User Interface Design of Digital Test Based on Backward Chaining as a Measuring Tool for Students' Critical Thinking

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***Abstract*—Assessing students' critical thinking skills is challenging due to the limitations of current measurement tools. Therefore, there is a need for a digital testing instrument that can effectively evaluate students' critical thinking abilities. The proposed digital test should be designed to present questions in a tiered manner, using a backward chaining approach that starts with general questions and progresses to more detailed ones. However, developing this measurement instrument requires careful planning. One of the initial steps in this process is to create a user interface design. The purpose of this study was to show the quality of the design of the user interface of a digital test based on backward chaining as a measuring tool for students' critical thinking in a differentiated learning atmosphere. Design development used the Borg and Gall model and only focused on three stages. These stages include design planning, initial testing, and revision for the initial testing results. Data collection was through initial testing of the design. The tool used to collect data was a questionnaire. Respondents involved in the initial testing were 34 people. The location for the study was at several IT vocational high schools spread across six regencies in Bali. The data analysis technique compared the percentage comparison of the quality of the user interface design with the quality standards of the user interface design and referred to a five scale. The results of the study showed that the design quality of the digital test user interface based on backward chaining was included in the good category, as indicated by a quality percentage of 88.94%. Specifically, the impact of the results on the field of educational evaluation is to make it easier for evaluators to make accurate measurements. In general, the effect of this study on the field of informatics engineering education is the existence of innovations in realizing a test to measure critical thinking in the domain of differentiated learning.**

Keywords*—User interface design; digital test; backward chaining; critical thinking; differentiated learning

I. INTRODUCTION

The rolling of the "*Merdeka Belajar*" (independent learning) policy provides students with the freedom to follow the learning process according to the differences in their needs and learning environment. This concept is called differentiated learning [1]. Currently, differentiated learning is a trend in the learning process at the IT Vocational School level.

The existence of differences in the way each student learns according to their characteristics and needs through differentiated learning certainly can encourage them to improve their critical thinking skills in dealing with the problems they face [2]. Differentiated learning can awaken students' critical thinking skills, but teachers find obstacles in its implementation. These obstacles are mainly related to measuring students' critical thinking skills. Based on these obstacles, it is necessary to find a breakthrough as a measuring tool in the form of a digital test that can easily measure students' critical abilities. The expected digital test can package sequentially backward test questions (backward chaining) from general question types to questions with more detailed or specific types so that later, the teacher can explore the student's critical thinking to solve the questions presented. The research question referring to the obstacles and breakthroughs initiated is "What is the form of the user interface design of a backward chaining-based digital test used to measure students' critical thinking in a differentiated learning atmosphere?"

The specific objective of this study is to show a backward chaining-based digital test that has good quality and accurately measures students' critical thinking skills in differentiated learning. The urgency of this study is to obtain a user interface design from a backward chaining-based digital test that effectively assesses students' critical thinking skills in differentiated learning, especially in Mathematics subjects at IT Vocational School in Bali.

Hizqiyah et al. conducted research on the development of digital problem-solving skills test instruments [3]. However, a gap in their research is that they did not demonstrate the test items graded sequentially from general types to more specific types. Ndibalema's research [4], on the other hand, focuses on a form of formative assessment conducted online. The key difference between Ndibalema's study and this current research lies in the type of evaluation used; Ndibalema's work leans towards formative assessment, while this research encompasses both formative and summative assessments. Additionally, Jaskova's research explores student satisfaction with online tests taken at home [5]. A limitation identified in Jaskova's study is the lack of information regarding the user interface design of the online tests administered at home. Noor's research highlights the use of Kahoot as a digital quiz tool [6]. However, a limitation of

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this study is that it does not provide details about the design of the Kahoot user interface as a digital quiz. On the other hand, the research conducted by Domínguez-Figaredo & Gil-Jaurena examines the impact of familiarity on digital assessments in online education [7]. A limitation of their study is that it fails to present the specific format of the digital tests utilized in the assessment.

Based on the research question and specific objectives of this study, it is essential to determine the form and quality of the backward chaining-based digital test used to assess students' critical thinking skills in differentiated learning.

