FEASIBILITY TEST OF AN RTL-SDR BASED DIGITAL MODULATION TRAINER IN A GUIDED INQUIRY LEARNING MODEL

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Abstract
Utilization technology software defined radio with the aim of maximizing hardware to build a software-based radio need balanced with readiness institution education in build curriculum, syllabus and tool adequate practice. This Study aim get digital modulation practice tool or trainer based on RTL-SDR for cadet with a guided inquiry learning model and know the feasibility of trainer. With a research model development that follows Thiagarajan's 4D rules and product feasibility testing study use questionnaire material experts , media experts, and trained cadets on the Mardapi's scale The trainer obtained a feasibility score of 85.2 which means very worthy used.

Keywords: Trainer, Feasibility test, Digital Modulation, RTL-SD

INTRODUCTION

Entering the 21st century, analog radio systems have been replaced by digital radio systems[1]. The development of radio telecommunications technology from analog to digital to achieve efficiency, quality and reliability of the frequency spectrum [2]. Software Define Radio (SDR) technology as programmable hardware is increasingly being used with the aim of maximizing hardware for building software-based radios [3].

Cadets are Makassar aviation polytechnic students who are high school graduates who have a sufficient level of maturity, have a tendency to learn independently, are interested in exploring and like challenges. Guided inquiry is a learning model that is suitable to be applied to cadets with a boarding school learning pattern.[4]. In the 2020 curriculum, the Air Navigation Technology study program at Makassar Aviation Polytechnic carries out learning with one of the transmitter engineering courses. The learning outcomes in this course are to equip cadets with the ability to know, understand and be skilled in carrying out the operation and maintenance of transmitting devices in flight data transmission. In this course, cadets only learn transmitter techniques with AM and FM modulation models.

In facing the industrial era 4.0. It is necessary to add digital modulation technology to the Transmitter Engineering course [5]. AM and FM modulation as analog modulation modes in transmitter engineering courses need to be enriched with digital modulation modes, namely Amplitude Shift Keying Modulation, Binary Phase Shift Keying Modulation, Quadrature Amplitude Modulation [6] and Orthogonal Frequency Division Multiplexing [7]. To meet the needs for learning media in transmitter engineering courses at the Makassar Aviation Polytechnic which accommodates the addition of digital modulation material, a trainer with a guided inquiry approach is needed. This research aims to obtain digital modulation trainers and

determine the level of media suitability using the Mardapi's scale[8].

RESEARCH METHODS

This development research uses a modified Thiagarajan 4D model approach with 3 stages, namely the Define, Design, Development stage without the Disseminate stage [9].. The Define stage begins with a front-end analysis step in the form of collecting data from course lecturers and continues with a learner analysis step. In this step, interviews were conducted with cadets to determine the characteristics of cadets, including learning style tendencies and initial knowledge regarding modulation techniques and digital techniques. The third step is concept analysis to formulate the learning concept that will be carried out in the form of identifying declarative and procedural knowledge. The fourth step is task analysis. In this step, the types skills to be achieved in a learning process are formulated[14]. The final step is to set learning objectives to formulate a form of evaluation which is a combination of the results of concept analysis and task analysis.

The design stage includes 4 steps, namely construction of test criteria, media selection, format selection and initial design. Criterion tests are the preparation of test standards which are also called benchmark reference tests[15]. In this step, a questionnaire is prepared which is an indicator of the trainer design that will be created. The second step is media selection, namely media selection according to material characteristics, concept analysis, task analysis and cadet characteristics[17]. The third step at the design stage is format selection, namely preparing a layout format that is adapted to the practical tools that have been determined at the definition stage. The final step of the design stage is creating a preliminary design. At this stage the trainer concept is ready to be realized at the development stage.

The development stage is carried out by making trainers through two stages, namely expert assessment and design testing. In the expert assessment step, the trainer design is validated by a team of experts. Validation is carried out by material experts and media experts. After revision, the trainer was tested on cadets to get input.

The next step is a feasibility test. This stage is carried out by providing a questionnaire/feasibility test instrument using a closed questionnaire model or in other words, answer options are provided for the respondent to choose.

