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Scandura Structure-Based E-Learning: Improving Science Learning Outcomes (Natural Science) for Junior High School Students

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Abstract: The aims of this study were to: (1) determine the feasibility of Scandura structure-based e-learning in science subjects; (2) know the practicality of Scandura structure-based e-learning in science subjects; and (3) determine the effectiveness of Scandura structure-based e-learning in science subjects. The type used by researchers is Research and development (R&D). The research subjects were students of SMP Negeri 2 Balige, Toba Regency. The object of this study was an e-learning tool that was used by 64 students in classes VIIIA and VIIIB (32 students in each class). The results showed that the feasibility of e-learning based on Scandura's structure was tested through the validation of material and media experts, with an average score of 3.85% and a percentage of 96% on the criteria of very Suitable for Science subjects at SMP Negeri 2 Balige. The practicality of e-learning based on Scandura's learning structure was tested on science teachers, with an average percentage of 3.22 (80.56%) in the Very Suitable category for science subjects. The effectiveness of e-learning based on Scandura's structure learning tested with N-Gain was found to be 61.84% in the Moderate criteria. The feasibility of e-learning in VIII IPA in Phase D can be said to be feasible for use in enhancing science learning in class and outside the classroom for students.

Keywords: e-learning; learn the structure of scandura; IPA

1. INTRODUCTION

Teaching materials are one of the learning tools developed by the teacher for the learning process in the classroom. According to Prastowo [1], teaching materials are all forms of materials used to assist teachers or instructors in carrying out the learning process in class. The material in question can be written or unwritten. Teaching materials are very helpful for students to practice at home. From the teaching materials given to students, students can repeat lessons that have been received in class by getting homework from the teacher, so that independence will grow and can help students evaluate their abilities in learning.

In science in class VIII, students feel confused about accessing the right learning for them even though the devices they have are able to access them from various sources. Teachers experience problems managing science learning when the resources used are still in the form of student worksheets. The development of learning tools that strengthen students' scientific thinking is not yet well structured, such as using web organizers or charts that make it easier for students to analyze. Vitti and Torres [2] wrote that scientific processes occur naturally and spontaneously in our minds. By logically outlining the steps in our thinking, we can use the process of science to figure out how to answer our questions about how the world works. The scientific process is useful not only in science but in any situation that requires critical thinking. Science process skills include the quality of observing, measuring quantities, sorting or classifying, concluding, predicting, experimenting, and communicating.

The problem of learning science, as stated by Jufrida et al. [3], is that learning science itself not only emphasizes and focuses students on aspects of knowledge but rather provides direct experience (experiments) of how scientists think about and explore a symptom or phenomenon so as to find scientific products. Science learning is expected to be able to increase scientific knowledge and develop the material itself so that students can apply it in everyday life.

Salamah [4] explained that in structural learning theory, all learned knowledge is called rules. In particular, the principles of knowledge have three components, namely: (a) the domain or field, namely the consistency of the internal relationship between the cognitive structure and the elements of the learning situation environment, so that students learn based on Structural Learning Theory or by George H. Stevens and Joseph M. Scandura Structural Learning Theory Rules Domain can obtain a specific result from instructional objectives: (b) distance, namely the structure of students' expectations of the rules of their learning outcomes and related to variations in behavior or decisions directed at achieving learning objectives; (c) operation, namely the sum of all decisions and the sequence of student actions in producing the expected knowledge rules. Therefore, the researcher wants to develop an e-learning learning tool in which structured learning principles can be used as the basis for developing learning that can increase the effectiveness of student learning, namely by what students are interested in, student learning variations that can be grouped, the development of knowledge charts, and students' scientific thinking. Based on the description of the problems in this study, the authors are interested in conducting research entitled "Development of e-Learning Learning Devices Based on Scandura Structure Learning for Science Subjects at SMP Negeri 2 Balige, Toba Regency."

1.1 The Nature of Learning and Science Learning Outcomes

Samatowa [5] also stated that natural science is a science that deals with natural phenomena and objects that are systematic, regularly arranged, and generally accepted in the form of a collection of observations and experiments. Systematic in science, according to the meaning of the Merriam Webster Dictionary, is the more common word; it most often describes something that is done according to a system or method. The method used in learning natural science is studied and structured to help someone study nature and all its phenomena.