II. Literature Review

Some of the research behind this study includes a 2020 study by Ariawan, Giri, and Divayana on the development of a CIPP evaluation application based on Simple Additive Weighting [8] obtained visualization results from a CIPP evaluation application based on Simple Additive Weighting that can measure the effectiveness of learning at health science colleges in Bali online. The obstacle is that the application is not for a large-scale implementation. A 2021 study on the dissemination and implementation of a CIPP evaluation application based on Simple Additive Weighting at several health science colleges in Bali conducted by Divayana, Ariawan, and Giri [9] showed the success of implementing a CIPP evaluation application based on Simple Additive Weighting at several health science colleges in Bali. The obstacle is that the evaluation application does not yet use the integrated evaluation aspects of the Balinese local wisdom concept, so the measurement of students' knowledge domains in the learning process cannot be measured optimally and in depth according to student characteristics. A 2022 study by Ariawan et al. showed the development of a Formative-Summative evaluation model based on Tri Pramana by inserting Weighted Product calculations [10]. The general description of the results obtained in the 2022 study is a Formative-Summative evaluation model design based on Tri Pramana by inserting Weighted Product calculations so it can determine the aspects that determine the quality of e-learning implementation. In the 2023 study conducted by Ariawan et al., a Tri Pramana-Weighted Product-Based Formative-Summative Model Evaluation Application has been obtained and has been field tested [11]. Further research for 2024 is the realization of a digital test user interface design based on backward chaining as a measuring tool for students' critical thinking in the nuances of learning differentiation.

Divayana et al. research [12] showed test instrument items to measure students' cognitive abilities in implementing distance learning. The validity of the content and reliability of the instrument is good. However, there is no packaging of test questions sequentially graded backward from general question types to more detailed or specific types. Easa and Blonder's research [13] showed an instrument to measure or evaluate teacher and student beliefs about differentiated learning in Chemistry. The constraint of Easa and Blonder's research was that it did not show an evaluation instrument sequentially graded backward from general to specific questions. Kholid et al.'s research [14] showed the implementation of diagnostic assessments in differentiated learning modules for English subjects. The constraint of Kholid et al.'s research is that it has not shown the form of a diagnostic assessment instrument for differentiated learning sequentially from complex things to more specific things.

III. Method

Several elements are presented in the methodology section of this research: 1) research approach; 2) subjects, objects, and research locations; 3) data collection instruments; and 4) data analysis techniques.

A. Research Approach

The research approach is development. The focus of development for this 2024 research was on three stages, including design development, initial trials, and revisions to the results of the initial trials (main product revision). The model used in the development process is Borg and Gall [15],[16],[17],[18]. The three stages of development referred to the researcher's desire/goal to realize a digital test user interface design based on backward chaining as a measuring tool for students' critical thinking in a differentiated learning atmosphere. The research stages carried out by the researcher can be seen in Fig. 1.

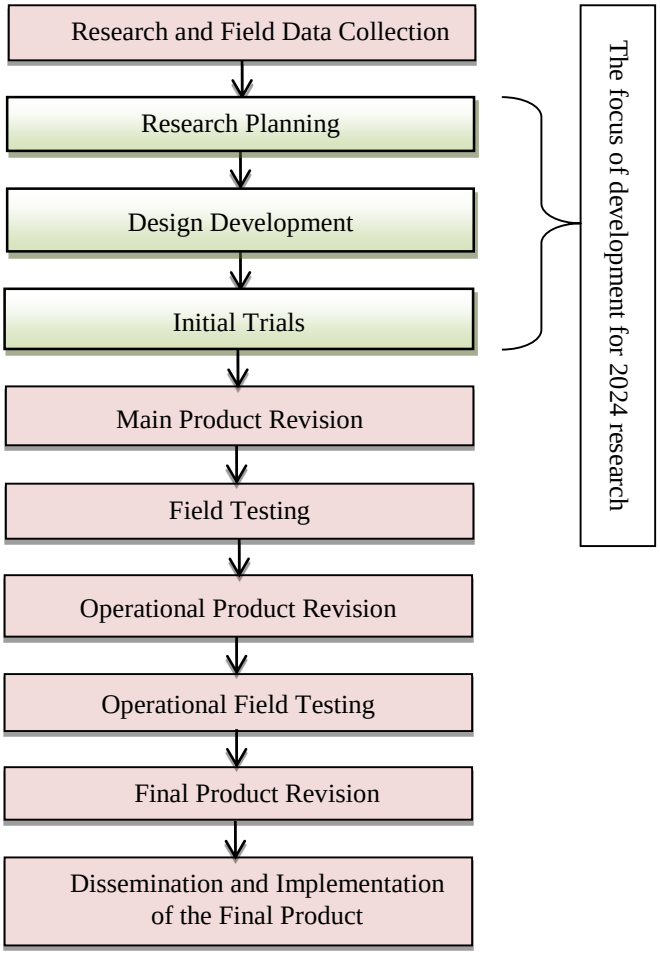

Fig. 1. The research stages that refer to the borg and gall design.

