The Development of Trigonometry E-Modules For Senior High School Using Differentiated Instruction (DI) Approach

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Abstract. This research aimed to develop trigonometry e-module for senior high schools through Differentiated Instruction (DI) approach based on Moodle. The method used in this research were Research and Development using Plomp model (2013), consisted of the stages of preliminary research, prototyping, and assessment. This research only discussed research results of the first two stages. Preliminary research stage was the analyzing step that included the curriculum, the students' characteristics, and learning materials analyses. The instruments used in this stage were the need analysis sheet, the observation sheet and the interview guidelines. The research subjects in the first stage were the principal, two Year 11 mathematics teachers and five Year 11 mathematics and science students selected randomly. The next stage was prototyping, where the researcher administered the validation sheet to five students. The result of preliminary stages showed that mathematics teachers have already used the curriculum 2013, and both students and teachers needed an interesting learning media. The validation result of the prototyping stages showed that the module developed was valid and practical. The subsequent stage will be testing the module.

1. Introduction
Trigonometry is one of the mathematics topics provided from the elementary to high school which contains concepts, definitions, theorems and proof. Trigonometry is a continuous material, studied and delivered from Year 10 to Year 12 [1]. Trigonometry is applicable in everyday life, such as in astronomy to calculate the distance to the nearest star, in geography to calculate the distance between certain points, and in architecture for the construction of houses, buildings and bridges [2].

Trigonometry is one of the difficult topics for students. It can be seen from students' national exam on the topic related to trigonometry in Senior High School studied, which only achieved 50.67% of the passing target in the academic year 2017/2018 [3].

Teachers’ efforts to solve students’ problems in trigonometry are by improving the quality of students’ learning, one of the ways is by developing learning media in the form of modules as teaching materials. During this time, the learning is carried out by using textbooks, so the learning has not been meaningful [2].

The module is a teaching material which has relatively short and specific contents that are arranged to achieve learning objectives. The module is also one of the teaching materials that have the characteristics of independent learning; students can develop themselves without depending on the
presence of teachers and face-to-face meetings in the class [4]. The advantages of learning modules for students according to [5] are: (1) the feedback, so the students can immediately know the learning results, (2) the mastery of the learning material thoroughly, (3) clear learning objectives, leading to learning motivation, (4) the learning flexibility, adjusting the characteristics of diverse students, (5) the collaboration, and (6) the remedial teaching.

The current learning at schools faces the challenges to achieve the needs of all students, either in the academic, social, and development as well as the progress of students. The students are grouped heterogeneously with different levels of ability and educational needs. Therefore, teachers must be able to distinguish learning instructions in class and can act as masters (experts) in meeting the needs of all students [6]. One approach that teachers make in learning is the Differentiated Instruction (DI) approach. DI is the learning done by the teacher by adjusting instructions and assessing each student's different characteristics. According to [7], DI could be done by three things, namely students’ readiness, students’ interest, and students’ learning styles.

Learning style is the individual's most preferable form of learning. It varies from one person to another because each individual has their passion and uniqueness [8]. There are several learning styles based on the modality of the senses which are divided into three: visual, auditory, and kinesthetic learning styles [9].

The changing of times demands teachers to transfer information more efficiently from paper-based modules to technology-based modules; one of them uses a computer and internet-based learning media called e-learning. The development of e-learning can be built by using the Learning Management System (LMS) software called Moodle. Moodle is open-source software that supports the implementation of e-learning with an integrated paradigm where various learning support features can easily be accommodated in an e-learning portal [10].

Based on the problems, the research question of this research is "Can the Moodle-based trigonometry e-module accommodate students with the Differentiated Instruction approach (learning styles)? And how the qualities of the trigonometry e-module with Differentiated Instruction (learning styles) approach based on the valid developed e-module in senior high school students according to the responses of the experts?"

2. Method
This research was developmental research (research and development) by using a model of Plomp (2013) which consisted of three stages: 1) preliminary research, 2) prototyping, 3) assessment. This paper discussed the results of the first two phases, namely preliminary research and prototyping. The activities at the preliminary research stage were: curriculum analysis, analysis of student characteristics, and analysis of learning content. The subjects at this stage were the principal, two Year 11 mathematics teachers, and five Year 11 Mathematics and Science students. They were randomly chosen from one of the senior high school in East Aceh, Indonesia. The instruments used at this stage were observation sheets, students’ learning style questionnaires, and interview guidelines.

