Assistive Technology Tools for Learning Physics Courses for Students with Special Needs

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Abstract

The spread of digital information has grown very rapidly and has become a common tool used by all people. This is in line with the development of various infrastructures and digital ecosystems for all lines of life in all fields without exception, especially in this paper which discusses the development of information technology in the field of education. Because in essence education can play an active role in developing the potential of students to develop religious spiritual values, self-discipline, personality, intelligence, noble personality, and abilities that are beneficial to themselves, society, the state, and the Indonesian nation. In line with the vision and mission of Jakarta Global University which concentrates learning on student centered which refers to 21st century learning, where learning is focused on the use of information technology to trigger a learning process that focuses on student learning experience. The development of this system aims to make it easier for students with special needs to understand physics concepts by using simulation methods assisted by modules and other learning tools that can be used by students with special needs, especially for students with hearing disorders. SUS Questionnaire are distributed to get after the posttest to get usability test for the system. Tests using Cronbach's Alpha have been used to find the value of validity and reliability by obtaining an average result of 0.702 for reliability and 0.312 for validity testing. This shows that the developed system can be used easily thanks to the optimization of the features that the author has implemented in the CDIES system to facilitate the needs of students with disabilities.

Keywords: 21st Century Learning; Assistive; Hearing Disorder; Student Centered Learning

1 Introduction

Education is a system to develop the potential of students to develop religious spiritual values, self-discipline, personality, intelligence, noble personality, and abilities that are beneficial to themselves, society, state, and nation (Martini et al., 2019; Munib, 2004; Muscott & O'Brien, 1999). Reflecting on developed countries that make education their top priority, this results in every citizen having quality resources both in hard skills and soft skills. Although in practice there are still many shortcomings, we can take the positive side where the mindset and awareness of people in developed countries towards education is directly proportional to the welfare and progress of the country (Citra Kurniawan, 2017).

In line with this, the State of Indonesia has also instilled the importance of education for all Indonesian people in the Constitution of the Republic of Indonesia as stated in the 1945 Constitution article 31 paragraph 1 that every citizen has the right to get an education including students with special needs. This is also strengthened by the latest Law no. 20 of 2003 concerning the national education system, mandating citizens who have physical, emotional, mental, intellectual, and social disorders of movement to get special education (Simorangkir & Lumbantoruan, 2021). PERMENRISTEKDIKTI

Number 46 of 2017 concerning Special Education and Special Services in Higher Education has been launched to prepare for the implementation of special education among Indonesian universities in the process of admitting and managing education for students with special needs.

However, in practice in the field of educational equity itself has obstacles and still has shortcomings in its implementation, especially in the implementation of education for students with special needs (Jauhari, 2017). Students with special needs and disabilities are two different things, where this disability itself is part of the special needs in question. There are some special needs that are not shaded by disability itself, such as gifted talents (special intelligence and special talents) which are included in exceptional learners where students are extraordinary but not disabled (Baker, 2021). Learning is focused on the use of information technology to trigger the learning process, especially on the learning experience of students. The development of a complementary curriculum where soft skills are developed in such a way as to be entitled Personal Enrichment Competencies (PEC), both for students in general and for students with special needs, to support the growth of students' abilities so that they will be ready to compete in the world of work (Portera, 2014).

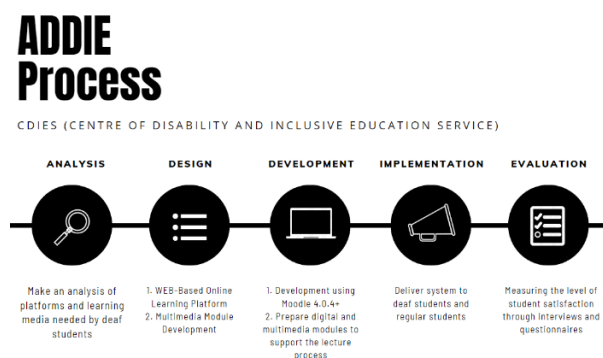## 2 System Development Methodology

Figure 1. CDIES system development methodology

Providing context for comprehending the significance of Figure 1, illustrating the CDIES (Center of Disability and Inclusive Education Service) developed through the ADDIE (Analysis, Design, Development, Implementation, Evaluation) methodology. This context underscores the systematic application of the

ADDIE framework in crafting the CDIES system, where each stage has been meticulously executed, as depicted in Figure 1, to yield a robust and scientifically designed educational solution (Brook, 2014).

