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How Eyes and Brain See Color: Definition of Color, Literature Review with Bibliometric Analysis, and Inquiry Learning Strategy for Teaching Color Changes to Student with Mild Intelligence Barriers

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ABSTRACT

The study aims to investigate how the eyes and brain see color. We added information regarding the definition of color and a literature review regarding current theories and research trends in color, including how light comes to an object and its reflection onto the eyes and brain, making the brain interpret the object. Also, we considered the concept and the implementation of inquiry learning strategies in learning activities to recognize color changes from primary, secondary, to tertiary color. To support our study, we employed bibliometric analysis, helping us to find out the current studies in implementing inquiry learning strategies, specifically in recognizing color and its changes in education. The concept of color changes was delivered to children with mild intellectual disabilities. The results showed that the teaching concept of how eyes and brain see color as well as learning activities to recognize color changes for children with mild intellectual disabilities is still rare. Learning activities can be implemented if the learning process is carried out appropriately, confirmed by the learning outcomes. This study can provide information for researchers and educators in carrying out learning activities to recognize color changes in children with intellectual disabilities through inquiry learning strategies.

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1. INTRODUCTION

The primary color is pure color that has not been mixed with other colors. This is usually called basic color. Basic colors consist of red, yellow, and blue (Nassau, 1980; Abramov & Gordon, 1994). Another type of color is secondary color, which is the result of the mixing of primary colors. For example, a combination of red and yellow will produce orange, or a combination of yellow and blue will produce green. By learning activities to recognize color changes through inquiry learning strategies, children can understand the theory of combining colors and discover new colors resulting from combining these colors.

The learning activity to recognize color changes from primary to secondary color is important, and it is needed to bring a discovery learning strategy. Specifically, when we face students with special needs. The addition of a new strategy is crucial and implemented as an inquiry learning strategy (Maryanti *et al.,* 2021; Rahmat, 2022). Through the inquiry learning strategy, children with intellectual disabilities can be active and enthusiastic in participating in learning activities (Mastropieri *et al.*, 1999; Brigham *et al.,* 2011; Scruggs & Mastropieri, 1994). The academic abilities of children with mild intellectual disabilities can follow the learning process, especially basic knowledge, one of which is learning to recognize color changes. Children with intellectual disabilities are taught to combine primary colors to produce secondary colors.

Currently, many reports discussed inquiry learning strategies (Ogunjimi & Gbadeyanka, 2023; Humphrey-Darkeh *et al.,* 2023), including analysis of application of the inquiry model in mathematics learning, application of the inquiry learning method to improve science learning outcomes regarding the use of plastic, wood, glass, and paper for class III blind students (Setyowati, 2020), improving science learning outcomes using the inquiry method for class VII blind students (Pratama *et al.*, 2020), increasing ability to understand object materials and its nature through the application of inquiry methods to deaf students in class IV (Aini, 2019), learning Islamic education strategies for deaf children (Suradi & Mawardi, 2020). However , until now there has been no research that discusses inquiry learning strategies in recognizing color changes in children with intellectual disabilities.

This research aims to investigate how eyes and brain see color by implementing inquiry learning strategies in learning activities to recognize color changes from primary color to secondary color in children with mild intellectual disabilities using bibliometrics and to find out the results of implementing inquiry learning strategies in learning activities to recognize color changes from primary color to secondary color in children with mild intellectual disabilities at one of the special schools in Bandung, Indonesia.

Inquiry learning strategies can be implemented if the learning process is carried out appropriately and following students' needs (Salovaara, 2005; Suryawati & Osman, 2017). It is hoped that the results of the research will provide information for readers, especially teachers, in learning activities to recognize color changes in children with intellectual disabilities through this inquiry learning strategy. Also, to complete this study, we added bibliometric analysis. We hereby give a comprehensive collection of bibliometric articles, as indicated in **Table 1**, with references to earlier bibliometric studies and our investigations into earlier bibliometric analysis.

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Table 1. Previous studies on bibliometrics.

No	Title	Result
1	The use of simple spectrophotometer in STEM education: A bibliometric analysis	The study, which made use of the VOSviewer program, found that modified spectrophotometers are frequently used in chemistry and STEM teaching, providing prospects for future research.
2	Correlation between process engineering and special needs from bibliometric analysis perspectives.	VOSviewer, a process engineering tool for mapping analysis, experienced a decrease in publications on "process engineering special demands" between 2017 and 2021.
3	Bibliometric analysis for understanding the correlation between chemistry and special needs education using VOSviewer indexed by Google.	An analysis of articles on chemistry and special education using VOSviewer and Publish or Perish showed a decline in publications in 2017 and a rise in 2021.
4	Implementation of Biotechnology in Education Towards Green Chemistry Teaching: A Bibliometrics Study and Research Trends	With journals being the most prevalent source, the study bibliometric analysis of research trends on biotechnology in education revealed four study concept potentials, underscoring the significance of teaching green chemistry in schools.
5	Research Trends about internet of things in Science Education: A bibliometric analysis	Research on IoT in science education is still very low, and only a few countries have just researched IoT in science education.
6	Bibliometric analysis of briquette research trends during the Covid-19 pandemic.	A review of 973 pertinent papers on briquettes was analyzed using VOSviewer, bibliometric analysis, and data mapping; the results showed a decline in research over the previous three years as a result of the COVID-19 pandemic.
7	Computational bibliometric analysis on publication of techno-economic education.	A study on science and Islamic research that employed data from the Scopus database from 2012 to 2022 and VOSviewer for bibliometric analysis found a reduction in research, mainly in Indonesia and Malaysia.
8	Bibliometric computational mapping analysis of publications on mechanical engineering education using VOSviewer	A study that used VOSviewer to chart the development of nano propolis research over the last ten years found a spike in research on nanoparticles and propolis.
9	Particulate matter emission from combustion and non-combustion automotive engine process: review and computational bibliometric analysis on its source, sizes, and health and lung impact	This study discusses the growth trend of scientific publications on the topic of particulate matter identified based on several categories such as the most cited, publisher, author, country, and affiliation.
10	Involving Particle Technology in Computational Fluid Dynamics Research: A Bibliometric Analysis	The purpose of this study was to ascertain: (i) the increase in the number of scientific publications in the area of particle technology in computational fluid dynamics (CFD); (ii) the top citations according to citation count, publisher, and nation; (iii) the most productive author's visualization; and (iv) the publication development map using keywords.

