# Early Analysis Of Augmented Reality Media On The Concept Of Optical Systems

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| | **Abstract.**<br>The optic system of the eye consists abstract concept. To deepen students' understanding of eye optic systems, appropriate learning media are needed. AR technology provides opportunities to be able to optimize learning and create learning effectiveness. The aim of this research is to produce a valid, practical and effective augmented reality (AR) medium to enhance students' understanding of the concept of eye optic systems. Research method used the ADDIE model, where the following research steps: (1) Analyze (Needsanalysis), (2) Design (Product design),(3) Develop (Product development),(4) Implementation (Implementation and product trials),(5) Evaluation (Product evaluation). From the entire stage of research carried out, obtained viable AR media (valid, practical and effective) to be used in improving students' understanding of the concept of the system optical eye. The external targets that will result from the first year's proposed activities are AR media products on the topic of eye optic systems and are listed in Intellectual Property Rights (IPR). In the second year, the external target of research is to obtain AR media products on the topic of valid optical eye systems based on expert assessments as well as research results that have been published in international conference. The thirdyear, the targeted external is to produce a valid, practical and effective virtual reality media prortype to enhance students' understanding of the concept of optical systems. through implementation and evaluation activities |

## A. INTRODUCTION

The transformation of information and technology development takes place in a short and fast time. The rapid pace of information and technology development is based on the demands of the times and adapts to the concepts carried out in the era of the industrial revolution 4.0. All systems and aspects in the line of life must be able to adapt and be ready to start digitization in various fields. One of the main focuses and concerns is the field of Education and learning, where the use of technology and information becomes the latest issue that is being widely researched and developed because the magnitude of the impact and benefits obtained. Utilization of technology can improve the quality of learning, support the ability of goals and can deepen material understanding (Zakirman et al., 2020). In the case of material whose characteristics are abstract, the utilization of technology can be

the best solution in improving understanding. One of the materials that are asbtrak is in the optical subjects, especially about the opticalsystem of the eye.

In the material of the optic system of the eye discussed about the structure of the eye,the process of vision in the eye, function and abnormalities in the eye and how to overcome abnormalities in the eye. Data from the assessment of discussions and assignments on the topic of optical systems in the online tutorial of optical courses of physics education program FKIP UT shows that the understanding of students is still low in thattopic. To deepen students' understanding of eye optic systems, appropriate learning media are needed. Based on the analysis of material characteristics, to overcome existing problems, AR media can be used. In summary AR is a virtual reality by utilizing technology so that users can interact with a virtual environment by utilizing media in the form of computers or smartphones. Virtual reality media can visualize virtually the structure of the eye,theprocess of vision in the eye,theprocess of formingabnormalities in the eye and how to overcome abnormalities in the eyes.

Industrial Revolution 4.0. Itrepresents a new way in which digital technology is predicted to be embedded and used in society (Cooper et al., 2019). The use of technology on a large scale will help and facilitate human performance. This becomes one of the characteristics of a new life in society. The development of science, technology, and communication can change human habits and ways of working (Gamo, 2019; Icen, 2020). The development of technology has also influenced major changes in the field of Education. Utilization of technology can improve the quality of learning (Isik, 2017).

The implementation of technology one of them can be applied in the field of physics learning. Studies from PER (Physics Education research) show that studentshave difficulty understanding abstract concepts, including optical phenomena (Ceuppens et al., 2018). Optical lecture material is dominated by abstract concepts, suchas: optical system of the eye. To learn about the optical system of the eye, students are expected to be able to understand the structure of theeye, the principle of eye work, abnormalities in the eye as well as solutions to deal with problems in the eye. abnormalities in the eyes. In order to accommodate the ability of learning goals on the topic of optical systems, the eye is needed learning media, namely AR.

The advent of AR offers significant opportunities to advance the learning process (Alfalah, S, F, 2018). AR can be broadly defined as an experience in which three-dimensional (3D) interactions are formed, this3D environment is a step to present reality or the "real world" in some way (Cooper et al., 2019; Ke & Xu, 2020). AR also allows users to experience physical or behavioral simulations (e.g., interacting) with

objects and environments (Parong & Mayer, 2021). AR technology provides opportunities to be able to optimize learning and create learningeffectiveness (Aiello et al., 2012).

