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To cite this article: M Wakid and Tafakur 2019 *IOP Conf. Ser.: Mater. Sci. Eng.* **535** 012007

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The development of realia for the planetary gear unit to improve students' understanding on the basics of automatic transmission

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Abstract. This study aims to design and develop a real model of a planetary gear unit providing three kinds of simulation for the basic configurations of the planetary gear unit in which one component member is locked, two members are held together, and two input members works. This is a research and development (R&D) to develop a realia of the planetary gear unit for the learning of automatic transmission basics. The realia is expected to demonstrate how the configurations in which one component member is locked, two members are held together, and two input members moves. This study was carried out through ten stages, namely analyzing potentials and problems, needs analysis, product design, focus group discussion, product development, pilot study (small-scale field test), product revision, large-scale field test, product revision, and final product. The data were collected by questionnaires and were analyzed quantitatively. The product of this study is learning media in the form of realia made of acrylic so that the components are clearly visible and the work of basic configurations of the three gears in the planetary gear unit is easy to understand. These basic arrangements can be operationalized on the learning media by applying brakes to the ring, carrier, and sun gears and applying clutches between the sun and carrier gears, the sun and ring gears, and the carrier and ring gears. Evaluated from its performance, the realia of the planetary gear unit can work well. The shaft can rotate well though some friction generated, the clutch and brake can work on its function, as well as the constituent gears can rotate as its real version does. This is reinforced by the responses from the material and media experts that reveal the product meets the very feasible category.

1. Introduction

It has been understood that various factors affect the quality of automotive learning, such as those from the student, teacher, facility, environment, and institution to name a few. Regarding this, active and creative students that are sufficiently assisted will produce effective learning outputs. However, some learning constraints still exist, one of which is on the learning of chassis, particularly on the Automotive Power Transfer System. Based on the observation on the automatic transmission materials delivered by teachers in some Vocational High Schools (VHSs) in Yogyakarta Special Region, lectures in the Automotive Engineering Education Department (AEED) of Faculty of Engineering (FE), Yogyakarta State University (YSU), the professional trainers at Yogyakarta Technical and Vocational Education and Training (TVET) Center, teachers in the Teacher Professional Education



and Training Program (*PLPG*) in the field of light vehicle, and teachers in the Teacher Professional Program (*PPG*) in the same field, it was proved that the lecturers' and teachers' understanding on the concept of the planetary gear unit is still low because the material is challenging.

The problem that arises is possibly caused by the difficult to imagine how a planetary gear unit works when the explanation is unaccompanied by any animation videos. Many students also required some real learning media that can be simulated directly during the learning process. In the AEED and some VHSs formerly assisted by the World Bank programs, real media for the planetary gear had been developed. However, they are only able to show one configuration model that holds one main component of the planetary gear with two main components configured for holding the ring and carrier gear.

Another problem is the difficulty of studying the automatic transmission system for both hydraulic and electro hydraulic systems. Suyitno states that real media is needed to show how the systems work to help student understanding [1]. Whereas if to overcome the problem of limited space and time, digital media in the form e-learning can be used [2]. As there has been no real media for learning the planetary gear sold in markets or e-commerce, new solutions should be found to ensure the teaching and learning process reaches its goals.

Based on the discussion above, therefore the problems are formulated as follows. (1) How is the realia capable of providing simulation variations on the basic configurations of the planetary gear unit? (2) How is the feasibility of the realia of planetary gear unit in terms of its functions? Based on the formulation of these problems, the objectives of this study are: (1) to design and develop a real model of planetary gear unit that can provide three kinds of simulations of the basic configurations of the planetary gear unit including the configuration of one locked member, two members held together, and two input members moving. (2) to describe the feasibility of the realia of planetary gear unit as the learning media.

Kustandi and Suctipto describe learning media as instruments that support the teaching and learning process and serve to make the information delivered more understandable [3]. Hamalik in Arsyad adds that the use of these media can encourage students' motivation and interest in something new, improve their motivation and involvement in learning, and even bring about psychological stimuli to them. With regards to this, Sudjana and Rivai add that learning media function to (1) encourage learning motivation, (2) improve the clarity of learning material delivery, (3) vary the learning methods and avoid students' boredom, (4) improve students' active participation by observing and performing instead of listening to the explanation, and (5) transfer some abstract theories into factual ones and the complex theories into simple ones [4]. Similar opinion was expressed by Susilana and Riyana that they see the benefits of learning media as: (1) making concrete some abstract concepts, (2) presenting objects that are too dangerous or difficult to obtain, (3) showing objects that are too large or small, and (4) showing movements that are too fast or slow [5].