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Table 1 (Continue). Previous studies on bibliometric

No	Title	Result
11	How Language and Technology Can Improve Student Learning Quality in Engineering? Definition, Factors for Enhancing Students Comprehension, and Computational Bibliometric Analysis	Reviewing advancements in language and technology research that have the potential to raise the standard of engineering education is the goal of the study. A bibliometric analysis (using the keywords "Language" AND "Engineering Learning" from Google Scholar (2020-2022) provides evidence for the explanation of many aspects that can affect the teaching and learning process.
12	Bibliometric data analysis of research on resin-based brakepads from 2012 to 2021 using VOSviewer mapping analysis computations	This study aims to analyze and demonstrate step-by-step bibliometric data analysis using VOSViewer completely and systematically. The analysis was carried out with the number of publications obtained, relating to the predetermined topics totaling 88 documents in 2017-2021.
13	Past, current and future trends of salicylic acid and its derivatives: A bibliometric review of papers from the Scopus database published from 2000 to 2021	Theoretical and practical interest in salicylic acid and its derivatives has increased over the last two decades, and with it, academic study in the field has been burgeoning. Most scientometric studies have only focused on a specific property of the topic compounds.
14	Research trends about STEM of Internet of things for science teachers: A bibliometric analysis	This study aims to analyze research trends about STEM Learning with the Internet of Things for science teachers by year, subject area, and country, and then visualization using Vos Viewer about deep research and networking with the other keywords.

2. LITERATURE REVIEW

2.1. Children with Intelligence Barriers

Intellectually challenged children are defined as children who experience intellectual functioning difficulties that are significantly below average, as well as deficits in adaptive behavior during their development. Children with this intelligence disorder have difficulty thinking (Nurhayati & Homdijah, 2020). Many reports regarding children with intelligence barriers have been published (Juhanaini *et al.,* 2022; Irawan, 2021; Maryanti, 2021; Apriyanti, 2023; Adesokan *et al.,* 2022; Manullang *et al.,* 2021; Maryanti *et al.,* 2021), informing these types of students need to be considered and treated to make them have better futures.

According to Nurhayati & Homdijah (2020), children with intellectual disabilities have deficiencies in learning information and skills in adapting to problems and new life situations, learning from new experiences, thinking abstractly, thinking creatively, assessing critically, avoiding mistakes, and overcoming difficulties. -difficulties, and the ability to plan for the future. The learning capacity of children with intellectual disabilities in abstract matters such as learning to read, write, and count is also hampered. The ability to learn tends to be without understanding or tends to learn by parroting.

Children with mild intellectual disabilities develop physically like normal children, but their IQ is below average. Children with mild intellectual disabilities experience limitations in cognitive function which impact the components of attention, memory, and generalization used in the learning process. Adaptability, personality, emotionality, independence problems, and thinking ability are all problems faced by children with mild intellectual disabilities (Yuliani & Armaini, 2019). The phrase "intellectual disability" refers to a child's multiple deficiencies in social, communication, and self-care abilities as well as cognitive functioning (Kilincaslan *et al.,* 2019; Burns *et al.,* 2019). A youngster

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may learn and develop more or differently from a child who is developing normally as a result of these flaws, or maybe more accurately, these restrictions.

Children with intellectual disabilities may find it challenging to communicate their true needs and wants to others and to take care of themselves (Lee *et al.*, 2015; Rogers, 2007). also, it could take a long time for Children with Intellectual Disability to learn, walk, speak, dress, or eat without help, they might face trouble learning in school. There are 1% of the overall population that is affected with Intellectual Disability, and those of about has 85% Mild Intellectual Disability. If we see gender-wise then males are more likely than females to be diagnosed with intellectual disability. Sometimes it can be caused by disease, injury, or any type of problem in the brain (Gupta & Sen, 2016; Sivanandam & Thakur, 2012; Ahmed *et al.*, 2017). However, in most cases, the reason behind their intellectual disability goes undiagnosed. Genetic factors (e.g., Fragile X syndrome, down syndrome, Williams syndrome), issues during pregnancy (e.g., consumption of alcohol during pregnancy, improper cell division), issues at birth (e.g., deficiency of oxygen), and health issues (e.g., malnutrition, inadequate medical care, contact with poisons, diseases like whooping cough, meningitis, or the measles) are some of the most common and known causes of intellectual disability.

Children who have mild intellectual disabilities have 3 characteristics: Low IQ (between 70-75 or below), onset before the age of 18 years old, and significant limitations in adaptive behavior (See **Figure 1**). For generalizations Intellectual Disability has 3 levels, they are mild, moderate, and severe /profound (DiStefano *et al.*, 2020 ; Engel -Yeger *et al.*, 2011). We explain each characteristics in **Table 2.** Especially for the Mild level, they have important relationships , may learn to read and write, and travel independently but may need help with money and organizing their daily lives. The moderate level has important relationships , uses certain words, and needs lifelong support in the planning and organization of their lives. Severe or profound levels probably have strong relationships with key people in their lives, have less or no speech, and need lifelong help in most areas.

