Implementation of CAT in Indonesia School: Current Challenges & Strategies

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Abstract Another problem is student readiness. Computer-based measurement models continue to develop from the Computer Base Test (CBT) to the Computer Adaptive Test (CAT). Accurate measurement of student abilities is needed in the exam process. The use of paper and pencil test (PBT) and CBT is not maximal in providing student ability results so it requires a CAT model measurement approach. This paper describes the challenges and strategies to overcome all obstacles in applying CAT in the cognitive, psychological and technological aspects of knowledge. The purpose of this research is to analyze school challenges and strategies in implementing the Computer Adaptive Test (CAT). This research is qualitative phenomenology. Data were collected through interviews with 10 participants in Yogyakarta Indonesia. Research participants are Prokor teachers at Junior High School (SMP) and High School (SMA). Data analysis is done by describing the data qualitatively using the reduction analysis in the form of identification of statements, determination of theme category, and reduction. The results showed that the school should provide facilities that support CAT, ensure the smooth and stability of the internet and electrical connections, conduct continuous human resources training, give students training and motivation and set up budget management for CAT implementation. By implementing this strategy, the effectiveness of CAT implementation in Indonesia can be improved.

Keywords Computer Adaptive Test (CAT), Strategies, Obstacles, Application

1. Introduction

One of the most effective human resource developments that needs to be embraced for industrialization in any country is through technical education [1]. Technological developments in the era of globalization have provided many benefits in progress in various fields. The development of this technology is in line with the 4.0 industrial era characterized by increased connectivity, interaction, and development of digital systems, artificial intelligence, and the virtual ones where humans and technology support educational Progress [2]. Human adaptation to technology is made so that technology and education can develop together with the new generation as the successor to the old generation. The progress of a nation depends on qualified human resources. It is written in Law number 20 of 2003 about the National Education System, one of contents discussing education that is a conscious and well-planned effort to create a learning atmosphere and learning process in order to actively develop the potential of himself to possess the spiritual power of religion, self-control, personality, intelligence, noble character, and skills needed himself, peoples and nations.

The process of education is a process that is deliberately implemented to form human resources that play a significant role in the development process of nations and countries. Schools, as formal educational institutions play an important role in the process of realizing an education

that can create competent human resources. One of the processes is through a more modern changing learning system, where the system has a significant difference compared to the traditional learning system [3]. Development of modern learning, e.g., e-learning. E-Learning has led to a massive growth in education that offers a wide range of services [4]. In e-learning, there is an evaluation model based on on-line known as Computer Based Test (CBT).

Before the year 2014, Indonesia had been implementing exams in schools using paper and pencil tests (PBT). Evaluation of this model has many shortcomings, among other easy leakages, cheating, and others. The value obtained from the results of the model also does not describe the ability of actual participants. In comparison the use of PBT model with CBT to find more accurate use of CBT in the participants with the moderate ability [5]. The model PBT requires a problem item and many exams to get a good level of precision [6].

The computer-based exam examinations are more efficient than PBT checks, so CBT must be adopted in all lessons [7]. This utilization has made significant breakthroughs in education, and the PBT exam format was replaced by computer-based testing [8]. The characteristic of the CBT test is the same as PBT. CBT models are still precise in the presentation of grain items and the time required. The problem is that because the assumption is to assume the students of the same age or education level has the same ability. In reality, there is a significant variation of ability. Also, the assessment model still ignores the variation of individual abilities resulting in weak results and student information. In other words, the CBT organizers provide a similar number of items in each test participant is less effective for most test takers especially low and high proficiency test participants [9]. To solve the problem of PBT and CBT model, the problem must be adjusted to the ability of test participant or adaptive.

An adaptive exam will be able to determine the estimated ability of the exam taker according to actual student skills. Exam participants can be given an item that maximizes their level of ability. Most of these adaptive test applications are based on the selection of adaptive items [10]. One of the models of adaptive exams is CAT, where the question item is presented from the question group and is known as the Question Bank. The question is arranged and selected to match the approximate level of proficiency of the test taker. If the test participant successfully replied, then the next one will be presented a slightly harder question and vice versa [9], [11]. Tests that have an item length fixed will not be efficient when used for all test takers. Thus, participants who have diverse abilities should be given enough with a few items that correspond to their ability. The length of the CAT is shortened without losing the precise testing to the problem condition had appropriately been calibrating. A complete psychometric attribute of test participant ability is thus required. The

computer system in running CAT works by selecting the question item at the individual level of exam participant's ability after the exam participant response occurs.

