented by a voltage of 0 to 0.7 Volts of direct current (DC, *Direct Current*), while logic '1' is represented by a DC voltage of 3.5 to 5 Volts [3] . In practical work, demonstration tools or trainers are very useful and necessary supporting tools, in order to make it easier for students visually to understand what they are getting and to increase the effectiveness in terms of time in the practical process itself [2] .

In this study, a logic gate IC identification and tester tool has been created which is used to help the effectiveness of the practical learning process in UMK Electrical Engineering. Where the digital IC Tester is an IC testing tool used to test integrated circuits on ICs. This IC tester consists of several units related to the field of digital engineering [6] . And in this study aims to determine the impact of the effectiveness of practical time with the use of a demonstration tool or trainer for identification and logic gate IC testers on UMK Electrical Engineering students with a quasi-experimental study method and *repeated measures* . Quasi-experimental research is a research method used to measure the effect of certain treatments on a variable without using full subject randomization [7] [8] [9] . In a study, sometimes the observed response in each experimental unit is carried out more than once at different times during the study. This kind of thing is usually called repeated observation or Repeated Measures [10] .

2. RESEARCH METHOD

This research was conducted in several steps, including literature review, data collection, data analysis, and conclusion drawing. This research was conducted in the UMK Electrical Engineering laboratory with 15 students with different levels of ability, where 5 people had good abilities, 5 people with sufficient abilities, and 5 people with poor abilities. The research method used in this study was a quasi-experimental design with a *Repeated Measures approach.* (repeated measurements) and comparative quantitative data analysis.

2.1. Quasi-Experimental Method

This study used this method by comparing two processes (manual testing as is currently being implemented and testing using a teaching aid/trainer) on the same subjects (in this case, students). The subjects were grouped based on their ability level (good, adequate, and poor).

2.2. Repeated Measures

Measurements in this study were carried out by taking data from the same subjects (students) in two different conditions:

a. Condition 1: Manual checking of logic gate conditions (which has already taken place during the practical process).
b. Condition 2: Checking the condition of the logic gate using a demonstration tool/trainer.

From the treatment given to the subject, the completion time will be obtained which will be analyzed directly

2.3. Research Variables

The variables of this study are:

a. Independent variables:
   - Checking methods (Manual and Teaching Aids)
   - Student Ability (Good, Sufficient, Poor)
b. Dependent Variable:

- Completion time (quantitative data, measured in units of time such as seconds or minutes)

3. RESULTS AND DISCUSSION

The research data is taken from the time value of students when testing the condition of the IC manually and using teaching aids. For the manual step, students assemble the TTL IC to be tested on the project board, then given a 5v voltage source and input logic 0, 1 for each gate, given different inputs and output checks by using LEDs and voltage measurements with a multimeter, the manual testing process can be seen in Figure 1. For testing with teaching aids, students only place the IC to be tested and select the push button IC to be tested, the rest of the teaching aids will automatically provide data on the condition of the IC, more details can be seen in Figure 2.

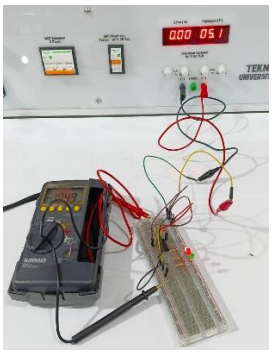

Figure 1. Manual Testing Process

Figure 2. Teaching Aid Testing Process

The results of manual testing data can be seen in Table 1, and Table 2 for the results of the teaching aid testing and Table 3 for the results of the effectiveness of using teaching aids.

Table 1. Manual Process Test Data

Student	Ability	Manual Test (seconds)						
		7408	7432	7404	7400	7402	7486	74266
A	Good	120	120	120	120	120	120	120
B		122	122	125	122	123	122	122
C		120	120	121	120	122	120	121
D	Enough	130	130	130	130	130	130	130
E		132	132	132	132	132	132	132
F		142	142	142	142	142	142	142
G	Not enough	150	155	150	152	155	152	155
H		160	162	161	161	162	162	162
I		165	165	164	163	162	163	163

Table 1 shows data using manual media in testing, with testing from each student carried out 3 times for all types of IC. The average results of the 3 tests are shown in Table 1. From Table 1, it can be seen that students with good abilities are very consistent in the time needed to complete this TTL IC test. It can be seen that students with good abilities are 18% faster than the group of students with sufficient abilities and 34% faster than the group of students with less abilities. From these data, it can be said that student abilities significantly affect the speed and consistency of manual test completion.

Table 2. Test Data Using Teaching Aids

Student	Ability	Testing of Teaching Aids/Trainer (seconds)						
		7408	7432	7404	7400	7402	7486	74266
A	Good	47	56	54	50	56	56	56
B		48	50	52	50	50	50	52
C		46	46	47	47	46	46	46
D	Enough	48	55	54	50	58	56	57
E		48	50	53	52	51	55	55
F		50	45	48	48	45	49	48
G	Not enough	50	56	55	51	58	56	57
H		48	51	53	50	50	56	57
I		50	46	50	50	51	50	50

Table 2 presents data from the test results using the training aid/trainer that has been produced. Table 2 shows that the time required to complete the IC test for students with good, sufficient, and poor abilities was significantly improved. The time gap seen in the manual test was overcome by the use of this training aid. The difference between the abilities of students with good and poor abilities during the manual test was approximately 38 seconds, and after using this training aid, the difference was reduced to 2 seconds. Therefore, this training aid has been proven to be able to equalize student performance in terms of the time required to perform the TTL IC test.

Table 3. Data on the Effectiveness of Using Teaching Aids

Mahasiswa	Kemampuan	Perbedaan waktu uji (Waktu Manual - Waktu Alat Peraga)							Efektivitas Alat Peraga (%)						
		7408	7432	7404	7400	7402	7486	74266	7408	7432	7404	7400	7402	7486	74266
A	Baik	73	64	66	70	64	64	64	61	53	55	58	53	53	53
B		74	72	73	72	73	72	70	61	59	58	59	59	59	57
C		74	74	74	73	76	74	75	62	62	61	61	62	62	62
D	Cukup	82	75	76	80	72	74	73	63	58	58	62	55	57	56
E		84	82	79	80	81	77	77	64	62	60	61	61	58	58
F		92	97	94	94	97	93	94	65	68	66	66	68	65	66
G	Kurang	100	99	95	101	97	96	98	67	64	63	66	63	63	63
H		112	111	108	111	112	106	105	70	69	67	69	69	65	65
I		115	119	114	113	111	113	113	70	72	70	69	69	69	69

Table 3 shows data processing from manual testing and the use of teaching aids. It can be seen that teaching aids can reduce processing time by 60-72%, or 73-115 seconds per student. The effect is most visible in the group of students with lower abilities, namely 98-115 seconds, which is the same as the performance of other student groups.

From the data presented above, it can be said that the IC tester training tool/trainer has succeeded in reducing the time for testing by an average of 60-72%, where the manual testing process requires an average completion time of 120-165 seconds/student, while with the training tool the testing time drops by an average of 45-58 seconds/student.

4. CONCLUSION

1. The IC tester demonstration tool is proven to speed up TTL logic gate IC checking by 60-72%, reducing the average time from 121-159 seconds (manual) to 45-58 seconds.

2. This teaching aid can be a solution so that the practicum process can run the same as the typical student based on their abilities, it can be seen that students with low abilities (less) have a reduction of up to 115 seconds, proving this tool as a cost-effective solution for practicum efficiency at UMK.
3. The consistency of using this teaching aid is between 10 seconds across all types of student abilities.

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