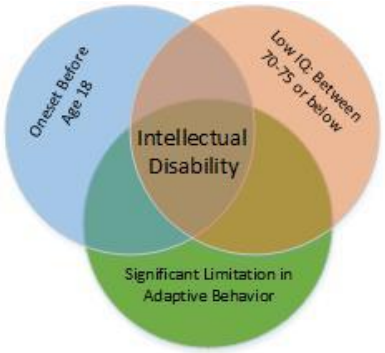

Figure 1. Characteristics for intellectual disability.

Table 2. Characteristics 3 levels intelectual disability.

	Mild	**Moderate**	**Severe/Profound**
IQ range	50-69	35-49	<35
% of cases	85%	10%	5%
Ability to self-care	Independent	Need some help	Limited
Language	Reasonable	Limited	Basic or none
Reading and writing	Reasonable	Basic	Minimal or none
Ability to work	Semiskilled	Unskilled, supervised	Supervised basic task
Social skill	Normal	Moderate	Few
Physical problems	Rare	Sometimes	Common
Aetiology discovered	Sometimes	Often	Usually
Academic skill	6^{th} grade or higher	2^{nd} to 3^{rd} grade	

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The more critical level of the Intellectual Disability, the earlier symptoms or signs can be detected. But it might be hard to tell how newborn children will be affected later in life. There are several different symptoms and signs of Intellectual Disability that can exist in children and alter depending on particular characteristics (Vissers *et al.*, 2016). These symptoms and signs may first become visible in childhood or some other cases might not notice until the child reaches school age. The most common symptoms include: sitting up, rolling over, crawling, or walking much later than developmentally appropriate, lower than average scores on IQ tests, issues in problem-solving or logical thinking, trouble learning in school, difficulty in communication, problems in remembering things, difficulties in talking, inability to connect actions with consequences, learning and developing more slowly than other children of the same age, and inability to make activities and everyday tasks such as utilizing the restroom without help or getting dressed.

Communication challenges are extensive within the intellectual disability field (Griffiths & Smith, 2016; García *et al.*, 2020). People typically struggle to read signs, communicate to get what they need , put some words to what they are going through , avoid being misunderstood, or make their voices heard. It is needed to keep in mind that people with a level of intellectual handicap do not necessarily indicate their aptitude or ability to communicate . Two factors influence intellectual barriers , namely : internal factors and external factors. An explanation of these two factors is in **Table 3.**

Table 3. Factors that influence intellectual barriers.

Internal Barriers	External Barriers
Cognitive impairment	Lack of appropriate or no easy-read material to support the person
Autism, behaviours that challenge, other phenotypes	Lack of reasonable adjustment to health information
Poor articulation skills	Inequitable services
Inability to read	Complex systems
Little or no education	Utilitarian approach
Fear or lack of confidence	Lack of understanding
Over-reliance on the carer	Ignorance
	Tendency to prioritise speech
	Use of complex language or jargon
	Insufficient allowance of time
	Fragmentation of information

2.2. Recognition of Color

The ability to recognize color is a child's knowledge about color, such as how to point, name, and group color according to the teacher's instructions in color recognition activities. If it is related to centers , then the introduction of color is found in natural materials centers . According to Hidayati *et al.* (2020), basic (primary) colors have three types, namely red, yellow, and blue when these colors are mixed , they will produce other colors (see **Figure 2**). This is following other opinion . In principle , there are three colors , namely red , yellow , and blue . Apart from these three colors, there are colors produced from these three basic colors.

Brewster 's theory existing color into 4 groups , namely : primary , secondary , tertiary , and quaternary color (Rashid *et al.*, 2020). This color grouping is often displayed in the form of a circle and is often called the Brewster color circle (**Figure 3**). According to the Brewster's theory, primary colors are basic colors, namely red (like blood), blue

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(like sea and sky), and yellow (like eggs). Secondary colors are a mixture of primary colors, such as red and blue to make purple, and yellow and red to make orange. Tertiary colors are the result of mixing primary colors and secondary colors, such as blue and purple to become purple-blue. Quaternary colors are the result of mixing color from mixing two tertiary colors, tertiary blue with tertiary yellow to become green brown.

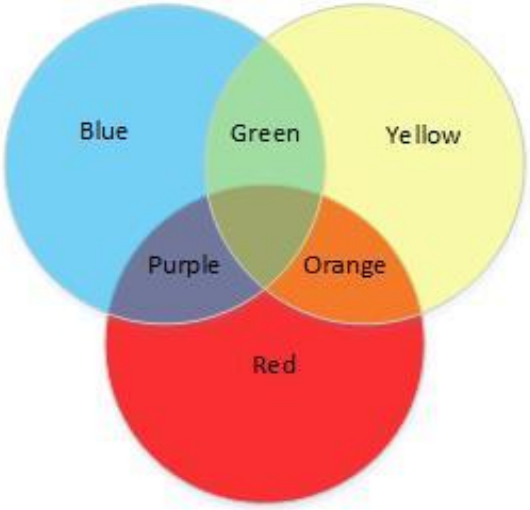

Figure 2. Three basic colors and produce the other color.