In relation to this, many alternative forms of media have been used in learning, one of which is realia or objects from the real life. Anitah describes that realia resemble an actual object in their intact form. Realia is a real-like object that is used as a learning resource [6]. Sudjana also adds that the use of real objects in the teaching and learning process mainly aims to introduce a particular unit of learning, the working process of a particular object of study and other aspects required [7].

Realia or real life objects are visual aids in learning, namely real models or real objects. Sumantri and Permana suggest that in general concrete media function as (a) instruments to actualize effective teaching and learning situation, (b) integral parts of the overall teaching situation, (c) proofs of actual basics and abstract concepts so that can make verbal explanations easier to understand, (d) instruments to improve students' learning motivation, (e) enhancing tools for the quality of teaching and learning [8].

Ibrahim and Syaodih state that real object media will provide stimuli that are very important for students in learning various things, especially those concerning the development of certain skills [9]. Additionally, Subari states that teaching aids are used by teachers to demonstrate teaching materials in

order to provide a clear understanding of the lesson [10]. Therefore, with these properties or realia, the automotive chassis learning on the automatic transmission section will be greatly supported.

2. Research Method

This is a Research & Development (R&D) to develop and validate the realia planetary gear unit as learning media with the adjustment and size suitable with the learning needs. This study was carried out through 10 stages, namely: analyzing potentials and problems, needs analysis, product design, focus group discussions, product development, pilot study (small-scale field test), product revision, large-scale field test, product revision, and final product presentation. These stages were adapted from the steps of Sugiyono [11].

The subjects of this study were students who had attended the course on the Power Transfer System. This research was carried out in the Automotive Engineering Education Department (AEED) of FE YSU. The data were collected by observation sheets and questionnaires. The questionnaires were used to gather the data from the material experts and from students. Then, the data were analyzed by means of quantitative descriptive analysis techniques. The scores obtained were consecutively compared to the table of the eligibility criteria as presented in Table 1.

Table 1. The Product Feasibility Criteria

No	Score	Category
1	1.00 – 2.50	Completely Unfeasible
2	2.51 – 5.00	Somewhat Feasible
3	5.01 – 6.50	Feasible
4	6.51 – 8.00	Completely Feasible

3. Results and Discussion

Based on the research objectives, this research was carried out to (1) design and develop a real model of the planetary gear unit which provides three kinds of simulation for the basic configurations of the planetary gear unit, that is the configuration of one locked member, two members held together, and two input members working. It also aimed to describe the performance of the real planetary gear unit model in terms of its feasibility as learning media. The stages of development that have been carried out include the followings.

3.1. Needs Analysis

As in the stage of identification of potentials and problems the problem of learning automatic transmission in the planetary gear unit has been known, the next is planning the development. The developed media needed should be able to (1) display the planetary gear unit components, (2) simulate the rotation of each planetary gear unit part, (3) show the clutch and brake configuration on the planetary gear unit, and (4) be easily used.

3.2. Product Design

The development of the realia design was carried out with a computer program to determine the construction, dimension, and work simulation of the developed media.

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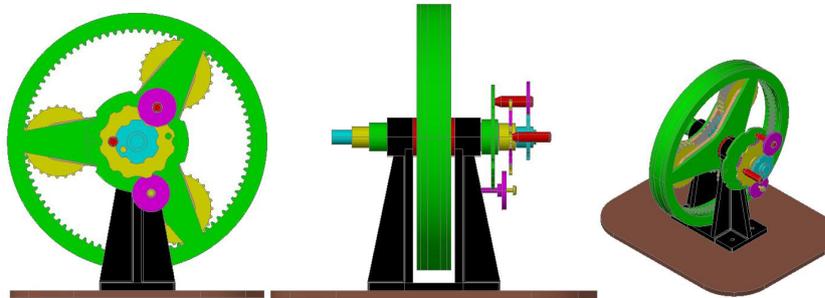


Figure 1. Product Design

In addition, the product materials were also determined based on the needs. To be able to show the performance of the components clearly, the main material chosen for the ring gears was acrylic because of its transparent nature. For gears, shafts, brake, and clutch mechanisms, the best material to be used was metal. The design was then discussed by the lecturer team to validate the product design that has been determined.