B. Subject, Object, and Location of Research

Subjects involved in the initial trial phase of the digital test user interface design based on backward chaining, including

education evaluation experts, informatics experts, and several teachers at IT Vocational School in Bali. The number of informatics education experts was two experts, the number of education evaluation experts was two experts, and the number of IT Vocational School teachers in Bali involved was 30 teachers. The selection of research subjects utilized a purposive sampling technique, involving individuals who possess in-depth knowledge and clear objectives regarding the object of study. The object of this research is the design of the digital test user interface based on backward chaining as a measuring tool for students' critical thinking in a differentiated learning atmosphere. The research location was at several IT Vocational School spread across six regencies in Bali.

C. Data Collection Instruments

The data collection tool used in this study is a questionnaire. All questions used in the questionnaire are related to the digital test user interface design based on backward chaining as a measuring tool for students' critical thinking in a differentiated learning atmosphere. The number of questions in the questionnaire was ten items. The details of the ten questions are explained in the discussion section of this paper. These ten questions are valid and reliable based on the instrument trials conducted by two education experts and two informatics experts.

D. Data Analysis Techniques

After being collected, quantitative data examination was a descriptive approach and descriptive percentage calculation. The technique for analyzing the initial trial data in this study was quantitative descriptive. It was to compare the percentage of the level of quality of the digital test user interface design based on backward chaining with the standard of user interface design quality that refers to a scale of five. The formula used to determine the percentage of the quality level of the digital test user interface design based on backward chaining is in equation (1) [19],[20],[21], then the quality standard that refers to a scale of five can be seen in Table I [22],[23],[24].

$$P = (f/N) \times 100\% \quad (1)$$

Notes:

f = Total acquisition value

N = maximum total value

TABLE I. QUALITY STANDARDS OF USER INTERFACE DESIGN OF DIGITAL TEST BASED ON BACKWARD CHAINING REFERRING TO FIVE SCALE CATEGORY

Percentage of Quality	Quality Category	Recommendations
90-100 %	Excellence	No Revision Required
80-89 %	Good	No Revision Required
65-79 %	Moderate	Revision
55-64 %	Less	Revision
0-54 %	Poor	Revision

IV. RESULTS AND DISCUSSION

A. Results

The results obtained on three stages of development focused on this research, including results at the design planning stage, the initial trial stage, and the initial trial revision stage. The data obtained based on the results at several stages of development in question are as follows.

1) Design Development: The design development stage produced a digital test user interface design based on backward chaining to measure students' critical thinking in a differentiated learning atmosphere. It was using the Balsamiq Mockups application. The form of the design intended is in Fig. 2.

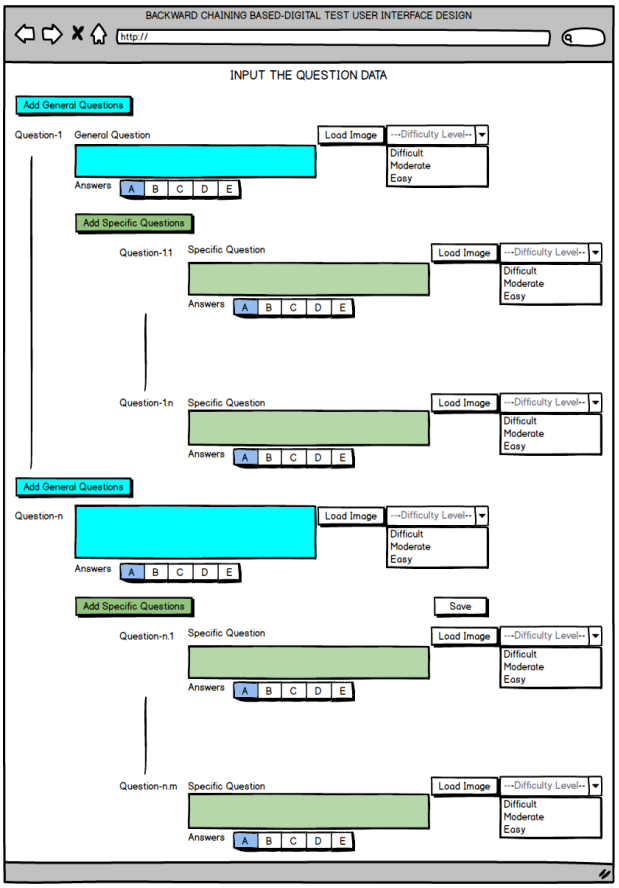

Fig. 2. The user interface design to enter question data.

Fig. 2 shows the user interface design of the form that functions to enter question data. There are several attributes in the form. The "add general questions" button to add general questions. The "add specific questions" button is the specific question from the available general questions. There is a "Load image" button to enter questions containing images. There is a "difficult level" combo box to select the level of difficulty question. Several "answers" buttons are answer choices for the available questions.