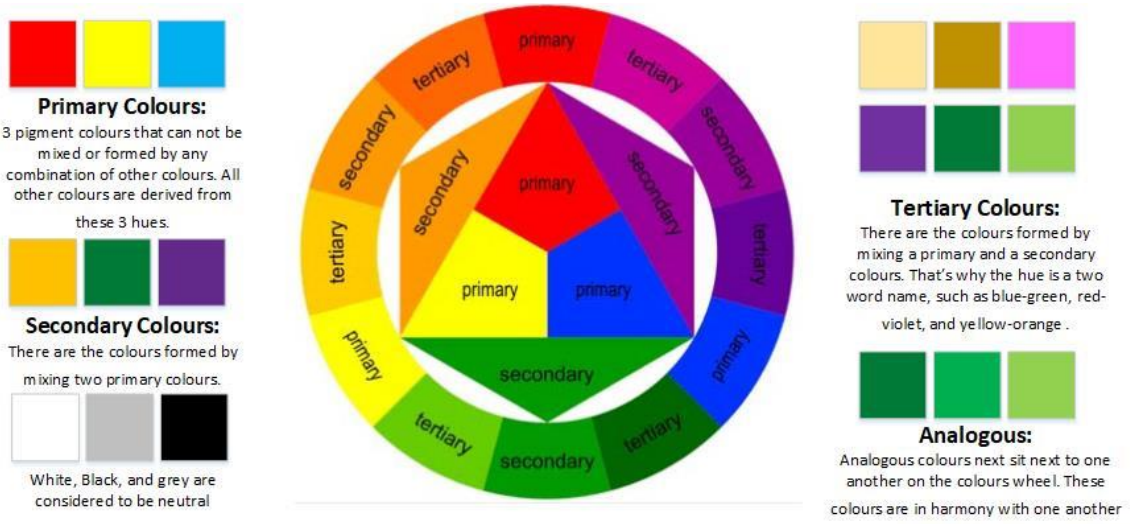

Figure 3. Brewster color circle.

Learning to mix colors improves children's creativity, children's cognitive abilities, and fine motor skills, especially if it is done continuously and becomes a reflection following the Montessori learning concept. The process that occurs when we see colors that are mixed and produce many colors directly provides a good stimulus for the performance of the human brain (Bae *et al.,* 2015; Elliot & Maier, 2014; Ramachandran & Hubbard, 2001)**. Figure 4** shows the process that occurs when humans read color. Color can be seen if there is light (**Figure 5**), where light has a light spectrum so that the color seen by the eye varies depending on the wavelengths that are scattered (**Figure 6**). The process by which the eye can see objects and color is illustrated in **Figure 7**, where The light captured by the retina is then transmitted to be processed in the back of the brain in the primary visual cortex (**Figure 8**).

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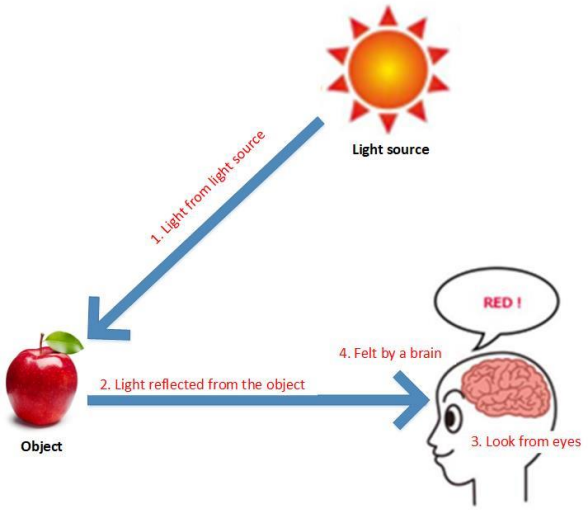

Figure 4. Processing how humans see and process an object and its color.

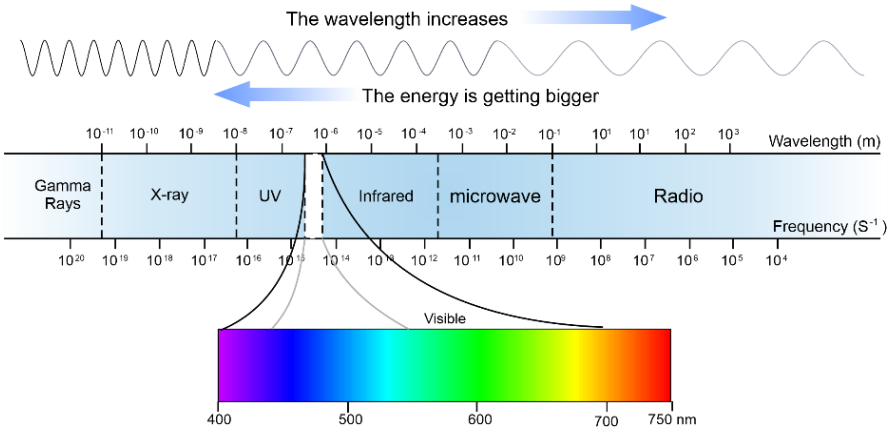

Figure 5. Light spectrum. The figure was adopted from literature https://byjus.com/physics/the- electromagnetic-spectrum-visible-light/; retrieved on January 2023.

