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Cybergogy Trends in Cognitive Psychology of Physics Learning: A Systematic Literature Review from 2019-2023 with NVivo

Achmad Samsudin[1*], Hera Novia[2], Andi Suhandi[3], Adam Hadiana Aminudin[4], Muhamad Yusup[5], Supriyatman Supriyatman[6], Masrifah Masrifah[7]

[1,2] Physics Education, Faculty of Mathematics and Natural Science Education, Universitas Pendidikan Indonesia, Street of Setiabudi No.229, Bandung 40154, Indonesia
[3] Science Education, Faculty of Mathematics and Natural Science Education, Universitas Pendidikan Indonesia, Street of Setiabudi No.229, Bandung 40154, Indonesia
[4] Electrical Engineering, Faculty of Industrial Technology, Universitas Kebangsaan Republik Indonesia, Street of Terusan Halimun No.37, Bandung 40263, Indonesia
[5] Physics Education, Faculty of Teacher Training and Education, Universitas Sriwijaya, Street of Al Gazali Mosque, Palembang 30128, Indonesia
[6] Physics Education, Faculty of Teacher Training and Education, Universitas Tadulako, Street of Soekarno Hatta No.KM. 9, Palu 94148, Indonesia
[7] Physics Education, Faculty of Teacher Training and Education, Universitas Khairun, Street of Pertamina Campus II Gambesi, Ternate, Indonesia

e-mail:, [1*]achmadsamsudin@upi.edu, [2]heranovia68@gmail.com, [3]andi_sh@upi.edu, [4]adamhadianaaminudin@mipa.ukri.ac.id, [5]m_yusup@fkip.unsri.ac.id, [6]spymfis.untad@gmail.com, [7]masrifah@student.upi.edu
*** Corresponding Author**

Abstract

The purpose of this Systematic Literature Review (SLR) is to identify the cybergogy trends in cognitive psychology in physics learning from 2019-2023. The focus of this review includes research methods, technology used, links to cognitive psychology, and physics concepts. A total of 60 articles (60 articles indexed Scopus and 29 of them indexed Scopus and WoS) were used in this review using the Prisma guide. The analysis was carried out with the help of NVivo12 as well as percentage calculations. The results show that: 1) The research method used is dominated by quasi-experiments (22%); 2) The technology used in learning is dominated by virtual reality/lab (35%); 3) Most of the links with cognitive psychology are devoted to conception (33%), and; 4) Physics concepts that are widely used in research are dominated by concepts related to electricity and magnetism (27%). The results of this review indicate that research on cybergogy directly in physics learning is still minimal. However, if it is generalized to research on technology in physics learning over the last five years, it can be seen that the trend is quite good. Thus, the results of this review recommend further research in developing technologies that are popular in physics learning cybergogy, such as the development of virtual reality/lab or Augmented Reality.

Keywords: Cybergogy; Cognitive Psychology; Physics Learning

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INTRODUCTION

Indonesia has declared Covid-19 a pandemic in early 2020. Various fields have begun to be affected by the pandemic, one of which is education. Many changes have occurred in education in Indonesia after the pandemic was inaugurated, for example in the learning process (Purwadi et al., 2021; Rahayu et al., 2022; Rasmitadila et al., 2020). The learning process in various schools must be carried

out by implementing health protocols by using masks, limiting distance, and interactions that were initially normal to be slightly disrupted. In fact, after the implementation of Distance Learning (PJJ) or Online Learning at all levels of education, from Early Childhood Education to Higher Education (Martha et al., 2021), making all levels of education practitioners have to adapt massively to technology. This situation became the beginning of the popularity of the use of technology in education in Indonesia. In fact, previously technology had also been widely used in learning due to the rapid development of technology and information, as well as the industrial revolution 4.0 (Lukita et al., 2020; Sudibjo et al., 2019; H. Sen Tan et al., 2020). Thus, that the pandemic in Indonesia seems to be the right momentum in making regulations related to the use of technology in education, especially when PJJ/Online Learning is enacted. In fact, after Indonesia stated that Covid-19 was no longer a pandemic, the use of online technology was still carried out in several educational activities (Febrianto et al., 2020; Prasetyanto et al., 2022; Yudiawan et al., 2021). The positive impact of this situation has made education in Indonesia grow. This is also marked by the increasing intensity of education practitioners, such as researchers, lecturers, teachers and students in using educational technology which can be accessed anytime and anywhere via the internet. The learning process that utilizes flexibility and independence is in line with the concept of cybergogy (Amiruddin et al., 2023; Panggabean & Wijaya, 2021; Wang & Kang, 2006).

Cybergogy is defined as a method in the virtual learning process in improving students' cognitive, emotional and social abilities that can be implemented independently and flexibly. Wang & Kang (2006) started introducing the concept of cybergogy since 2006 regarding the online learning environment with cognitive, emotional and social factors. The details of the three factors can be seen in Table 1 (Wang & Kang, 2006).

