

Research Trends of Pre-Service Physics Teachers' Critical Thinking Skills During 2001 to 2022

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ABSTRACT

Objective: This research tends to visualize the trend research of PsPT CTS between 2001 and 2022. At the same time, no previous study has used bibliometrics to analyze the PsPT CTS in higher education. The main implication of this research are to find the novelty of the PsPT CTS research to increase their ability to teach physics critical thinking to students. **Method:** This research is a bibliometric analysis using Scopus as the primary metadata source. The document analyzed is a document between 2001 and 2022 or the last twenty years. **Results:** The trend of PsPT CTS tends to be interesting to future research, building upon the increase in the publication in PsPT CTS each year. The conference paper is the most used type of document in PsPT CTS due to its practice. It has a more visible impact since it is shown at a conference for many specialists from several disciplines to observe. The most widely used language in PsPT CTS publications is English due to its flexibility of readers around the world to have a good grip of the paper. For future research, it is still possible to develop or improve the obstacle PsT. Specifically, integrated STEM to enhance PsPT CTS due to its minimal keywords. **Novelty:** One of the 21st-century components is critical thinking, the trend of critical thinking research has become an exciting topic in the era of society 5.0. Therefore, to improve and develop the movements of critical thinking, especially in physics, an effort must be made.

INTRODUCTION

Pre-service teachers (PsT) must be prepared to teach to satisfy 21st-century competencies. Critical thinking skills (CTS) are one of the 21st-century competencies that must be developed in higher education. Many colleges teach students, including PsT, to fulfill the competencies required by employers (Gauthier, 2020; List, 2019). In formal learning contexts, PsT is still a learner (Astalini et al., 2018; Darmaji et al., 2019). However, physics, as a complicated subject, pre-service needs acquiring relevant content knowledge to develop the requirements of critical thinking skills. The development of critical thinking is a form of thinking that necessitates cognitive abilities to solve issues, make judgments, and reach conclusions (Malik et al., 2018; Malik, 2018; Sawyer et al., 2020).

CTS has sparked an interest in educational research these days. When physics PsT becomes teachers, PsT equipped with ecocritical thinking abilities in basic science concept materials is considered the first capital transferred to students in the working environment (Purnami et al., 2021). The significance of analyzing a person's knowledge of critical thinking skills has deteriorated over the previous decade, posing a threat to humans and the homeland (Richardson & Mishra, 2018). According to statistics from the Programme for International Student Assessment 2018, the CTS of Indonesian students

remains relatively poor. Indonesia's literacy score is 382, with a grade of 64 out of 65 nations. The problem has six stages (lowest level 1 and highest level 6) (Marudut et al., 2020). Indonesia still has an average score significantly lower than the OECD acquisition average, indicating that students in Indonesia cannot employ CTS and that their learning is limited to memorizing and knowing a phenomenon (Lestari et al., 2021).

Pre-service physics teachers' (PsPT) CTS is relatively low, with most pre-service physics teachers performing below average on all critical thinking measures (Satriawan et al., 2020). Teaching critical thinking involves a comprehensive strategy that includes a set of meaningful learning models based on aim and may help learners modify their cognitive talents (Thompson, 2011). Educators and prospective teachers who are prepared and capable of thinking critically will be able to maximize students' analytical abilities. Since the trend of pre-service physics research is an increase in academic institution learning aim is to generate PsT who think critically (Verawati et al., 2019). Thus, this research tends to visualize the trend research of PsPT CTS between 2001 and 2022. At the same time, no previous study has used bibliometrics to analyze the PsPT CTS. Hence this research problems are 1) how is the PsPT CTS research trends during 2001 to 2022?; 2) How is the novelties to increase the PsPT CTS based on the mapping visualization?; 3) How is the authorship and institution for the references of the development of the PsPT CTS?. The main implication of this research are to find the novelty of the PsPT CTS research to increase their ability to teach physics critical thinking to students.