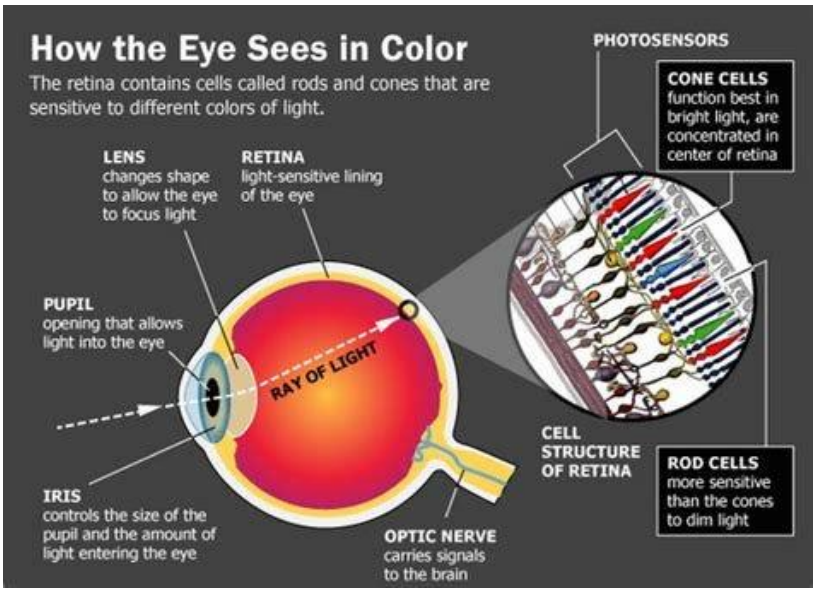

Figure 6. How the eye sees in color. The figure was adapted from https://www.quora.com/How-do-we-see-colours-Whats-the-science-behind-it; retrieved on January 2023.

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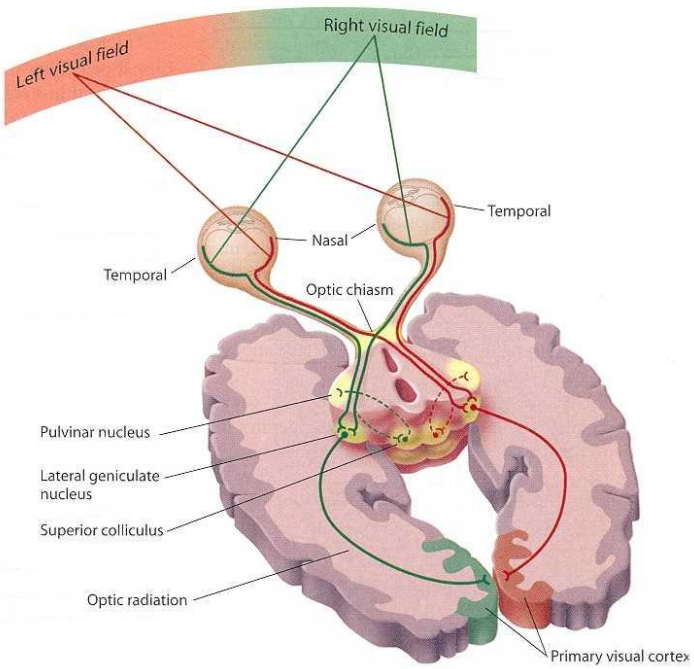

Figure 7. The visual system. The figure was adopted from https://www.researchgate.net/figure/Brain-anatomy-and-visual-pathways-from-81_fig5_39425470; retrieved on January 2023.

2.3. Inquiry Learning Strategy

According to Sanjani (2019), Inquiry learning strategies are those that get students ready for long-term self-research projects or experimental settings so they can see what's going on and take action. The inquiry-based learning approach centers on the process of discovering the subject matter, with the instructor serving as a guide and facilitator for the student's learning. The Inquiry Model places a strong emphasis on the process of looking for information. Students are expected to search for solutions to problems related to a subject topic, and teachers serve as facilitators and guides for their learning. In general, inquiry is a dynamic process that motivates students to look into issues and gather data.

The main characteristics of inquiry learning strategies according to Hamdani (2020). First, the inquiry learning strategy focuses on maximum student activity in searching for a problem and finding a solution . Second , all activities carried out by students are directed towards searching for and finding answers to something that is being questioned / problematic . In the inquiry learning strategy , students are not only required to be able to master the learning material but also how students can maximize their potential to develop their knowledge about the essence of a learning material . Steps for implementing the inquiry learning strategy according to Hamidah (2020) include:

(i) Orientation is the teacher's orientation in inviting students to think about solving a problem by inviting and stimulating students through something that makes them interested and motivated in finding and solving the problem.
(ii) Formulating problems means the teacher brings students to problems that contain puzzle elements. This is expected to create challenges for students so that they can be motivated to solve the problems they face.
(iii) Formulate a hypothesis, providing a temporary answer to a problem being studied.
(iv) Collecting data, in this stage the teacher asks students questions that can direct them towards the intended learning objectives.

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(v) Testing a hypothesis is a step to determine the level of truth of the alleged answers given by students.
(vi) Formulate conclusions, the last step is to invite students to be able to briefly describe all of their findings based on the results of testing their hypothesis.

Inquiry learning strategies are learning strategies that prepare students in experimental situations or extensive research on themselves to see what is happening and do something. The inquiry model focuses on the steps of searching and discovering, while the teacher acts as a facilitator and guides students in the teaching and learning process.

3. METHOD

3.1. Bibliometric Analysis Method

The methodology employed in this study is a bibliometric analysis technique combined with computational mapping analysis. Detailed information for the utilization of the application as well as the use of bibliometric analysis is well-explained elsewhere. Utilizing the fundamental principles of bibliometrics , every analysis employs statistical and mathematical methods to statistically examine , elucidate , and visually represent the pertinent research domain. Assessing the status and major aspects might aid in identifying and predicting future research trends and areas of high interest. The research was carried out in five distinct stages, specifically keyword identification, data gathering, data processing and analysis, result analysis, and conclusion.

The research focuses on the keyword "teaching AND color AND changes AND for AND student AND disability". Keywords are utilized to designate articles that are deemed pertinent. The Abstract and Title serve as criteria for picking articles based on pre-established keywords. The study period included in the evaluation process spanned from 2010 to 2023. On February 27, 2023, a data search was performed using Scopus. The study concept and methodology of this paper are illustrated in **Figure 8**.

