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Biliometric Analysis of Development Comic-based Physics Learning Media Research Trends in 2012-2022

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Abstract. The results of the 2018 PISA, Indonesia is ranked 70th which shows that students in Indonesia have low higher order thinking skills. This skill can be improved by upgrading learning medium, namely using comic media rather than textbooks. Before developing educational physics comic, it is necessary to have trend data of development of educational physics comic in order to produce better educational physics comic. Therefore, this article aims to discuss the development and publication of the development of educational physics comic. This study used a bibliometric analysis method with meta data from Scopus of 54 articles from 2012-2022. It is concluded that; (1) most publications when 2021 with 16 publications; (2) the most frequently used format is conference paper; (3) The keywords that often appear are high school students, media experts, and events; (4) Indonesia has published the most on this topic (5) The top author of this topic is Prof. Dr. Heru Kuswanto, M.Sc. (5) The top Publisher is the Institute of Physics.

1. Introduction

As time goes on, the ability possessed by students must also develop in order to compete when they graduate. These abilities are Critical Thinking and Problem Solving, Creativity, Communication Skills, and Ability to Work Collaboratively [1]. A skill that is often related to physics subjects is the ability to solve problems (Problem Solving). It was very closely related to the field of physics that solved problems in architecture, electrical design, electronic devices, etc. A simple example in a school environment is that students must find solutions to contextual problems and problems when carrying out experiments.

Based on the results of PISA (Programme for International Student Assessment) issued in 2018, it shows that the ability of Indonesian students in science reached 389 with an OECD (Organization of Economic Co-operation and Development) average score of 489 and ranked 70th out of 78 countries [2-3]. PISA (Programme for International Student Assessment) is an international study that aims to evaluate education systems around the world by testing skills and knowledge in participating countries and is conducted every three years using tests in the fields of reading, math, and science [4]. Tests in PISA are in the form of problems that require high-order thinking skills, including problems that involve problem-solving skills. This shows that the problem-solving ability of Indonesian students in the field of science is relatively low, so students have low problem-solving abilities in the field of physics because physics is included in the realm of science.

One way to improve problem-solving skills is to update the learning media used. The demands of this change require the world of education to continue to keep pace with technological developments in efforts to lift the quality of education, especially adjusting the use of developing technology, especially in the process of implementing learning [5]. Learning media has a very important role in facilitating the learning process to take place more effectively. One of the potential learning media used in physics learning is comics.

Comics are one of the media that has many advantages in learning, including interesting images, distinctive characters, and easy-to-understand stories. Comics can also make it easier for students to understand complex physics concepts through fun illustrations and narratives. In recent years, physics comics as a learning medium are increasingly used by several educational institutions, such as those implemented by setiana, harijanto, and prastowo which show that the improvement of student learning

outcomes after using android-based physics comic teaching materials shows moderate N-Gain criteria with a score of 0.54, so that android-based physics comic teaching materials have effective criteria and are suitable for use as teaching materials on the subject of temperature and heat [6]. In research conducted by Palupi and Wiyatmo, it was concluded that the increase in learning outcomes after using physics comic learning media based on the N-Gain test was 0.58 with the medium category and the increase in learning outcomes based on the One Sample T-Test test stated an increase [7]. As well as research conducted by Agustin, Bektiarso, et al showed that the physics comic module is quite effective when applied in the classroom with an effectiveness of 71.38% [8].

Based on the results of previous research, the use of physics comics as a learning medium can help students to understand physics concepts that are difficult to understand through verbal and written explanations alone because they are treated to visual concepts. Physics comics media has the potential to be an effective learning medium. Research on trending publications Research on the development of physics comics learning media needs to be known in order to know the trending publication year, topics that are often raised in comic media, countries that publish the most, authors who publish the most, and articles that are most often cited by other authors. The trending research is to find out the type of good development, authors who have good development experience, and correlated keywords so that better development research can be made in the future. Therefore, this study aims to discuss the development of research and publications on the development of physics comics learning media because physics comic media has good potential for learning media.

2. Methods

This research is a type of descriptive research using bibliometric analysis methods. The source of this research is the Scopus Data Base. Scopus is used because Scopus has quality and reputation that is internationally recognized by research institutions (Sulardja, 2021). This causes the scopus data base source to provide valid data in scientific publications. This study is based on research on the development of comic-based physics learning media conducted between 2012 to 2022 by describing the development of topics, such as the number of publications, articles, research, approaches, and topic productivity. Data sources are obtained from *Scopus Data Base* with *keyword "educational physics comic"* Based on the results of searching for research sources, a total of 54 documents were obtained with the topic of physics comic-based learning media.