Further estimates of the student's ability are updated, and the next problem item is selected to determine the optimal property on the new estimate [12]. The computer continuously re-evaluates the student's ability and checks until the accuracy of the statistical estimation with acceptable levels or when an on-demand limit is reached, such as the maximum number of items a test is presented. Each item presented to the selected exam participants can provide because the question has been through the process of computing the student's response to the previous question [13].

CAT has advantages over CBT, shorter testing, faster, flexible testing schedules increased security testing. The Presented problem can be controlled, the test content balance for all ability levels, and the update of faster test items [14]. Another advantage is that the CAT can provide tests on-demand, and score results are provided immediately. CAT can produce the same level of precision as a fixed test, which has about twice the number of grains [15]. CAT is adaptive, so no questions are harder or easier. This model allows the use of an appropriate test target, i.e., test with difficulty level by the ability of the student, CAT stops when the ability to estimate test takers have converged with specific default errors. With this presentation model, the time it takes for the exam to be shorter.

The implementation of CAT in schools should pay attention to the calibration of problems that have been compiled [16]. The parameters used are psychometric, namely the difference in power problem, difficulty level, and the guessing factor by involving equations in the response theory of grain [17]. Some CAT challenges and consistent solutions can help CAT implementation go well in measuring test taker proficiency levels [18]. Therefore, there is a preparation of various elements supporting the implementation of the CAT implementation. Excavating information is intended so that we can know what is needed to implement CAT from HR, infrastructure, facilities, and infrastructure and readiness of students to face CAT. Thus, it can be compiled solutions and strategies as a solution of existing constraints, so it can explore the challenges and strategies for implementing CAT in Junior High School (SMP) and High School (SMA) in Yogyakarta.

2. Materials and Methods

This study was conducted through a qualitative phenomenological approach. This study is a descriptive research-exploration. The function of phenomenological research is used to describe the current phenomenon. This descriptive exploratory is done to describe the various obstacles and challenges faced by the school to apply CAT.

CAT is explored from several aspects, namely infrastructure, supporting equipment, human resources, and exam participants. Data was collected through interviews respondents to explore all conditions of the school relating to THE implementation of the paint. After the interview, researchers have shared questionnaires to support interviews. The interview results were then transcribed and performed a focus group discussion (FGD) to find the data reduction used to provide strategies and solutions.

The respondent to this study was Guru Prokor. Prokor is the officers who determine the course of conducting exams at school. In general, the principal task of the Prokor operates the server so that it can provide problems on the computer. Respondents came from 5 public schools and 5 private schools in the Special Region of Yogyakarta, namely Yogyakarta City, Sleman Regency, Kulon Progo Regency, and Bantul Regency. The number of respondents was 10. The characteristics of the respondents' profile involved in this study were shown in table 1.

Table 1. Characteristics of Respondents

Initials Name	School / Institution	Gender
WS	SL-1	Male
SR	SL-2	Female
SK	SL-3	Male
NH	SL-4	Male
SS	SL-5	Female
EP	SL-6	Male
WR	SL-7	Male
MP	SL-8	Female
PM	SL-9	Male
NR	SL-10	Male

Respondents and schools in this study were disguised in order to protect study participants and ensure the confidentiality of the information shared and anonymity [19], [20]. The school profile used in this study is shown in Table 2.

Table 2. School Profile

Name	Status	Geographical Location
SE-1	State	Sleman Regency
SE-2	Private	Sleman Regency
SE-3	State	Kulon Progo Regency
SE-4	Private	Bantul Regency
SE-5	Private	Sleman Regency
SE-6	State	Bantul Regency
SE-7	State	Kulon Progo Regency
SE-8	State	Yogyakarta City
SE-9	State	Yogyakarta City
SE-10	State	Yogyakarta City

The data was collected using interview techniques with

a duration of 60 to 90 minutes. Interviews were conducted in private; only the researcher and participants were in the room. This final interview is intended to ensure that the real identity and information provided by participants are confidential [21]. The questions asked in this interview are open-ended. During the interview, the researcher creates a conducive, comfortable, and relaxed atmosphere so that participants feel free and open in responding to any questions asked. In addition to using interviews, this data collection uses a questionnaire. The questionnaire model used is a closed questionnaire and is answered directly on the spot. This model is taken because this questionnaire is only used as supporting data for interviews.