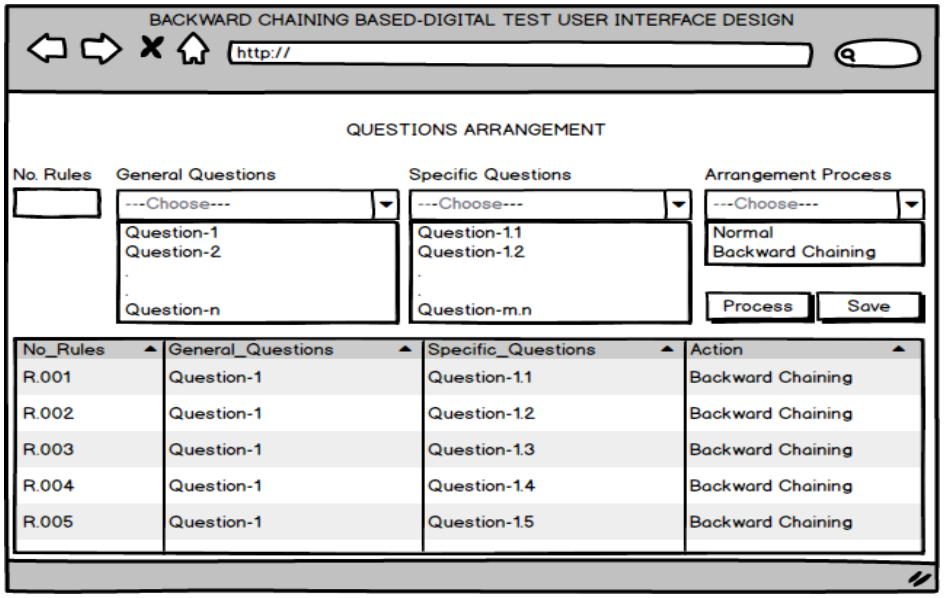

Fig. 3. The user interface design for questions arrangement based on backward chaining.

Fig. 3 shows the user interface design of the form that manages questions by referring to the backward chaining method. There are several features available on the form. The function of the "no. rules" textbox is to enter the rules number. This number is unique so that no one can duplicate it. There is a "general questions" combo box to select general questions. There is a "specific questions" combo box to specific questions. There is an "arrangement process" combo box to the question arrangement process referring to normal conditions or conditions that refer to the backward chaining concept. The "process" button to run the arrangement process. The "save" button to save the arranged question data. There is a data storage database. The data storage consists of several fields, including No_rules, General_Questions, Specific_Questions, and Action.

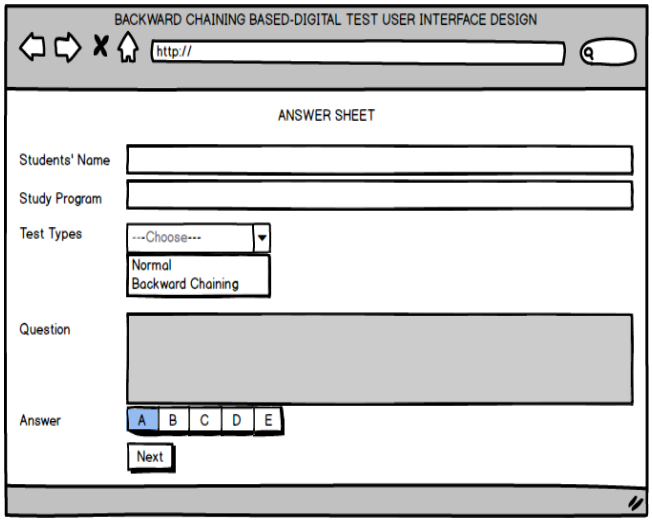

Fig. 4. The user interface design for the question-answering facility is based on the test type and employs a backward chaining approach for packaging.

Fig. 4 shows the user interface design of the form that functions as a place to answer questions. There are several features on this form. A text box to enter students' names and study programs. The combo box for selecting the test type. There is a text area used to display questions. An "answers" button that is useful as a choice of answers to the available questions. There is a "next" button to go to the next question.

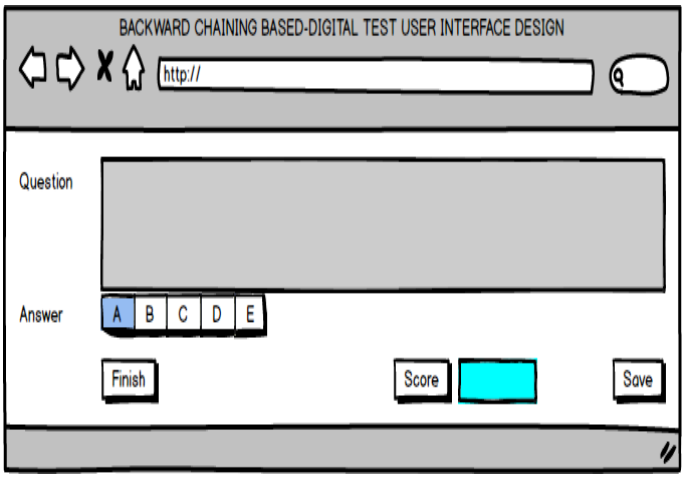

Fig. 5. The user interface design to display final score.