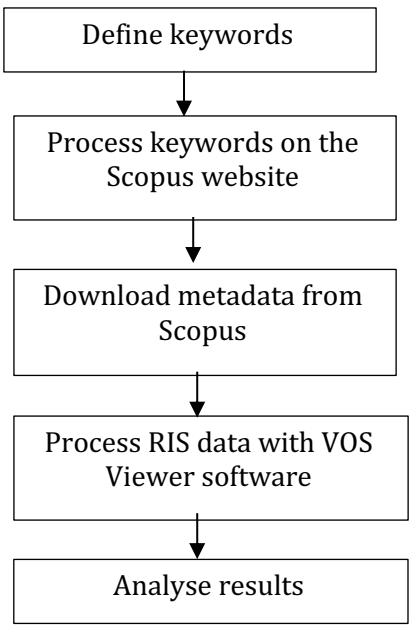

Figure 1. Research Method Flowchart

3. Results and Discussion

Data search was conducted through Scopus metadata in May 2023 with a range of 2012-2022 and obtained 54 documents. The metadata results are processed through VOS Viewer which shows unstable writing trends from year to year as shown in figure 2.

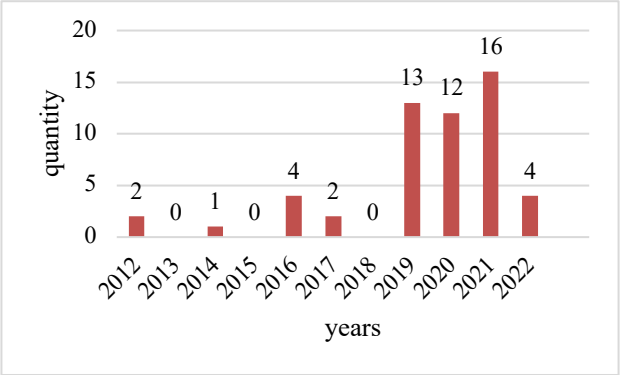

Figure 2. Research Trends of Development of Comic-based Physics Learning Media from 2012-2022

In 2012, there were 2 articles published. Then, the number of publications increased in 2019 by 13 articles. The increase in article publications for the development of physics comics learning media reached its peak in 2021 with 16 publications, but after that it decreased, as in 2021 only 4 publications.

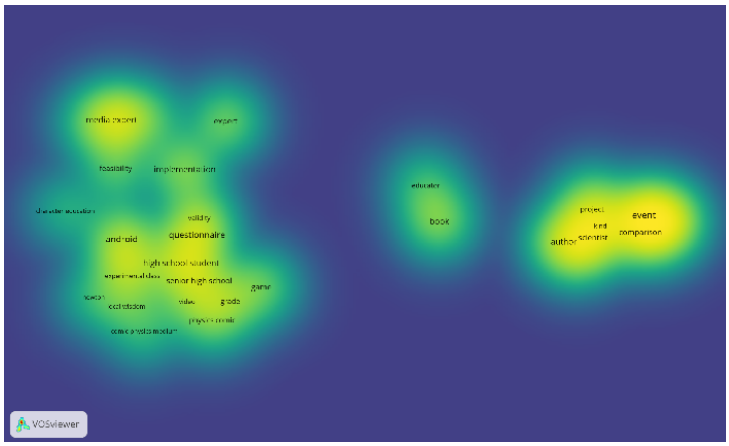

Figure 3. Density Visualization on the Topic of Comic-based Physics Learning Media

Based on density visualization, it is obtained that aspects that are often discussed in the topic of developing comic-based physics learning media are high school students, media experts, and events. This is because most of the comic-based physics learning media are implemented to high school students, because most physics material are taught during high school. Also, many discuss media experts because in the process of media development there is validation stage involving media experts to assess material on the media is feasible to be applied, the design of comic, and the learning steps in comics are in accordance with the curriculum. Also, the event aspect due to the core story of physics comics mostly discusses natural events then it linked to physics concepts.

The format of 54 research publications for the development of comic-based physics learning media is divided into 5 types, namely books, chapters in books, articles, conference papers, and review conferences. Most of them are in the form of 31 conference paper publications, 17 article publications, 3 book chapters, 2 in the form of conference reviews, and 1 publication in book form.