Many studies and surveys show that AR is perfectly suited to be applied in classroom learning environments (Parong & Mayer, 2021). AR-based learning can foster and stimulate student engagement; offer simulations that cannot be done in the real world; conceptualize abstract ideas and concepts; and facilitate the delivery of materials (Taçgın, 2020; Xu & Ke, 2016). There are several types of AR approaches: immersive AR and non-immersive AR. The immersive concept is expressed as the experience provided to the user, where the user seems to be in a realconstituency. Non-immersive or desktop AR is defined as 3D visuals created with multimedia tools on a computer and can be explored interactively using tip-input devices such as monitors, keyboards, or mice. 3D games and simulations are basic examples of non-immersive AR (Çakiroğlu & Gökoğlu, 2019). The realistic nature offered by AR has driven the increased use of AR in the classroom (Lamb et al., 2020). As part of the growing digitization of education and teaching,AR is seen as a transformative tool, with the potential to improve quality and worthy of use as a support for the learning process (Cooper et al., 2019).

## B. RESEARCH METHOD

The type of research that will be done is development research (Research and Development),with the selected development model being ADDIE. Addie development model begins with initial Analyze /analysis activities (needs analysis, including analysis of media needs reviewed from user aspects, conformity with curriculum and strengthening using literature review), Design/ product design (designing products based on the results of needs analysis), Develop /develop products(including assessment activities by experts), impelementation (small-scale and large-scale trials) and evaluation as a formof final assessment of research products (Trust & Pektas, 2018). The research flows can be seen in the figure 1 below.
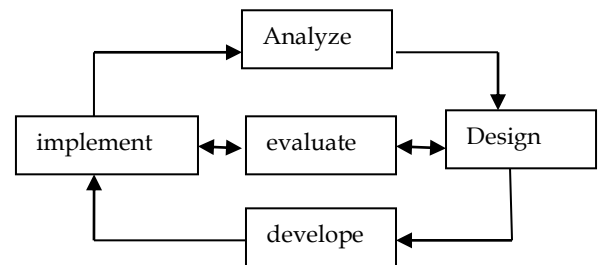


**Figure 1**. ADDIE research model flow

The research is divided into three stages of the researchyear, where in the first year the research is carried out an analysis of the needs of the prototype and the design of the initial product. In the second year of research the activity to be carried out is to develop products including product testing by experts. The third year is the year of product implementation and evaluation before disseminating. In this third year, the product is

tested on a small scale and large scale. Product evaluation is carried out based on the results of tests and product implementation.

## C. RESULTS AND DISCUSSION

The development of AR media in year I is the initial stage in the implementation of development research. Year I is the year of *preliminary research* implementation where at this stage data and information is carried out from respondents related to research and product design issues that want to be Developed according to the needs of the user (Analyze*and Design)*. The target of research activities in year I is to produce ar media design that suits the needs of users both students and tuton. Description of the results of ar media needs analysis as follows.

A. Results of Needs Analysis

Needs analysis is done by involving respondents, namely students and tutors. Needs analysis needs to be done by involving respondents i.e. product users so that the AR media produced is in accordance with the needs. The term needs analysis generally refers to the activities that are involved in collecting information that will serve as the basis for developing a curriculum that will meet the needs of a particular group of students (Songhori, 2008). Data analysis of needs from the student side is obtained by providing instruments in the form of a test of understanding the student's concept on the material of the optical system consisting of 10 questions. Furthermore, students are also

asked to fill out questionnaires related to the analysis of material characteristics and media needs in materials in optical subjects. Tutors involved in the needs analysis stage are tuton tutors who have studied optics. Needs assessment used as the systematic exploration of the divergence or discrepancy between the current situation or level of services ("what is") and the desired situation or level of services (Vatanartiran & Karadeniz, 2015). The questionnaire given to the tutor contains severalquestions including the tutor's perception of the validity of the material,the complexity of the material and other questions that support the development of AR media.

1. Student

The needs analysis involved 18 students from 3 UPBJJ namelySerang, Bogor and Jakarta. The initialactivity is to provide questionnaires and test instruments to see the level of understanding of student material to the material of the optical system of the eye. The questionnaires distributed aim to see the extent of AR media needs according to student perceptions.