RESEARCH METHOD

This study is bibliometric and uses VosViewer for visualization mapping (Lestari et al., 2021; Satriawan et al., 2020). The first step is to refine the keyword, then filter to the article title, abstract, and keyword, and set the year 2001 to 2021. The details of the keywords refine to Scopus as: (*TITLE-ABS-KEY(physics AND teacher AND critical AND thinking AND skills) AND (LIMIT-TO (PUBYEAR,2022) OR LIMIT-TO (PUBYEAR,2021) OR LIMIT-TO (PUBYEAR,2020) OR LIMIT-TO (PUBYEAR,2019) OR LIMIT-TO (PUBYEAR,2018) OR LIMIT-TO (PUBYEAR,2017) OR LIMIT-TO (PUBYEAR,2016) OR LIMIT-TO (PUBYEAR,2015) OR LIMIT-TO (PUBYEAR,2014) OR LIMIT-TO (PUBYEAR,2013) OR LIMIT-TO (PUBYEAR,2012) OR LIMIT-TO (PUBYEAR,2010) OR LIMIT-TO (PUBYEAR,2009) OR LIMIT-TO (PUBYEAR,2006) OR LIMIT-TO (PUBYEAR,2002) OR LIMIT-TO (PUBYEAR,2001))*)). However, the terms applied in this study are common to use in general academic papers. To wider results, this study use TITLE, ABSTRACT and KEYWORD. However, mostly papers, conferences, journals or/and proceeding are providing an English title, abstract and keywords even the main language of the papers are depending on its country.

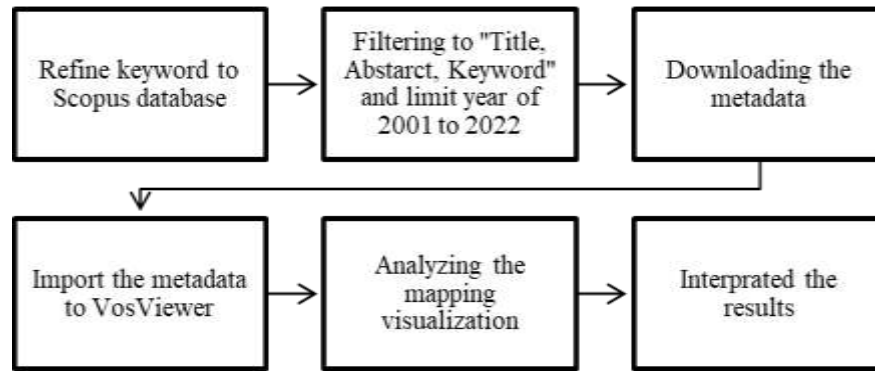


Figure 1. Research flowchart

The data was gathered on March 25, 2023, using Scopus as the primary metadata source. Furthermore, the 116 documents (including all academic papers listed in Scopus) that are collected are downloaded in the form of .ris and .csv for further analysis using VosViewer and Microsoft Excel. Final steps, data are analyzed descriptively to fulfill the research objectives.

RESULTS AND DISCUSSION

Results

PsPT CTS research trends during ten year (2001 to 2022)

Based on 116 documents obtained over the past ten years. An intriguing discovery seems to be that the research trend for PsPT CTS is growing yearly. It is known in **Figure 2**.