Before the instrument is used, a trial of the instrument items is carried out in the form of a validity test of the instrument items and a reliability test of the instrument. After the instrument is declared valid and reliable, the test instrument/questionnaire is given to cadets, media experts and material experts receive an assessment.

The results of the assessment of all aspects are measured using a Likert Scale. In this study, the answers to the instrument items were classified into five choices. Each indicator measured is given a score on a scale of 1-5, namely 5 (very good/ very suitable/ very appropriate/ very clear), 4 (good/ suitable/ decent /clear), 3 (not good/ not suitable /not suitable/ not enough clear), 2 (not good/ not appropriate/ not appropriate/ unclear), and 1 (very not good/ very inappropriate/ very inappropriate/ very unclear).

Then, to determine the suitability of the media, the percentage is calculated by comparing the score obtained with the maximum score. The results of the questionnaire determined the suitability of the trainer based on the Mardapi assessment scale [8].

Eligibility categories are based on the following criteria.

Table 1. Media eligibility criteria

No	Score in percent (%)	Eligibility Category
1	< 21 %	Not really worth it
2	21 – 40 %	Not feasible
3	41 – 60 %	Decent Enough
4	61 – 80 %	Worthy
5	81 – 100 %	Very Worth It

RESULTS AND DISCUSSION

A. Define

The development of digital modulation trainer begins with the define stage. The first step is front-end analysis, namely collecting data from lecturers in transmitter engineering courses. From interviews, data on the curriculum used was obtained, there was no discussion regarding digital modulation. Transmitter technology engineering only discusses AM modulation and FM modulation. Considering the need to develop radio communication technology, it is necessary to develop knowledge about Amplitude Modulation, Frequency Modulation, Amplitude Shift Keying Modulation Techniques [10], Binary Phase Shift Keying Modulation, Quadrature Amplitude Modulation [6] and Orthogonal Frequencies. Multiplexing Division [7].

The next step from the Define stage is learner analysis. In this research the students were Makassar Aviation Polytechnic cadets. Interviews with cadets succeeded in exploring independent learning styles, high curiosity and the ability to use scientific methods to develop and construct knowledge. so that the guided inquiry learning model was chosen as the learning model [11][4].

Step 3 of the definition stage. namely formulating the learning concept that will be implemented. In this step, declarative and procedural knowledge is identified to determine core competencies and basic competencies. Judging from the interview data from lecturers and cadets, it is proposed that trainers can support the use of the 7-step guided inquiry model.[12].

B. Design

The design stage consists of 4 steps, namely construction criteria testing, media selection, format selection and initial design. At this stage, indicators are prepared which are the basis for selecting media, format and initial design criteria. In designing the hardware trainer kit, 23 indicators from 4 aspects are arranged as follows

Table 2. 23 indicators of trainer

Aspect	Indicator
Maintainable	Trainer spare parts are easy to find on the market
	The dimensions of the trainer adapt to the cadet's work environment
	The trainer is equipped with a Manual Book
	The trainer is equipped with a protection system
Hardware Specifications	There is an RTL/SDR Module
	There is an RF Hacking Module
	Equipped with antenna
	Equipped with power supply
	Compatible with USB series laptops
	The output voltage is 5 v with a current of 300 mA
Compatibility with practical requirements	The trainer is able to fulfill the needs of the AM Modulation practicum
	The trainer is able to meet the needs of the FM Modulation practicum
	The trainer is able to fulfill the ASK Modulation practicum needs
	The trainer is able to fulfill the BPSK Modulation practicum needs
	The trainer is able to meet the needs of QAM practicum
	The trainer is able to meet ODFM practicum needs
Supports the need for guided inquiry	The trainer supports cadets to identify Analog and Digital Modulation phenomena/problems.
	The trainer supports cadets to formulate problems/gain focus on questions
	The trainer supports cadets to plan investigations to get answers to practical questions
	The trainer supports cadets to carry out investigations to get answers to practical questions
	The trainer supports cadets to analyze data and prove in practice to get answers to questions

	The trainer supports cadets to build new knowledge in practice to get answers to questions
	The trainer supports cadets to communicate new knowledge in practice to get answers to questions

At the media selection stage, appropriate media is selected to train skills and develop scientific thinking. Media is selected based on material characteristics, concept analysis, task analysis and cadet characteristics. From the results of the analysis at the definition stage, it was concluded that the media used was a trainer that was integrated into an RTL-SDR module so that it could stimulate scientific thinking.