Questions given include material ability, material complexity, percentage of learning objectives, difficulty of material and media needs on the material. The next activity is to provide problems with the type of choice and equipped with the reason for choosing the answer option. The question item is given as many as 10 items related to the understanding of the concept of optical systems of the eye. Data is analyzed

descriptively and the results obtained are analyzed and taken into consideration in developing AR media in the concept of optical systems.

a) Ar Media Needs According to Student Perception of Eye Optic System Material

This stage is also known as the analysis of material characteristics and content (curriculum) in optical courses according to student perception. Students are given a printed questionnaire and asked to provide a response by providing two answer options, namely yes/no. Each student gives a response on several things, including: misconceptions that have the potential to be caused to the material, the need for material visualization, the level of understanding of student material. in the material, the complexity of the material and the needs of the media in accordance with the topic of the material in the optical course. Based on the results of the analysis of 9 modules, each of which consists of 2 Learning Activities (KB), it was concluded that AR media needs to be developed in KB 2 Module 3 which discusses the system. Optical eye. The results of the analysis can be seen in the following image.
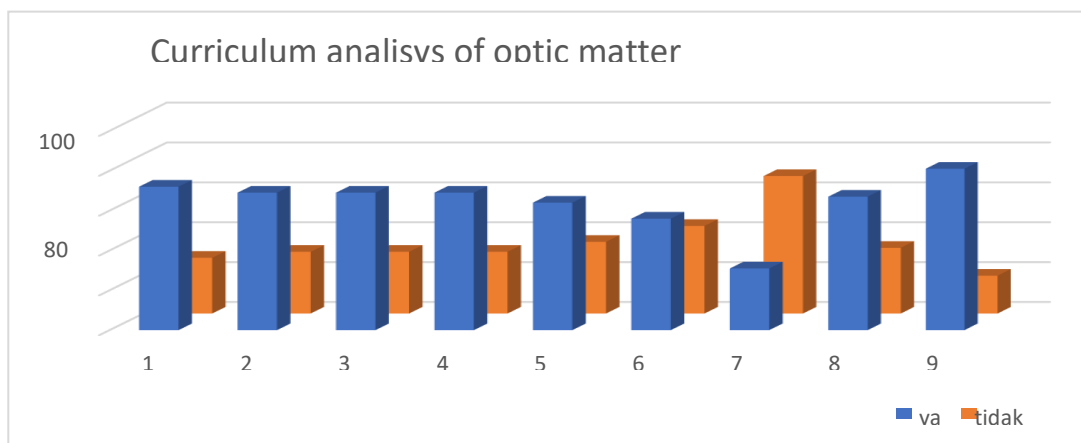


Figure 2. Results of Curriculum Analysis and AR Media Needs by Students on Eye Optic System Materials

Description:

1=material potentially causing misconception

2 = need to visualize material

3 = Low Student Material Understanding

4 = Abstract Material

5 = Elusive Material

6 = Percentage of Low Learning Goals

7 = Can Be Learned Without Media

8 = Complex Matter

9 = Need AR Media

Findings on curriculum analysis based on student perception can be concluded that the optical system material of the eye has material characteristics that have the potential to cause misconceptions. The concept of material is abstract so that it requires visualization of material. To project the course of light such as the process of shadow formation on the eye, recognizing the structure and parts of the eye, then a medium with type AR is needed. AR media can be a medium that helps students can facilitate understanding of the material of the optical system of the eye, increase the percentage of learning objectives and help understand the material that is abstract. The use of AR media also makes it easier for students to understand about differences about eye defects such as nearsightedness, nearsightedness and astigmatism. To find out the level of understanding of students about the material of the optical system of the eye, given a test consisting of 10 questions.

b) Understanding student concepts in eye optic systems

Based on the results of the analysis that has been done on the perception of students about the characteristics of the material in the optical subjects, it was concluded that some of the material as in module 3 in KB 2 concerning Optical systems are still difficult to understand, and require visualization to understand the material i.e. AR media. Referring to these findings, an in-depth analysis of the understanding of student concepts on the material of the optical system

of the eye. The questions compiled have been adapted to the learning objectives in module 3, especially in the material of the optical system of the eye.

Referring to the analysis of the results of the student material understanding test on the concept of the optical system of the eye, it was found that the average student's score was 53.3. If converted into final assessment, the average grade of the value is at a less satisfactory level. Following up on these findings, advice and input from students on optical courses are as follows:

1) It is necessary to add visualization to clarify the understanding of material concepts

2) It takes AR media to make eye system material more concrete

2. Tutor

Products in the form of AR media developed in eye optic system materials have targeted prospective users, namely students and tutors. Needs analysis is not only done on students, but to see the importance of AR media development also conducted needs analysis with tutor respondents. Tutors selected as survey respondents are tutors who have been or are studying optics. Tuton tutors involved in needs analysis activities are asked to fill out questionnaires related to curriculum analysis regarding the importance of AR media in Optika courses.