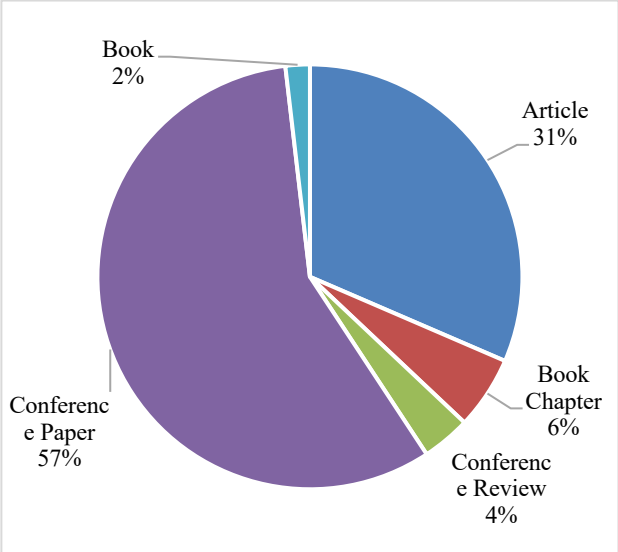

Figure 4. Types of Publications

Based on density visualization by country using VOS Viewer obtained that research publications came from Indonesia, America, and France. Based on its density, Indonesia contributes the most research publications to the development of comic-based physics learning media.

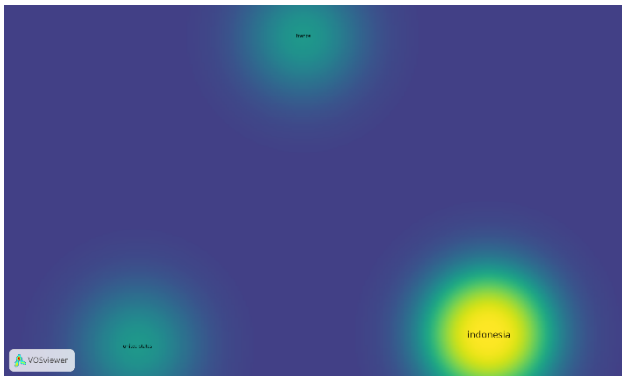

Figure 5. Document Distribution Density with Country Variations

This shows that there are still few who are interested in conducting research on the development of comic-based physics learning media. This is because comic media considered less suitable for learning medium because it has drawbacks, namely it is only effective for students with visual learning styles, some students are only interested to see the picture in comics rather than understanding the material presented, and simple and concise explanations in comics can cause different interpretations between information understood by students and writers or with other students thus it requires a more in-depth explanation by the teacher [9-12].

Figure 6 shows the cluster of top writers in the research and shows the productivity of research on the development of comic-based physics learning media in Indonesia. Cluster 1 consists of Kuswanto H; Wardiani R; Nikma S; Jumadi &; Wilujeng I; and Haroky F. cluster 2 consisting of Ratnaningtyas I; Wilujeng I; Jumadi &; Kuswanto H.

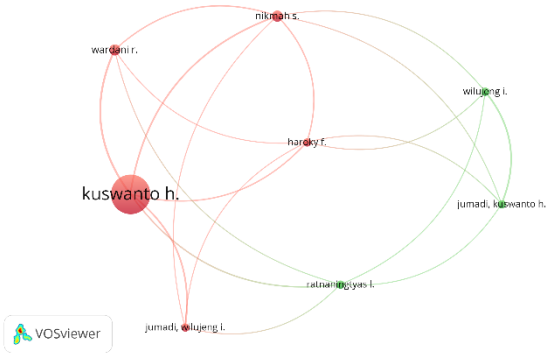

Figure 6. Top Researchers in Development Comic-based Physics Learning Media

It was found that the dominating author was Kuswanto, H. Because the size of the circle shows the intensity of research carried out related to the topic. If the size of the circle is getting bigger then, the more publications there are. Prof. Dr. Heru Kuswanto, M.Si. is an educator at Yogyakarta State University who has expertise in fiber optic materials and learning physics (local culture) with android. He is in the work unit of the Faculty of Mathematics and Natural Sciences, majoring in physics education, and has a position as a professor. He has the top 3 development articles of comic-based physics learning media with 8 citations. The three articles are titled "Development of Android Comics media on Thermodynamic Experiment to Map the Science Process Skill for Senior High School", "Android-based Physics Comic Media Development on Thermodynamic Experiment for Mapping Cooperate Attitude for Senior High School", and "Android-Assisted Physics Comic Learning to Train Students' Conceptual Understanding of Newton's Gravity". The three articles are widely cited because they present several related previous research, research novelty, research methods, data analysis methods, research results, the results of the comics application, analysis of research results associated with the influence of comic media on the data obtained, and most importantly attach the developed comics. This is because comics are usually not attached to articles so that readers are confused if they want to develop similar educational comics. Also, many citations to those articles because the article raised the topic of "physics comic" which has a high density.