UNESCO, on a page entitled Science for Society [6], writes that natural science produces solutions for everyday life and helps us answer the great mysteries of the universe. In other words, natural science is one of the most important channels of knowledge and has a specific role as well as multiple functions for the benefit of society: creating new knowledge, enhancing education, and improving the quality of life.

The American Meteorological Society [7] also explains that most scientists recognize that the pursuit of objectivity in research, even though it may be impossible for humans to fully achieve it, is the cornerstone of science. The natural sciences generate knowledge and understanding by trying to eliminate potential sources of bias, often through controlled experiments. This pursuit of objectivity enhances the credibility of scientific progress and broadens people's willingness to take in and use the new knowledge and understanding that science provides.

Based on the Guidelines for Implementing the Curriculum in the Context of Learning Recovery, it is explained how the structure of the SMP/MTs curriculum consists of one (one) phase, namely Phase D. Phase D is for classes VII, VIII, and IX. The structure of the SMP/MTs curriculum is divided into two parts, namely: (a) intra-curricular learning; and (b) The project to strengthen the profile of Pancasila students, which is allocated around 25% (twenty five percent) of the total JP per year.

The implementation of the project to strengthen the Pancasila student profile is carried out flexibly, both in terms of content and in terms of implementation time. In terms of content, the profile project must refer to the achievement of the Pancasila student profile in accordance with the student phase and does not have to be linked to learning achievement in the subject. In managing implementation time, projects can be carried out by adding up the allocation of project study hours from all subjects, and the total amount of implementation time for each project does not have to be the same.

1.2 Evaluation of e-Learning

The most widely used e-learning interactive learning model in learning design is the Edmodo-assisted interactive learning model [8] [9]. Edmodo has a website that is used by teachers, lecturers, and students and parents to facilitate online learning. Edmodo offers a more secure and connected classroom by offering a real-time class-based platform to exchange ideas, content and to access homework, grades, and important information from the school. This interactive learning model helps in planning, analyzing, implementing, and managing learning. It also provides access to learning materials whenever and wherever students are. Apart from Edmodo, there are still many applications that can be used to evaluate student learning.

Evaluation is an assessment of the data collected through assessment activities [10]. Hilda Taba in Hermawan [11] revealed that, in principle, the focus of evaluation is the level at which students achieve goals. The definition of evaluation itself is how to achieve an activity objective based on an assessment of existing data through testing. Ruslan [12] writes that the meaning of assessment is a general term that includes all methods that can be used to assess the performance of individual students or groups. The assessment process includes collecting evidence to demonstrate students learning achievements. The definition of assessment relates to every part of the educational process, not just learning success but all teaching and learning processes.

Assessment, also according to Siregar and Nara [13], is a process for making decisions using information obtained through measuring learning outcomes, using either test or non-test instruments. Pramono [14] suggests that the implementation of evaluation is a condition of planning carried out in the field. Implementation of evaluation in the field is very dependent on the choice of model and evaluation objectives that have been previously planned. Teachers who want to carry out the process of assessing teaching and learning outcomes can use tests, and teachers can also use non-tests. The process of implementing evaluation in the field is certainly in accordance with the choice of each teacher in choosing the test instrument.

Mustusilo [15] suggests homework that can be developed for students so that it is not monotonous and creates stress for students by providing instructions for making projects that are adapted to learning materials, utilizing the Ministry of Education and Culture's Learning House portal as a virtual lab (e-laboratory) for students to study, making vlogs or existing application-based videos, and leveraging Google Sites with content using Google Forms. Homework that does not burden students will actually increase their interest in learning in class and at home. Homework that increases students' creativity will further excite them to learn. Student homework can be used as a learning evaluation where Student Activity sheets, which are part of student teaching materials at home, are a guide and assessment for the students themselves to assess the extent to which they understand the lessons they receive from class.

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Figure 1. Material chart of IPA Phase D Human Digestive System

Figure 2. Online tests or quizzes on e-learning learning devices

1.3 The Nature of Learning the Scandura Structure

Cognitive and constructive roles can be seen in Scandura's theory of structural learning. Scandura's theory is known as Structural Learning Theory (TBS), which pays major attention to (1) the specifications of what students must learn, (2) the characteristics of students, and (3) the process of continuous interaction between teachers and students based on predetermined goals. The learning principles expressed in Scandura's theory contribute to learning theory, namely (1) choosing higher rules, rules, and atomic components and (2) sorting simple to complex. Next to reveal are: (1) the specifications of what must be learned; (2) the characteristics of the cognitive problems of the learner; and (3) the process of interaction between the teacher and the students according to the existing goals.

