Design of Spectrum Analyzer Android-based Instructional Media for Vocational High School Student

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***Abstract*— This research aims to produce *spectrum analyzer* instructional media that will be implemented in Radio Transmission Operations and Maintenance subjects. Research development adopts the ADDIE model according to William W. Lee & Diana L. Owens, which includes: analysis, design, development and implementation, and evaluation. In the development and implementation steps, there are activities in the form of expert validation of instructional media based on Android applications. Theory experts, media experts, and users were necessary for the evaluation. Furthermore, the *spectrum analyzer* instructional media was tested on learning activity in Telecommunication Transmission Engineering Skill Competency at SMK Telkom Jakarta. The gain from the range of questionnaire values is converted to determine the eligibility category. The results showed that teaching and learning activities in operating and maintaining radio transmission subjects require instructional media for practical activity learning in the form of software on an Android-based smartphone consisting of theory, quiz, and job sheets; and a manual guide of media. The research results show that the value of the *spectrum analyzer* instructional media quality, in general, is 3.46, which is interpreted in the excellent category. Because the Android-based *spectrum analyzer* instructional media obtained an excellent feasibility value, this media reliable to be implemented in classroom learning.**

Keywords*— *Instructional Media,* Spectrum analyzer*, Mobile Application, Vocational High School

I. Introduction

7th President Ir. Joko Widodo conveyed that the development of Human Resources is necessary that bring Indonesia compete in the needs of the 4.0 industry [1]. In order to develop and increase the industry, it requires workers with hard and soft skills. Therefore, vocational secondary education provides besides the mission : Improving the quality of learning at Vocational High Schools to produce graduates who are competitive in work [2]. However, graduates of Vocational High School is highest the education unit that have unemployment rate on 2021 [3]. Information and Communication Technology is the highest unemployment rate out of 9 scope in Vocational High School in 2019 [4]. Meanwhile, the projected workforce needs in the Information and Communications sector will grow by more than 10% annually from 2022-2025 [5]. One of the hard skills in Information and Communication Technology sector is measuring tools operation. Based on the survey of several parties in the field of Information and Communication Technology, namely Vocational High School students, bachelor students, and practitioners, it the most measuring instrument that the least understood measuring instrument is a spectrum analyzer with a frequency of 31.34%.

A spectrum analyzer is a measuring instrument used to determine the energy distribution of a frequency spectrum generated by an electrical signal. A spectrum analyzer is a reliable device to measure a movement in the frequency domain [6]. In addition, the Spectrum analyzer is also useful in planning and testing radio frequency circuits, analyzing or testing the condition of a system in a communication network. However, with the advantages of this tool, the spectrum analyzer has one drawback: the price is quite expensive so not everyone can afford it [7]. It could provide the lack of information about using the Spectrum analyzer in the school environment. Even though the vocational school has a spectrum analyzer, not many can apply this tool, therefore learning is important regarding using a spectrum analyzer in schools.

Learning is a series of activities organized to provide convenience with the aiming of facilitating the transfer of knowledge in the student learning process so that students can gain an easy understanding of ideal learning practices [8]. To realize a good understanding of students in learning, especially in the subjects of Operation and Maintenance of Radio Transmission, instructional media is needed that provides convenience. Effective learning can apply if the teacher can utilize instructional media per the curriculum demands [9]. Instructional media is a tool that can assist the teaching and learning process and clarifies the meaning of the message or information conveyed, so that it can achieve the planned learning objectives [10].

To provide the optimal understanding and physical experience achievement, the subject of radio transmission

operation and maintenance requires media that reflect the competencies required in the industry. Media of education perspectives is an ideal strategic instrument for determining the success of the teaching and learning process because it can directly provide dynamical situations to students. With the use of Android phone technology obtained by students, it is supposed that students can learn effectively and efficiently [11].