Table 1. Cybergogy Online Learning Environment

Factors	No	Types
Cognitive	1	Prior knowledge/Experience
	2	Achievement goals
	3	Learning activity
	4	Cognitive/learning style
Emotion	1	Feeling of self
	2	Feelings of community
	3	Feelings of learning atmosphere
	4	Feelings of learning process
Social	1	Personal attributes
	2	Context (socio-cultural)
	3	Community
	4	Communication

The factors contained in Table 1 are expected to be present in cybergogy learning. Thus, currently education practitioners in Indonesia are not only required to have pedagogical skills, but also technological skills (Caena & Redecker, 2019; Falloon, 2020; Kim et al., 2019), in development or use to create a cybergogy learning environment. Then, to identify its popularity, a data search was carried out through the Scopus database related to cybergogy.

An initial search was conducted (7 July 2023) on the Scopus database with the following criteria: (title (cybergogy) or title (cyber and pedagogy) or title (digital and pedagogy)) and (limit-to (pubyear, 2019) or limit-to (pubyear , 2020) or limit-to (pubyear, 2021) or limit-to (pubyear, 2022) or limit-to (pubyear, 2023)) and (limit-to (subject, "soci")) and (limit-to (doctype, "ar")) and (limit-to (pubstage, "final")) and

(limit-to (srctype, "j")) and (limit-to (language, "english")). As a result, there were 103 articles which were then analyzed using VOSviewer (Figure 1).

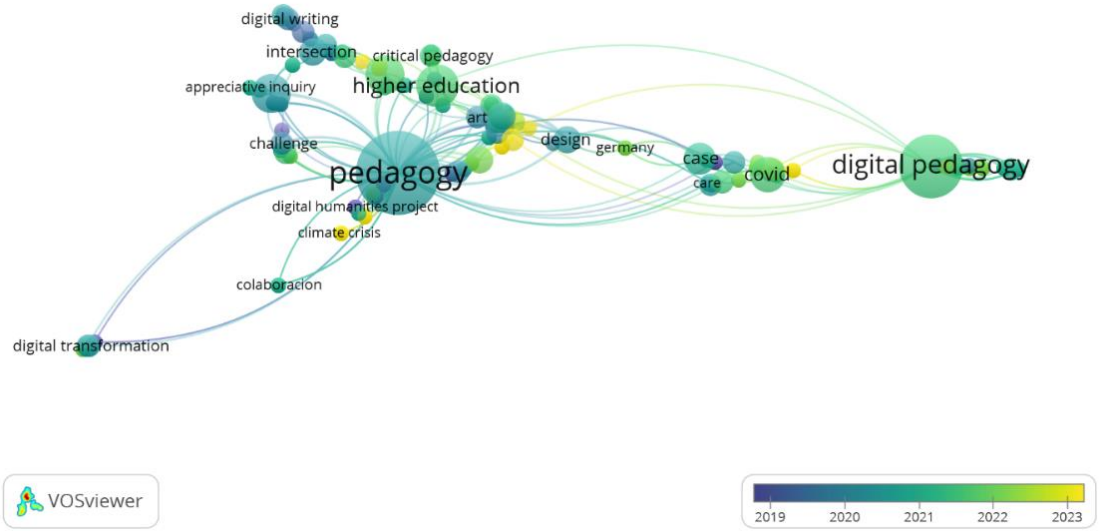

Figure 1. Analysis of the Cybergogy Article by Title

Figure 1 shows that research on cybergogy (specifically aimed at research titles) is dominated by Pedagogy and Digital Pedagogy research. However, conceptually, it is still difficult to find its relation to physics learning. Further analysis is then carried out with the same data using keywords for the specification. The results can be seen in Figure 2.