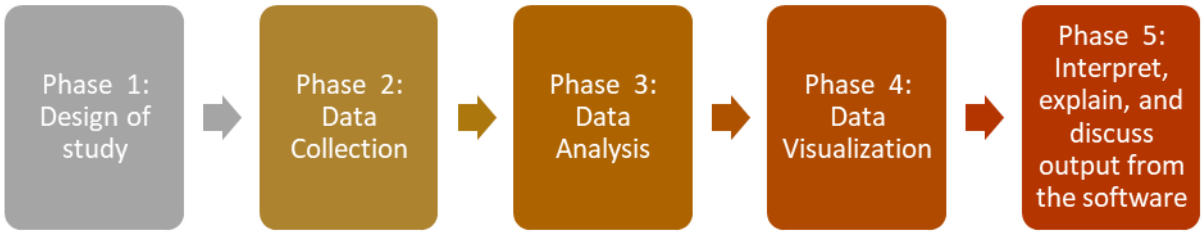

Figure 8. Science mapping workflow using bibliometric analysis.

3.2. Descriptive Qualitative Technique Research for Information Regarding the Phenomenon of Learning Activities using the Inquiry Method

In this research, the descriptive qualitative research method was employed, which is a type of research method where the researcher does not provide any treatment or change the object of research (Colorafi & Evans, 2016), and the data obtained is not manipulated, so that the picture of the phenomenon that occurs is following the data and information in the field. Therefore, this descriptive qualitative research technique provides complete information regarding the phenomenon of learning activities using the inquiry method in recognizing color changes in children with mild intelligence barriers in one of the special schools in the city of Bandung. The technique used in this research is to collect observation and interview data. The research procedure is in **Figure 9.**

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The research was carried out starting with carrying out a literature study by collecting studies and theories related to inquiry learning strategies, children with intellectual disabilities, and changing primary color into secondary color. After the studies and theories were collected, observation and interview guidelines were created which were used to collect data. The source of the data obtained in this research was obtained through interviews with class teachers. Interviews were conducted using guidelines to obtain the desired data through questions and answers with the teacher. Observations were carried out by observing the subject of learning activities using inquiry learning strategies in recognizing color changes in students with mild intellectual disabilities at various levels starting from elementary, secondary, and high school levels specific for special needs students. The target research subjects this time were 5 students and female students. This research was conducted in one of the special schools in Bandung, Indonesia with learning conditions outside the classroom, precisely in the field where students gather to participate in learning activities.

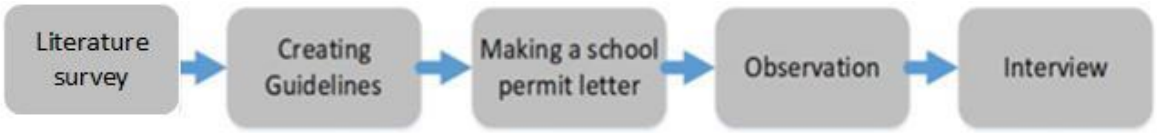

Figure 9. Research procedures.

4. RESULTS AND DISCUSSION

4.1. Bibliometric Analysis of Teaching Color Change with Intellectual Disabilities

Bibliometric analysis has been employed to facilitate study analysis across several research domains . This study employed bibliometric analysis to gain insight into the contemporary research trends related to teaching color change.

4.1.1. Development of research in the teaching color changes to intellectual disabilities by year

A total of 11 publications, spanning from 2010 to 2023, have been published on the topic of teaching color change with intellectual disabilities. The titles, abstracts, and article data were screened to ensure their relevance to the specified study issues. The evolution of research in color change is depicted in **Figure 10**. In general, fewer studies were conducted between 2010 and 2023. There were 2 articles in 2010, no article in 2011, 1 article in 2012-2013, no article in 2014-2015, 1 article in 2016, no articles in 2021, 3 articles in 2022, and 2 articles in 2023.

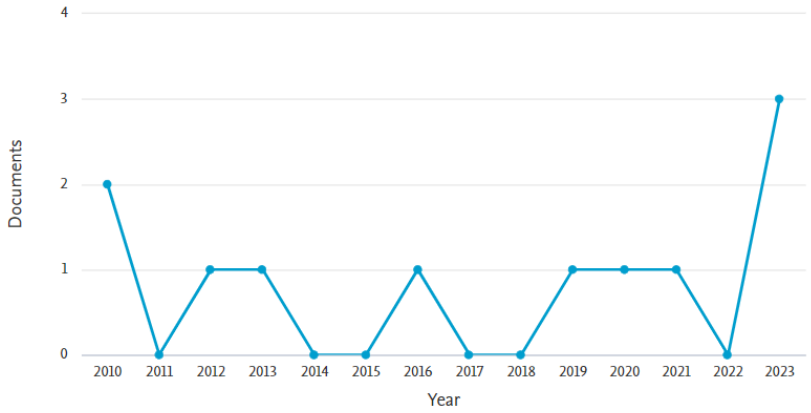

Figure 10. Development of published articles per year related to teaching color change with intellectual disabilities (2010 – 2023).

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4.1.2. How has the development of teaching color changed for student disability research in Indonesia?

Figure 11 shows that research on teaching color changes for student disability is still very rarely carried out and is still zero in Indonesia. Understanding that research on teaching color changes for student disability is still rare and minimal in Indonesia requires some basic understanding of the state of research in that country; 1) Lack of Focus and Priority: In Indonesia, research in the fields of social sciences and humanities, including leadership, may not yet be the main focus for many research institutions and universities. As a result, research on teaching color changes for student disability may not have received enough attention from researchers, 2) Limited Resources: Lack of funding and research infrastructure can be a major obstacle in promoting research in specific fields such as teaching color changes for student disability. Research involving advanced technology or big data often requires significant investment, which may not be available at many institutions in Indonesia. To address the lack of research in this area in Indonesia, ongoing efforts are needed to raise awareness, obtain financial support, strengthen research infrastructure, and increase collaboration between research institutions, universities, and industry. Thus, there will be an increase in the number and quality of research on teaching color changes for student disability carried out in Indonesia.