Another finding, a survey was conducted on 3rd grade students of the Telecommunication Engineering skill program at Telkom Vocational School, and it was revealed that the students had never received material on the use of a *spectrum analyzer*, only given the theory about the *spectrum analyzer*. Whereas the subject of Operation and Maintenance of Radio Transmission is one of the compulsory subjects that students must take in the Telecommunication Transmission Engineering study program further, knowledge of the use of a *spectrum analyzer* is one of the essential materials pos To achieve optimal understanding and provide the real experience, the subject of radio transmission operation and maintenance requires practical media that reflect the competencies in today's world of work. Media, in the perspective of education, is a very strategic instrument in determining the success of the teaching and learning process. Because its existence can directly provide its dynamics for students, currently, with the development of information and communication technology, many can be used as instructional media. One of them is the use of Android, which is currently proliferating. In this case, using technology as a learning medium is mobile learning based on Android. This media utilizes technology in the form of mobile phones and tablets owned by teachers and students today; as educators, we must be observant to see developments that occur in the community.

Based on the description above, improving the learning process is by optimizing the impact of the media produced in practical activities. The development of spectrum analyzer instructional media in this study refers to the ease and intelligence that is not too complicated and sophisticated. Overall, the assumption is that students who apply the results of this study have a background that does not know about using a spectrum analyzer.

II. METHODS

A. ADDIE Development Model

The Android-based Spectrum Analyzer instructional media required to be arranged for vocational students to understand optimally how the Spectrum Analyzer device works even though the Spectrum Analyzer is the least understood device by vocational students, bachelor students and practitioners. The need for a method that could afford improvements earlier in each phase that encourages designers to monitor instructional development and evaluate whether results fulfill learning goals. In the ADDIE method, a learning model can be deployed, feedback gained from students, adjustments made at the appropriate ADDIE stage, and the module updated to better match instructional goals. The method applied in this study was the research and development design with the ADDIE development model, which has four stages [12], which are:

1) Analysis

The analysis stage is conducting beginning observations and needs studies. The results of the beginning observation are in the form of identification of problems that occur in Telecommunication Transmission Engineering Study Program learning, peculiarly practicum of the parametric analysis in measuring radio quality in the subjects of radio transmission operation and maintenance. There are ten steps of analysis carried out in this study, namely: (1) Audience Analysis; (2) Technology Analysis; (3) Situation Analysis; (4) Task Analysis; (5) Critical Incident Analysis; (6) Objective Analysis; (7) Issue Analysis; (8) Media Analysis; (9) Extant Data Analysis; (10) Cost Analysis [12]. Table 1 presents the analysis results of students through a survey in the period 12th to 19th February 2022.

TABLE I. RESULT OF THE ANALYSIS OF STUDENTS

No	Indicator	Frequency	
		Yes	*No*
N1	Received the subject Operation and maintenance of Radio Transmission	10	0
N2	Received telecommunication measuring tools theory	10	0
N3	Teacher usage of a spectrum analyzer in the practicum	0	10
N4	Practicum learning accompanied by a worksheet/worksheet/module	7	3
N5	Acquaintances with the spectrum analyzer device	1	9
N6	Teachers use diverse methods of learning activities	7	3
N7	Received theory of spectrum analyzer device practice	0	10

The following steps were interviews and observations with learning practitioners (teachers). Aspects of the interview contain five aspects: learning process, alternative media that can be used, current media, competencies taught to students, and the media need. From interviews with student observation and teacher, accomplished the demand of *spectrum analyzer* instructional media with job sheets and manual guide.

2) Design

The design stage aims to plan the learning multimedia that will develop. The design stages in the development of this instructional media include: (1) making a schedule for making products, for finding out the process of making media up to media trials; (2) determination of media specifications, to design spectrum analyzer instructional media using an android mobile phone consisting of software, spectrum analyzer hardware, and worksheets and manual guides; (3) making the structure of the material (content), the material used is contained in one of the essential competencies, namely analyzing the parameters used in measuring radio quality, bandwidth, bitrate, C/N, using a spectrum analyzer.

3) Development and Implementation

The development and implementation stage aims to start the media development according to specifications from the previous stage. This stage includes a series of activities: (1) Pre-production, which creates flowcharts, and storyboards to develop interface designs and material presented. (2) Production; develops the pre-production process into physical form (form). (3) Post-production and Quality Review; testing the developed tools includes performance tests, theory and media experts, and the product revision stage.

Pre-production stages shown on flowcharts and storyboards can facilitate the ease of development step in the instructional media work system shown in Fig. 1 and Fig. 2.