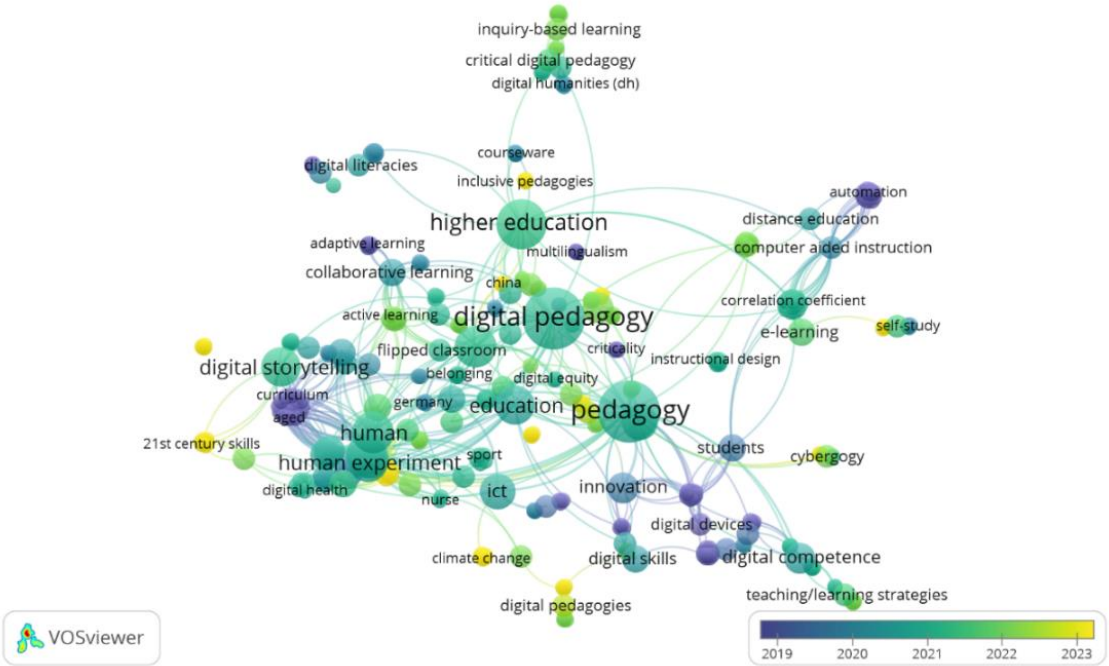

Figure 2. Analysis of the Cybergogy Article by Keywords

The same results are shown based on the analysis of keywords in Figure 2. Based on this analysis, the three keywords that appear the most are Pedagogy, Digital Pedagogy, and Higher Education. However, the relationship with physics

learning specifically still cannot be identified. Whereas, physics learning is greatly helped by the development and use of technology (Fatmawati & Sulisworo, 2021; Handhika & Sasono, 2021; Wahyudi et al., 2021). For this reason, this review divides the word cybergogy into various words that are still related to it and focuses on types of technology and cognitive psychology in learning physics.

Cognitive psychology is closely related to mental states such as learning, remembering, and thinking about information (Furnham, 2019; Syrjämäki & Hietanen, 2019). Cognitive psychology is also closely related to learning (Houwer, 2021). Such as the cognitive abilities contained in cybergogy described Wang & Kang (2006) seen as part of the human ability to process information like a computer. Psychological events that occur generally involve input, process, and output. Syrjämäki & Hietanen (2019) explains the cognitive psychology information processing model contains three stages, namely perception, cognitive and affective evaluation, and (long-term) memory. Thus, the purpose of this review is to identify cybergogy trends in cognitive psychology in physics learning from 2019-2023. Meanwhile, the focus studied in this review is summarized in the following questions:

1. What research methods trends are mostly used by researchers in cybergogy?
2. What technology trends are mostly used in cybergogy?
3. What cognitive psychology trends are mostly used in cybergogy?
4. What physics concepts trends are mostly used studied in cybergogy?

METHODS

1. Design

This Systematic Literature Review (SLR) was carried out using the Prisma guide because they could choose articles according to their needs (e.g. Ortiz-Martínez et al., 2019; Page et al., 2021; Zarate et al., 2022). The Prisma guidelines in research can be seen in Figure 3.