ADDIE Model formulates the flow of system development from the analysis process to the evaluation stage of the system. This model has advantages in evaluation at each stage to minimize the error rate and shortcomings of the system (Spatioti et al., 2022). This evaluation stage itself is carried out by analyzing the function of the system to the accuracy of the application of this system to students with hearing disorder.

a. Analisis

This system analysis process includes platform analysis to convey what learning and learning media are needed and can be used by students with special needs.

b. Design

The design process in this model is the author designed a WEB-Based Online learning platform that can be used by students through various devices that they can use for the learning process (Srivastava et al., 2014). Development of Multimedia Modules that can be understood by students with special needs, especially the deaf, namely by using Ebooks and interactive learning videos that combine visuals elements of video recordings of speakers, subtitles and if possible combined with sign language videos (Ambron & Hooper, 1988; K. U. Mayer, 2009; R. E. Mayer, 2017).
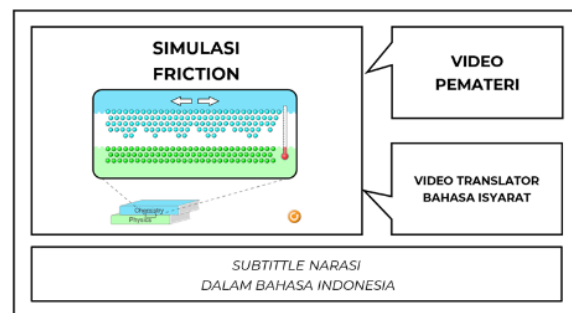

Figure 2. Learning video design

c. Development

After determining the platform that can be accessed by students with the devices they have, the author then began to develop an

LMS (Learning Management System) using Moodle 4.0.4+ which already has various learning media criteria intended by the author in the previous stage. Preparing digital and multimedia modules to support the lecturing process, Ebooks and Videos equipped with H5P Plugins that can insert questions related to the material being discussed by interactive Educators (Sarfo & Yidana, 2016). The purpose of using this H5P is to monitor student involvement in paying attention to the material presented online (Freeman et al., 2014).

d. Implementation
When all learning components have been embedded into CDIES LMS, the next step is the process of delivering the system to regular students and to students with special needs.

e. Evaluation
The last stage of the ADDIE model is the process of measuring student satisfaction levels by going through an interview and questionnaire process. To measure user satisfaction, we are using an SUS questionnaire to get feedback in the form of a Likert scale (Jebb et al., 2021) from the users with the following question.

Table 1. SUS (System Usability Scale) Questionaire (Nik Ahmad & Hasni, 2021).

Code	Question
Q1	I think that I would like to use this system frequently
Q2	I found the system unnecessarily complex
Q3	I thought the system was easy to use.
Q4	I think that I would need the support of a technical person to be able to use this system.
Q5	I found the various functions in this system were well integrated.
Q6	I thought there was too much inconsistency in this system.
Q7	I would imagine that most people would learn to use this system very quickly.
Q8	I found the system very cumbersome to use.
Q9	I felt very confident using the system.
Q10	I needed to learn a lot of things before I could get going with this system.

After we collect the data then we measured the score using the scale to determine individual SUS Score. Scle for this scla can be seen in figure 3 Below.
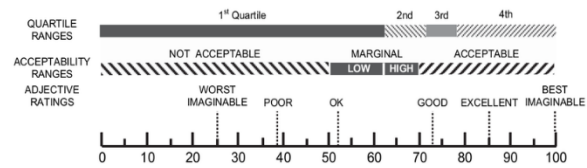

Figure 3. SUS Score Determination

From the scattered questionnaires, and then calculations are carried out using the following formula. To measure user satisfaction from the SUS method.

$$\bar{x} = \frac{\sum x}{n} \tag{1}$$

To support the lecture process, of course, several additional features are needed in the form of plugins. For example, adding a student database, attendance features, and features that are no less important to support an interactive learning process.