Based on these 3 articles, the advantage of physics comic media is that it can explain abstract physics concepts using a concise arrangement of images and text so that they are easy to understand, physics concepts presented in the form of comics can increase reading interest and learning motivation, and stimulate learning activities because stories in physics comics make students carry out observation activities and solve problems [13-15].

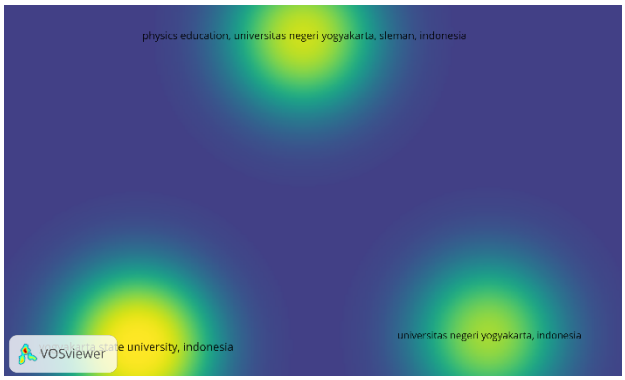

Figure 7. Density Organizations that Publish Research of Development Comic-based Physics Learning Media

Based on figure 7, there are 3 clusters of organizations that publish but they are not related. The organization that most publishes research on the development of comic-based physics learning media is Yogyakarta State University. This can be seen from the high density and Yogyakarta university in all clusters. Also, the author who contributed the most to research on the topic of developing physics comics is Prof. Dr. Heru Kuswanto, M.Si. because he is educator at Yogyakarta State University thus the Yogyakarta State University publishes the most research on the topic.

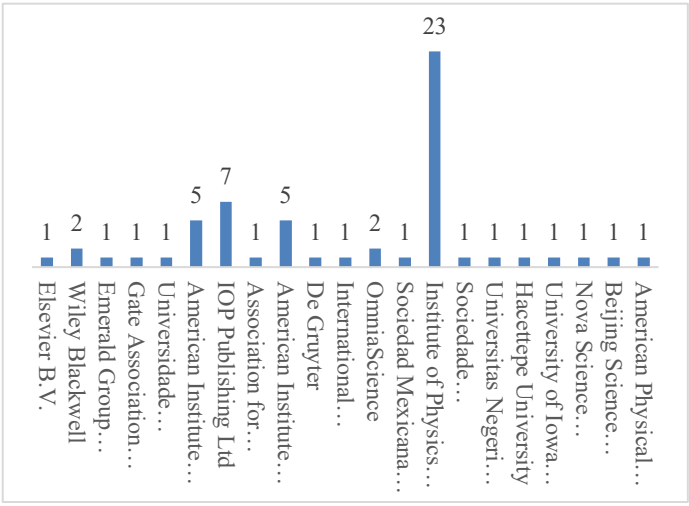

Figure 8. Trend Diagram Publisher in Research Development of Comic-based Physics Learning Media from 2012-2022

Based on Figure 8, the publisher who has released the most research on the development of comic-based physics learning media is Institute of Physics with a total of 23 publications. This is because, the Institute of Physics publishes research from Indonesia and based on figure 5 Indonesia is the most contributor to research in the topic of developing physics comic media.

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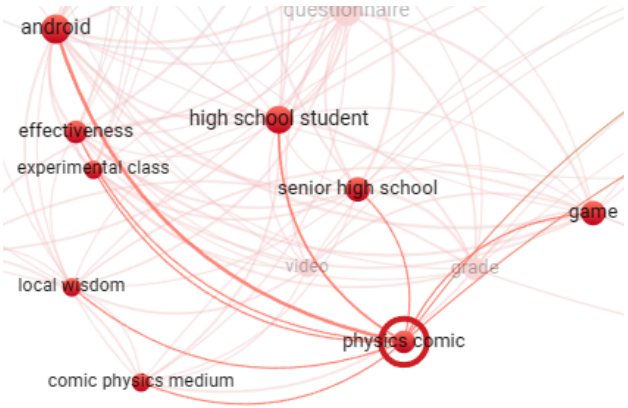