At the format selection stage, you need to pay attention to an attractive and simple design so that it helps cadets learn. At this stage, a layout format is prepared that is adapted to the practical tools that have been determined at the definition stage.

The final stage of design is the initial design. At this stage the module concept has been agreed upon and is ready to be developed at the development stage. Of course, the opinions of media experts are very much needed to enrich the concepts/designs that we have.

C. Development

At the development stage, learning modules are created through two stages, namely expert assessment and development testing. At this stage the learning module concept is validated by a team of experts. The Expert Team consists of course lecturers and industry practitioner lecturers. Assessments and corrections from the expert team are used to perfect the product modules to be developed.

Table 3. Assessment of material experts and media experts on the trainer design

Indicator	Materials Expert	Media Expert
Spare parts for trainers/training equipment are easy to find on the market	Okay	Okay
The dimensions of the teaching aids/practice equipment are appropriate to the cadet's work environment		
The trainer/practice tool is equipped with a Manual Book	Okay	Okay
Training/practical tools equipped with a protection system	Okay	Okay
There is an RTL/SDR Module	Okay	Okay
There is an RF Hacking Module	Okay	Okay
Equipped with antenna	Okay	Okay
Equipped with power supply	Not needed	Not needed
Compatible with USB series laptops	Okay	Okay
The output voltage is 5 v with a current of 300 mA	Not needed	Not needed
The trainer is able to fulfill the needs of the AM Modulation practicum	Okay	Okay
The trainer is able to meet the needs of the FM Modulation practicum	Okay	Okay
The trainer is able to fulfill the ASK Modulation practicum needs	Okay	Okay
The trainer is able to fulfill the BPSK Modulation practicum needs	Okay	Okay
The trainer is able to meet the needs of QAM practicum	Okay	Okay
The trainer is able to meet ODFM practicum needs	Okay	Okay
Trainers support cadets to identify Analog and Digital Modulation phenomena/problems.	Okay	Okay
Coaches support cadets to formulate problems/gain focus on questions	Okay	Okay
Coaches support cadets to plan investigations to get answers to practical questions	Okay	Okay
The trainer supports cadets to carry out investigations to get answers to practical questions	Okay	Okay
Coaches support cadets to analyze data and prove in practice to get answers to questions	Okay	Okay
Coaches support cadets to build new knowledge in practice to get answers to questions	Okay	Okay
Coaches support cadets to communicate new knowledge in practice to get answers to questions	Okay	Okay

From the results of lecturers' and practitioners' assessments, it is known that there are several criteria that need to be refined, including not requiring power supply and output voltage specifications. The final concept of the trainer is as shown below

Figure 1 Final trainer design

D. Product Eligibility

Product feasibility testing is carried out by giving questionnaires to material experts, learning media experts and cadets. The feasibility test questionnaire includes 4 indicators from the maintainability aspect, 4 indicators from the hardware specification aspect, 7 indicators from the conformity aspect with the needs of the guided inquiry learning model and 6 indicators from the conformity aspect with the content and learning objectives of transmitter engineering courses.

At this stage, 2 material experts, 2 media experts and 24 cadets of Air Navigation Technology batch 13B were selected to fill out a closed questionnaire instrument on a scale of 1-5. The values obtained are calculated to obtain the average value for each group of respondents. Then the average value is converted to a scale of 100 to obtain the following results

Figure 3. Practical activities in the context of feasibility testing

Table 4. Feasibility test results from the aspect of ease of maintenance

No	Maintainable	Material Experts	Media Expert	Cadet	Average score
1	Spare parts for trainers/training equipment are easy to find on the market	95	90	92	92,3
2	The dimensions of the teaching aids/practice equipment are appropriate to the cadet's work environment	87	85	82	84,7
3	The trainer/practice tool is equipped with a Manual Book	89	92	91	90,7
4	Training/practical tools equipped with a protection system	71	70	75	72,0
Average score					84,9

From the table it is known that this trainer design has the advantage of being easy to maintain because spare parts are easy to obtain. Apart from that, trainers who are equipped with manual books make it easier for cadets to use them in practical activities. The weakness of this design is the lack of a protection system against excess current and connection errors.

