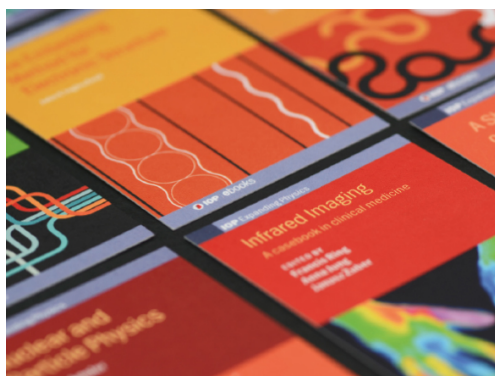


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The development of online vocational aptitude test

I W P Yudha¹, I M Candiasa² and G Indrawan³

¹Computer Science, Ganesha University of Education, Singaraja

²Mathematics Education, Ganesha University of Education, Singaraja

³Electrical Engineering Education, Ganesha University of Education, Singaraja

E-mail: yudhaejr@gmail.com¹, candiasa@undiksha.ac.id²,
gindrawan@undiksha.ac.id³

Abstract. Directing students to be able to choose the right program to follow is a very important activity for education, in an effort to increase graduate competence. In order to be able to direct students into appropriate study programs, the aptitude of students is very important to be recognized. If students can participate in educational programs that are relatively in accordance with their aptitude, their learning motivation tends to increase, so that the competencies achieved will be better and the learning time will be shorter. Thus, the allocated education resources can be used more efficiently. In addition to the school and students, parents are also very important to know their children's aptitude, in order to be able to negotiate with their children to choose an educational program. Aptitude tests have been widely developed, however, that there are still many limitations to use them, such as limited access on the part of respondents, difficulty in presenting various tests, and difficulty in scoring. Efforts towards the development of online aptitude tests have been widely sought. This research attempted to develop an online vocational aptitude test. This test was developed to detect the vocational aptitude of junior high school graduates who will enter a vocational high school which is currently the leading education program. The vocational aptitude test developed was based on verbal aptitude, numerical aptitude, logical aptitude, and scholastic aptitude. The aptitude test developed adopts a multiple-choice test model with four choices. Review by expert shows that the developed vocational aptitude test has a content validity ratio (CVR) which is in the range of 0.78-0.86, so it meets the content validity requirements. Based on the tryout of the test, it was found that the reliability of the test had met the requirements with an alpha cronbach coefficient (α) = 0.83. Tests on students who had chosen vocational programs got precision = 0.76; recall = 0.82; and accuracy = 0.83. Therefore, vocational aptitude tests already met the requirements of online vocational aptitude tests.

1. Introduction

Aptitude test is an activity that is very important for education because it can provide information about the aptitudes of students. Information about students' aptitudes is highly necessary, so students can choose educational programs that are more relevant to their aptitudes. If students can take part in an education program that is relatively in accordance with their aptitudes, the motivation to learn tends to be better, the competencies achieved will be better and the learning time will be shorter. Thus, the allocated education resources can be used more effectively and more efficiently.

Information about the influence of aptitude on learning outcomes has long been studied. Therefore, aptitude tests have been developed to determine the aptitudes of students. It's just that most existing aptitude tests are still an aptitude test done manually which is commonly called a paper and pencil test. Such aptitude tests have many limitations, such as the limitations of the respondents that can be reached, the difficulty of getting varied tests, and the difficulty of scouting. As a result, the



implementation of aptitude tests must involve experts in their fields, especially for scoring and interpreting results.

Online aptitude tests are expected to be able to overcome the limitations of existing manual aptitude tests. The characteristics of information and communication technology (ICT) that are able to penetrate geographical and time limitations are expected to overcome respondents' limitations. The ability of a computer database to become a data bank can be utilized to create a question bank, so that the difficulty of varying test items can be overcome. Likewise, the difficulty of manually extracting a test can be overcome because the computer can be programmed to be able to do the automatic extraction, and then provide information on the results of the test automatically as well.

The online aptitude tests generated by this study can be used by anyone, without having to master competency in the field of evaluation. Students themselves who want to know their aptitudes can do their own tests and can directly know the results. Teachers or principals who want to know the aptitudes of their students can use this test to test their students' aptitudes and can find out the results directly. Parents of students who want to know their children's aptitudes can use this test to test their children's aptitudes and can find out the results directly. The results of the aptitude tests will give consideration to students to choose the next major or educational program. For teachers or principals, the results of the aptitude tests can be used as a basis for advising students to choose majors and choose their next educational program. Likewise for parents of students, the results of the aptitude test can be used as a guide to give consideration to their children about the majors and educational programs that must be chosen.