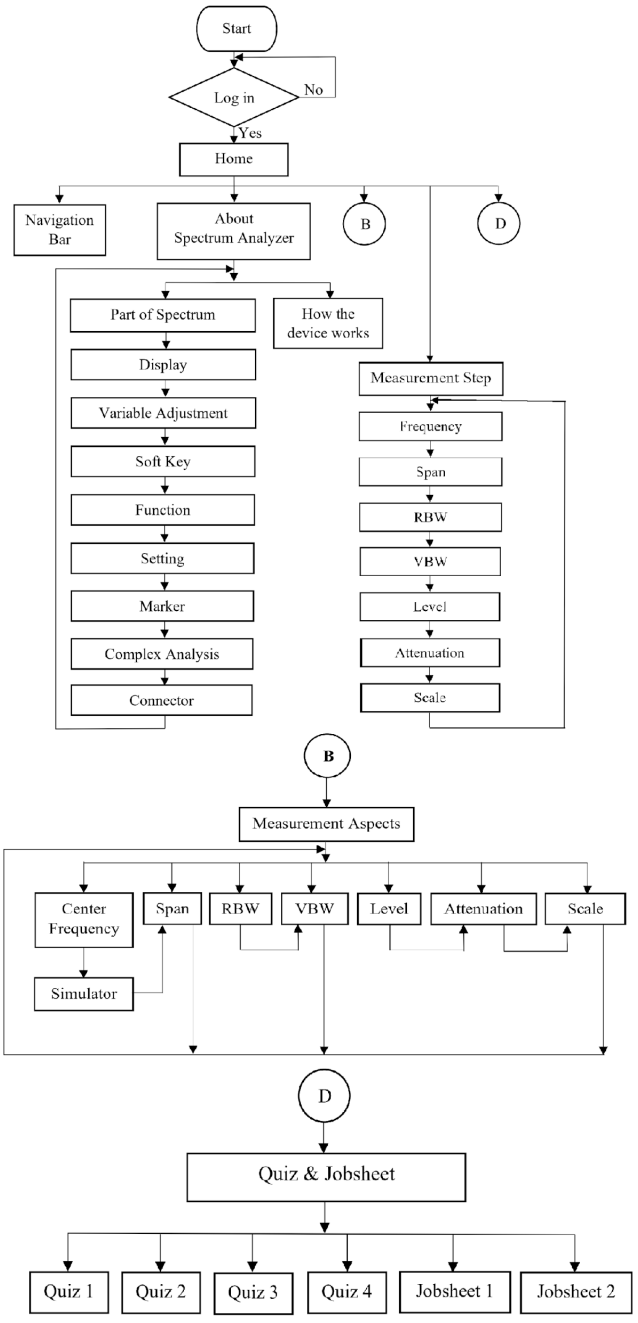


Fig. 1. Application Flowchart.

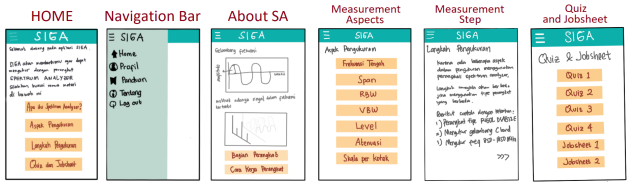


Fig. 2. Application Storyboard.

The preparation of material texts, quizzes and job sheets is compiled from various spectrum analyzer learning references which are summarized based on syllabus references applied in schools. In the preparation of the material, the material is prepared to refer to the syllabus of the radio transmission operation and maintenance subject in Telecommunication Transmission Engineering study program which stands with 18 basic competencies, and this study uses one basic competency: analyzing the parameters used in measuring radio quality using a spectrum analyzer [13]. The design of content carried out in this application is the creation of backgrounds, animation concepts and effects.