Table 5 Feasibility Test Results from the aspect of specification t

No	Specification	Material Experts	Media Expert	Cadet	Average score
1	There is an RTL/SDR Module	96	95	97	96,0
2	There is an RF Hacking Module	96	95	95	95,3
3	Equipped with antenna	96	95	96	95,7
5	Compatible with USB series laptops	96	95	96	95,7
Average score					95,7

In terms of specifications, this trainer consists of RTL SDR and Hack RF one modules so that it matches the initial design.

Table 6 Feasibility test results from the aspect of Supporting Learning Objectives

No	Supports Learning Objectives	Material Experts	Media Expert	Cadet	Average score
1	Trainers/practice tools are able to meet AM practicum needs	94	94	95	94,3
2	Teaching aids/practice tools are able to meet FM practicum needs	94	93	96	94,3
3	Teaching aids/practice tools are able to meet ASK practicum needs	75	78	70	74,3
4	Teaching aids/practical tools are able to meet BPSK's practical needs	75	75	72	74,0
5	Trainers/practice tools are able to meet the needs of QAM practicum	74	75	70	73,0
6	Teaching aids/practice tools are able to meet ODFM practicum needs	74	73	70	72,3
Average score					80,4

In achieving learning objectives, trainers are very supportive of AM and FM training activities. Meanwhile, in other learning activities, this trainer needs to be developed even better.

Table 7 Feasibility Test Results from The Aspects of supporting the Guided Inquiry Model

No	Supports the guided inquiry	Material Experts	Media Expert	Cadet	Average score
1	The practical tools provided, support cadets in identifying Analog Modulation and Digital Modulation phenomena/ problems.	80	80	77	79,0
2	The practical tools provided, support cadets to formulate problems and gain experimental focus	81	80	78	79,7
3	The practical tools provided support cadets to plan investigations to obtain answers to problem formulations	82	80	78	80,0

4	Practical tools meet the needs of cadets to carry out investigations to get answers to problem formulations	81	80	80	80,3
5	The practical tools provided support cadets to analyze data and provide evidence in getting answers to problem formulations	82	80	76	79,3
6	The practical tools provided support cadets in building new knowledge in practical activities	77	78	76	77,0
7	The practical tools provided support cadets to communicate new knowledge in practical activities	75	77	75	75,7
Average score					78,7

From the table it can be seen that this trainer is very supportive of research data collection activities and proving research hypotheses. However, other guided inquiry syntaxes show low ratings. This shows the need for worksheets that guide cadets in carrying out learning according to the stages in guided inquiry learning.

Table 8. Feasibility digital modulation trainer base RTL-SDR

No	Aspect	Material Experts	Media Expert	Cadet	Average score
1	Maintainable	85,5	84,3	85,0	84,9
2	Specification	96,0	95,0	96,0	95,7
3	Supports Learning Objectives	81,3	81,7	82,0	81,7
4	In accordance with guided inquiry syntax	79,7	79,3	77,1	78,7
	Average score	85,6	85,1	85,0	85,2

CONCLUSION

Development research using Thiagarajan's 4D Model adoption steps can be used in developing learning media for digital modulation techniques. The research results show that the development of learning media has advantages in the customization aspect, meaning that the resulting media will better accommodate user needs. This will affect the level of learning effectiveness[16]. In detail, the level of media effectiveness in terms of the use of time in the learning process needs to be researched further. Another thing that needs attention is that the suitability of practical tools for the guided inquiry learning model has the lowest value. This shows that practical tools will be optimally useful if they are accompanied by clear practical instructions that can guide practical procedures in more detail and clarity[13]. With clear practice instructions, cadets will be able to direct practice according to learning outcomes in each subject more optimally. In general, this trainer is very worthy used. with feasibility score of 85.2 for an RTL-SDR based digital modulation training tool in the guided inquiry learning model.

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