The online aptitude test developed can be used by anyone without being limited by place and time. Whenever and wherever the test can be used with the same performance. Test results bias due to repetition of the tests presented can be avoided because the tests are taken from the question bank database which can present different test variations for each presentation. On the other hand, this effort was made to accustom students to behave using the internet because it was able to improve achievement [1] and positively influence students' attitudes towards research [2].

Aptitude is an innate ability to learn certain fields quickly and easily [3]. Phrases such as "born as a scientist", "created as a technocrat", "aptitudeed athlete or musician", "instructor or natural politician", "teacher with innate abilities", and other similar expressions indicate the aptitudes of someone who is different from others. Through looking at this context as if these people are successful in their respective fields because of their aptitudes, it seems they get it all without effort. However, in reality all successful people always have struggle. It's just that for people whose jobs are in accordance with their aptitudes, the work done will be fun, so they work not feel as forced laborers. Aptitudeed scientists will always be interested in finding problems that need to be solved in their fields. Aptitudeed musicians will enjoy the music sung. Meanwhile, aptitudeed computer technicians will work on computer repair in the laboratory with perseverance and pleasure.

Aptitude is often confused with ability (ability) or achievement (achievement). Carter provides a fairly clear description of differences in aptitude, abilities, and achievements [4]. Individual aptitude refers to how fast or how easily the individual can learn in the future. Meanwhile, the ability of individuals refers to what can be achieved in the future. On the other hand, achievement refers to what has been achieved in the past. Addition arithmetic achievements illustrate what students have mastered in the area of arithmetic addition. The ability to solve story arithmetic problems shows what students can achieve in terms of solving arithmetic story problems in the future. Numerical aptitude shows how fast and how easily students can learn material or activities that use numerical calculations.

Aptitude is measured by aptitude tests. Aptitude tests are developed to cover up weaknesses from intelligence or intelligence tests. Intelligence tests have limitations in terms of abilities that can be covered. This was realized by experts well before the dual aptitude test was developed. The intelligence test concentrates on abstract functions, including the use of verbal or numerical symbols, so that more specific interests, which involve more concrete or practical abilities are forgotten. These gaps are overcome by special aptitude tests. The importance of vocational school selection and handling of counseling spurred the development of tests to measure mechanical aptitude, administrative aptitude, musical aptitude, artistic aptitude, and aptitudes in other fields. Even for the selection of employees in certain fields still requires more specialized aptitude tests, such as aptitude

tests of observation, hearing, and dexterity. Employee selection for industry or selection of military personnel requires observation, hearing and agility.

Mapping the existing majors with individual aptitude patterns has provided a strong impetus for the development of aptitude tests. Likewise, the mapping of job vacancies to the individual aptitude patterns has provided a very strong impetus for developing special aptitude tests. Individuals who have mechanical aptitude are directed to go to a vocational school in the field of mechanics. Individuals who have musical aptitude are advised to pursue the field of music. Likewise, individuals who have strong clerical aptitudes are placed in matters that have a lot to do with administration.

Mechanical aptitude, music, art, and other special aptitudes are further recognized as complementary to IQ in individual descriptions. However, with the emergence of factor analysis it was slowly recognized that intelligence was composed by relatively independent aptitudes, such as verbal knowledge, logical reasoning, numerical calculations, visualization of space, ability of associations, and so on. Even some traditional special aptitudes, such as mechanical aptitude and administrative (clerical) aptitude are also integrated into the dual aptitude battery.

Some specific fields, such as observation aptitude, listening aptitude, dexterity aptitude, and artistic aptitude are rarely covered by battery multiple aptitudes. The situation in this field is very special in being able to decide on the results of the test in a dual aptitude battery. Specialized aptitude tests are also used in fields that are already covered by dual aptitude batteries, such as administrative aptitude and mechanical aptitude. In some tests, general intelligence tests are combined with relevant special aptitude tests. The reason lies in the extensive normative and validation of data from frequently used special aptitude tests. The second reason is procedure flexibility, which does not only provide relevant aptitude alternatives, but is also complemented by the measurement of each aptitude for specific purposes.

