

[Research Article]

## Development of Phyvar Media on Fission Reaction Material to Support Students' Spatial Intelligence

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DOI: <https://doi.org/10.15575/jotalp.v9i2.35769>

Received: 13 June 2024 ; Accepted: 24 December 2024 ; Published: 31 December 2024

### ABSTRACT

This research aims to determine the characteristics and feasibility of Physics In 3D Virtual Reality media on Fission Reaction material to support students' Spatial Intelligence. The research method used is Research and Development (R&D) with the Rowntree development model. The Rowntree model stages consist of 3 stages, namely the planning stage, development stage and evaluation stage. The subjects of this research consisted of 2 expert validation people, namely material and experts and limited trials on 36 students who were/had studied renewable energy subjects. The results of the material expert validation obtained a score of 97%. The validation results from media experts obtained a score of 94%. The assessment results from students as users were 85%. It can be concluded that the PHYVAR media in fission reaction material is very suitable for use and supports students' spatial intelligence.

*Keywords: Fission Reaction, Spatial Intelligence, Fission Reaction Simulation*

**How to cite:** Prayoga, A. F., Guntara, Y., and Septiyanto, R. F. (2024) Development of Phyvar Media on Fission Reaction Material to Support Students' Spatial Intelligence, *Journal of Teaching and Learning Physics* 9 (2), 130-137. DOI: <https://doi.org/10.15575/jotalp.v9i2.35769>



## 1. INTRODUCTION

Intelligence and some of its aspects are a very important part of human existence that plays a role in the welfare of others in all fields of life. With this intelligence, the civilisation of society can progress. There has never been a unified understanding of intelligence and the problems that surround it, some experts such as two psychologists, David Wechsler (1958) and Charles Spearman (1927) believe in the theory of unique intelligence. Similarly, Von Sternberg (1985) and Howard Gardner (1983) believe in multiple intelligences. Howard Gardner, an intellectual in the field of Educational Psychology from Harvard University, put forward a theory of intelligence consisting of 9 types. One of the intelligences proposed by Gardner is Spatial Intelligence, which he considers to be the principle of being able to recognise a subject in detail and change the point of view of the subject being observed. An intelligence that is considered to convey some understanding of map viewing and image reading to reinforce this kind of understanding in the general public. Spatial intelligence is defined as thinking in pictures & visualising. Then, the ability to understand, and change back the shape & behaviour of various aspects in the visual world. Its application in the learning process in the classroom can improve spatial intelligence skills. Based on the analysis of the workings of the spatial ability test, two components of spatial intelligence were found. The first component is to choose a flexible strategy between mental images and analytical thinking, and the second component is to use external visual - spatial representations for a task (Malekian et al., 2012).

However, this type of intelligence is rarely considered in the learning process. Many students tend to memorise formulas without knowing how physics phenomena work. Students lack learning media to improve spatial intelligence. One of the methods used is to use the analogy of a physical object with materials that are around sometimes does not match the actual physics phenomenon, so that students cannot

imagine three-dimensional space in their minds appropriately. In Indonesia, in the 2020s, there are still many conventional learning media being applied. The learning process is carried out in a room by teachers and students and is bound by the time limit given. This learning method is considered less effective because it only involves one-way conversations and monotony. Students only focus on listening to what the teacher says, there is no interaction of curiosity from students, causing students to become bored. Making it less active in the learning process (Auri Pramesti et al., 2022).

Visual-spatial intelligence is the ability to accurately perceive the visual world, change or modify initial perceptions, and reproduce aspects of visual experience in the absence of associated physical stimuli. The link between visual-spatial intelligence and engineering chemistry, engineering mathematics, and engineering physics courses can be found in abstract subject matter. Abstract objects in the material of these three courses require the imagination of each individual, so that each individual must have sufficient visual-spatial intelligence to solve problems in studying the course. (Perdana & Amay Suherman, 2017).

Especially in learning Physics. The material in class X has entered the introduction of Core Physics which is known to have abstract concepts and relate to microscopic objects. Quantum mechanics is a modern physics discipline that discusses physical phenomena that cannot be explained by classical physics, such as blackbody radiation, the photoelectric effect, and the Compton effect. The theory of quantum phenomena is more abstract than the theory of classical physics. Theories always arise from hypotheses based on previous laws, and their truth is assumed to be assured by combining all existing laws of physics into one law. (Lukman & Nana, 2021). Therefore, it is necessary to utilise the development of digital technology, especially the use of virtual reality media to make learning methods in education more modern, effective and

adapted to the advancement of science and technology.

One of the applications of quantum mechanics in the energy field is the Nuclear Power Plant, which in the process uses the Fission Reaction. The fission reaction itself is the breakdown of heavy atoms  $U_{92}^{235}$  by  $n_0^1$  become lighter, the result of the fission reaction can be  $Ba_{56}^{144} + Kr_{36}^{89} + 3n_0^1$ .