3.3. Product Development

In this process, the product development was carried out in accordance with the predetermined design. There were several plan changes, including the gear materials that were all made of acrylic because of an obstacle in the manufacture of gears from metal. Considering the limited time for production, it was decided that the gears were made of acrylic.

3.4. Product Evaluation

After the product was developed, it was evaluated by the media experts and material experts. The results of product validations are presented in Table 2.

Table 2. The Product Validation Results

Item	Media Experts	Material Experts
Score	109	105
Maximum Score	120	112
Number of Item	15	14
Means	7.27	7.5
Catodory	Completely Feasible	Completely Feasible
Suggestions	<ol style="list-style-type: none"> 1. A bearing should be installed to prevent sliding friction. 2. The bushing can be made of metal to maintain the product durability. 	<ol style="list-style-type: none"> 1. A rotation sign for the input/output shaft should be given. 2. The components should be lubricated.

Based on the results of validation by material experts and media experts, the developed media was found to meet the criteria of feasible learning media and suit the planetary gear unit material. However, suggestions were given, namely: (1) giving lubricants to moving components, and (2) giving a description on the input and output on the realia. After the revision, the realia was then tested in small groups of students (the small-scale tryout).

3.5. The Field Tests

The small-scale tryout involved ten practical course students as respondents. The test results of realia media are presented in Table 3.

Table 3. The Results of the Small-scale Field Test

Aspect	Total Score	Max Score	Means	Category
Material	509	8	6.36	Completely Feasible
Media	445	8	6.36	Completely Feasible

Based on the test results in Table 3, it can be seen that in overall the realia developed is completely feasibility. Each indicator meets the feasibility criteria, both from the media and material aspects. The next step taken was the large-scale field test by the use of realia in a large class. The respondents of this field test were twenty practical course students. The results for the large-scale field test are presented in Table 4.

Table 4. The Results of the Large-scale Field Test

Aspect	Total Score	Max Score	Means	Category
Material	1,106	8	6.91	Completely Feasible
Media	964	8	6.94	Completely Feasible

Based on the results of the large-scale field test, it can be seen that the overall score obtained is high with a means of 6.94, thus the media developed is categorized as completely feasible. Therefore, the learning media can be used to support the teaching and learning process. This is in line with the statement that the use of media in learning is very helpful in improving learning outcomes, one of which was revealed by Hertanto in the results of his research [12].

3.6. Product Revisions

After the product field tests, the realia was revised to provide a sign on the rotating objects so that it is easier for the students to observe the rotation. In practice, this planetary gear unit is expected to facilitate students' understanding of the planetary gear unit configurations. As stated earlier, the work of automatic transmission on vehicles utilizes the planetary gear unit principle. A realia that is easy to use and attractive, and functions as the original object therefore will help the students in understanding the basic principles of the automatic transmission. With this media, students are expected to be more motivated to learn the automatic transmission materials because some students were found to have low understanding on the materials.

As revised, the realia components are clearly visible so that the media can help students to identify planetary gear components, the work of the clutch and brake setup, and the gear ratio on the planetary gears. Thus, if the abstract planetary gear unit that can be delivered in terms of its working process, animation, and image will be more understandable when such realia is used. This media can help learning as what the original object does so that the students can easily understand the work of the planetary gear unit through the model. Consequently, when the students understand the planetary gear concept, they will be easier to understand the automatic transmission. This is in accordance with the statement that to achieve effective learning in vocational education, competency must be achieved well before going to the next competency [13].

4. Conclusion

Based on the results of data analysis and the discussion on the development of the realia of the planetary gear unit, some conclusions presented are as follows. (1) This realia is made of acrylic material so that the components are clearly visible and the work of the gears can be easily understood. The realia presents the three rounds of the planetary gear basic arrangements by applying a brake to the ring, carrier, and sun gear and applying a clutch between sun and carrier gears, between the sun and ring gears, and between the carrier and ring gear. (2) Evaluated from its performance, it is known that

the realia of the planetary gear unit apparently works well. The shaft rotates well though it produces friction, the clutch and brake work on its function, as well as the rotating gears move as on its real version. This is reinforced by the response from material and media experts, and from the users who state that the realia can work well, and that it meets the Completely Feasible category.

5. Refereces

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