Aptitude tests measure abilities that are more specific and more limited compared to intelligence tests [5]. Single aptitude tests only measure one domain of ability, whereas multiple aptitude tests produce scores for several different ability areas. Mechanical aptitude tests, musical aptitude tests, and aptitude aptitude tests are special aptitude tests. On the other hand, the Scholastic Aptitude Test (SAT) and Differential Aptitude Test (DAT) are multiple aptitude tests. The SAT contains verbal abilities and numerical abilities tests, while DAT contains eight tests namely verbal abilities, numerical abilities, abstraction abilities, clerical speed and accuracy, mechanical abilities, spatial relations, spelling, and language use.

The test for measuring multiple intelligence developed by Gardner is a multiple aptitude test [6]. Initially, the theory of multiple intelligences contained seven intelligences, namely mathematical intelligence and mathematics logic, linguistics intelligence, kinesthetic intelligence, interpersonal violence, intrapersonal intelligence, spatial intelligence, and musical intelligence. Next, two more intelligences are added, namely environmental intelligence and religious intelligence.

Aptitude tests are different from ability tests and achievement tests. Carter [3] states that aptitude tests in general are tests aimed at measuring the potential to achieve certain achievements. Cronbach [7] adds that aptitude tests are intended to predict the success of individuals in certain activities or occupations. Aiken [8] more clearly describes that aptitude tests focus on future behavior, i.e. what individuals will be able to learn with appropriate learning, while achievement tests assess individual abilities based on what they have learned in the past. A similar statement was given by Gronlund and Linn [9] by stating that the difference in aptitude tests and achievement tests lies in the use of the results. The results of aptitude tests are used to predict learning success in the future, while the results of achievement tests are used to indicate the level of learning success in the past.

Based on the description above it is concluded that aptitude is an innate potential that an individual has in a particular field that determines how fast, how easy, and how accurately the individual can complete his activities in that field. Aptitude is different from achievement and ability. Aptitude determines the potential for individual success in the future, the ability to achieve individuals in the future, and achievements show the success of individuals in the past or in the past.

This study has deliberately chosen the development of vocational aptitude tests for several reasons. Firstly, vocational education focuses on specific activities to instill practical skills that enable individuals to engage in certain activities or occupations [10]. As a result, the introduction of vocational aptitude before they choose an education program becomes very important. Secondly, the management of vocational education is very complex because of the large number of students served

and the stakeholders involved in decision making are very numerous [11]. Therefore, vocational education requires an integrated and quality framework [12].

Preliminary studies that have been carried out are: 1) identification of dimensions or indicators for each aptitude test that will be developed, 2) formulation of descriptors for each dimension or indicator for each aptitude test that will be developed, and 3) identification of many items for each dimension or indicator on each aptitude test that will be developed. Until now there have been several aptitude tests developed. However, most of these aptitude tests are developed in other countries. Therefore, efforts are needed to make the aptitude test appropriate to the context in Indonesia.

Online tests refer to tests conducted using computer networks and their various facilities (internet) as a medium. Students receive questions through the display of text, graphics, pictures, or videos on a computer monitor. Furthermore, students provide answers or responses by using a keyboard or mouse. Computers can work fast and carefully to correct student responses, so they can give scores quickly and can even provide feedback quickly too.

There are several advantages of computer-based communication that can be used to improve the quality of test implementation, namely context-free, free of social conventions, and guaranteeing privacy. If the test uses a computer as a communication medium, there is no face-to-face communication between testers and test takers. Therefore, test takers will not feel supervised. They can work straightforwardly without the thought of the supervisor who is always stalking them. The confidentiality of information from each student is very guaranteed. Information from a test taker will not be known to other test takers. Such conditions make students free from anxiety, so they will be able to show optimal abilities.

Muwanga-Zake [13] found that computer-based tests were very useful because students had time to revise answers, get corrections immediately, be able to rework the test, and be able to find out the remaining time. In addition, students get immediate feedback so they are able to do remedial learning. Similar to the findings of Muwanga-Zake, Williams [14] found that students' experiences and attitudes towards web-based tests were very positive and they preferred web-based evaluation over written evaluation. There are several benefits gained from web-based evaluation, namely feedback is obtained immediately, schedules can be arranged more flexible, cheaper, more reliable reliability, flexible in terms of time and place both in terms of students and teachers, faster scoring, security and confidentiality more secure, students' student records can be saved automatically, more opportunities to monitor student progress, easily identify problem errors, and easily standardize the evaluation environment.