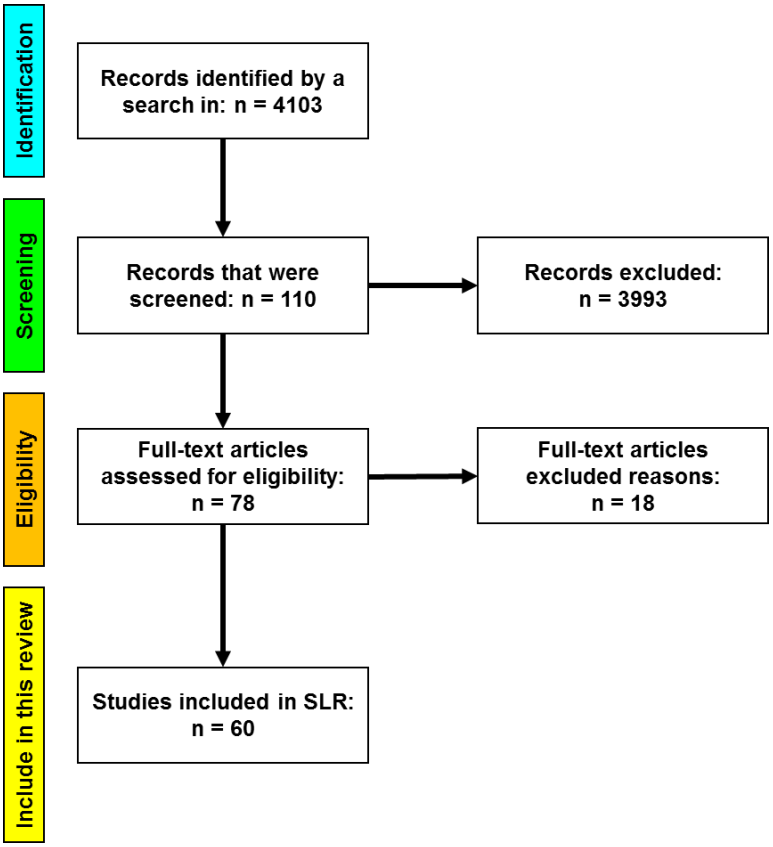

Figure 3. The Prisma guidelines

Figure 3 shows the Prisma guide beginning with the "identification" stage. This stage is an initial search from the Scopus database with the solving keyword from cybergogy. This is done because in Figure 1 it has been identified that a direct search for the word cybergogy has not yielded maximum results. For this reason, searches at this stage are carried out by entering keywords related to cybergogy. The search was carried out using the following criteria: (title (cybergogy) or title (cyber and pedagogy) or title (digital and pedagogy) or title (virtual) or title (reality) or title (simulation) or title (media) and title (physics and learning) or title (physics and education) or title (physics) or title (physics and concept) or title (conceptual and change) or title (misconception) or title (alternative and conception) or title (mental and model)). As a result, 4103 articles were obtained which were then filtered as needed at the "screening" stage. The screening is carried out in the following sections: subject area (Social Sciences), Document Type (Article); Publication stage (Final); Source Type (Journal); Language (English). Thus, 110 articles were included in this screening. Furthermore, at the "eligibility" stage, only research articles are examined, excluding literature review articles. As a result, there are 78 articles that fit these criteria. Finally, we examine the 2022 SJR quartiles at the “include in this review” stage. So that the articles used in this review amounted to 60 articles.

2. Samples

Based on the Prisma guidelines in Figure 3, the articles used in this review are 60 articles indexed by Scopus (Q1, Q2, Q3, and Q4) and 29 of them are indexed by WoS (Emerging Sources Citation Index (ESCI), Science Citation Index Expanded (SCIE), SSCI, and Science Citation Index Expanded - Social Sciences Citation Index

(SCIE-SSCI)). An example of the identities of the 60 articles used can be seen in Table 2.

Table 2. Example of 10 articles from a total of 60 articles used

Code	Title	Year	Journal	SJR 2022	WoS
A1	Physics learning by PhET simulation-assisted using problem based learning (PBL) model to improve students' critical thinking skills in work and energy chapters in MAN 3 Sleman	2019	Asia-Pacific Forum on Science Learning and Teaching	Q4	-
A2	Effects of learning physics using Augmented Reality on students' self-efficacy and conceptions of learning	2021	British Journal of Educational Technology	Q1	SSCI
A3	University Learners' Motivation and Experiences in Using Virtual Laboratories in a Physics Course [Motivation et expériences des apprenants universitaires dans l'utilisation de laboratoires virtuels dans un cours de physique]	2022	Canadian Journal of Learning and Technology	Q3	-
A4	Limits on simulation approaches in intuitive physics	2021	Cognitive Psychology	Q1	SCIE-SSCI
A5	A framework utilizing augmented reality to improve critical thinking ability and learning gain of the students in Physics	2021	Computer Applications in Engineering Education	Q1	SCIE
A6	Integrating augmented reality into problem based learning: The effects on learning achievement and attitude in physics education	2019	Computers and Education	Q1	ESCI
A7	Development and evaluation of granular simulation for integrating computational thinking into computational physics courses	2022	Education and Information Technologies	Q1	SSCI
A8	The effect of using computer simulation on students' performance in teaching and learning physics: Are there any gender and area gaps?	2021	Education Research International	Q3	
A9	Fostering Pre-Service Physics Teachers' Pedagogical Content Knowledge Regarding Digital Media	2022	Education Sciences	Q2	ESCI
A10	An investigation of students' use of a computational science simulation in an online high school physics class	2019	Education Sciences	Q2	ESCI

*Note: SSCI= Social Sciences Citation Index; SCIE= Science Citation Index Expanded; ESCI= Emerging Sources Citation Index

Table 2 shows 10 examples of articles from a total of 60 articles used in this review. All articles used in this review can be accessed on the page https://bit.ly/60ArticlesSLR. Meanwhile, a summary of the entire indexation of the 60 articles used can be seen in Figure 4.