Ikegulu [16] explains in his journal that structural learning theory provides a basis for the unification of declarative and procedural knowledge necessary for various common problem-solving tasks in an effort to explain observed individual performance with various experiences. The basic principle of structural learning theory is that the basic activities associated with a particular task are essentially the same for all individuals with prior task exposure, regardless of skill and experience, and that differences in individual performance that are observed are due to the declarative task-specific knowledge possessed and utilized by individuals.

The structured learning approach is a structured approach developed from learning theory and behavior modification in psychology. In Cowie & Dawn [17], the structured learning approach has a pattern of training steps consisting of five hierarchical components. The five components, namely (1) Instruction, (2) Modeling, (3) Role Playing, (4) Feedback, and (5) Transfer of Training, each of which is defined as a social skills training procedure, These steps aim to provide comprehensive skills training through structured stages. Each is defined as a procedure for changing behavior. Among these components, Miltenberg [18] explained that the learning given to students to practice skills must be specific and clear. Instruction in learning helps students see an outline of what will be learned.

According to Smith & Ananiadou in Rahayu et al. [19], practicing certain tasks facilitates learning at a later time only for similar tasks; this is referred to as transfer of training exercises. The tasks given are in the form of (1) interpersonal tasks related to various tasks to overcome any difficulties experienced during assertive behavior training; (2) writing on reflection sheets about their feelings during and after carrying out assertive training; and (3) transferring and directly practicing the behavior that has been learned in people's lives.

Structural learning theory has been widely applied to mathematics and also provides an interpretation of Piaget's theory. The main focus of this theory is problem-solving instructions [21]. Scandura [20] has applied a theoretical framework for the development of writing tools and software engineering. The principles of Scandura's structure learning theory include: (1) If possible, teach high-level rules that can be used to derive lower-level rules; (2) Teach the simplest solution path first, then teach the more complex path or set of rules; (3) Teaching must consist of the minimum abilities possessed by students. The basic principle of structural learning theory is that the basic activities associated with a particular task are essentially the same for all individuals with prior task exposure, regardless of skill and experience, and that differences in individual performance that are observed are due to the declarative task-specific knowledge possessed and utilized by individuals.

The research problem is formulated as follows: (1) Is the Scandura structure-based e-learning learning tool developed suitable for use in science subjects? (2) Is the developed Scandura structure-based e-learning learning tool practically used in science subjects? (3) Is the e-learning learning tool developed on the basis of Scandura's learning structure effective in Science Subjects?

2. METHOD

The type used by researchers is research and development, or what is called research and development (R&D). Sugiono [22] explains that research and development methods, or in English, research and development, are research methods used to produce certain products and test their effectiveness. This study developed an e-learning learning tool based on Scandura task analysis in science subjects at SMP Negeri 2 Balige.

The implementation of this research was carried out at SMP Negeri 2 Balige. And, the implementation time for the development of e-learning learning tools and research will be carried out in March 2022, in the Even Semester of the 2022–2023 Academic Year. Research subjects are individuals who participate in research. The subjects of this study were students of SMP Negeri 2 Balige, Toba Regency. The object of this study was an e-learning tool that was used by 64 class VIIIA and VIIIB students (32 students in each class) during the lesson.

Learning Achievements Based on the Independent Curriculum by studying science in an integrated manner, students develop themselves according to the profile of Pancasila students and can: (1) Develop interest and curiosity so that students are motivated to examine phenomena that exist around humans, understand how the universe system work and provide a reciprocal impact on human life; (2) Playing an active role in maintaining, protecting, preserving the natural environment, managing natural resources and the environment wisely; (3) Develop inquiry process skills to identify, formulate and solve problems through real action; (4) Understand the requirements needed by students to become members of a community and nation group and understand the meaning of being a member of the nation and world community, so that they can contribute to solving problems related to themselves and the environment around them; and (5) Developing knowledge and understanding of concepts in science and applying them in everyday life.