The production stage is the realization stage of pre-production which in this study was made using android studio software. This media is in the form of an application called SIGA (Spectrum Analyzer That's Easy) and the writing and use of this application are arranged in Indonesian so that it is easy to learn at SMK Telkom Jakarta. The following is the appearance of the application that has been developed in Fig. 3 and Fig. 4:

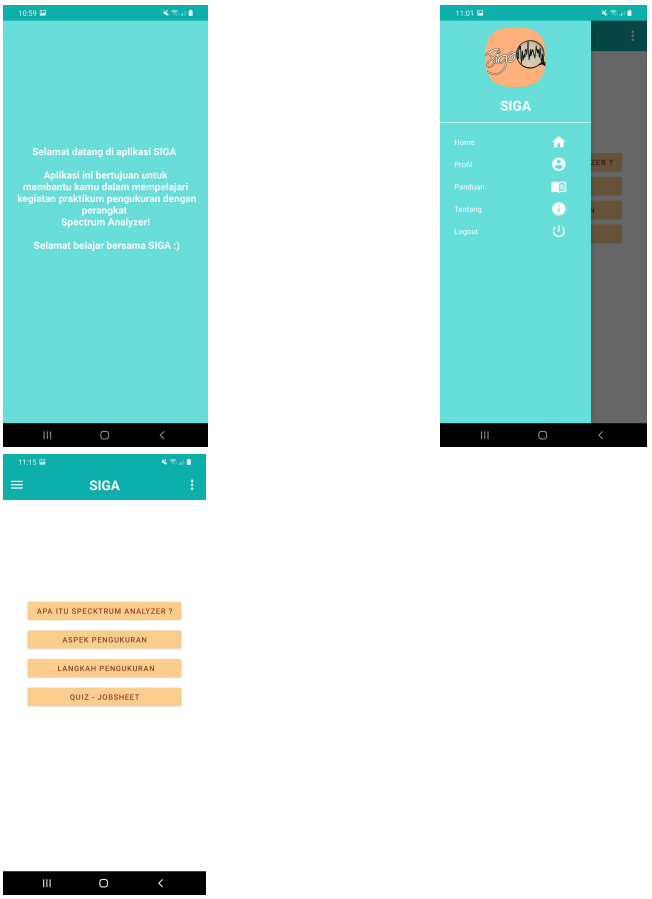


Fig. 3. Display of Splash Screen, Navigation Bar, and Home

Fig. 4. Display of Measurement Step and Quiz Job sheet menu

4) Evaluation

The purpose of the evaluation stage ensures that the result of instructional media can provide convenience for students to learn spectrum analyzer practice in the radio transmission operation and maintenance subject. The beta test was conducted in two stages which were a limited user test and a field test. The limited user test was taken by 2 students who had received radio operation and maintenance subjects. Furthermore, the field test was taken with 12 students.

B. Data Collection

Research on "The Development of Instructional Media *Spectrum Analyzer* Based on Android" was conducted at SMK Telkom Jakarta, located at Jl. Daan Mogot KM. 11, Cengkareng, Jakarta. This study's data collection techniques were interviews, observation, and pre-survey by distributing questionnaires. The research data collection instrument includes three aspects, namely educative (material), technical, and visual (aesthetic) aspects. The data types of this research were quantitative data and qualitative data. To find the average score in providing an assessment of the products developed used the eq.1.

$$X_i = \frac{\sum x}{\sum a \; x \; \sum n} \quad (1)$$

Note:

X_i = Average score

$\sum x$ = Total score

$\sum a$ = Total of aspect observed

n = Total of responden

In the questionnaire, four alternative options are given to respond to the developed media: a score of 1-4 based on the criteria for each score and then converted to a four scale value. The following is a four-scale value conversion table 2 that will be used [14].

TABLE II. CONVERSION OF QUALITATIVE DATA INTO QUANTITATIVE DATA

Scale	Criteria	Frequency	
		Calculation	***Result***
4	Excellent	2.5 + (1.5*0.5) up to 2.5 + (3*0.5)	3.25 up to 4
3	Good	2.5 + (0*0.5) up to 2.5 + (1.5*0.5)	2.5 up to 3.25
2	Less	2.5 - (1.5*0.5) up to 2.5 + (0*0.5)	1.75 up to 2.5
1	Very less	2.5 - (3*0.5) up to 2.5 - (1.5*0.5)	1 up to 1.75

III. RESULTS AND DISCUSSION

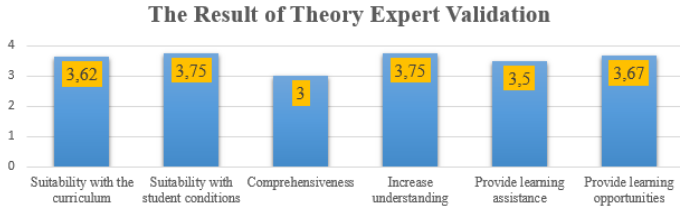
The trial of the Instructional media that has been produced is part of the formative evaluation stage used to determine the assessment of the developed product. In this study, the trials conducted are alpha test (validation of theory experts and media experts) and beta test (limited trial and field test).