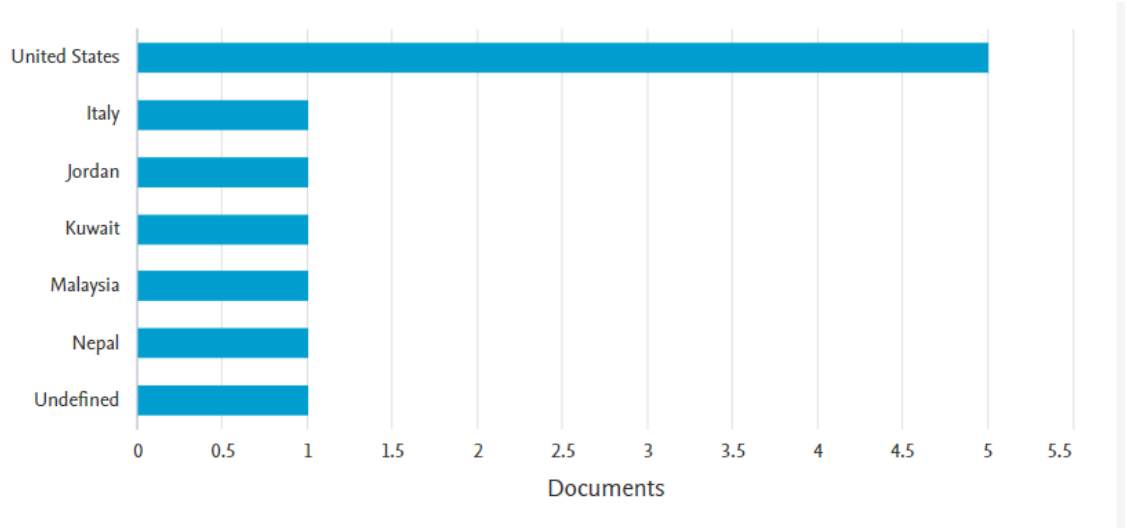

Figure 11. Development of published articles by country related to teaching color changes for student disability.

4.1.3. How is the development of teaching color changes for student disability research based on subject areas in the fields of business, management, and accounting?

Figure 12 shows that the subjects. The analysis showed that there is only 1 article, namely the article entitled "Specific learning disorders in vocational music training: Screening tools and qualitative study among students of AFAM institute". The findings of the article are in an attempt to overcome the challenges. They extend their study sessions. The most important point is its focus on memorizing the compositions and making adjustments to the score (i.e. colors, symbols, etc).

Many students use the layered method of studying, which involves adding aspects of the score one after the other. The interviews also provided insight into their perspectives and recommendations for enhancing students' access to music education at the Conservatory. This shows that from the special needs education and psychology

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perspective, research still needs to be improved regarding teaching color changes to students with special needs.

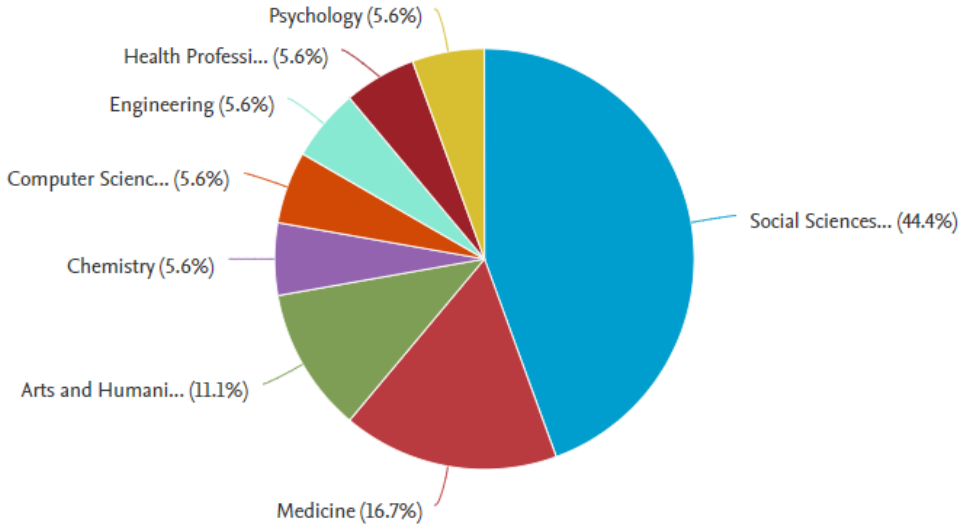

Figure 12. Development of published articles by subject area related to teaching color changes for student disability.

4.2. Student Demographics as a Subject for Teaching Color Changes Experiments

The research was conducted on children with mild intelligence barriers. The research was conducted on 5 students with the initials K, U, G, R, and A. Children with mild intellectual disabilities are children who experience intellectual disorders, where children have an IQ below the average, namely 70 to 50.

Children with mild intellectual disabilities (IQ 50-70) are those who are included in the group whose intelligence and social adaptation are hampered, but they can develop in academic lessons, children with intellectual disabilities can be developed optimally and they need special service (Maulidiyah, 2020). The impact of mental retardation causes them to experience problems in the academic field, adapting to the environment, and experiencing speech, language, and emotional disorders. Children with mild intellectual disabilities have the same intelligence level as children aged 9-12 years. For children with mild intellectual disabilities, getting to know color will help children in everyday life. Color is very meaningful for someone to know in everyday life (Gil & Le Bigot, 2014). One example is when a child determines his favorite color and when coloring to produce a work, he no longer needs to ask people about the color to be used.