Fig. 5 shows the user interface design of the form to display the final score. This design shows a text area that functions to display questions. An "answers" button that is useful as an answer choice for the available questions. The "finish" button is to end the process of answering questions. The "score" button is to calculate the final score. The "save" button to save the final score.

2) Initial Trials: Four experts and 30 teachers of IT vocational schools in Bali conducted an initial trial of the digital test user interface design based on backward chaining. The questionnaire for the initial trial consisted of 10 questions. The results of the initial trial are in Table II.

TABLE II. RESULT OF INITIAL TRIALS TO DIGITAL TEST USER INTERFACE DESIGN BASED ON BACKWARD CHAINING AS A MEASURING TOOL FOR STUDENTS' CRITICAL THINKING IN DIFFERENTIATED LEARNING NUANCES

Experts	Items-										∑	Percentage of Quality (%)
	1	2	3	4	5	6	7	8	9	10		
Expert-1	5	4	4	5	4	5	5	4	5	5	46	92
Expert-2	5	5	5	4	5	4	4	4	4	5	45	90
Expert-3	5	4	5	5	4	4	5	4	4	5	45	90
Expert-4	4	5	5	5	5	5	4	5	5	4	47	94
Teacher-1	5	4	4	5	4	5	4	5	4	4	44	88
Teacher-2	5	5	4	4	5	5	4	5	4	5	46	92
Teacher-3	5	4	4	5	4	4	5	5	4	5	45	90
Teacher-4	5	4	5	5	5	4	5	4	5	4	46	92
Teacher-5	4	4	5	5	4	4	4	5	5	4	44	88
Teacher-6	5	4	4	5	4	5	4	5	4	4	44	88
Teacher-7	5	5	4	4	4	4	5	4	5	4	44	88
Teacher-8	5	4	4	5	5	4	4	5	5	4	45	90
Teacher-9	5	4	5	4	4	4	5	4	4	5	44	88
Teacher-10	4	4	5	4	4	5	5	5	4	5	45	90
Teacher-11	5	4	4	5	4	5	5	4	4	4	44	88
Teacher-12	4	4	5	4	4	4	5	4	5	4	43	86
Teacher-13	4	5	5	5	5	4	4	4	5	5	46	92
Teacher-14	4	5	5	4	4	4	5	4	4	5	44	88
Teacher-15	4	4	5	4	4	5	4	4	4	5	43	86
Teacher-16	5	4	4	4	5	4	4	4	4	5	43	86
Teacher-17	4	4	5	4	4	5	4	5	4	4	43	86
Teacher-18	4	5	4	4	5	4	5	4	4	4	43	86
Teacher-19	4	4	5	4	5	4	4	5	4	5	44	88
Teacher-20	5	4	4	5	5	4	5	5	4	5	46	92
Teacher-21	4	4	5	4	4	5	4	4	5	5	44	88
Teacher-22	4	5	5	5	4	5	4	5	5	4	46	92
Teacher-23	4	5	5	4	4	4	4	5	4	5	44	88
Teacher-24	4	4	5	4	5	4	5	5	4	5	45	90
Teacher-25	5	4	4	5	5	4	5	4	5	5	46	92
Teacher-26	4	4	5	4	4	5	4	5	5	5	45	90
Teacher-27	4	5	5	5	4	5	4	5	5	4	46	92
Teacher-28	4	5	5	4	4	4	4	5	4	4	43	86
Teacher-29	4	4	5	4	5	4	5	5	4	4	44	88
Teacher-30	4	4	4	4	4	4	4	4	4	4	40	80
Average												**88.94**

Respondents/assessors provided several suggestions in the initial trial stage. Improvements to the digital test user interface design based on backward chaining used several of these suggestions. Some of them are in Table III.

TABLE III. RESPONDENTS' SUGGESTIONS IN THE INITIAL TRIAL

No	Experts	Suggestions
1	Expert-1	Add the test date to the answer sheet form.
2	Expert-2	Add a list of test participants' scores.
3	Expert-3	There needs to be a facility to display a recapitulation of test results.
4	Expert-4	There needs to be a test date.
5	Teacher-12	There needs to be a facility to view a recapitulation of test results.
6	Teacher-16	There needs to be a test completion time duration.
7	Teacher-18	There needs to be a facility to view the scores of each test participant.
8	Teacher-28	It is better to prepare a facility to display the test implementation date.
9	Teacher-30	There needs to be a facility to display the test completion time duration.