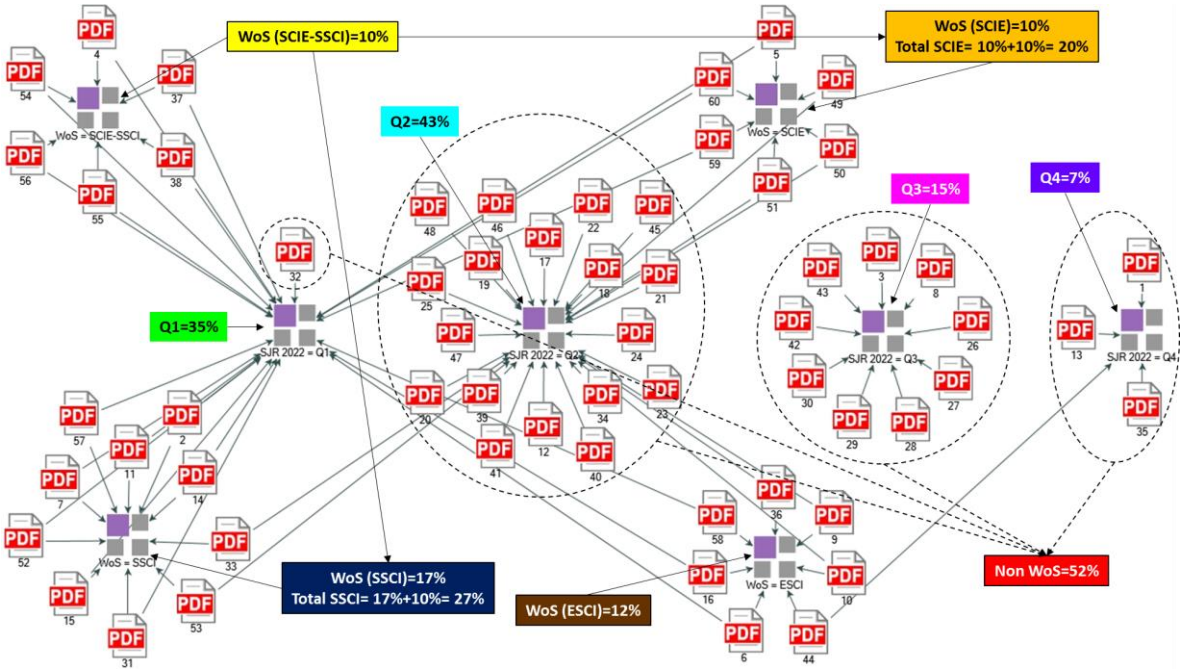

Figure 4. Indexation of 60 Articles Used

Figure 4 shows that the Scopus indexation of the 60 articles used is dominated by Q2 articles (43%) (Blue box) and at least there are Q4 articles (7%) (Purple box). Meanwhile, the WoS index is dominated by the SSCI index (17%). However, because there is a SCIE-SSCI index (10%) indicating that the article is WoS indexed on SCIE and SSCI, the overall SSCI index becomes 27% (Navy Box). This percentage is the index that dominates WoS indexation. While the lowest WoS indexation was found in ESCI (12%) (Brown Box). However, the highest percentage is actually found in articles that are not WoS indexed (52%) (Red Box). However, the focus of this review is to prioritize the Scopus index because this index is currently popular in Indonesia.

3. Data analysis

The data analysis used in this review uses the help of NVivo12 and uses percentages for the calculations. NVivo analysis is used to create maps and make it easier to read data and turn it into information (Rasmitadila et al., 2020; Samsudin et al., 2023; Syaodih et al., 2021). The percentage used is calculated as in Equation 1.

$$\% = \frac{Articles\ Included\ in\ the\ Category}{Total\ Articles} x100 \quad (1)$$

RESULTS AND DISCUSSION

1. Trends in Research Methods

The results of the NVivo12 analysis regarding trends in research methods used in cybergogy research can be seen in Figure 5.