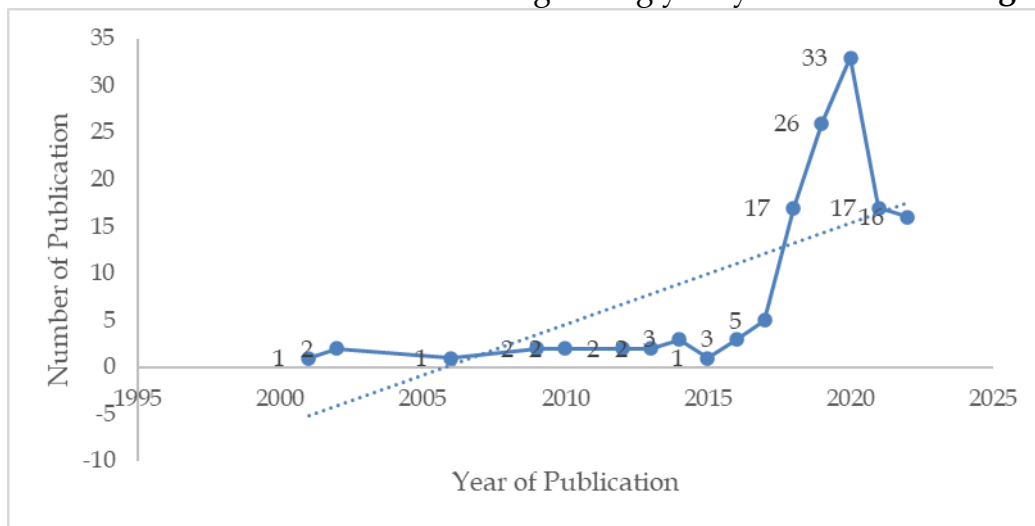


Figure 2. The trend of PsPT CTS during 2001-2022

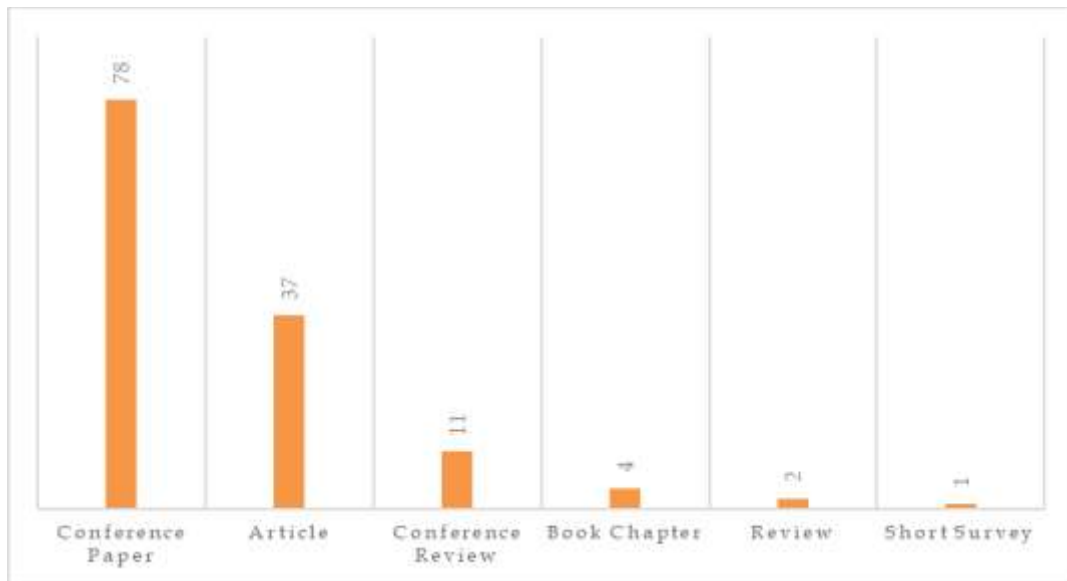


Figure 3. Type of documents to PsPT CTS research during 2001 to 2022

The most used types of documents are conference papers, totaling 78 documents. This is because conference papers have a practically.

Mapping visualization of PsPT CTS research during past ten years (2001 to 2022)

After we know about the trend of PsPT CTS, the metadata results are analyzed by VoSViewer to give the mapping visualization of the PsPT CTS to find novelty in future research. **Figure 3** is shown the mapping visualization of PsPT CTS research based on metadata.