3) Revision of Initial Trial Results: Revision of the user interface design of the digital test based on backward chaining based on several respondents' suggestions in the initial trial. It is necessary to make revisions, especially those related to the test implementation date referring to the suggestions of expert-1, expert-4, and teacher-28. They were creating a user interface design to display the test implementation date. The improved design form is in Fig. 6.

It is necessary to make revisions, especially those related to the recapitulation of test results referring to the suggestions of expert-2, expert-3, teacher-12, and teacher-18. They were creating a user interface design to display the recapitulation of test results. The form of the improved design is in Fig. 7.

It is necessary to make revisions, especially those related to the display test completion time referring to the suggestions of expert-16 and teacher-30. They were creating a user interface design to display the display test completion time. The form of the improved design is in Fig. 8.

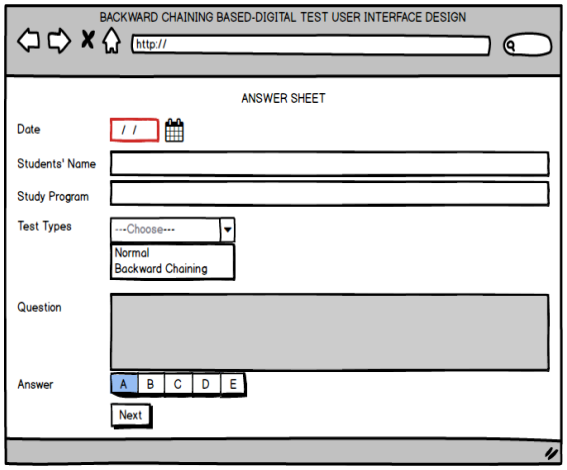

Fig. 6. User interface design to display test implementation date.

Fig. 6 shows the user interface design display for the test execution date. Fig. 6 shows the improvement. There is a date time picker "date" to show the test execution date.

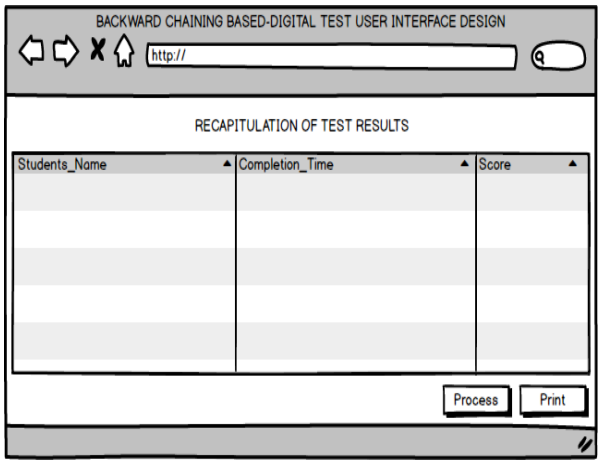

Fig. 7. User interface design to display test result recapitulation.

Fig. 7 shows the user interface design display for the recapitulation of test results. Fig. 7 shows that improvement. There is a database that shows the recapitulation of test results. They are Students_Name, Completion_Time, and Score.

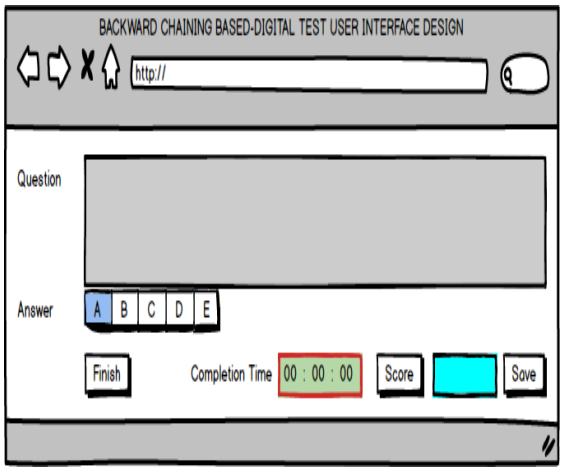

Fig. 8. User interface design to display test completion time.

Fig. 8 shows the user interface design display for the test completion time. Fig. 8 shows the improvement. There is a timer that shows the completion time.

B. Discussion

Referring to the percentage of quality shown in Table II, the digital test user interface design based on backward chaining is good quality. It is because of 88.94%, if checked through the quality standards shown in Table I, then it is true that the quality of the user interface design is good. The reference in providing assessments by respondents in the initial trial, resulting in the data shown in Table II, is in the form of ten questions.