The procedure in this study is to produce certain products or improve existing products and test their effectiveness. According to Thiagarajan, it is known as the 4D Model, which consists of four stages, namely: (1) Define; (2) Front-end analysis; (3) Learner analysis; and (4) Task analysis. Concept analysis, Specifying instructional objectives, (2) Design, Compile test criteria, and choose learning media by utilizing Google Sites and free websites that are appropriate to the material and characteristics of students; Selection of the form of presentation of learning; Simulating the presentation of material with media and learning steps that have been designed; (3) Develop; expert appraisal and developmental testing. Expert appraisal is a technique to validate or assess the feasibility of a product design. In this activity, evaluation is carried out by experts in their fields. (4) Disseminate: The packaging of the learning model can be done by printing a guidebook for the application of the learning model. After the e-learning learning tools are published online, they are disseminated so that they can be absorbed (diffusion) or understood by others and used (adopted) in their classes.

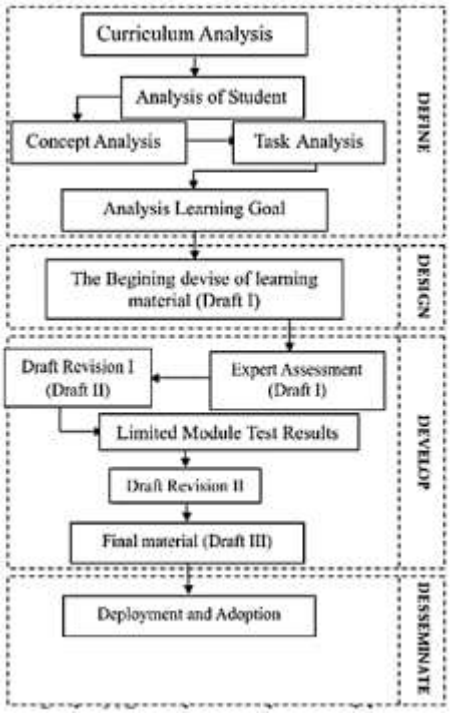

Figure 3. 4-D Model Development Flow by Thiagarajan

The total assessment score can be calculated using the following formula:

$$\text{Percentage of eligibility} = \frac{\text{Total score of data collection results}}{\text{total ideal maximum score}}\ x\ 100\%$$

The percentages obtained from the feasibility testing of experts and the practicality of using teachers and students are converted into tabular form that can be read in the research results. The determination of the criteria is done by: (1) Determine the percentage of the ideal score (maximum score) = 100%; (2) Determine the percentage of the lowest score (minimum score) = 0%; (3) Determine the range = 100 – 0 = 100; (4) Determine the desired interval = 4 (very feasible, feasible, sufficiently feasible, and less feasible); (5) Determine the internal width (100/4 = 25).

Applying a study of the percentage table that presents the feasibility aspect, Sugiono [22] makes the percentage scale table as follows:

Table 1. Eligibility Percentage Scale

Achievement Percentage	Value Scale	Interpretation
76% ≤ skor ≤ 100%	4	Very Eligible
51% ≤ skor ≤ 75%	3	Eligible
26% ≤ skor ≤ 50%	2	Fairly Decent
0% ≤ skor ≤ 25%	1	Fairly Decent

Table 2. Practicality Percentage Scale

Achievement Percentage	Value Scale	Interpretation
76% ≤ skor ≤ 100%	4	Very Practical
51% ≤ skor ≤ 75%	3	Practical
26% ≤ skor ≤ 50%	2	Practical enough
0% ≤ skor ≤ 25%	1	Less practical

The validation questionnaire related to the suitability of the material and design of the product being developed has four answer choices according to the question content. The suitability data is used to determine the feasibility level of the resulting product. The following is a table of assessment scores according to Sugiyono [23]:

Table 3. Answer Choice Rating Score

No	Category	Score
1	Very good	4
2	Good	3
3	Good	2
4	Not good	1

Table 4. Eligibility Criteria

No	Percentagee (%)	Validity
1	81 – 100	Very Valid
2	61 – 80	Valid
3	41 – 60	Invalid
4	0 - 40	Very Invalid

Before testing the hypothesis, a prerequisite test is carried out with the normality test and the data homogeneity test. The test given did not test the homogeneity of pre-test and post-test scores; the test tested on students was valid because it used a test developed by the Bookkeeping Center. Conduct a difference test (t test) to see the significance of the difference between the pretest and posttest scores. Statistical test results with the following conditions: (a) If the probability value, or Sig. (2-tailed), is 0.05, then there is a significant difference in the pretest and posttest values. (b) If the probability value, or Sig. (2-tailed), is > 0.05, then there is no significant difference in the pretest and posttest scores.