Relatively more specific information was found by Botge et al. [15] that for children who have low academic ability, computer-based tests can improve their ability to understand tests, they spend time for doing tests relatively similar to children who have high academic abilities, and they are able to learn by scaffolding. In the future it is expected that integration will occur between interactive assessment of interactive learning to facilitate formative evaluation to facilitate teachers to individualize learning and facilitate integrated summative evaluation.

2. Research Methods

The online aptitude tests generated by this study can be used by anyone, without having to master competency in the field of evaluation. Students themselves who want to know their aptitudes can do their own tests and can directly know the results. Teachers or principals who want to know the aptitudes of their students can use this test to test their students' aptitudes and can find out the results directly. Parents of students who want to know their children's aptitudes can use this test to test their children's aptitudes and can find out the results directly. The results of the aptitude tests will give consideration to students to choose the next major or educational program. For teachers or principals, the results of the aptitude tests can be used as a basis for advising students to choose majors and choose their next educational program. Likewise, for parents of students, the results of the aptitude test can be used as a guide to give consideration to their children about the majors and educational programs that must be chosen.

The development of this online aptitude test followed the development of a waterfall or better known as the classic life cycle (CLC) or the classic life cycle, which is the most ancient paradigm that is often used in making software that has become an archetype in other paradigms and is often called

the waterfall a six-stage model of system engineering, analysis, design, code, testing, and maintenance [16].

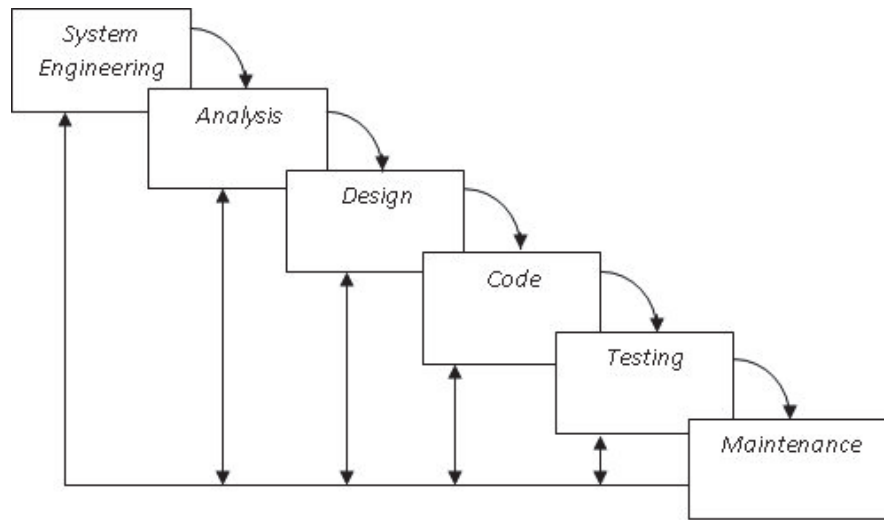


Figure 1. Waterfall Model.

System engineering focused on a feasibility study of system development based on technological, economic and human resources aspects of the process. Analysis focused on analyzing the need for developing online vocational aptitude tests. In the analysis phase a vocational aptitude test was prepared which would be developed into an online test. The vocational aptitude test that was developed including five components, namely numerical aptitude, logical aptitude, technical aptitude, linguistic aptitude, and administrative aptitude. The validity of the contents of the instrument was evaluated by seven panelists and the results were analyzed with the Lawshe formula as follows [17].

$$CVR = \frac{n_e - \frac{N}{2}}{\frac{N}{2}} \quad (1)$$

in which the CVR is the content validity ratio, n_e is the number of panelists indicating "essential" and N is the total number of panelists. Test items were declared valid if the CVR exceeds 0.75. Next, a vocational aptitude test was tested on 80 students and the results were analyzed with the Cronbach alpha formula, like equation (2) [18].

$$\alpha = \left(\frac{n}{n-1} \right) \left(1 - \frac{\sum V_i}{\sum V_t} \right) \quad (2)$$

In formula (2), α expresses the Cronbach alpha coefficient, n is the number of items, V_i is the item variant, and V_t is the total variant. Cronbach's alpha reliability coefficient for a test is considered relevant if it exceeds 0.68 [19].