A. Alpha Test Results of Theory Expert

The content of the theory expert test is in terms of educative aspects (materials) containing six indicators consist 17 questions in the testing instrument. Table 3 and Figure 5 below show that four of six aspects are interpreted as an excellent category considering the score higher than 3.25, while one aspect below 3.25 is in the good category. However, the theory expert test generally obtained an average score of 3.28, which was interpreted as excellent (above 3.25), and the developed media can be tested further with a note of some improvements.

TABLE III. CONVERSION OF QUALITATIVE DATA INTO QUANTITATIVE DATA

No	Aspects	Indicator	Total Score	Mean	Criteria
1	Educational (theory)	Suitability with the curriculum	29	3.38	Excellent
2		Suitability with student conditions	15	3.50	Excellent
3		Comprehensiveness	18	2.83	Good
4		Increase understanding	15	3.50	Excellent
5		Provide learning assistance	20	3	Good
6		Provide learning opportunities	23	3.50	Excellent
Average				**3.28**	**Excellent**



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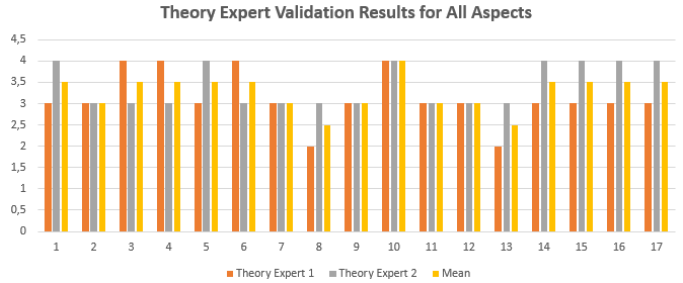


(b)

Fig. 5. (a) Graph of each aspect of the theory expert validation (b) Graph of the theory expert validation results for all aspects

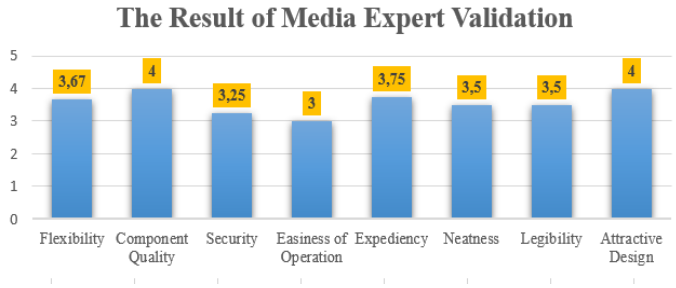
B. Alfa Test Results of Media Expert

Testing on media experts is technical and the appearance (aesthetic) of Instructional media in application development. The total of all aspects of this media expert validation is eight, with 20 questions. An average score of 3.55 (above 3.25) can be interpreted very well. The device can be tested at a later stage with this excellent

interpretation. The following are the results of media expert validation in Table 4 and Fig. 6.

TABLE IV. ALPHA TEST RESULTS OF MEDIA EXPERT

No	Aspects	Indicator	Total Score	Mean	Criteria
1	Technical	Flexibility	22	3.50	Excellent
2		Component Quality	24	3.67	Excellent
3		Security	13	3.25	Excellent
4		Easiness of Operation	12	2.50	Good
5		Expediency	28	3.50	Excellent
6	Appearance (aesthetic)	Neatness	14	3.50	Excellent
7		Legibility	14	3.50	Excellent
8		Attractive Design	16	3.75	Excellent
Average				**3.45**	**Excellent**