The effectiveness of e-learning learning tools is measured by measuring the increase in the extent to which targets are achieved from the start before treatment (initial ability test or pretest) to the target learning outcomes after being given posttest treatment. Oktavia et al. [24] wrote that in the one group pretest and posttest design, the pretest was carried out on the research subject group, after which treatment was given, and then a posttest was carried out with the same measurements. Students who were subjected to the pretest and posttest came from the same class (within subject design), namely in Class VIII-B, while Class VIII-A was a product trial class. The pretest is carried out by asking a number of questions related to the material that will be reviewed in the class. Furthermore, the treatment is carried out in the form of procuring a strengthening program and providing modules. Then, after the treatment, a posttest is given in the form of filling in the questions again.

Testing the effectiveness of Scandura structure-based e-learning tools uses manual calculations, namely the N-Gain effectiveness formula. The Normalized Gain Test (N-Gain) was carried out to find out how much effect the Scandura structure-based e-learning tool received after being given learning on it.

Archambault [25] explains the calculation of the normalized Gain score with the formula: N-Gain Score = $Skor\ Posttest - Skor\ Pretest\ Skor\ Maksimal - Skor\ Pretest\ x$ 100% Normality This gain is also analyzed for the mean value of pretest and post scores test. The following is presented the formula to determine the mean value: $Mean\ Sk$or Pre fix = Total Pretest Value Number

Hake [26] explained that the results of the Normalized Gain calculations were then interpreted based on the N-Gain interpretation table.

Table 5. Criteria for N-Gain Score e-Learning Learning Devices Based on Scandura Structure Learning

No	N-Gain Presentation	Criteria
1	71 – 100%	High
2	31 – 70%	Moderate
3	1 – 30%	Low

3. RESULTS AND DISCUSSION

3.1 RESULTS

The results of the evaluation of e-learning learning tools in the form of a website were validated for material experts, media experts, individual trials, small group trials, and limited field trials for all aspects of the assessment determined by the average score. The results of the assessment were then analyzed and determined whether or not it was appropriate to develop Scandura structure-based e-learning tools. The average percentage of the results of the assessment of media experts, material experts, individual trials, small group trials, and field trials is shown in Table 6 below:

Table 6. Results of the Feasibility Assessment of Scandura Structure-Based E-Learning Learning Tools

No	Categorization	Percentage of average score%	Criteria
1.	Material Expert Validation	96,00	very worth it
2.	Media Expert Validation	86,54	very worth it
3.	Individual Trial	80,00	very worth it
4.	Field Trials	81,67	very worth it
The average		86,05	very worth it

Scandura structure-based learning e-learning learning tools show that the results of material expert validation, media expert validation, individual trials, and field trials show an average of 86.05% in the very feasible category, which means the use of e-learning media Scandura's learning-based structure meets the needs of learners.

The practicality test of e-learning learning products in the form of a website was conducted for VIII grade science teachers to find out whether Scandura structure-based e-learning learning tools were practical or not to be used in the next grade of science learning. The results of the practicality test can be seen from the validation questionnaire analysis data as follows:

Table 7. Product Use Practicality Test Results

No	Aspect	Percentage of average score%	Criteria
1.	Effective	81,25	very practical
2.	Interactive	79.17	Practical
3.	Efficient	87,50	very practical
4.	Creative	75,00	Practical
The average		81,25	very practical

E-learning learning tools based on Scandura structure practicality show that the use of effective, interactive, efficient, and creative aspects as a whole averages 81.25% in the very practical category, which means the use of e-learning learning media based on Scandura structure learning very practical to use in the learning process for students.

The results of the SPSS t-test from the results of the pretest and posttest in class VIII-B are as follows:

Table 8. T-test results

t-Test

	40	*85*
Mean	57,258065	83,225806
Variance	84,731183	47,580645
Observations	31	31
Pearson Correlation	0,3539375	
Hypothesized Mean Difference	0	
df	30	
t Stat	-15,46838	
P(T<=t) one-tail	3,861E-16	
t Critical one-tail	1,6972609	
P(T<=t) two-tail	7,722E-16	
t Critical two-tail	2,0422725	

From the test results above, it shows that the average pretest value is 57.25 and the posttest value is 83.22. The value of t is 1.69 and the value of t from the distribution of t table is 2.04, where if the probability value or Sig. (2-tailed) < 0.05, then there is a significant difference in the pretest and posttest scores.