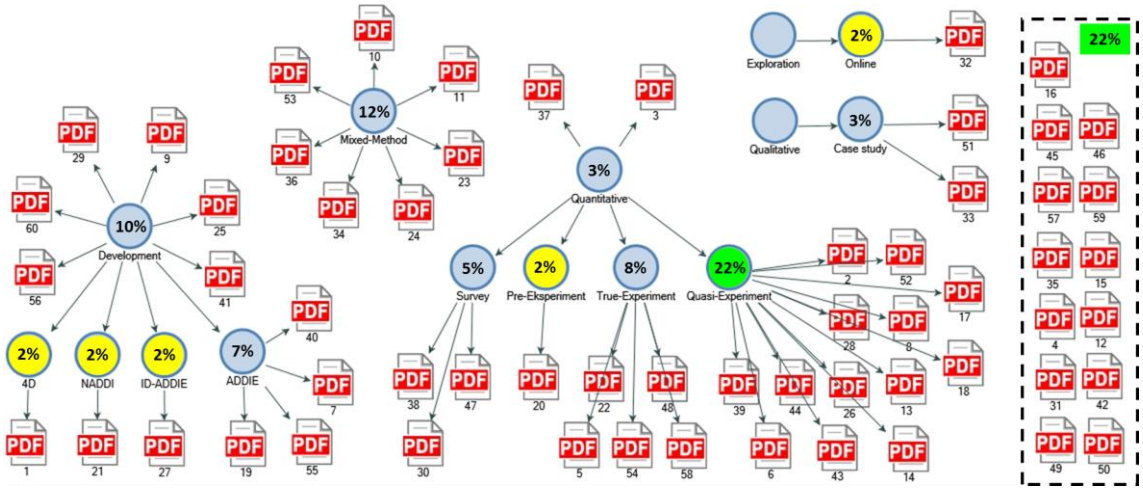

Figure 5. Analysis of Trends in Research Methods

Figure 5 shows the trends in the research methods used by the 60 articles analyzed. It can be identified that the methods used in cybergogy research include: 1) Development method (10%+2%+2%+2%+7%=23%) (with designs including 4D (Define, Design, Develop, Disseminate), NADDI (Needs Assessment, Design, and Development & Implementation), ID-ADDIE (Instructional Design Analyze, Design, Development, Implementation, Evaluation), and ADDIE (Analysis-Design-Development-Implementation-Evaluation)); 2) Mix-method (12%); 3) Quantitative method (3%+5%+2%+8%+22%=40%) (with designs including survey, pre-experiment, true-experiment, and quasi-experiment); 3) Qualitative method (3%) (with the design used is a case study), and; 4) Exploratory method (2%) (with the design used is online). However, the design used was dominated by a quasi-experimental design (22%) (green circle). Meanwhile, the least used designs include 4D design, NADDI, ID-ADDIE (development method), pre-experimental design (quantitative method), and online design (exploration method) which all have a percentage of 2%. The other 22% are articles that do not clearly state the research method (box with dotted line). These results are supported by statements Gopalan et al. (2020) which explains that in the last few decades, the use of quasi-experimental research designs in educational research is often found. This is because in educational research, research is usually conducted on students who are grouped into experimental and control groups. The sample selection is usually done by purposive sampling technique because usually there are certain criteria in sample selection. In addition, in educational research it is usually unavoidable from external factors, so the use of quasi-experiments has become a popular method in educational research.

2. Tren in Technology

The results of the NVivo12 analysis regarding technology trends used in cybergogy research can be seen in Figure 6.

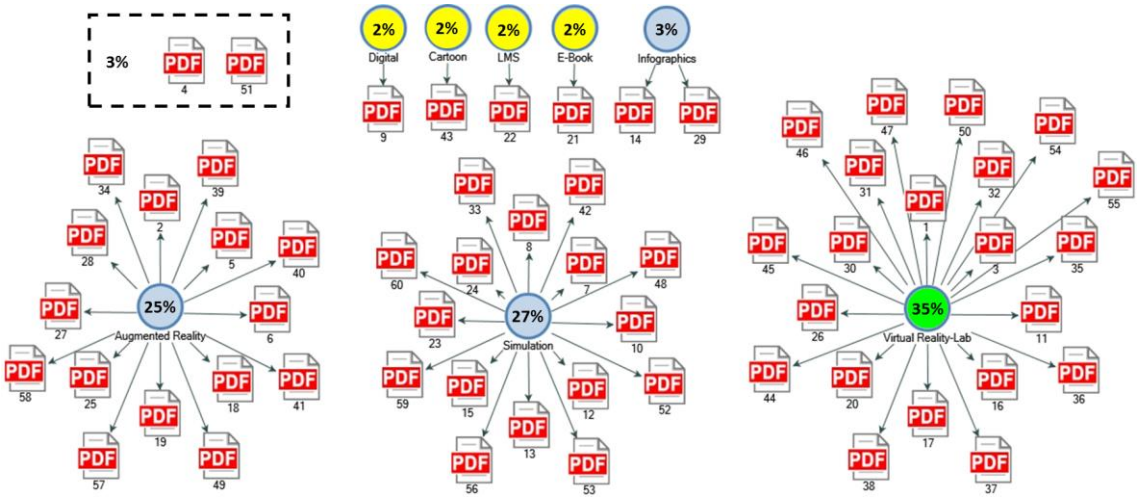

Figure 6. Analysis of Trends in Technology

Figure 6 shows a list of technologies used in research related to cybergogy. Some of these technologies include: 1) Augmented Reality (25%); 2) Simulation (27%); 3) Virtual Reality-Lab (35%); 4) Digital (2%); 5) Cartoon (2%); 6) LMS (2%); 7) E-Books (2%), and; 8) Infographics (3%). Thus, that it can be identified that the technology that is widely used is the Virtual Reality-Lab (35%). While the technology that is minimally used is Digital, Cartoons, LMS, and E-Books, all of which have a percentage of (2%). The other 3% of articles are unclear in mentioning the technology they use. These results are supported by research Martín-Gutiérrez et al. (2017) who explained that virtual reality has attracted many people, and the education sector is one part that can benefit from it. So this makes it possible to present virtual environments that are impossible to visualize in class, such as access to virtual laboratories, creating simulations, or even medical scenarios. (Huang et al., 2019; Martín-Gutiérrez et al., 2017; Y. Tan et al., 2022). However, between Virtual Reality (VR) and Augmented Reality (AR), each has its own advantages. Huang et al. (2019) explained that VR is more immersive and engaging through its mechanics, while AR is a more effective medium for conveying information with immersive experiences. So it is not surprising that the results of reviews of the technology used are dominated by VR, and followed by AR.