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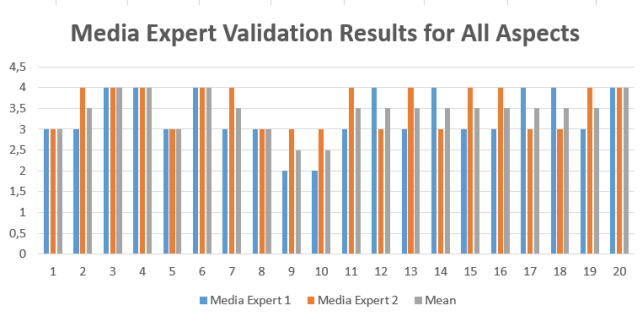


(b)

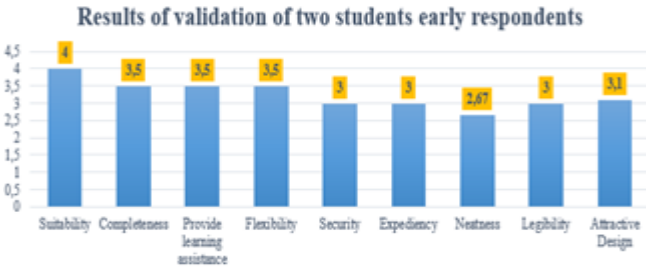
Fig. 6. (a) Graph of each aspect of the media expert validation (b) Graph of the media expert validation results for all aspects

C. *Beta test results (respondent)*

The beta test data was demanded from questionnaires. Students will respond after using instructional media in android-based applications and consist of two parts which are the limited trial and the field test. The results of the limited trial can be seen in Table 5 and Fig. 7.

TABLE V. LIMITED TRIAL TEST RESULTS

No	Aspects	Indicator	Total Score	Mean	Criteria
1	Educational (Theory)	Suitability	16	4	Excellent
2		Completeness	14	3.5	Excellent
3		Provide learning assistance	14	4	Excellent
4	Technical	Flexibility	14	3.5	Excellent
5		Security	12	3.25	Good
6		Expediency	18	3.5	Excellent
7	Appearance (aesthetic)	Neatness	16	3	Good
8		Legibility	18	3.5	Excellent
9		Attractive Design	19	3.67	Excellent
Average				**3.55**	**Excellent**



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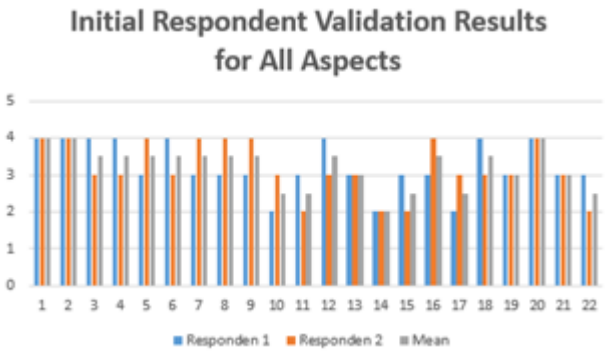

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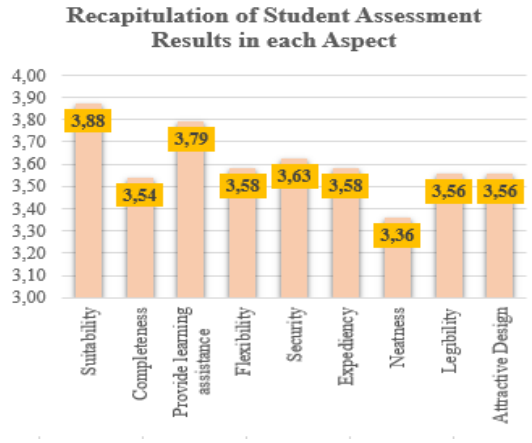
Fig. 7. (a) Graph of each aspect of beta test (b) Graph of the test validation results for all aspects

From the above diagram, two of the nine aspects are interpreted in the good category, and the another was in the excellent category. The final result generally has an average score of 3.55 and is interpreted as excellent. After conducting a limited trial, testing continues in the field test. Table 6 and Figure 8 show the scores for each aspect of a total of 12 student respondents.