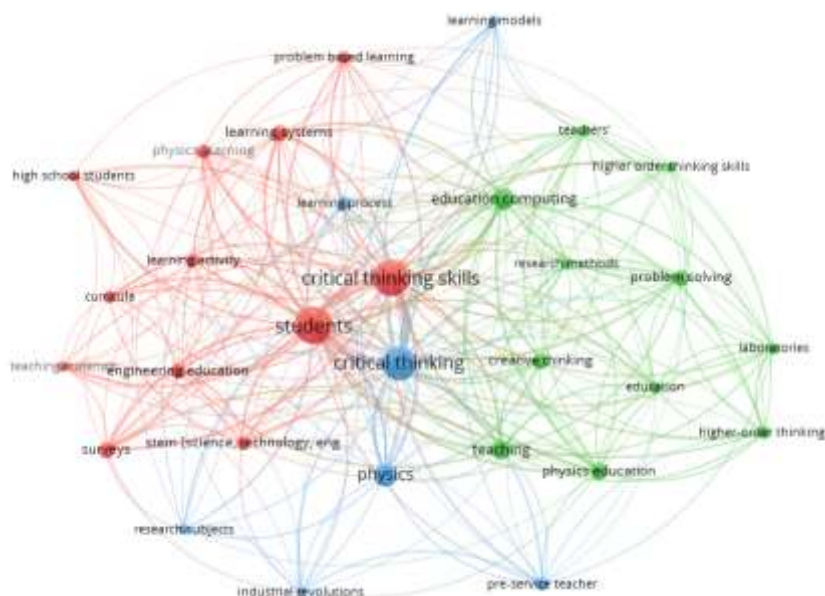


Figure 4. CTS focuses on mapping visualization

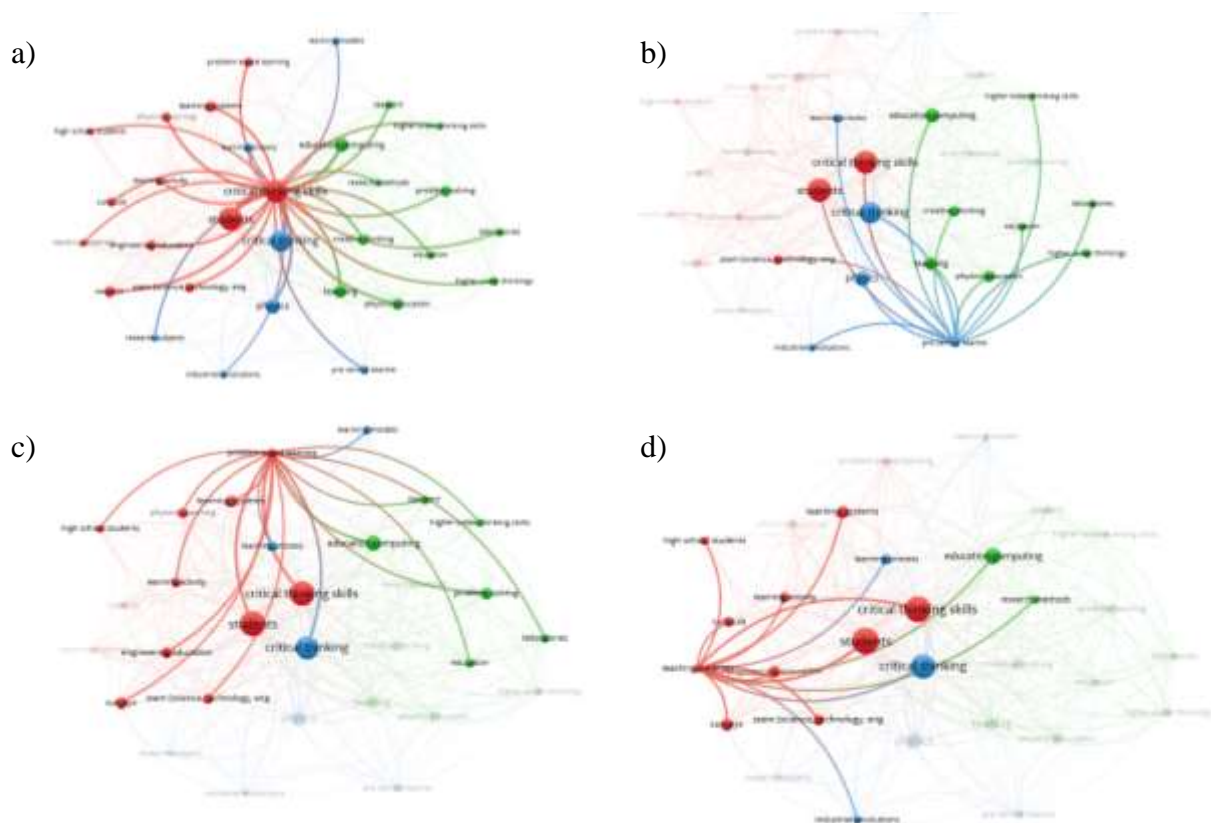


Figure 5. The mapping visualization of PsPT CTS during 2001 to 2022

The mapping of metadata keywords was used to discover the uniqueness of earlier research. To detail the strength of novelty findings, co-occurrence between the link of PsPT CTS research during 2001 to 2022 each keyword is analyzed as information shown in **Table 1**. The keywords listed in Table 1 are the results of the refined keywords and the analyzing of mapping visualization of the **Figure 4** in VosViewer.

Table 1. Strengthen each keywords in PsPT CTS research.