Based on the results of the analysis, it can be concluded that the material of the optical system of the eye has the potential to

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cause misconceptions according to the perception of the tutor. Optical system of the eye with details of matter such as the structure and parts of the eye, the process of vision in the eye and eye defects is a concept of asbtrak that requires visualization according to perception. Tutor. Recognizing the structure and function of the eye can not only be done by implementing audiovisual media, but it requires AR media so that the material can be conveyed properly. Utilization of technology can improve the quality of learning (Isik, 2017).

B. AR Media Design on Eye Optical System Material

Before AR media products on the concept of optical systems are ready to be validated and piloted, several stages of activity are carried out. FGD is an early activity to equalize perceptions between researchers, experts and product developers to get the appropriate product quality. FGD activities are important activities to evaluate and check the progress of AR media product development periodically.

The focus group discussion (FGD) is a rapid assessment, semi-structured data gathering method in which a purposively selected set of participants gather to discuss issues and concerns based on a list of key themes drawn up by the researcher /facilitator (Escalada & Heong, K, 2007). Focus group discussion is a discussion activity by presenting speakers to provide input and provide guidance in the development of AR media in eye optic system materials. FGD

activities in research in the first year were carried out 3 times by presenting expert sources in the field of AR.

1. Focus Group Discussion (FGD) preparation of AR Media on Optical Eye System

FGD activities involving AR media experts are focused on discussions regarding product radiance, content and product design. FGD which took place for 3 meetings was attended by all members of researchers and AR media experts. Here is the exposure of FGD results that have been done.

a) FGD Session stage I

FGD session I is carried out with a focus on creating an AR media story board to be developed. The developed story board is analyzed and examined by AR media experts. The accuracy and clarity of the story board determines the quality of AR media completion. The initial stage of preparation, ar media story board on the concept of optical system of the eye developed, the story board immediately focused on the explanation of material content. The initial story board also has not been equipped with learning objectives, problems to measure student understanding.

Based on the input and suggestions obtained on FGD I activities, the story board was first revised and adjusted to the suggestions and inputs of the teams present in FGD activities. The learning objectives added in the AR media story board are tailored to the learning objectives contained in the digital teaching materials of optical subjects

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at RBV UT. This adjustment of learning objectives aims for there to be synchronization between AR media and digital teaching materials that have been used in optical lectures in UT Physics Education study program.

Suggestions and inputs in FGD session I are also related to the content of the material contained in the story board. The suitability of the theory between the structure of the eye becomes a record in the preparation of ar media story boards. The design of the shape and color of the eye part was revised again after getting input from FGD session I activities. In addition to content, technical things such as instructions for use are also points of improvement of the story board. AR technology is something that is still new in the world of education. The implementation of AR technology has not been fully able to reach and be socialized to all students in Indonesia. Therefore, not all students can easily operate AR media. The initial appearance of the product needs to be equipped with instructions for the use of AR media, this relates to the application that must be downloaded and the procedure for performing a scan marker. The existence of instructions on the use of AR media is expected to facilitate the learning process using AR media later.

Focus group discussion is a technique where a researcher assembles a group of individuals to discuss a specific topic, aiming to draw from the complex personal experiences, beliefs, perceptions and attitudes of the participants through a moderated interaction (O.Nyumba et al., 2018). The addition of problems in the story board is also an important note for the improvement of AR media story boards. To know the difference in understanding between before and after using AR media, it is necessary to add instruments in the form of problems. The effectiveness of AR media can be measured by differences in results from before and after the use of AR media. The problem is also designed to be adapted to the purpose of learning so that the problems inserted in the story board in accordance with the achievements and curriculum.

b) FGD Session stage II

Story boards that have been developed are then processed into AR media. After the AR media is completed, then FGD session II is carried out. FGD session II activities are focused on examining the material in the structure of the eye. An important part of ar media developed in the concept of optical systems of the eye is the shape of the eye. The structure and shape of the eye is the basic part, so it needs more detailed use so that there is no material misconception by students. Here are presented suggestions and input of FGD session II participants.