The pretest result scores and the pottest result scores were obtained from the questions given to students and calculating the N-Gain. The effectiveness of science learning through Scandura structure-based e-learning learning tools according to Archambault (2008) is calculated from the normalized Gain score with the formula:

$$N - Gain\ Score = \frac{\text{Posttest Score} - \text{Pretest Scoret}}{Maximum\ Score - Pretest\ Score}\ x\ 100\%$$

From the processing of the pretest and posttest data above, it was found that:
a. Pretest score ($\bar{X}Pretest$) : 57,83
b. Posttest score ($\bar{X}Posttest$) : 83,91
c. Maximum Score: 100

$$N - Gain\ Score\ = \frac{83{,}91\ - 57{,}83}{100\ - 57{,}83}\ x\ 100\%$$

Then the N-Gain Score = 61,84%

Table 9. N-Gain Scores of Scandura Structure-based e-Learning Learning Devices in class VIII

Score	Result
Pretest	57,25
Post-Test	83,22
N-Gains	70,23
Criteria	Moderate

In Hake's explanation [28] regarding the calculation of the Normalized gain, which is interpreted based on the N-Gain interpretation table, a value of 70.23 is obtained in the Moderate criteria. The effectiveness of the e-learning learning tools in class VIII IPA in Phase D is used to improve science learning in class and outside the classroom for students.

3.2 DISCUSSION

Development research was carried out to develop e-learning learning tools consisting of teaching materials and the evaluation of learning science in class VIII with the Scandura Learning Structure. Utilizing websites and Google Sites in developing learning content is a practical way for materials to be used in class, at home, or wherever students want. Websites and Google Sites can be effective in the process of distance learning and blended learning in schools.

Rosiyana [29] wrote in his research that learning using websites and Google Sites provides benefits for students and teachers, namely as follows: (1) Websites and Google Sites can make students lives more interesting and fun; (2) Websites and Google Sites can provide learning materials that can be downloaded so that students can learn from them anywhere and anytime. (3) Websites and Google Sites can provide material from the beginning to the end of the meeting; students can re-read the material provided by the teacher because the material does not automatically disappear. (4) Students can upload assignments that have been assigned separately; (5) Websites and Google Sites may provide separate announcements regarding assignments or other information.

The feasibility of this e-learning tool using websites, Google Sites, and e-tests obtained by 91% of material and media experts can lead students to learn structure, according to Scandura. Barnwell [30] suggests that structural analysis is a specification of the problem domain and an identification of the rules needed to solve the problem. Science learning in class VIII SMP Negeri 2 Balige is carried out by identifying all problems related to the Human Digestive System, Additives and Addictive Substances, and the Human Circulatory System. The problems raised in certain parts of the e-learning tool lead students to identify a rule, such as practicing.

The practicality of this e-learning learning tool, seen from the aspects of Effective, Interactive, efficient, and creative, was obtained at 80.56% from the response of science teachers at SMP Negeri 2 Balige. The practicality of these e-learning tools helps teachers carry out a series of Scandura-structured learning activities, where Barnwell [31] explains that the first step requires students to do an analysis to decide which way is right to represent the facts given to the problem and how to find a suitable solution. related to the big question of what will be studied. Then do an analysis to choose what problems students must solve through an analysis of learning material or content available on e-learning learning tools at dapenda.yolasite.com, where students will be directed to follow further learning steps in class or assignments from the teacher through Cause and Effect, Compare and Contrast, and others as explained in Chapter II. Furthermore, a set of problem-solving methods and strategies that can be traced through learning content on e-learning learning tools that have been developed and the consistency of students to complete assignments or assignments given.

4. CONCLUSION

Based on the results of the research and discussion above, it can be concluded that:

1. The feasibility of the Scandura structure-based e-learning tool was tested through the validation of material and media experts, with an average score of 3.85% and a percentage of 96% on the criteria. Very suitable for use in science subjects at SMP Negeri 2 Balige.
2. The practicality of the Scandura structure-based e-learning learning tool, which was tested on science teachers with an average percentage of 3.22 (80.56%) in the Very Suitable category for use in science subjects at SMP Negeri 2 Balige.
3. The effectiveness of the Scandura structure-based e-learning learning tool tested with the N-Gain calculation was found to be 61.84% in the Moderate criteria. The feasibility of e-learning learning device products in class VIII IPA in Phase D can be said to be feasible for use in enhancing science learning in class and outside the classroom for students.

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