TABLE VI. FIELD TEST RESULTS

No	Aspects	Indicator	Total Score	Mean	Criteria
1	Educational (Theory)	Suitability	93	3.88	Excellent
2		Completeness	85	3.54	Excellent
3		Provide learning assistance	91	3.79	Excellent
4	Technical	Flexibility	86	3.58	Excellent

No	Aspects	Indicator	Total Score	Mean	Criteria
5		Security	87	3.63	Excellent
6		Expediency	129	3.58	Excellent
7	Appearance (aesthetic)	Neatness	121	3.36	Excellent
8		Legibility	128	3.56	Excellent
9		Attractive Design	128	3.56	Excellent
Average				**3.61**	**Excellent**



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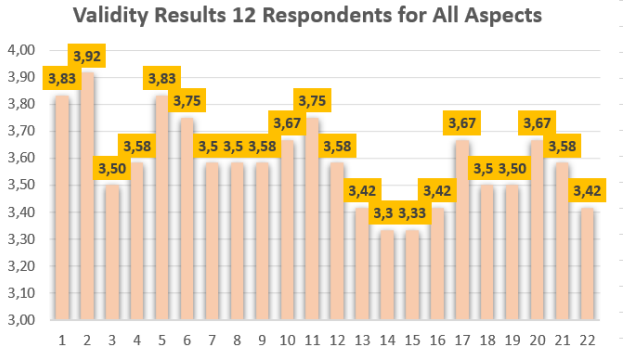

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Fig. 8. (a) Graph of each aspect of the students (b) Graph of the validation of field test respondents for all aspects.

Based on the research results, the percentage of quality aspects of spectrum learning materials and media is categorized as very good. Based on the results of research obtaining a limited percentage of tests and field tests thus, the quality of the feasibility level of instructional media spectrum analyzer based on android is categorized very well. Here is a summary of all the tests performed shown in Table 7 and Figure 9.

TABLE VII. COMPARISON OF THE VALUES OF ALL TESTS PERFORMED

No	Test	Average	Criteria
1	Theory Expert Validation	3.28	Very Good
2	Media Expert Validation	3.40	Very Good
3	Limited Trial	3.55	Very Good
4	Field Test	3.61	Very Good
Average		3.46	Very Good

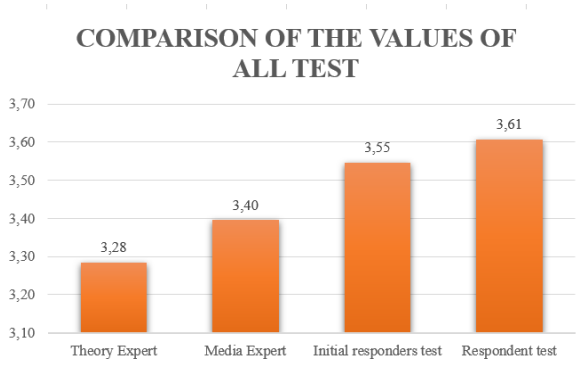

Fig. 9. Comparison of Alpha and beta test values

IV. CONCLUSION

This research aims to provide a solution in the form of developing instructional media according to the need in learning the practice of radio transmission operation and maintenance in the study program of SMK Telkom Jakarta, which spectrum analyzer instructional media. The instructional media developed are (1) spectrum analyzer software (software/applications) consisting of material, quizzes, and worksheets on the practice of using spectrum analyzers (2) guidebook for using spectrum analyzer instructional media that can facilitate students in using spectrum analyzer instructional media. The test results of this study proved the instructional media had met the feasibility level seen from the assessment of theory experts and media experts as expert judgment (alpha test), as well as assessment of student responses as users (beta test).The trial of the Instructional media that has been produced is part of the formative evaluation stage used to determine the assessment of the developed product. In this study, the trials conducted are alpha test (validation of theory experts and media experts) and beta test (limited trial and field test).