Item-1 is about the suitability of the user interface design form for inputting question data. Item-2 is about the suitability of the general questions form. Item-3 is about the suitability of the specific questions form. Item-4 is about the sequence of relationships between general questions and specific questions. Item-5 is about the ease of creating questions containing image elements. Item-6 is about the ease of setting the level of difficulty of the questions. Item-7 is about the suitability of the user interface design form for backward chaining-based questions arrangement. Item-8 is about the suitability of the backward chaining concept in arranging questions based on the sequence of relationships between general and specific questions. Item-9 is about the suitability of the user interface design form for question answering facilities. Item-10 is about the suitability of the user interface design form for displaying the final score.

This study answers several constraints in the research of Ariawan, Giri, and Divayana [8], the research of Divayana, Ariawan, and Giri [9], the research of Divayana et al. [12], the research of Easa and Blonder [13], and the research of Kholid et al. [14]. The results of this research have been able to show well the design of the user interface of a digital test based on backward chaining packages of the test questions in a sequential manner backward from the general type of questions to questions with more detailed or specific types. In principle, the results of this research also have similarities with several studies of Putra et al. [25], research of Samrgandi [26], research of Darmawan et al. [27] by showing the existence of a user interface design for a measurement/test application.

The novelty of this research is the concept application of backward chaining in artificial intelligence to the preparation of digital test questions in educational evaluation. Based on the internalization of artificial intelligence into educational evaluation, the test formed is a measuring tool for students critical thinking in a differentiated learning atmosphere. However, this research also has constraints. The constraint of this research is that it has not formed a physical application for direct application in the field. It is only limited to the user interface design.

V. CONCLUSION

In general, the findings of this study effectively demonstrate the quality of the user interface design for a digital test based on backward chaining, which serves as a tool for measuring students' critical thinking in a differentiated learning context. A key innovation/novelty of this study is the arrangement of test questions using the artificial intelligence method known as

backward chaining. This approach organizes the questions systematically, progressing from general to specific types, thereby facilitating a deeper exploration of students' critical thinking abilities. Future work that needs to overcome the obstacles of this study is to create a physical application in the form of a backward chaining-based digital test that is ready for field testing. The impact of the results of this study on educational evaluation science is to make it easier for evaluators to conduct tests to measure students' critical thinking. The impact of research results on informatics engineering education, in general, is to show innovations in digital-based test development to determine the critical thinking in differentiated learning.

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REFERENCES

[1] R. Febriana, S. Sugiman, and A. Wijaya, "Analysis of the implementation of differentiated learning in the implementation of the independent curriculum in middle school mathematics lessons," *International Journal of Humanities Education and Social Sciences*, vol. 3, no. 2 2, pp. 640-650, 2023.

[2] N. Hidayat, Y. Ruhiat, N. Anriani, and S. Suryadi, "The impact of differentiated learning, adversity intelligence, and peer tutoring on student learning outcomes," *IJORER: International Journal of Recent Educational Research*, vol. 5, no. 3, pp. 537-548, 2024.

[3] I. Y. N. Hizqiyah, A. Widodo, S. Sriyati, and A. Ahmad, "Development of a digital problem solving skills test instrument: Model rasch analysis," *Jurnal Penelitian Pendidikan IPA*, vol. 9, no. 4, pp. 1658-1663, 2023.

[4] P. Ndibalema, "Online assessment in the era of digital natives in higher education institutions," *International Journal of Technology in Education (IJTE)*, vol. 4, no. 3, pp. 443-463, 2021.

[5] J. Jaskova, "Digital testing during the pandemic crisis: university students' opinions on computer-based tests," *International Journal for Innovation Education and Research*, vol. 9, no.1, pp. 36-53, 2021.

[6] P. Noor, "Kahoot! as a digital quiz in learning english: Graduate students' perspectives," *Journal of English Teaching and Research*, vol. 8, no. 2, pp. 124-132, 2023.

[7] D. Domínguez-Figaredo, and I. Gil-Jaurena, "Effects of familiarity with digital assessment in online education," *Distance Education*, pp. 1-16, 2024.

[8] I. P. W. Ariawan, M. K. W. Giri, and D. G. H. Divayana, "Simulation of SAW-based CIPP evaluation model calculation in determining improvement priority for e-learning services," In *4th International Conference on Vocational Education and Training (ICOVET)*, pp. 24-29, 2020.

[9] D. G. H. Divayana, I. P. W. Ariawan, and M. K. W. Giri, "CIPP-SAW application as an evaluation tool of e-learning effectiveness," *International Journal of Modern Education and Computer Science (IJMECS)*, vol. 13, no. 6, pp. 42-59, 2021.

[10] I. P. W. Ariawan, W. Sugandini, I. M. Ardana, I. M. S. D. Arta, and D. G. H. Divayana, "Design of formative-summative evaluation model based on tri pramana-weighted product," *Emerging Science Journal*, vol. 6, no. 6, pp. 1477-1491, 2022.