3 Result

CDIES was developed using Moodle version 4.0.4+ which supports adaptive page displays that can adjust the size of the device window used, be it using a PC / Laptop, Tablet, or Smartphone.

Figure 4. Learning Portal.

a. Features
To support the lecture process, of course, several additional features are needed in the form of plugins. For example, adding a student database, attendance features, and features that are no less important to support an interactive learning process (Kouser & Majid, 2021). The feature and plugin that we are added to our system is bulk user upload, attendance and H5P.

First, the Bulk user upload plugin is used in this project to add student data. This plugin is indispensable for recording students and grouping students by major and cohort / intake. With this

system, admins can easily group students to enroll students into the subjects they take based on the main database of the Global University of Jakarta. Bulk upload APIs are used to efficiently and seamlessly upload large amounts of data or files in a single action, streamlining the process and optimizing resource utilization (John & Siddique, 2021).

The attendance plugin is used in this feature to record students who have attended lectures online. Scientifically, consistent attendance in education significantly correlates with enhanced academic performance, active engagement in learning, refined social skills, and the development of essential life habits (Leos-Urbel, 2015). This attendance fosters access to resources, participation in assessments, and the cultivation of strong teacher-student relationships, all contributing to students' preparedness for future academic and professional endeavors.

Finally, the H5P is an excellent built-in feature but not many educators use this feature. Using this feature can make educators insert questions in the middle of the video to track student participation in the material presented digitally. Studies reveal that H5P's interactive content creation capabilities enhance student engagement and comprehension, fostering active learning. These interactive modules, encompassing quizzes, simulations, and presentations, facilitate personalized and self-paced learning experiences, catering to diverse learning styles (Wehling et al., 2021)

b. Embeddable Material

Embeddable material in Learning Management Systems (LMS) refers to various types of content, such as videos, documents, presentations, and interactive elements (Buhu & Buhu, 2017), that can be seamlessly integrated and displayed within the LMS environment. This integration maintains the content's original appearance and functionality while minimizing the strain on the LMS server (Ruano et al., 2016). For instance, educational videos can be hosted on external platforms like YouTube and then embedded in the LMS, allowing smooth video playback without overwhelming the LMS server resources. Here we are embedded the material from PhET, Interactive Learning Video that we have been design in methodology and e-book.

An online science and technology learning portal in which there are many simulations that can be used for more interactive learning to increase students' understanding, such as simulations of basic physics concepts in the form of friction, electric charge, parabolic motion, and so on. Scientific research demonstrates that PhET Interactive Simulations serve as effective virtual labs for learning. These simulations enhance conceptual understanding by offering interactive experiences that bridge theory and practice. They foster engagement, critical thinking, and personalized learning, leading to improved knowledge retention and enthusiasm for STEM subjects (Moore et al., 2014).

Figure 5. Embeded Virtual Lab Simulation from PhET.

By embedding video through the embed feature, then this will not overload the server, compared to storing the video on the server.
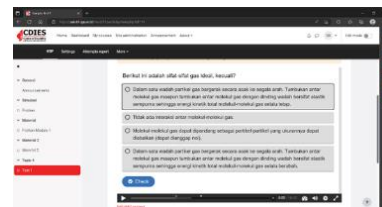

Figure 6. Implementation of H5P and subtitles.

The eBooks feature embedded on the page can make it more interactive and can also be used as a temporary repository. So that both lecturers and students do not need to store internal storage.

Figure 7. Online Ebook module by using the embed page feature.

c. Implementation and Testing

Implementation in an online class by utilizing lecture support features such as E-book Material Share and Interactive Video, Attendance, Virtual Simulation. Testing is conducted in regular classes at Jakarta Global University, equipped with questioners from SUS (System Usability Scale). The form of SUS is to measure the satisfaction level of users of information systems according to the subjective point of view of the users. The data on the results of the implementation and measurements that we do, will be discussed in the Test Result.

d. Test Results

From the test results, it was found that students can take part in lecture activities by monitoring the track record as long as students access the learning media that is given inside CDIES system. This test is carried out through two stages from SUS method, and the Validity Test and Reliability Test using Alpha Cronbach's (Özkaya et al., 2021).