3. Trends in Cognitive Psychology

The results of the NVivo12 analysis regarding cognitive psychology trends used in cybergogy research can be seen in Figure 7.

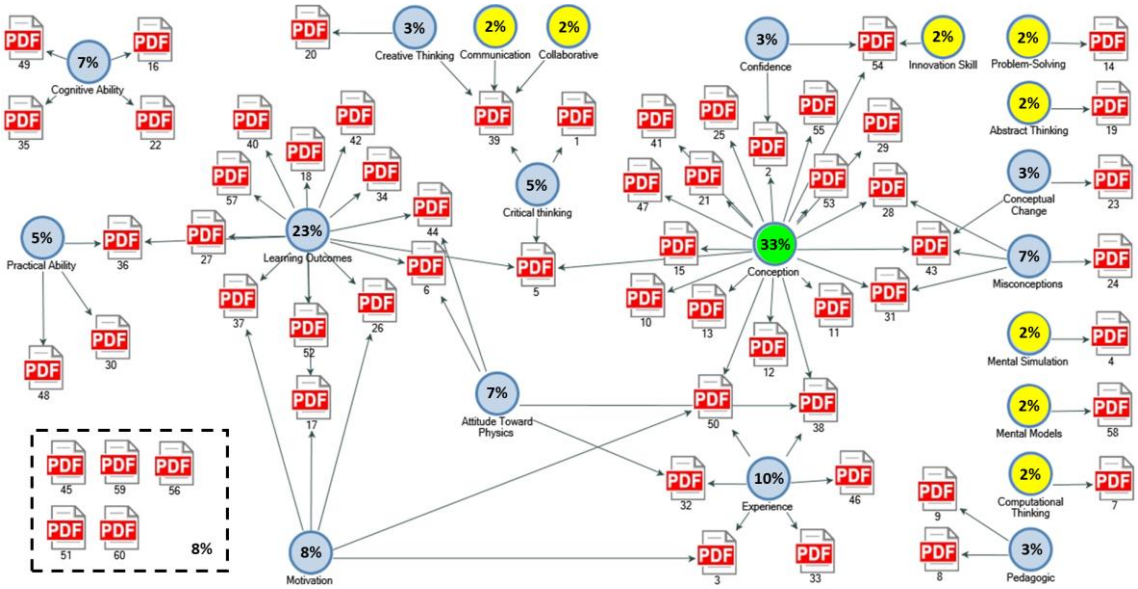

Figure 7. Analysis of Trend in Cognitive Psychology

Figure 7 shows a more complex picture regarding the identified cognitive psychology outcomes. This happens because one article can discuss 2-3 outcomes from cognitive psychology. There are 21 outcomes, including: 1) Cognitive Ability (7%); 2) Practical Ability (5%); 3) Learning Outcomes (23%); 4) Motivation (8%); 5) Attitude Toward Physics (7%); 6) Creative Thinking (3%); 7) Communications (2%); 8) Collaborative (2%); 9) Critical thinking (5%); 10) Confidence (3%); 11) Conception (33%); 12) Experience (10%); 13) Innovation Skills (2%); 14) Problem-Solving (2%); 15) Abstract Thinking (2%); 16) Conceptual Change (3%); 17) Misconceptions (7%); 18) Mental Simulation (2%); 19) Mental Models (2%); 20) Computational Thinking (2%), and; 21) Pedagogic (3%). Based on these results, the cognitive psychology of the 60 articles is dominated by Conception (33%), and at least there are Communication, Collaborative, Innovation Skills, Problem-Solving, Abstract Thinking, Mental Simulai, Mental Models, and Computational Thinking which all have a percentage by 2%. Of the 21 cognitive psychology categories identified, we matched the cybergogy learning environment accordingly (Wang & Kang, 2006) in Table 1, and the results can be seen in Table 3.