The results of the interview were converted into an interview transcript using the google doc application to match the results of the interview. The findings from the interviews were discussed using FGD with additional data from questionnaires. The results of the FGD were then summarized for the analysis of the results data by grouping them into variations, categories, and reductions. Variation is the prokor teacher's statement that will be a challenge in this study. A category is a group of themes from several variations that are considered as a family, and reduction in the core of several categories. All analyzes are presented in tabular form. After the data is presented, strategies and solutions for solving challenges are created in tabular form. From the tabular form will be seen what strategies and solutions are offered to schools if CAT is implemented. This descriptive analysis is the result of explaining the findings.

3. Result

One of the strategic efforts that need to be made to improve the quality of education is the use of information technology to support learning in schools. Learning technology, which is a translation of instructional technology, is a theory, a field of work, and a profession that is very concerned with efforts to facilitate the learning of learners (learners) and continue to improve performance with appropriate learning processes and resources and entertaining. This learning facilitation is provided (by learning technology) by individual characteristics so that students can learn quickly, exciting, fun or motivated, and more efficient. As said by WS: *"The current use of Information Technology, especially e-learning in supporting learning in schools, is urgently needed because currently, all learning materials come from digital sources with technology, so the absorption of material will be faster, so technology facilities are needed in learning"*. E-learning, as a direct result of the integration of technology and education, is a powerful learning medium, especially the use of Internet technology. With the help of information technology, students' motivation to learn will be even higher.

In the world of education, the delivery of information using IT is very important in the learning process. MP said: *"In order for IT technology to continue to be used by teachers, the benefits of training must be by the needs to solve daily problems; otherwise, the technical skills will be easily forgotten"*. NS said: *"Along with improving teacher competence, schools must have information technology training programs"*. The importance of technological knowledge makes all administrative matters of teacher, student, student evaluation technology-based. SS said: *"with the phenomenon of technology transfer in education, teachers who have not mastered IT should often attend training in the IT field, so that little by little teachers will master IT"*. EP said: *"with CBT will produce good tests, cases of cheating can be overcome easily"*. Also, NR said: *"with computer-based exams, all administration related to CBT will be easily completed and on time"*. Therefore, motivation is needed to prepare student exams so that students remain enthusiastic and optimistic in working on computer-based problems. Motivation is a change in energy in a person, which is marked by the emergence of feelings and reactions to achieve a goal. PM said: *"students need motivation at all times, the task of a teacher is not only to organize teaching, research, develop, and managing an educational institution, especially students, but also responsible for tires generate motivation to learn students"*.

The significant difference between the CBT and CAT models lies in the adaptive test. CR said: *"that CAT is more significant for testing students than CBT, this is because CAT is independent and the number of questions is following the ability, but paint is still difficult to implement in schools because of many obstacles. It needs an in-depth study of the various obstacles faced"*. NH said: *"an initial constraint analysis and strategy is needed for the implementation of CAT in schools as an effort to fulfill the need for computer-based examinations, especially CAT, which is considered very heavy for some schools in Indonesia"*. This statement is in line with what SR said: *"there are several technical requirements that must be met, namely having a computer device according to the computer-based exam specifications, the appropriate network topology, an internet network with sufficient bandwidth, the availability of adequate electricity, and other supporting equipment"*. One of the most crucial components in efforts to optimize Information Technology as a learning and evaluation aid is the existence of a computer laboratory. MP said: *"a good computer laboratory management effort is needed to support the optimal role and function of the laboratory, especially for both CBT and CAT exams"*.

The current computer laboratory is inseparable from the internet network so that it can provide significant developments in the world of education, even though in its implementation, there are many obstacles in managing

it. As said by SK: *"the existence of the internet in schools is a necessity, this can be proven by the exams that are currently being carried out on-line either from the teacher or from school management, but there are many obstacles such as frequent dropouts, limited bandwidth, errors in the server, etc. Often there are problems with the internet network; a separate handler is needed"*. WR said, *"an internet network needs to be managed so that it can be of optimal use, especially when using student exams"*. What must be considered for a computer laboratory is the supply of electrical power.