Keyword	Total Link Strength	Occurrence
Students	257	58
CTS	225	53
CT	162	46
Education computing	113	20
Teaching	77	15
Physics	67	22
Physics education	63	12
Learning systems	59	11
Creative thinking	52	10
Problem-solving	51	11

Top five contributed source title, affiliation and authors to PsPT CTS research

As a reference to future study, the contributed source title, affiliation and authors are presented in **Table 2**.

Table 2. The Top Contributed Source Title, Affiliation and Author.

Top source title		Top Affiliation		Top Author	
Source title	Total	Affiliation	Total	Author	Total
Journal Of Physics Conference Series	62	Universitas Pendidikan Indonesia	17	Setiawan, A.	9
Iop Conference Series Earth And Environmental Science	7	Universitas Negeri Padang	9	Suhandi, A.	9
Aip Conference Proceedings	4	Universitas Sebelas Maret	8	Malik, A.	6
Jurnal Pendidikan IPA Indonesia	4	Universitas Negeri Yogyakarta	7	Kaniawati, I.	5
ASEE Annual Conference And Exposition Conference Proceedings	3	Universitas Lampung	6	Permanasari, A	5

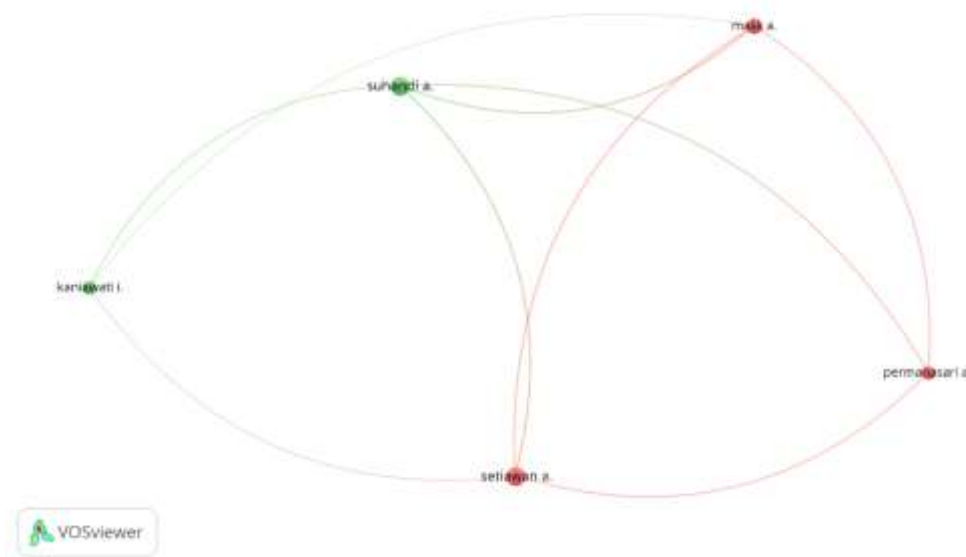


Figure 6. Top Five Contributed Authors Visualization

Figure 6 showed Setiawan, A. has 78 citation with total link strength 20; Suhandi, A. has 70 citation with total link strength 21; Malik, A. has 68 citation with 18 total link strength; Permanasari, A. has 67 citation with 15 total link strength; and Kaniawati, I. has 9 citation with 6 total link strength.



Figure 7. The contributed countries of PsPT CTS research

Table 3. Most used language to PsPT CTS research for ten years.

Language	Total
English	131
Italian	1
Russian	1
Turkish	1

Furthermore, the contributed countries of PsPT CTS research during the past 2001 to 2022 can be analyzed based on metadata. **Figure 7** shows that in line with top affiliates and top authors, Indonesia is the country with the most publications in pspt CTS research with a total of 73 documents. Then, in second place is the United States of America with a total publication of 10 documents. Other countries, each of them has less than 5 publications over ten years.