The 3.28 score obtained from the theory expert (excellent category) considered the needs of students. Media learning improves students' understanding of the use of a spectrum analyzer. Improvements in media require the completeness of the material to be made in terms. In the future, media must have more complex explanation material by using a spectrum analyzer with another electronic alternative, such as Arduino. The test results score from media experts are 3.40, which can be categorized as excellent category and feasible to be developed with indicators that support the quality of components, attractive forms, and the usefulness of this instructional media. Then things that need to be improved and developed in terms of media (applications) are neatness, legibility, and ease of operating instructional media applications. After improvement and development, a limited beta test was carried to two new students with a result of 3.55 (excellent category); then the last test was carried out with a field test and obtained a result of 3.61 and showed the improvement aspect of the previous test obtained an increasing value and can be categorized as instructional media, this Android-based spectrum analyzer can be used in classroom learning.The trial of the Instructional media that has been produced is part of the formative evaluation stage used to determine the assessment of the developed product.

In this study, the trials conducted are alpha test (validation of theory experts and media experts) and beta test (limited trial and field test).

The form of instructional media must be feasible to use, so each student should (1) have a user manual and study it first before using the SIGA application with spectrum analyzer; (2) have a practice worksheet for independent study, especially on frequency measurement theory material. Then the school can provide the components needed for measuring with spectrum analyzer such as spectrum analyzer devices, input-output connectors, and other electronic components that can be combined in frequency measurement and adjust the number of equipment needs with the number of students. Instructional media can provide equipment for learning experiences in the world of work, and learning activities can be more effective and meaningful was the reason for the feasibility of this instructional media.

The spectrum analyzer instructional media will be further developed, especially in the software section, with performance that is more than just looking at the radio frequency response. Further development aims to increase interactive animations in the media to attract students' attention when using the media. The worksheets are more varied so that students can do practicum well. Generally, the material in instructional media can be developed with broader material.

References

[1] Badan Pusat Statistik. 2019. Statistik Pemuda Indonesia. Jakarta: Badan Pusat Statistik

[2] PSMK. 2016. Visi Misi PSMK. Jakarta: Kementerian Pendidikan, Kebudayaan, Riset, dan Teknologi Republik Indonesia

[3] Survei Angkatan Kerja Nasional. 2022. Tingkat Pengangguran Terbuka Berdasarkan Tingkat Pendidikan 2019-2021. Jakarta: Kementerian Pendidikan dan Budaya

[4] Pusat Penelitian Kebijakan. 2021. Meningkatkan Keterserapan Lulusan SMK dalam Dunia Industri dan Dunia Kerja. Jakarta: Badan Pusat Statistik

[5] Pusat Perencanaan Ketenagakerjaan. 2021. Proyeksi Kebutuhan Tenaga Kerja Di Perusahan Berdasarkan Kompetensi Pada Sektor Teknologi Informatika & Komunikasi Pada Tahun 2022 – 2025. Jakarta: Kementerian Ketenagakerjaan Republik Indonesia

[6] Thomas, S., & Haider, N. S. (2013). A Study on basic of A Spectrum analyzer. International of Advanced Research in Electrical, Electronics and Instrumentation Engineering, 2308-2315. Retrieved from https://www.ijareeie.com/upload/june/25D_A%20study.pdf.

[7] Hengjun, Z., & Wenxing, W. (2015). A Design and Implementation of Portable Spectrum analyzer. International Journal of Multimedia And Ubiquitous Engineering, p235-243.

[8] Suparman, M. A. (2012). Desain Instruksional Modern. Jakarta: Erlangga

[9] Akbar, S. 2013. Instrumen Perangkat Pembelajaran. Bandung: PT Remaja Rosdakarya, pp.102-105.

[10] Surraya. 2012. Pengaruh Media Dalam Proses Pembelajaran. Jambi: UIN Sulthan Thaha Saifuddin

[11] Hadi. 2009. Media Pembelajaran berbasis E-Learning. Surabaya: UIN Sunan Ampel

[12] Lee, W., & Owens, D. L. (2014). Multimedia–Based Instructional Design. San Francisco: Pfeiffer. pp.270-279.

[13] Direktorat Pembinaan Sekolah Menengah Kejuruan. 2018. 3 2 1 KIKD Teknik Transmisi Telekomunikasi COMPILED. Jakarta: Kementerian Pendidikan, Kebudayaan, Riset, dan Teknologi Republik Indonesia p140

[14] Santoso, D., Slamet, Utami, P., & Wulandari, B. (2016). Pengembangan Trainer Signal Conditioning. Yogyakarta: JPTK, UNDIKSHA.