The main supply must be above the power required by the total laboratory computers. This will guarantee fluency in computer-based exams, especially CAT. WR said, *"the supply of electrical power in some schools is still lacking, so they have to turn on the electric load alternately. The existence of an electric generator is needed as a backup in case of a power cut"*. As WS said: *"schools cannot rely on electricity from the State Electricity Company (PLN) because sometimes PLN blackouts occur suddenly so that a generator must be prepared"*. A computer laboratory certainly has conditions that are different from classrooms, both in terms of environment and room area. EP said: *"the condition of the computer laboratory should be equipped with an Air conditioner (AC) so that the room will feel cool so that it is comfortable to use for studying"*. The average room temperature is around 18 to 25°C. EP said: *"with such large room temperature, there are usually students who are cold or allergic to cold, so sometimes the temperature needs to be raised"*. The sense of belonging to a computer that has implications for students' sense of responsibility towards the computer used is a concern that teachers must instill in students. SS said: *"often students make something that causes the computer device to have problems, for example, by making jokes or playing with the mouse to open other applications that are not yet needed, besides that, they often scribble on the monitor using a pencil or other writing equipment"*.

Regarding the implementation of the CAT exam, of course, it takes a teacher or proctor and technician who is ready to handle the CAT process. NH said: *"there are not many proctor teachers and technicians in the school, only one person each; thus, training is needed for teachers and administrative personnel so that they can help implement CAT. The lack of Human Resources (HR) is inseparable from the educational background of teachers and employees in school"*. As MP said: *"education personnel and teachers do not have technical backgrounds, most of them are educators so that additional external personnel are needed"*. CAT is a relatively new exam model in Indonesia, so it needs careful preparation in its implementation. Therefore, training is needed on the implementation of CAT, both from question making to student ability analysis. With continuous training, human resources will be trained and can handle problems that arise.

The results show that (1) schools must strive to provide electronic equipment that supports CAT; (2) the obstacles that occur are unstable internet connections and insufficient electricity supply; (3) the need for continuous training aimed at teachers, supervisors, and CAT technicians; (4) there are still many students who have not to understand the use of information technology; (5) it is necessary to develop strategies, collaborate with related parties, make efforts to prepare human resources internally, and the need for a budget strategy to meet the minimum needs of CAT.

The following is an explanation of the challenges in implementing CAT that is faced by schools, especially in Yogyakarta. In implementing CAT, schools must provide adequate facilities. However, the fact is that many schools have not fulfilled the CAT minimum standard facilities. Table 3 shows a summary of CAT challenges, which are reduced from interviews' results that have been discussed through the FGD.

Based on observations, it was found that the availability of computers, space, internet bandwidth capacity, and electricity did not meet the requirements for implementation. The first problem is the limited number of computers. The school must fulfill computers that are positioned as servers and clients with the following minimum specifications: the server computer is a PC / tower/desktop type with a Xeon or i7 processor, 12 GB RAM, 1TB hard disk, and 1200VA UPS, while the client computer is a PC / a laptop with a 12-inch screen monitor, an i5 processor, and 500 MB RAM with a total of 40 computers so that 1 server can serve 40 client computers.

There are at least 1 backup server computer, 1 client computer that can be used by one participant, and a backup client computer of 10% of the ideal number. The need for server and client computers can be met by utilizing the computers available in the laboratory. However, many schools do not have computer labs with the required specifications; many computers are old and often break down. The cost of providing servers and client computers is a heavy burden on the school.

The second obstacle is the availability of computer rooms, where schools do not have individual buildings for computer-based examinations. These cases are usually resolved using laboratory rooms or classrooms. However, this resolution raises several problems. The first problem is that the computer room does not fit the design for managing CAT. This greatly affects the client-server computer ratio. The computer's layout is also arranged so that the distance between the computers is not too close so that test-takers are comfortable and do not interfere with each other. The distance from one computer to another is well adjusted so that participants cannot communicate and see other students' monitors [22]. The next problem is related to the computer placement layout. Usually, schools use computer laboratories to manage the needs of various computer applications, including CBT, CAT, etc. Unfortunately, the layout of the computer labs in some schools was permanently installed, making it impossible to modify. Therefore, it can use the classroom by arranging the seats facing each other [23].