The focus of FGD session II activities is the study of materials, especially on the structure of the eyes. The initial appearance of the eye requires some revision and improvement. The purpose of making this AR media is so that there is no misconception of the material about the eye. For this reason, it is necessary to examine the shape and structure

of the eye. Improvements to the design of the eye made by the development team include: eye shape, color of the inside of the eye, affirmation of the conjunctiva and clarity of color on the part of the cornea. When all parts of the eye are appropriate, then the product development team continues the process of working on the product process in the eye vision process and eye defects.

c) FGD Session stage III

At the end of FGD activities, the discussion focused on reviewing the material on the topic of vision processes in the eyes and eye defects. Based on the story board that has been designed at the FGD session I stage, the development team continues the finalization of the product related to the topic of vision process in the eye and eye defects. The course of light and the process of shadow formation in the eyes became the focus in the discussion on the activities of FGD session III.

The initial appearance of the product is concerned with material regarding the process of vision in the eye and eye defects need some improvement. Less precisely the position of shadow formation when the eyes are normal becomes an important note for the development team to improve the position of the fall of shadow formation. The process of shadow formation and the fall of light during the process of shadow formation in the normal eye that is displayed is not appropriate, the position falls behind the retina. The course of light entering the eye is visualized like the following image.

The process of the entry of light in the eye, the course of light/light When passing through some part of the eye is an important part in the AR media. The light passing through the object is well projected, but needs improvement in the form of visualization of rays passing through parts of the cornea. The position of the light that has not been so precise when passing through the lens, will give rise to the potential for misconceptions. To address this problem, the research team again provided instructions in the form of images that are in accordance with the theory to represent the course of light. Once the product is displayed, some important notes become suggestions in improving the quality of the product. Some participants provide input and suggestions on the content or visual appearance of the product.

FGD session III is the final activity before ar media products on the concept of optical systems are piloted. Advice and input on FGD session III focuses on the content and content of material related to the vision process in the eye and eye defects. Visualization contained in AR media must be equipped with the process of the course of light/rays so that students become more aware of both the process of vision and eye defects. The completeness of the material contained in AR media is also a suggestion and input on the activities of FGD session III. In the material described regarding eye defects, but has not been equipped with solutions to overcome eye defects. Therefore, in order for the explanation of the material to be intact, the

development team needs to add a material section regarding the explanation of solutions to overcome eye defects such as nearsightedness. Farsightedness, nearsightedness and astigmatism. After the overall repair is completed, the AR media product on the concept of optical eye system is ready for trial.

2. AR Media Product Design on EyeOptical System Material

In story boards that have been designed at the initial research activities, the content and media sections of AR are divided into groups. In the first section, it contains the identity of ar media developers, be it the logo of the Open University institution and the names of researchers involved in research activities. Furthermore, students or users are asked to fill in the identity in the form of a name. When the identity has been filledin, next will appear instructions for the use of AR media. Pre-test questions will appear after the media usage instruction menu. The pre-test problem aims to see the extent of students' understanding of the material of the optical system of the eye.The available problem is in the form of a statement. The student's job is to choose the correct/wrong answer option in accordance with the statement available in the problem. There are 10 questions that must be done by students, and after the whole is completed, students can immediately see the score of the problem that has been done.

The main menu in developed AR media consists of several sub-sections, including CPU courses, content/content of material,and

ARmedia. At the beginning of the AR media display, the identity of the developer isntitusi that is the Open University and users are asked to enter an identity in the form of a name. The logo and topic title are clearly visible at the beginning of this AR media display. Once the identity is valid and has been dientry, there will be instructions for use. For instructions for use relating to information that informs users about the procedure for the use of AR media. Once the user understands the instructions for use, it will appear about pre-test as many as 10 items. After the whole problem is done, it will appear directly the student score. The score that appears contains information about the correct number of questions that successfully answered by students. This emerging score can be the initial benchmark for students in studying the material. After using AR media on this optical eye system concept, it is expected that students willget a better score. AR technology provides opportunities to be able to optimize learning and create learning effectiveness (Aiello et al., 2012).