To obtain the results of the calculation of usability we have distributed the questionnaire to 40 respondents using the SUS questionnaire model that we have previously compiled. From the measurement data using the SUS method (equation 1), the average SUS score result is 75. These results show that the system that has been developed can be understood quite easily. With various features that have been implemented by maximizing the multimedia elements used to facilitate the online lecture process.

Next, we conducted testing using Alpha Cronbact testing to test the validity and reliability of the previously shared questionnaire using the SUS method.

Table 2. Case Processing Summary

		N	%
Case	Valid	40	100.0
	Excluded	0	.0
	Total	40	100.0

Based on the "Case Processing Summary" output table above, it provides information about the number of samples or respondents (N) analyzed by 40 people without any empty data, so the valid number is 100%.

Table 3. Reliability Statistics

Cronbach's Alpha	N of Items
.702	10

Table 4. Item-Total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
Q1	33.53	9.999	.125	.816
Q2	31.55	8.408	.532	.655
Q3	32.60	8.554	.277	.697
Q4	31.63	8.138	.638	.639
Q5	32.60	8.810	.386	.677
Q6	31.70	8.472	.530	.657
Q7	33.75	8.397	.509	.657
Q8	31.83	7.892	.461	.659
Q9	33.75	8.141	.687	.635
Q10	31.75	8.756	.443	.670

Meanwhile, in the "Reliability Statistics" table, it is known that there are 10 N of Items with a Cronbach's Alpha value of 0.702. Where 0.702 > 0.60 so it can be inferred if the question item for the test variable is reliable or consistent. Then in the table "Item-Total Statistics" found the result of Cronbach's Alpha value of each question > 0.60 so that all question items were also declared valid or reliable.

In addition to the results of the analysis on Alpha Cronbach's reliability test, if the sum of the values of N is compared with the values in the r table, it will occupy a significance value of 5% of 0.312.

4 Conclusion

Educational Technology that has developed currently is very helpful in the educational process, especially equity for students with special needs to access learning media. By adjusting existing technology with whatever elements are needed by students with special needs. A good education system is not only given to those who can afford it or who want it but must be distributed equally to all students without any age or intellectual economic limitations. This equity not only requires all students to receive education, but also must be balanced with resources and facilities that can adapt to the needs of students to get an equal level of education that they can apply nationally and internationally.

With the vision of Jakarta Global University which focuses its education on the 21st Century Learning learning model. Where this method

integrates student centered learning and technology. The implementation of well-rounded education for all JGU students will be increasingly realized by optimizing the implementation of the CDIES system with evidence from the results of the tests that the authors have conducted. Where the author gets positive results on system usability from calculating the results of the SUS questionnaire which is followed by testing the validity and reliability with Alpha Cronbach's testing using SPSS software. The results of testing the SUS model state that the user agrees to use this application for the learning process and is easy to understand. This is because the system is a moodle-based application and is familiar to be implemented in various educational institutions. These results were also strengthened by the results of the Cronbach's Alpha test of 0.702 which exceeded the set parameters, namely above 0.60 for each question asked. Then for the comparison of the r table, a satisfactory significance of 5% or 0.312 is obtained.

With various features embedded in this system to facilitate the learning process, especially in basic physics subjects which help increase student understanding of the implementation of the material delivered with the virtual lab presented in this CDIES LMS. Besides that, the incorporation of various interactive multimedia elements in this system makes students more interested and easier to understand the topics available during the implementation and testing process.

Acknowledgement

References

Ambron, S. Robinson., & Hooper, Kristina. (1988). *Interactive multimedia: visions of multimedia for developers, educators & information providers*. Microsoft Press.

Baker, P. (2021). Educatio of Exceptional Learner. *Polari - The Lost Language of Gay Men*, 27–46. https://doi.org/10.4324/9780203167045-5

Brook, R. L. (2014). Using the ADDIE Model to Create an Online Strength Training Program: An Exploration. *(Doctoral Dissertation, Virginia Polytechnic Institute and State University)*.

Buhu, A., & Buhu, L. (2017). Developing interactive elearning courses based on HTML5 for students in textile engineering. *Edulearn17 Proceedings*, 9214–9219.

Citra Kurniawan. (2017). *Hubungan sistem pendidikan dengan masyarakat sebagai supra sistem*.