Table 3. Challenges in Facility Requirements for CAT

Challenges	Theme	Inter-Theme Relation
Expensive server computers	Many schools do not yet have the ideal server computer as recommended for CAT implementations	Availability of computers with specifications that do not meet the standards, access to Internet networks are still difficult, limited electrical power and computer space causing the availability ratio between the server and the client computer, and the computer layout does not match.
Some schools do not have a standard server computer		
Number of limited Server computers		
Most computers in school laboratories have missed the specifics	Number and specifications client computer become a constraint in administration paint	
Client computer specifications do not meet CAT standards		
A limited number of client computers		
Limited computer room area	Limited space affects the server computer's ratio to the client computer and ideal computer layout	
Difficult to meet the ideal layout between client computers		
Computer structuring in a school lab is permanently		
Big Power Required	Many schools are constrained by stability and electric power	
There are difficulties of power access to the school		
There are power outages take turns		
Unlimited internet network and capacity	Many schools are still experiencing problems and management of internet network connection	
There is difficulty internet access to school		
Unwell-laid Internet network management		

To turn on many computers, of course, require an electrical network installation that meets the electrical installation standards of the State Electricity Company (PLN), both in terms of the type of cable, the installation model, and the electrical control. When turning on these computers for the first time, it cannot be the same, because the instantaneous electrical power consumed by the computer at the same time will be very high, twice the total power of many computers. This can be overcome by installing delay time ON equipment on each computer. Another problem related to the power supply is the use of tubular monitor or CRT, this monitor model requires large electrical power, so it is diverted to the use of LCD or LED. The blackout from PLN is also a separate concern for the school, if it happens when CHAT is carried out, it will undoubtedly disturb. Most schools that are going to implement CAT for the first time have to try to increase their electric power or set priorities for the use of electricity so that the computer is fully supplied with electrical power, and all electronic devices are on properly.

Internet network stability and understanding of CAT software largely determine whether CAT runs smoothly or not. CAT needs a reasonably good internet network connection stability. However, the reality is that in Yogyakarta province, which is categorized as a signal-rich zone, there are still areas where the internet connection is stable. Data obtained from interviews and internet speed tests in several schools tended to be slow. For this reason, the school must propose the installation of an internet network using optical fibre. The geographic location of the school also greatly affects the stability of the Internet connection. Some schools are geographically located in mountainous areas that are prone to lightning; this causes the risk of damage to internet network equipment. Some

schools are located close to tall buildings or behind hills so that an internet connection is rather difficult. In contrast, fibre-optic networks are not yet covered in all areas.

Students' readiness to take CAT exams needs to be considered because adverse psychological factors will affect the CAT results. Table 4 is a mapping of the test taker's readiness challenges.

The problem of allocating time needed by test takers to do CAT is a problem in itself. This is because students are not familiar with adaptive-based exam time stopping, so the time allocation cannot be predicted. Student psychological factors also greatly influence the success of students in running the exam. The sense of belonging to a computer that has implications for the sense of responsibility of students towards the computer used is a concern that must be instilled by teachers to students. When carrying out learning using computers, students often make tantrums that cause the computer device to have problems. Some schools complain that students do not use computers that are not following established procedures. Some cases are often found by students who often make jokes or play with the mouse to open other applications that are not needed; besides that, they often scribble on the monitor using a pencil or other writing equipment. CAT is usually carried out in a laboratory with air conditioning facilities (AC), which can make students who are allergic to cold uncomfortable. Thus, causing health reactions in students, be it dizziness, nasal congestion, nausea, extreme cold, which implies that the student cannot focus on the exam being carried out.

Another obstacle in managing the CAT is HR. Table 5 is an illustration of some conditions that are not ideal for the number of supervisors and technicians affecting the CAT success process.

Table 4. The Challenges of Participants Readiness

Challenges	Category	Data Reduction
Some students are unskilled in operating computers.	Student mastery of information technology is still minimal	Students do not understand computer and CAT operations. Students have not been can be to responsibility either on themselves or computer equipment; students with special needs are still constrained.
The students can not recognize the CAT testing model.		
The dismissal system will surprise students.	Some students do not yet have a sense of belonging and responsibility towards the computer and themselves.	
Students joke action in operating computers		
The low motivation of students		
Student discipline is lacking.	Some students experience obstacles related to health and individual needs.	
Some students are allergic to AC.		
Some students have issues in vision and hearing.		