As (Susdarwono, 2021) Nuclear energy produces energy from the reactions of atomic nuclei. There are two types of nuclear reactions: fission and fusion, both of which produce enormous amounts of energy. Energy production is done differently in the two types. Nuclear fission, which is the splitting of nuclei from heavy to lighter atoms, occurs in nuclear reactors, while fusion, which is the fusion of lighter atomic nuclei, into heavier nuclei often occurs in solar nuclei. As nuclear fission and fusion are exothermic reactions, the amount of energy involved in nuclear ignition (transmutation) reactions can be estimated.

Efforts to improve spatial intelligence in students on quantum physics sub-materials are important for educators and education teachers to continue to improve students' cognition, because this will have a positive impact on students' cognitive development and prepare them to face future challenges. According to (Nur Aini et al., 2023), Students' cognition is also influenced by several factors, including teaching methods, the learning environment, the curriculum applied, and the use of appropriate learning media. Effective, interactive and innovative learning methods can boost students' interest and motivate them in the learning process. A supportive learning environment, including support from teachers and parents, also plays an important role in achieving good learning outcomes. In addition, the use of relevant and varied learning media can also have a significant impact on learning outcomes and students' cognitive development. Learning media such as books, videos, educational games, and digital technology have

been used to enhance students' interaction with learning materials. In an increasingly digitalised era, Virtual Reality learning media has also emerged as an interesting and innovative medium in education.

One learning approach that provides experience during the learning process is an innovative technological approach, for example Virtual Reality. Broadly speaking, some researchers such as Burdea and Lee Wong define Virtual Reality as an effort to replicate or simulate the environment, especially fission reaction events through VR. To access VR, it can be done using one of them with Unity 3D software.

## 2. METHOD

The research method used in this study is Research and Development (R&D). According to Borg and Gall, Research and Development research is a process used to develop and validate educational products. According to (Sugiyono, 2013) Development research or research and development (R&D) is a research method that focuses on developing a product and testing the effectiveness of the product, and not to test the theory. So it can be concluded that the research and development (R&D) research method is a research method that aims to develop and validate a product. The development of Physics In 3D Virtual Reality learning media on the material of this Fission Reaction uses the Rowntree research model with a research design consisting of 3 stages, namely the planning stage, the development stage, and the evaluation stage.

The research subjects consisted of testing from material experts, media experts and also to users, namely 36 students who were or had studied the physics subject of renewable energy at SMAN 1 Cikande.

The object of research in this study is a virtual nuclear power plant media with the name Physics In 3D Virtual Reality on Physical Reaction material that supports spatial intelligence.

This research will be conducted in the academic year 2024/2025, namely in the even semester with the research location at SMAN 1 Cikande, Serang Regency, Banten.

### 3. RESULT AND DISCUSSION

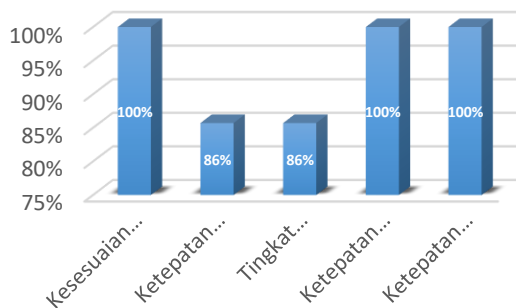
#### 3.1 Expert Validation Results

The assessment aspects for material expert validation consist of the correctness of the material content, the currentness of the material, the coverage of the material (to the learning outcomes), the depth of the material (the material is deep or not), and the adequacy of the references used. The results of the material expert validation of PHYVAR media on Physical Reaction material can be seen in the following graph 3.1.



**Gambar 3.1** Results of Material Expert Validation of PHYVAR media.

The assessment aspects for media expert validation consist of the suitability of media delivery strategies with student characteristics, the accuracy of media delivery strategies, the level of possibility of supporting students' spatial intelligence, the accuracy of media selection compared to other media, and the accuracy of simulation selection with the objectives and content of the material. The results of media expert validation of PHYVAR on Physical Reaction material can be seen in graph 3.2.



**Gambar 4.2** Results of Media Expert Validation of PHYVAR media.

Based on the assessment that has been carried out on PHYVAR media on escalated Physical Reaction material, it can be analysed based on the perspective of material and media experts with the assessment aspects that have been presented PHYVAR Good to Very Good in accordance with the interpretation of the media feasibility category. The description of the assessment results is as follows:

- 1) The material expert's assessment of PHYVAR media on Physical Reaction material in the aspect of the correctness of the content of the material has a percentage of 100% with a very good category, the aspect of the current material has a percentage of 100% with a very good category, the aspect of material coverage (to the learning outcomes) has a percentage of 100% with a very good category, the aspect of the depth of the material (the material is deep or not) has a percentage of 100% with a very good category, and the aspect of the adequacy of the reference (reference) used has a percentage of 85.71% with a good category. The five aspects of the material expert's assessment of PHYVAR media on Physical Reaction material have a percentage value of 97% which is declared Very Good in accordance with the assessment category, namely 86% to 100%.