The menus consist of: Main menu options, sub-sections that explain the parts of the eye, general achievement of the subjects,and eye defects. It looks asfollows.
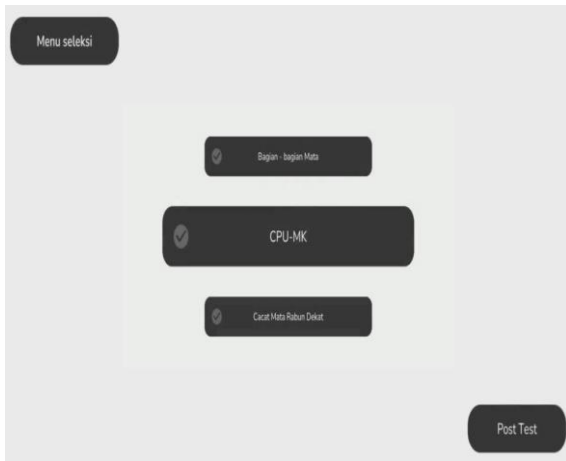
Figure 3. Display menus contained in AR Media in the Concept of Optical Systems

After the student has finished clicking and understanding the information contained in the section contained in ar media, a notification will appear in the form of a check mark that is lit and green. This indicates that the sub-menu has been clicked and studied by students. text form is followed by sound as an information suppressor. At the end of the explanation, there will be a menu option to continue on the AR menu. After the AR menu is clicked, it will automatically appear the camera display and the user is expected to scan to the marker that has been provided. Ar media display after scan marker is seen in the following image
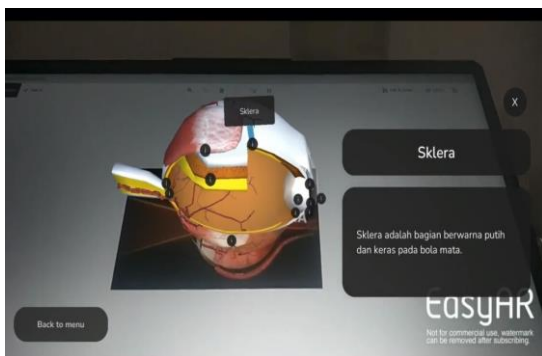


Figure 4. Display of EyeParts Containe in AR Media in the Concept of Optical System of the Eye

In the image visible parts of the eye and equipped with explanatory information on each part of the eye. As seen in the example of the image, the section shows the sclera, where the position of the sclera is visible on the structure of the eye and information appears related to the sclera. The same will happen when clicked on the other part of the eye, then information will appear about the highlighted part.

The part of the eye displayed in AR form can be rotated and rotated 360°. This can be done by touching the eye then scrolling or twisting using the help of fingers on the smartphone screen. The entire inside of the eye structure can be clicked by the user, in addition to complete information about the part provided at the same layer. On the menu of this material, there is no access time limit. This means that each user is free to determine his or her own study time, without having to rush with the time set by the app. This kind of ease accommodates the diversity of students' ability to understand the material.

The next menu that is also contained in the AR media section of the concept of eye optic systems is about eye defects. In the defect of the eye, explained the formation of shadows, the process of the entry of light through each part of the eye as well as the final process of the formation of shadows. With this visualization, students can understand the difference between normal eyes, nearsighted eyes, nearsightedness and astigmatism. A view regarding AR media on the topic of eye defects is presented in the
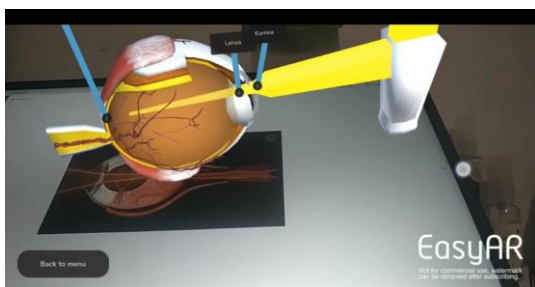
following image.



Figure 5. Examples of Display of Vision Processes in the Eye Contained

The visualization of shadow formation is good for normal eyes, nearsightedness and nearsightedness will facilitate the understanding of student concepts. This section is one of the important parts in achieving the learning objectives on KB 2 in module 3 of Optika courses. During this lecture process only relies on materials contained in RBV, so that with the ar media is expected to contribute to the improvement of student understanding.

## D. Conclusion

The results of the needs analysis that has been carried out in the early stages of this study show that there is some material that is summarized in learning activities that have the potential to cause misconceptions, requiring visualization. and AR media to learn. The material in question is contained in module 3, namely KB 2 regarding the optical system of the eye. Based on the results of data analysis on student response to eye optic system material, 81% of students agree and need AR media to study eye optics systems. 72% of students agree that the material of the optical system of the eye will potentially

cause misconceptions if studied without the use of media. Therefore, it is needed to develop AR media on the concept of optical systems to support the learning process in optical subjects.

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