At the design stage, online vocational aptitude test framework was formulated, which consisted of designing web structures and designing menu layouts. Code generation was the process of translating design results into code that was understood by computers. After the coding was complete, it was continued by the testing process to determine the effectiveness of tests that include, precision, recall, and accuracy by using formula (3), formula (4), formula (5) which was derived from contingency table [20]. Precision is the level of accuracy between the actual information and the answers provided by the test. Recall is the level of success of the test in finding a true information from information that is true. Accuracy is a measure that states the level of success of the test in making predictions.

Table 1. Contingency Table.

		Real Positive	Negative
Predicted	Positive	True Positive (TP)	False Positive (FP)
	Negative	False Negative (FN)	True Negative (TN)

$$Precision = \frac{TP}{TP+FP} \quad (3)$$

$$Recall = \frac{TP}{TP+FN} \quad (4)$$

$$Accuracy = \frac{TP+TN}{TP+TN+FP+FN} \quad (5)$$

As long as the online vocational aptitude test developed did not meet the desired level of effectiveness, a revision would be continuously carried out. Each revision would be followed by another trial. If the level of effectiveness was considered sufficient, a maintenance stage was carried out, as the final stage of development process.

3. Result and Discussion

The vocational aptitude test was based on verbal aptitude, numerical aptitude, logical aptitude, and scholastic aptitude. It was developed into 70 items, but in its implementation, it became an online aptitude test involving only 60 items. There were ten items that were not involved for various reasons, such as three items were invalid and 7 items were already represented by other items. The validity of the contents of the instrument was carried out by expert testing and the results were analyzed by the Lawshe test. The results of the analysis got a content validity ratio (CVR) in the range of 0.78-0.86, therefore all of the items were valid. Furthermore, the results of trials on 80 students obtained an alpha crobranch coefficient of 0.83, far exceeding 0.68. So, the vocational aptitude test developed already met the reability requirements. Based on this information, the developed test was feasible to be applied in the measurement of vocational aptitude.

The vocational aptitude test was developed into an online application, and was later called the online vocational aptitude test. In this system there are two levels of users namely administrators and participants. Administrator level has facilities to do login activities, manipulate question category data, manipulate questions, manipulate test participant data and log out. Then the level of participants has the facility to view general instructions for answering tests, conducting test list activities, answering questions on the web, getting the results of tests conducted, and logging out.

The vocational aptitude test that was developed was emperically tested on 228 students who had chosen the program. They consisted of 80 vocational students and 148 non-vocational students. Vocational aptitude tests were able to detect as many as 95 vocational students. Based on these data, a contingency table can be made as follows.

Table 2. Test Result in a Contingency Table.

		Real Program	
		True	False
Predicted Program	True	68	27
	False	12	53

Based on the test results listed in the table, it was found that the vocational aptitude test developed had precision = 0.76, recall = 0.82, and accuracy = 0.83. These results indicate that online aptitude tests are feasible to be implemented but improvement efforts are still needed. The improvements intended specifically include content, both in terms of depth and in terms of variability.

4. Conclusion and Future Work

Online aptitude test that has been developed is a system that is expected to be utilized by the general public to find out their vocational aptitudes, so that they can direct the next educational process. In terms of content, the developed aptitude tests have met the feasibility, with a content validity ratio (CVR) in the range of 0.78-0.86. The instrument reliability of 0.83 has exceeded the minimum alpha reliability coefficient of 0.68. The results of empirik tests on students who have made their choices gave the value of precision = 0.76; recall = 0.82; and accuracy = 0.83. These results indicate that the test is appropriate for online use.

The test can be used without having to involve a measurement expert. Therefore, students can independently recognize their own talents, as a consideration in choosing the right educational program. This information is also useful for parents of students to consider the education of their children. The selection of educational programs according to aptitude can increase learning motivation, thus it gives opportunities for students to achieve more optimal achievement. On the other hand, educational resources can be utilized as fully as possible.

Improvement efforts that still need to be done is to make the contents more varied and deeper. This is intended to include aptitudes that are broader in scope and more detailed in their disclosures. Thus, the results obtained will be more optimal, so it gives more careful consideration to the people who need it. In terms of systems, the ease of operation still needs improvement and the interpretation of results still needs to be detailed and clarified.

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