Based on graph 4.1, it can be seen that the Kememadaiian aspect of the reference used

has a lower percentage than the other 4 aspects. This is because there is a need for reference sources and material presented in the media as well as with at least 15 adequate articles, so that researchers include shortcomings as material for product improvement to make it more valid in the future. Although there is one aspek with the lowest percentage of 85.71%, however, it is still in the good category as in accordance with the interpretation of feasibility (Sugiyono, 2013). The other four aspects include the correctness of the content of the material, the current aspect of the material, the coverage aspect of the material (to the learning outcomes), the depth aspect of the material (the material is deep or not) received a percentage of 100% in the Very Good category. Based on the feasibility of the material, the average percentage of assessment reached 97% in the Very Good category. So that the PHYVAR media has been validated very well and the material is suitable for use by students. This is in line with research (Pratiwi et al., 2019) and (Syefrinando et al., 2020). The results of this study show that good media is composed of material that is feasible to be applied in it, interpreted from the results of the percentage of feasibility according to predetermined criteria.

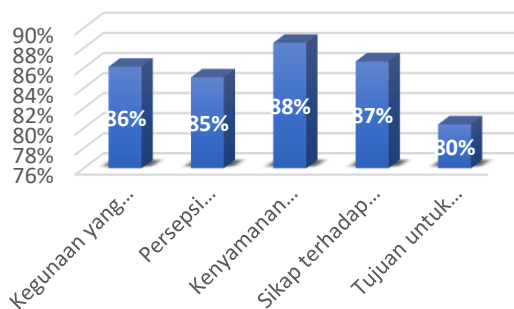
- 2) Media expert assessment of PHYVAR on Physical Reaction material with aspects of the suitability of media delivery strategies with student characteristics has a percentage of 100% in the Very Good category, aspects of the accuracy of media delivery strategies have a percentage of 85.71% in the Good category, aspects of the level of possibility of supporting students' spatial intelligence have a percentage of 85.71% in the Good category. This is in line with research (Hermansyah & Herayanti, 2015). Based on the five aspects of the media expert's assessment, it can be concluded that the PHYVAR media on the material of Physical Reactions obtained an average percentage of 97% which can be

categorised as Very Good with an assessment category of 86% to 100%, and the aspect of the accuracy of simulation selection with the objectives and content of the material has a percentage of 100% with a category of Very Good. Based on the five aspects of the media expert assessment, it can be concluded that the PHYVAR media on the Physical Reaction material obtained an average percentage of 97% which can be categorised as Very Good with an assessment category range of 86% to 100%.

Based on graph 4.2, it can be seen that the aspects of the accuracy of the media delivery strategy and the level of possibility of supporting students' spatial intelligence get the lowest score among others. This is because it is necessary to add editorial sentences giving directions to each menu and submenu in PHYVAR, and there is a need to add simulations close to reality, such as smoking reactors, the movement of electrons on cables from transformers so that a score of 6 out of 7 is given as material for product improvement to make it even more valid in the future. However, the aspects of the accuracy of the media delivery strategy and the level of possibility of supporting students' spatial intelligence in the Good category with a percentage of 85.71%. The other three aspects are in the aspect of the suitability of media delivery strategies with student characteristics, the accuracy of media selection compared to other media, and the accuracy of simulation selection with the objectives and content of the material getting an average perfect percentage of 94% with a Very Good category. So that PHYVAR is appropriate to use.

- 3) User assessment was carried out with a limited trial of students who were or had studied the physics subject of renewable energy. The users in this study were 36 students of class X SMAN 1 Cikande. Listed in graph 3.3.

### 3.2 User Validation Results



**Gambar 3.3** Results of User Validation of PHYVAR media

Based on graph 3.3, it can be understood that the assessment of each aspect by 36 users of PHYVAR media is categorised as Good with an average percentage of 85.3%. User responses are described based on several aspects as follows:

- 1) The aspect of perceived usefulness and feedback received a percentage of 86% in the Very Good category. For example, the use of the application is quite interesting, I hope it can be more High Definition which gets a percentage of 88% with a Very Good category; for the apk is pretty good, the initial appearance is quite interesting, in my opinion it is lacking in the menu or the choices are still monotonous and few, the menu choices should be increased again to make it more interesting, getting a percentage of 90% with a Very Good category; the appearance can be improved again so that it can dance more, getting a percentage of 86% with a Very Good category; in my opinion, the application is good but too simple and focuses on one material only, for the size it can be more compressed so as not to increase the quota and ROM obtained a percentage of 91% with a very good category; the application is interesting and looks good, maybe you can also add audio so that you get directions when using it obtained a percentage of 92% with a very good category. Based on the results of student assessments in this aspect, it can be
- 2) The perceived ease of use aspect obtained a percentage of 85% in the Good category. For example, more attractive and easy to understand obtained a percentage of 88% with a Very Good category; there is nothing more to be improved, but it must still be improved again the content obtained a percentage of 76% with a Good category; the appearance of this apk is attractive, but for the installation process if it can be placed in the play store only to make it easy and there is no potential virus notif obtained a percentage of 93% with a Very Good category; for the application itself is good and interesting, but for pre and post tests there are still not many obtained a percentage of 94% with a Very Good category; there are obstacles in the installation process, it can only be installed on middle to upper cellphones, when it is installed the display is cut off, further increase the difficulty level obtained a percentage of 95% with a Very Good category. Based on the results of student assessments in this aspect, it can be concluded that they can feel that PHYVAR media has ease of use, which can increase learning and motivation so that it is Very Good in terms of ease of use.
- 3) The perceived convenience aspect received a percentage of 88% with a very good category. For example, the display is concise so that it is easy to master, but it is difficult to download, the suggestion can be inputted into the Google Play Store obtained a percentage of 90% with a Very Good category; the application version is too high so it is not relevant to smartphones obtained a percentage of 87% with a Very Good category; the use of the application is very enjoyable, making it easier for me to understand the Physical Reaction material, if it can also be placed on the Google Play Store, but there are obstacles such as the difficulty of downloading obtained a percentage of 93%

with a Very Good category; the display is cut off so it is difficult to explore this media, in the future it can be better prepared before launching it obtained a percentage of 90% in the Very Good category; there is a hazard warning notice, the suggestion can be placed on the Google Play Store obtained a percentage of 82% in the Good category. The students who commented that the assessment in the questionnaire reached number 10, because the application made was good and interesting. Based on the results of students' assessments in this aspect, it can be concluded that they can feel that PHYVAR media has comfort, which can increase learning and motivation so that it is Very Good in terms of comfort.

- 4) The items of this aspect consist of using PHYVAR is fun obtained a percentage of 87% with a very good category. For example, the application is good and interesting, but needs improvement so that it is easy to access, obtaining a percentage of 80% in the Good category; the application is good and interesting, but needs improvement so that the screen is not cut off when accessed by everyone, obtaining a percentage of 80% in the Good category; the application is good and interesting, the advantages are Reactors and Transformers and their nameplates, but needs improvement so that the screen is not cut off when accessed by everyone, obtaining a percentage of 80% in the Good category. Based on the results of student assessment in this aspect, it can be concluded that it can be felt that PHYVAR media has an attitude towards use, which can increase learning and motivation so that it is good in terms of attitude towards use.
- 5) The aspect of the purpose to use gets a percentage of 80% with a very good category. For example, the application made is very interesting and improve a little to get a percentage of 97% with a Very Good category; the application is good for the learning process but there are still improvements

regarding the truncated display to get a percentage of 91% with a Very Good category; the explanation of the material is good, but there are still improvements so that the display is not truncated to get a percentage of 92% with a Very Good category; the quality of the application can be improved again to get a percentage of 92% with a Very Good category; the application is interesting and good, but cannot be installed on all Smartphones to get a percentage of 84% with a Good category. Based on the results of student assessments in this aspect, it can be concluded that PHYVAR media has a purpose to use side, which can increase learning and motivation so that it is good in terms of the purpose to use.

#### 4. CONCLUSION

From the research development of Physics In 3D Virtual Reality (PHYVAR) on Physical Reaction material to support students' spatial intelligence are as follows:

1. Physics In 3D Virtual Reality (PHYVAR) media on Physical Reaction material to support students' spatial intelligence has been developed through several stages of development so as to produce a medium that can be accessed through mobile applications, especially Android. PHYVAR has three main menus, namely Theory, Exploration, and Quiz..
2. The feasibility test of Physics In 3D Virtual Reality (PHYVAR) media was conducted by media and material experts with one each who is also a lecturer and by users who are grade X students. PHYVAR media assessment based on material experts covering 5 aspects has a percentage value of 97%. PHYVAR media assessment based on media experts obtained a percentage of 94.3%. The assessment results from 36 students as users obtained a percentage of 85%. The percentage results show that the assessment is in the range of 72% to 86% which represents the Good category, then 86% to 100% which represents the Very Good

category. Based on the data that has been processed and analysed, Physics In 3D Virtual Reality (PHYVAR) media on Physical Reaction material to support students' spatial intelligence is declared suitable for use in learning..

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