Figure 9. Keyword Correlation of Physics Comics Media

Based on Figure 7, physics comic media is related a lot to high school students because physics material begins to be taught at the high school level, therefore most of the targets of physics comic media are high school students. comic-based physics learning media is related to android because most of the physics comics developed are digital comics so that they can be used on android. This type of digital comic is used because it is easy in the media implementation stage. It is cost-effective because it does not need to be printed. It is quickly distributed because in the form of digital data so it can be shared via Google Drive, the internet, WhatsApp, and e-mail. practical because it can be read anywhere as long as

students bring mobile devices [16]. Also, the creation of digital comics is more time-efficient and easy to store and maintained.

Related to effectiveness and experimental classes because physics comics not only provide learning material, but also train cognitive abilities such as learning outcomes, critical thinking skills, creative, and problem solving in experimental classes. Also, train affective aspects such as increasing interest and motivation to learn. Therefore, comic media must go through an evaluation stage that measures the effectiveness of comics in training cognitive and affective abilities in the experimental class [17].

Physics comics contain aspects *Local Wisdom* So that students easily understand the material and quickly remember it is important material in learning physics because of the application of local wisdom related to everyday life [18].

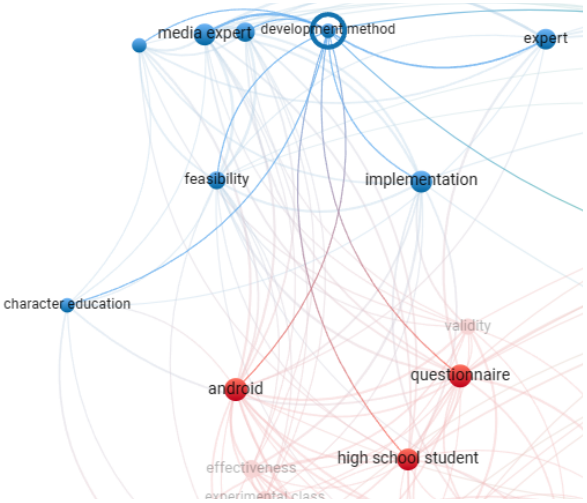

Figure 10. Keyword Correlation Development Methods

The development method correlates with implementation and questionnaires because after the comic is developed it is implemented in order to obtain quantitative data such as grades and qualitative data such as student responses. Questionnaires are used to obtain qualitative data, such as opinions about physics comics, whether comics are interesting or not, how the material in the comics is presented whether it is clear or not, how motivation and interest in learning You are after learning with physics comics, etc. [20]. Score data can be obtained from written tests and digital-based tests. This qualitative data was then used to revise the physics comics media [9].

The development of physics comics involves experts and media experts because physics comic media needs to be validated by experts and media experts after being designed and developed or before being implemented to students. The experts involved are material experts, curriculum experts, media experts, pedagogy experts, and physics teachers. This validation stage for the sake of quality of the comic-based physics learning media that given to students already having the right material, learning steps have followed the curriculum correctly, he pedagogic aspects that are trained are in accordance with the media's objectives, the media design is pleasing to the eye and in accordance with the principles of learning media design [9], [19].

4. Conclusions

Based on the results of bibliometric analysis using VOSViewer, it can be concluded that the most physics comic media development research publications in 2021 occurred in 2021, with a format that is often used, namely conference paper. In the study, the keywords that most often appear are high school students, media experts, and events because physics comic media is targeted at high school students because physics is taught at that level, comic media development requires media experts to validate the feasibility of the media, and the content of comics discusses events then connected to physics concepts. Indonesia is the country that contributes the most publications and the author who plays the most role is

Prof. Dr. Heru Kuswanto, M.Si. who is an educator at Yogyakarta State University. The organization that publishes the most topics on the topic of developing physics comic media is Yogyakarta State University and the publisher that publishes a lot is the Institute of Physics. Research on the development of physics comics learning media correlates with high school students as research subjects, experimental classes because they are part of the research method, android because it is a digital comic that can be read via android mobile phones, local wisdom so that students more easily memorize and understand, effectiveness to evaluate whether comic media can train the expected cognitive or affective abilities. As well as the developer's method, it has a lot to do with media experts because in the development stage they will validate the learning media of physics comics. Implementation because after being developed, comics are applied in order to get data.

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