Table 5. Challenges of the CAT Committee and Supervisors

Challenges	Category	Data Reduction
The limited number of teachers and employees to prepare to become supervisors and exam technicians	Some schools do not yet have quality human resources about information technology.	Lack of qualified human resources in the field of information technology and not yet socialized CAT exam models can hamper CAT test preparation.
The number of teachers and employees who understand information technology is limited.		
Teacher and employee understanding of CAT is very minimal.	Not yet well-socialized CAT test model.	
Teachers and employees do not yet understand the procedures for implementing the CAT.		
The teacher does not understand how to analyze the results of the CAT.		

Also, there are obstacles for supervisors, human resources, and technicians, supervisors must understand information technology and CAT issues. At the same time, currently, there are only a few human resources in schools who understand information technology. From a technician's point of view, most schools do not have technicians, so they have to hire technicians from outside the school, which means they have to spend more money. Test takers must also be prepared in advance, because they still lack in information technology knowledge, especially about CAT, so they need a continuous orientation for CAT.

4. Discussion

The development and implementation of CAT in educational environments, especially in the testing process, and evaluation continue to develop rapidly in a comprehensive manner. Many educational organizations use CAT to reduce examination costs, workloads, assessment delays, and human errors. Also, educational experts try to improve the accuracy and efficiency of testing. So that any CAT models have been developed, but from the many development models, the essence is the same, namely measuring the ability of computer-based test takers by adjusting the students' abilities and the questions presented. The CAT model that is used to measure the level of higher-order thinking skills (HOTS) of physics is called PhysTHOTS-CAT. This test instrument can provide questions based on students' abilities. The results showed that PhysTHOTS-CAT was valid for measuring the HOTS of Physics of class X SMA students according to teacher and student assessments of PhysTHOTS-CAT material and media of 82.28%. Thus, it can be concluded that PhysTHOTS-CAT can be used and is feasible to measure the Physics HOTS of class X SMA students [24].

CAT implementation in the Yogyakarta region requires an in-depth study before CAT is implemented. CAT is different from CBT. The first significant difference is in the question bank that must be calibrated following the rules of the item response theory. Second, starting from the selection of the items presented, the estimation of the

ability of the test takers, the calculation of the value of the question information, the termination of the questions, and the final assessment using the item response theory. Third, the concept of CAT is a test that is tailored to the ability of the test taker, so that in presenting the items the CAT machine must be able to adjust the abilities of the test participants. Fourth, it takes psychometric parameters, namely the difficulty level of the items, the difference in the items, and the guess factor. Meanwhile, CBT only conducts testing based on whether or not the answer is correct so that the presentation of the questions is not based on the estimation of the test taker's ability.

The use of CAT can be divided into 15 domains, which are categorized into 3 dimensions, namely educational, technical, and economic [25]. From the results of interviews and FGDs, there are many obstacles to implementing CAT. These obstacles include the provision of computers, space, electricity stability, internet network stability, human resources, and student psychology test participants are prepared in advance. Even almost all test takers are still minimal regarding knowledge of information technology, especially about CAT; thus, a continuous orientation is required. The implementation of CAT in schools is also used for diagnostic tests, namely CAT-WPLT, which was developed to maximize the effectiveness of WPLT as a diagnostic test. This implementation was given to 760 Japanese university students. The evaluation is based on a comparison of the measurement accuracy with the WPLT version of the fixed items. The results show that the CAT-WPLT can provide diagnostic information to test users about the test taker's strengths and weaknesses in additional knowledge with a smaller number of items and with equal or greater precision than the previous WPLT version [26].

In general, the problem is budget constraints. This causes difficulties for schools to meet various facility needs, especially those related to the availability of computers, the availability of electrical power and servers. In order to overcome problems amid budget constraints, the school must take several steps even without adequate funding support. The results of the mapping carried out for strategies to overcome challenges resulting from limited school funds are presented in table 6.