Freeman, S., Eddy, S. L., McDonough, M., Smith, M. K., Okoroafor, N., Jordt, H., & Wenderoth, M. P. (2014). Active learning increases student performance in science, engineering, and mathematics. *Proceedings of the National Academy of Sciences of the United States of America*, *111*(23), 8410–8415. https://doi.org/10.1073/pnas.1319030111

Jauhari, A. (2017). Pendidikan Inklusi Sebagai Alternatif Solusi Mengatasi Permasalahan Sosial Anak Penyandang Disabilitas. *IJTIMAIYA: Journal of Social Science Teaching*, *1*(1). https://doi.org/10.21043/ji.v1i1.3099

Jebb, A. T., Vincent, N., & Tay, L. (2021). A review of key Likert scale development advances: 1995–2019. *Frontiers in Psychology*, *12*.

John, E., & Siddique, M. (2021). Efficient semantic web services development approaches using rest and json. *2021 International Conference on Decision Aid Sciences and Application (DASA)*, 231–235.

Kouser, S., & Majid, I. (2021). Technological tools for enhancing teaching and learning process. *Technological Tools for Enhancing Teaching and Learning Process. Towards Excellence*, *13*(1), 366–373.

Leos-Urbel, J. (2015). What works after school? The relationship between after-school program quality, program attendance, and academic outcomes. *Youth & Society*, *47*(5), 684–706.

Martini, E., Kusnadi, E., Darkam, D., & Santoso, G. (2019). *Competency Based Citizenship 21st Century Technology in Indonesia*. https://www.researchgate.net/publication/357764699

Mayer, K. U. (2009). New directions in life course research. *Annual Review of Sociology*, *35*, 413–433.

Mayer, R. E. (2017). Using multimedia for e-learning. In *Journal of Computer Assisted Learning* (Vol. 33, Issue 5, pp. 403–423). Blackwell Publishing Ltd. https://doi.org/10.1111/jcal.12197

Moore, E. B., Chamberlain, J. M., Parson, R., & Perkins, K. K. (2014). PhET interactive simulations: Transformative tools for teaching

chemistry. *Journal of Chemical Education*, *91*(8).

Munib, A. (2004). pengantar ilmu pendidikan. *UNNES Press*, 142.

Muscott, H. S., & O'Brien, S. T. (1999). Teaching character education to students with behavioral and learning disabilities through mentoring relationships. *Education and Treatment of Children*, *22*(3), 373–390.

Nik Ahmad, N. A., & Hasni, N. S. (2021). ISO 9241-11 and SUS Measurement for Usability Assessment of Dropshipping Sales Management Application. *ACM International Conference Proceeding Series*, 70–74. https://doi.org/10.1145/3457784.3457794

Portera, A. (2014). Intercultural competence in education, counselling, and psychotherapy. *Intercultural Education*, *25*(2), 157–174.

Ruano, I., Cano, P., Gámez, J., & Gómez, J. (2016). Advanced LMS integration of SCORM Web laboratories. *IEEE Access*, *4*, 6352–6363.

Sarfo, F. K., & Yidana, I. (2016). University lecturers experience in the design and use of MOODLE and blended learning environments. *The Online Journal of New Horizons in Education*, *6*(2), 143–154.

Simorangkir, M. R. R., & Lumbantoruan, J. H. (2021). Aksesibilitas Anak Berkebutuhan Khusus Di Era Pendidikan 4.0. *Jurnal Dinamika Pendidikan*, *14*(1), 196–203. https://doi.org/10.33541/jdp.v12i3.1295

Spatioti, A. G., Kazanidis, I., & Pange, J. (2022). A comparative study of the ADDIE instructional design model in distance education. *Information*, *13*(September), 104.

Srivastava, M., Pandey, H., Shukla, S., & Thakur, B. K. (2014). A Literature Review of E-Learning Model Based on Semantic Web Technology. *International Journal of Scientific & Engineering Research*, *5*(10), 174–178. http://www.ijser.org

Wehling, J., Volkenstein, S., Dazert, S., Wrobel, C., van Ackeren, K., Johannsen, K., & Dombrowski, T. (2021). Fast-track flipping: flipped classroom framework development with open-source H5P interactive tools. *BMC Medical Education*, *21*(1), 1–10.