Furthermore, at the prototyping stage, the researchers used a validation sheet that was filled by five validators consisting of 2 content experts and three media experts. The content validation sheet includes several aspects, namely: content validity, face validity, and language validity. The validation sheet for the media experts was developed based on TAM (Technology Acceptance Model). The TAM model was used for cognitive assessment and user-friendliness [11]. The TAM Assessment Sheet includes Moodle format, Moodle language, and Moodle content.

3. Results and Discussions
The study results were explained as follows:

3.1. The results of preliminary research
At this stage, the researcher analysed the curriculum, students’ characteristics and learning content. The results of direct observation to the school principal, two maths teachers and 110 students obtained the following data:

The results of curriculum analysis showed that Senior High School investigated in this study had used the 2013 curriculum. The researchers followed basic competencies based on the regulations of the Minister of Education and Culture Year 2016 Number 24. It contains the competencies that must be achieved by Year 11 Mathematics and Science students on analytical trigonometry topic.

Furthermore, the researchers conducted an analysis of students’ characteristics as a study of students’ learning styles in mathematics learning that would be carried out. The research of learning style was developed based on quantum learning style[12]. Out of 110 Year 11 Mathematics and Science students, 41% of students had a visual learning style, 30% of students had an auditory learning style, and 29% of them had a kinaesthetic learning style. The students with the learning style category similar to their daily learning style tended to store information longer, apply the learning effectively, and show a positive attitude towards learning [13]. Furthermore, [14] argued that student achievement increases when the learning method matches the learning style of students, following the development of their characteristics.

Analysis of learning materials was done by researchers to obtain data regarding students' difficulty in presenting contextual problems in trigonometry, that were not easily understood and imagined by students in understanding the concept of trigonometry [15]. According to [16], there were difficulties in trigonometric learning were often found in schools.

3.2. At the prototyping stage.
As mentioned previously, the validation process was done by five validators (two content validators and three media expert validators). The validity category was determined by matching an average total score to the percentage of validation criteria [17] as described in Table 1.

| Percentage | Validity Criteria | Information     |
|------------|-------------------|-----------------|
| 85 – 100   | Very valid        | No need revision|
| 70 – 84    | Valid             | No need revision|
| 55 – 69    | Valid enough      | No need revision|
| 50 – 54    | Invalid           | Needs revision  |
| 0 – 49     | Invalid           | All revision    |
Table 2. Results of content experts’ validation

| No | Aspect               | Average in Every aspect | Percentage of Validation | Validation Criteria | Information         |
|----|----------------------|-------------------------|--------------------------|---------------------|---------------------|
| 1  | Content Validity     | 3.5                     | 87.5%                    | Very Valid          | no revision needed  |
| 2  | Face Validity        | 3.6                     | 91.67%                   | Very Valid          | no revision needed  |
| 3  | Language Validity    | 3.58                    | 89.58%                   | Very Valid          | no revision needed  |
|    | **Total Average**    | **3.56**                | **89.58%**               |                     |                     |

Based on Table 2, the average of all aspects was 3.56. The percentage average of validation was 89.58% which was in the range of 85-100 and could be concluded that the validation criteria were very valid and no revision needed. At this stage, there were some suggestions for improvement, including content clarity, the use of language connected to the learning video and build a word problem or application of trigonometric formulas.

Table 3. Results of media experts validation

| No | Aspect            | Average in Every aspect | Percentage of Validation | Validation Criteria | Information         |
|----|-------------------|-------------------------|--------------------------|---------------------|---------------------|
| 1  | Moodle Format     | 3.78                    | 94.5%                    | Very Valid          | no revision needed  |
| 2  | Moodle Language   | 3.85                    | 96.25%                   | Very Valid          | no revision needed  |
| 3  | Moodle Content    | 3.51                    | 87.91%                   | Very Valid          | no revision needed  |
|    | **Average**       | **3.71**                | **92.89%**               |                     |                     |

Table 3 shows an average of all aspects was 3.71, and an average percentage of validation was 92.89%. They were in the range between 85 to 100, so it could be concluded that Moodle media was very valid and did not need revision. At this stage, there were several suggestions given by the validators for the improvement of the media to be able to make Moodle use instructions and websitemap.

4. Conclusions
The conclusion of this study is that teachers and students need a learning media that accommodate students with different learning styles on trigonometry material. Furthermore, the developed modules meet the valid criteria with the percentage of validity is 92.4%. These results indicate that the module is worth testing in learning. So, for the next stage, researchers will test the module.
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