Discussion

Figure 2 concludes that from 2001 to 2022, the research on PsPT CTS significantly increased. It can be supposed that the PsPT CTS research is being interesting topic to researchers nowadays. Thus, there is wide open research to explore the PsPT CTS. However, latest year, PsPT CTS research decreased to 51%. It could be that there is still minimal novelty shown in the papers of the previous PsPT CTS. Also, the implications of the previous study on those periode of the times are not showing a novelty to next research. Hence, to help future researchers, on the next discussion will find the novelty of PsPT CTS research so that we can explore more PsPT CTS to enhance CTS to physics learning both for the teacher and the students. Furthermore, based on the final search results after filtering, there are 133 documents for PsPT CTS research, consisting of a lots variety of documents type. The types of papers are shown in **Figure 3**. The most used types of documents are conference papers, totaling 78 documents. This is because conference papers have an practically. It also has a more extensive and visible impact

since it is shown at a conference for specialists from several disciplines to observe (Baas et al., 2020; Bakri et al., 2021; Putri et al., 2021).

Figure 4 shows mapping visualization throughout the PsPT CTS research during 2001 to 2022. It consists of three main clusters, namely: cluster 1, marked by red node (n=12); cluster 2, characterized by green node (n=11); and cluster 3, marked by blue node (n=7 items). To find the novelty of the PsPT CTS research, we can remark between the primary keywords to the minor keyword. For example, in **Figure 5, a) and b)** CTS are highly related to 'students' and also 'PsT' comparing **c) and d)** 'Problem-based learning' and 'teaching material' that does not have any link to PsT.

Table 1 describes that the most strength link of each keyword is students (n=257), followed by CTS (n=225) and CT (n=162) in the third place. Then, it is known that the PsPT CTS research is much more related to students and CTS or CT itself. It can be concluded in **Figure 5** and **Table 1** that in the 'students,' 'CTS' and 'CT' are still possible for future research to develop or improve the previous research. Based **Table 2**, the top source title is the Journal of Physics Conference Series with a total of 62 documents. This is in accordance with the type of document that is widely used in PsPT CTS research is conference paper, so, the source title that contributes most to PsPT CTS research is conference series or conference proceedings.

Then, for top affiliation, the Universitas Pendidikan Indonesia ranked first in the publication of PsPT CTS research with 17 documents. This is in line with the focus of the Universitas Pendidikan Indonesia which is involved in the field of education, of course, it will not be separated from PsT and CTS. **Figure 6** showed Setiawan, A. has 78 citation with total link strength 20; Suhandi, A. has 70 citation with total link strength 21; Malik, A. has 68 citation with 18 total link strength; Permanasari, A. has 67 citation with 15 total link strength; and Kaniawati, I. has 9 citation with 6 total link strength. It can be seen that each top contributed authors are linked each other are mean related to each other (Hudha et al., 2020; Sun & Yuan, 2020). However, the most widely used language in PsPT CTS publications is English, this is shown in **Table 3**. English is the most used paper language (n=131). Because English is an international language, everyone understands it (Caruso, 2018; Cenoz & Gorter, 2020; Haidar & Fang, 2019; Hao et al., 2019; Jindapitak, 2019; Matsuda, 2019; Song & Xia, 2021). So it can be the flexibility of readers around the world to have a good grip of the papers.

However, research by Ryu et al. (2019) many obstacles that PsT encountered or expected when teaching STEM topics using integrated methods. Hence, it could be a novelty to alleviate the obstacle and become an opportunity to improve the PsPT CTS. Further research also believed that the integration of technological based learning are tend to enhance the PsPT CTS (Tondeur et al., 2019), in specific way technological pedagogical content knowledge (TPACK) provides recommendations to improve the potential (Tondeur et al., 2020). Hence, it is in line with the finding of mapping visualization of the novelty that on problem based learning and teaching material that can integrating or also assisting with the technology based education.

CONCLUSION

Fundamental Finding : Based on the analysis of PsPT CTS bibliometric research during 2001 to 2022, it can be concluded that the trend of PsPT CTS tends to be interesting to future research, building upon the increase in the publication in PsPT CTS each year. The conference paper is the most used type of document in PsPT CTS due to its practice. It has a more visible impact since it is shown at a conference for many specialists from several disciplines to observe. **Implication :** The PsPT CTS is highly related to 'students' and 'PsT' compared to 'problem-based learning and teaching material that does not have any link to PsT. **Limitation :** This study is still limited to Scopus data base only. **Future Research :** It is still possible to develop or improve the obstacle PsT. Specifically, integrated STEM to enhance PsPT CTS due to its minimal keywords and so adding other database to larger the mount of documents gathered.

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