Table 3. Cognitive Psychology Outcome Relationship with Cybergogy Online Learning Environment

Factors	No	Types	No	Cognitive Psychology Outcome
Cognitive	1	Prior knowledge/Experience	1	Cognitive Ability
			2	Practical Ability
			3	Learning Outcomes
			4	Creative Thinking
			5	Critical thinking
			6	Conception
			7	Innovation Skill
			8	Problem-Solving
			9	Abstract Thinking
			10	Conceptual Change
			11	Misconception
			12	Mental Models
			13	Computational Thinking
	2	Achievement goals	1	Cognitive Ability
			2	Practical Ability
			3	Learning Outcomes
			4	Creative Thinking

Factors	No	Types	No	Cognitive Psychology Outcome
			5	Critical thinking
			6	Conception
			7	Innovation Skill
			8	Problem-Solving
			9	Abstract Thinking
			10	Conceptual Change
			11	Misconception
			12	Mental Models
			13	Computational Thinking
	3	Learning activity	1	Experience
			2	Mental Simulation
			3	Mental Models
			4	Pedagogic
	4	Cognitive/learning style	1	Experience
			2	Pedagogic
Emotion	1	Feeling of self	1	Motivation
			2	Confidence
	2	Feeling of community	1	Experience
	3	Feeling of learning atmosphere	1	Experience
			2	Pedagogic
	4	Feeling of learning process	1	Experience
Social	1	Personal attributes	1	Attitude Toward Physics
	2	Context (socio-cultural)	1	Experience
			2	Pedagogic
	3	Community	1	Collaborative
	4	Communication	1	Communication

Based on the results in Table 3, the most dominant factor is the cognitive factor for the type of Knowledge/Previous Learning Experience and Achievement Goals. This can be identified from the results of research that focuses on learning outcomes, and their relation to student knowledge. Based on these findings, the overall concept of cybergogy can be fulfilled for all factors.

4. Tren Konsep Fisika

The results of the NVivo12 analysis regarding the trend of physics concepts used in cybergogy research can be seen in Figure 8.

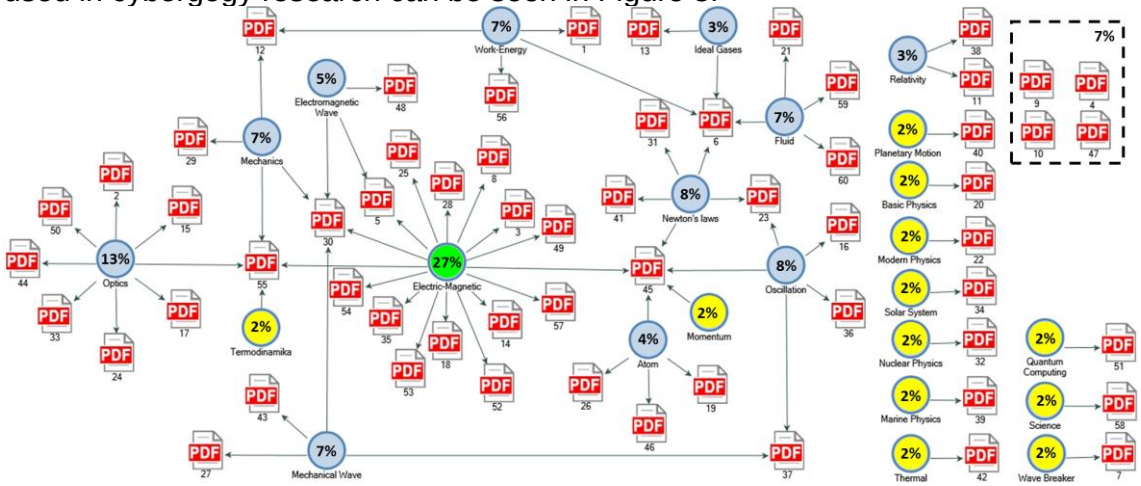

Figure 8. Analysis of Trend in Physics Concepts

Figure 8 shows the trend of physics concepts used from the 60 articles analyzed. The most widely used physics concept in research related to cybergogy is the electric-magnetic concept (27%) (green circle). Meanwhile, the physics concepts

that are least used are the concepts of thermodynamics, momentum, planetary motion, basic physics, modern physics, solar systems, nuclear physics, marine physics, thermal, quantum computing, science, and wave breaker, all of which has a percentage of 2% (yellow circle). Thus, it can be said that the electric-magnetic concept is one of the interesting concepts to be developed in the form of learning technology.

RECOMMENDATION

Based on the reviews that have been done, it can be concluded that: 1) The research method used is dominated by quasi-experiments (22%); 2) The technology used in learning is dominated by virtual reality/lab (35%); 3) Most of the links with cognitive psychology are devoted to conception (33%), and; 4) Physics concepts that are widely used in research are dominated by concepts related to electricity and magnetism (27%). The results of this review indicate that research on cybergogy directly in physics learning is still minimal. However, if it is generalized to research on technology in physics learning over the last five years, it can be seen that the trend is quite good. Thus, the results of this review recommend for further research in developing technologies that are popular in physics learning cybergogy, such as the development of virtual reality/lab or Augmented Reality.

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