Table 6. Strategies of the Server Challenges

Challenges	Category	Data Reduction
Using a server that is not standard	Schools can upgrade existing computers or borrow from students' parents.	The solution of the minimum budget can be finished by utilizing available assets and maximizing its use through collaboration and partnerships with related elements
Upgrading computer to server computer		
Borrowing the server from other sides		
Borrow client computer	The school uses available computers, upgrades existing computers, and borrows client computers from other schools.	
Upgrading laboratory computers		
Upgrading laboratory computers	The school arranges the computer layout as best as possible by the room and optimizes the quality of the internet network.	
Adjustment the computer layout according to computer space available		
Optimizing internet network		

The price of a server computer is costly, it is rare for a school to have a server computer plus the limited budget capacity makes it even more challenging to have it. The first way to deal with this condition is to buy a server computer with lower specifications but still within the required specifications. The second way is by modifying an existing computer to be upgraded to a second server computer. The decision of this method certainly has a considerable risk for the smooth running of CAT. Therefore, it is recommended that schools conduct a trial first to test server performance to manage CAT properly. The third strategy is to borrow the server computer that is needed, but access to borrow the server computer is not easy considering the high server computer specifications.

Many schools do not yet have computers as clients. The ideal number of computer rooms is a maximum of 40 computers, so the cost to fulfill that number is hefty. The first strategy is to buy a client computer with limited specifications but still meet the lowest standards for CAT. The second strategy is to modify or upgrade client computers. The third strategy is borrowing computers or laptops from other sources, especially from teachers or employees at the school. If the number of computers is not met, the school can borrow from parents or other institutions that have computers or laptops, but it would be better if the three strategies were combined.

The availability of spaces for the layout of client and server computers is a problem that cannot be easily resolved because, in addition to requiring considerable costs, its provision cannot be made as quickly as possible. The unavailability of a particular room for CAT allows the use of classrooms that are equipped with adequate electrical installations, internet access, air conditioning, and other room needs. Schools can also use ICT laboratories as an option because they have an internet connection and adequate electrical power. The computer layout that must be considered is the distance between the computers, the network model, and the electrical infrastructure. As a recommendation, the ideal distance between computers is 1 meter so that supervisors can easily control every student working on CAT.

Another critical element of CAT implementation is the power supply as a power source to build a capable CAT. We present various problems related to power supplies in a variety of ways. Table 7 presents strategies for overcoming sources of electrical energy.

Table 7. Strategies for Electricity Supply

Challenges	Category	Data Reduction
Using an electrical regulator for each computer	Working closely with the state electricity company to increase electricity power and electrical stability while providing generator sets as a backup in the event of a power outage	Prepare, manage, and make strategies to optimize the consumption of electricity.
Cooperating with the State Electricity Company		
upgrade electrical power		
Provision of other sources of electricity such as generators		
Focusing on electricity consumption for CAT	Manage the sources to achieve efficiency and effectiveness of electricity usage when CAT	
Turn on the client's computer, alternatively not simultaneously at the same time.		
Minimize the use of electrical loads other than for CAT purposes		

The strategy to overcome the shortage and reserve of electric power needed is to cooperate with the State Electricity Company or private electricity providers, especially regarding network maintenance and electricity stability. Usually, schools have sufficient electrical power to supply their daily operational needs. However, they have a little problem carrying out computer-based exams. In these conditions, communication and cooperation with PLN are critical so that schools can prepare backup electricity (generators) before a blackout occurs.

Table 8. Strategies of Internet networks

Challenges	Category	Data Reduction
Prepare the modem	Solving connection problems and internet network stability	A good internet network connection is a connection with a stable bandwidth and hassles free from either the network or other user access
collaboration with internet service providers		
Cooperating with Indonesian telecommunications		
Minimize or limit Internet usage	Savings on internet access when used for CAT-based exams.	
Block video streaming and video sites during CAT test usage		

Strategies to overcome network linkages, schools can collaborate with Indonesian telecommunications companies to improve coordination between schools and state companies. Another strategy is to build cooperation with the nearest ISP to access Fibre Optic (FO) connections. By using an FO connection, it can improve CAT performance and is better than using conventional cables. School users should restrict CAT users to avoid accessing inappropriate content in the CAT process. In this condition, the network admin can restrict user access rights in the CAT environment.