[11] I. P. W. Ariawan, W. Sugandini, I. M. Ardana, G. A. D. Sugiharni, A. W. O. Gama, and D. G. H. Divayana, "Forms and field trials of a digital evaluation tool: integrating F-S model, WP method, and balinese local wisdom for effective e-learning," *Journal of Applied Data Sciences*, vol. 5, no. 2, pp. 441-454, 2024.

[12] D. G. H. Divayana, I. G. Sudirtha, and I. K. Suartama, "Digital test instruments based on wondershare-superitem for supporting distance learning implementation of assessment course," *International Journal of Instruction*, vol. 14, no. 4, pp. 945-964, 2021.

[13] E. Easa, and R. Blonder, "The development of an instrument for measuring teachers' and students' beliefs about differentiated instruction and teaching in heterogeneous chemistry classrooms," *Chemistry Teacher International*, vol. 5, no. 2, pp. 125-141, 2023.

[14] B. Kholid, A. Rahman, and L. A. Irawan, "Implementing diagnostic assessment in designing differentiated learning for english language learning at the junior high schools," *Journal of Language and Literature Studies*, vol. 4, no. 2, pp. 445-458, 2024.

[15] E. Faridah, I. Kasih, S. Nugroho, and T. Aji, "The effectiveness of blended learning model on rhythmic activity courses based on complementary work patterns," *International Journal of Education in Mathematics, Science and Technology*, vol. 10, no. 4, pp. 918-934, 2022.

[16] K. Rusmulyani, I. M. Yudana, I. N. Natajaya, and D. G. H. Divayana, "E-Evaluation based on CSE-UCLA model refers to glickman pattern for evaluating the leadership training program," *International Journal of Advanced Computer Science and Applications*, vol. 13, no. 5, pp. 279-294, 2022.

[17] D. G. H. Divayana, "Development of duck diseases expert system with applying alliance method at bali provincial livestock office" *International Journal of Advanced Computer Science and Applications (IJACSA)*, vol. 5, no. 8, 2014.

[18] N. M. Ratminingsih, L. P. P. Mahadewi, and D. G. H. Divayana, "ICT-Based Interactive Game in TEYL: Teachers' Perception, Students' Motivation, and Achievement," *International Journal of Emerging Technologies in Learning (iJET)*, vol. 13, no. 9, pp. 190-203, 2018.

[19] G. A. D. Sugiharni, "The development of interactive instructional media oriented to creative problem solving model on function graphic subject," *Journal of Educational Research and Evaluation*, vol. 2, no. 4, pp. 183-189, 2018.

[20] A. Adiarta, I. M. Sugiarta, K. K. Heryanda, I. K. G. Sukawijana and Dewa Gede Hendra Divayana, "User interface design of sevima edlink platform for facilitating tri kaya parisudha-based asynchronous learning," *International Journal of Advanced Computer Science and Applications(IJACSA)*, vol. 15, no. 12, pp. 795-804, 2024.

[21] D. G. H. Divayana, "Development of ANEKA-Weighted Product evaluation model based on Tri Kaya Parisudha in computer learning on vocational school," *Cogent Engineering*, vol. 5, no. 1, pp. 1-33, 2018.

[22] B. Suratno, and J. Shafira, "Development of user interface/user experience using design thinking approach for GMS service company," *Journal of Information Systems and Informatics*, vol. 4, no. 2, pp. 469-494, 2022.

[23] D. G. H. Divayana, A. Adiarta, and I. G. Sudirtha, "Instruments development of tri kaya parisudha-based countenance model in evaluating the blended learning," *International Journal of Engineering Pedagogy (iJEP)*, vol. 9, no. 5, pp. 55-74, 2019.

[24] D. G. H. Divayana, P. Wayan Arta Suyasa, N.K. Widiartini, "An innovative model as evaluation model for information technology-based learning at ICT vocational schools," *Heliyon*, vol. 7, no. 2, pp. 1-13, 2021.

[25] Z. F. F. Putra, H. Ajie, and I. A. Safitri, "Designing a user interface and user experience from piring makanku application by using figma application for teens," *International Journal of Information System & Technology*, vol. 5, no. 3, 308-315, 2021.

[26] N. Samrgandi, "User interface design & evaluation of mobile applications," *International Journal of Computer Science and Network Security*, vol. 21, no. 1, pp. 55-63, 2021.

[27] I. Darmawan, M. S. Anwar, A. Rahmatulloh, and H. Sulastri, "Design thinking approach for user interface design and user experience on campus academic information systems," *International Journal on Informatics Visualization*, vol. 6, no. 2, pp. 327-334, 2022.