Strategies to overcome internet network connections, schools can collaborate with Indonesian telecommunications (Telkom) to improve coordination between schools and Telkom. Another strategy is to build cooperation with the nearest ISP to access Fibre Optic (FO) connections. By using an FO connection, it can improve CAT performance and is better than using conventional cables. Users in the school environment may not access content that would interfere with CAT access. Thus, the admin of the internet network can temporarily limit access rights to users in the school environment.

Another critical problem is the mentality of the students. In this section, we present strategies for dealing with student psychology by providing orientation and motivation. This activity is given in a relaxed and accurate manner. Orientation can be done on an ongoing basis to provide information, motivation, a sense of responsibility both to oneself and to computer equipment [27]. Students need practice in computer-based technical procedures [28]. The feeling of having equipment or computers and other supporters is also instilled in the test takers, including rooms or buildings so that the equipment is not easily damaged and can be used optimally.

Another problem is student readiness, aspects of cognitive, psychological and technological knowledge. Readiness is interpreted as the skills, behaviour, and character of the child concerning the activities to be carried out [29]. Therefore, as a solution, schools must hold continuous training. In this condition, teachers play a role in the readiness of CAT participants. Skills, knowledge, and attitude of teachers are very important and influence increasing readiness [30]. Student anxiety also significantly affects student concentration. Anxiety will negatively affect their ability to complete CBNE [31]. Thus, it is hoped that the role of schools and parents in

preparing mentally. Also, it is important to adjust the room temperature according to the weather conditions at that time, so that the atmosphere is not too hot or cold, so it is hoped that it will provide a relaxed atmosphere to the condition of the test taker's body.

Table 9. Strategies of CAT Lack of Knowledge Obstacles

Challenges	Category	Data Reduction
Give initial orientation time.	Provide a more comprehensive orientation and excellent assistance	Communication, assistance and room temperature adjustment
Providing guidance and supervision		
Allows test takers to ask technical questions about the operation of the CAT before the test begins	explained how to operationalize the CAT and adjust room temperature	
Set room temperature to adjust to student comfort		

Geographical problems, distance, and availability of internet networks around schools affect CAT implementation. Schools located in urban areas have easy access to the internet network. However, rural schools find it difficult to access the internet due to geographic difficulties. We recommend the school install a modem connection or VSAT connection. Another strategy is to build cooperation using a cable or WIFI connection with an internet connection around the school.

Limited financing is the main obstacle in providing facilities, computers, electricity supply, and internet connection. Thus, we propose a strategy to overcome this problem by innovating on school financial management and optimizing available assets. Another approach is to collaborate with external parties or partners to build CAT delivery facilities.

The results of this study differed from the results of research conducted by Retnawati [27]. There is a fundamental difference in the system used, namely CBT whereas we use CAT, CBT does not require continuous student preparation because this exam is, in principle, the same as the PPT exam, whereas we need student preparation. After all, CAT has a different system work pattern from CBT. There is no need for specialized training in making questions, whereas we teachers need training on item response theory. Internet network stability is needed because the CAT system we use is WEB-based with Central servers.

5. Conclusions and Recommendations

Nowadays, CAT becomes a novel technique to measure student abilities effectively. In principle, the CAT is a model that can adjust between students' abilities and the level of difficulty of exam questions. However, many schools face various challenges in CAT implementation. However, it requires a new model to overcome this obstacle with effective and novel strategies. In this paper, we present several CAT challenges in Indonesia and propose current strategies to deal with the issue. Implementing our current strategies, including managing facilities, collaborating with relevant parties, optimizing the room, preparing students, and training human resources, can increase the effectiveness of CAT implementation in Indonesia. As future work, it should conduct a study with interested parties in collecting school data. In order to expand this study, it should collaborate with the parties or local governments and adopt innovative technology in the computer-based exams.

From the results of the research we have carried out, we recommend:

1. In the process of making questions must be under the rules of Item Response Theory (TRB)
2. Questions that have been completed should be tested first on students with the CBT model, the results of student responses are analyzed using the model (TRB)
3. Must ensure the smooth running of the internet and electricity networks
4. CAT simulation is required for students
5. Teachers need training on the analysis of computer-based CAT results
6. Participants and research subjects here are drawn from the Yogyakarta region, but the results of this study can be used for all major cities in Indonesia because Yogyakarta Province is a province known as the city of Indonesian students, a reflection of Indonesian education.

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