4.3. Learning Process

Based on the observations, we found phenomena before implementing the inquiry learning strategy on 5 students with the initials K, U, G, R, and A who were categorized as children with intellectual disabilities. **Table 4** shows learning results before implementing inquiry learning strategies. The teacher received data that students were not able to recognize color changes (Yani & Sopandi, 2020). This is also confirmed by research conducted where children with mild intellectual disabilities experience obstacles in the concept of color recognition.

After knowing the student's learning outcomes in learning activities to recognize color changes. The teacher then carried out learning activities to recognize color changes using appropriate inquiry learning strategies using the steps for implementing inquiry learning

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strategies according to Hamdani (2020). **Table 5** shows steps for implementing inquiry learning strategies. We have six steps for implementing inquiry learning: (i) orientation, (ii) formulating the problem, (iii) formulating the hypothesis, (iv) collecting data, (v) testing the hypothesis, and (vi) making conclusions.

Table 4. Learning results before implementing inquiry learning strategies.

No	Aspect	Observation Results				
		K	U	G	R	A
1.	P	M	TM	M	TM	M
2.	S	M	TM	TM	TM	M
3.	PS	TM	TM	TM	TM	TM

Note: M is for the child who is capable; TM is for the child who is not capable; P is for the child who can name primary colors; S is for the child who can name secondary colors; PS is for children who can communicate the results of mixing colors.

Table 5. Steps for implementing inquiry learning strategies.

No	Learning Stage	Student Learning Activities
1.	Orientation (when the teacher understands the condition of students to be ready to carry out the learning process)	1. The teacher explains the objectives and expected results, namely changing primary color into secondary color through painting activities on tote bags. 2. The teacher motivates students to continue participating in learning enthusiastically. One of them is singing about color. 3. The teacher introduces the media used, such as watercolor, tote bags, and brushes that will be used 4. Teachers always accompany their students in their learning
2.	Formulating the Problem (bringing students to a problem that contains a puzzle)	1. The teacher encourages students to be able to find problems regarding problems related to color. 2. With the teacher's encouragement, one of the students succeeded in bringing up the problem of changing primary colors into secondary colors.
3.	Formulating a hypothesis (provide a temporary answer to a problem being studied	1. The teacher names and shows the colors in watercolors 2. Students repeat the colors previously mentioned by the teacher. 3. The teacher asks random questions about the colors shown and then the students answer them. 4. The teacher asks about color changes that can produce other colors. 5. Students see color images (from media that have been prepared by the teacher) and identify the colors.
4.	Collecting Data	1. Students accompanied by the teacher have a discussion with their friends for the colors produced 2. The teacher asks students' opinions about changing primary to secondary colors 3. The basic color which is part of the secondary color of the color is chosen by the student and depicted with the palm and then attached to the tote bag media
5.	Testing Hypotheses	1. Students who have completed their drawings submit the results of their work by stating the constituent components of the secondary colors produced. 2. Prove the color results mentioned with color image media data that has been prepared by the teacher.
6.	Making Conclusions	Formulate conclusions from all the guided inquiry learning steps with the material of changing primary color to secondary color.

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After implementing the inquiry learning strategy in learning activities, students experienced significant learning improvements where students experienced a lot of development in their abilities. Inquiry learning strategies can improve students' critical thinking abilities (Prasetiyo & Rosy, 2021; Lusidawaty *et al.*, 2020). **Table 6** shows the results of implementing inquiry learning strategies.

Table 6. Results of implementing inquiry learning strategies.

No	Aspect	Observation results				
		K	U	G	R	A
1.	P	M	M	M	M	M
2.	S	M	TM	M	M	M
3.	PS	M	TM	M	TM	M

Note: M is for the child who is capable; TM is for the child who is not capable; P is for the child who can name primary colors; S is for the child who can name secondary colors; PS is for children who can communicate the results of mixing colors.

Students who attended the color recognition activity through painting on tote bags (bags) were children with mild intellectual disabilities from elementary, junior, and high school levels. One of the learning strategies currently used is the inquiry learning strategy. Inquiry learning is a learning model that invites students to always be active optimally. With inquiry learning, students become learning objects who are not only recipients of the material but must be able to find the material being studied themselves (Dhamayanti, 2022). In implementing this strategy, teachers must choose learning that is suitable for children. For example in science and arts learning. Using inquiry learning can activate students' learning processes and can develop critical and creative thinking skills while practicing open collaboration skills with students. The material presented by the teacher is about the basics that will be studied by students. One of them is learning to recognize color. The aim is for students to improve their ability to recognize color through painting activities on tote bags.

This learning strategy is applied to children with mild intellectual disabilities, where students are not yet able to recognize and determine the color they are asked about. Before implementing it, the teacher first prepares the drawing media that the students will use, such as tote bags, brushes, and watercolor. The teacher used the question-and-answer play method. Because the question-and-answer method helps students' brain development in their learning progress. By using this method, teachers can ask students, and respond to each other's answers and students have the opportunity to ask questions and convey their views to the teacher. The implementation of the inquiry strategy at SLB This is supported by the results of an interview with one of the school teachers, that teachers must continue to direct and accompany their students. Thus, they participate actively in participating in learning (Prijanto & De Kock, 2021). In their activities, all students are always directed to search for and find their answers to something that is being questioned (Putri & Fathoni , 2022). This strategy is also quite effective if implemented in learning that is appropriate for children. The learning process is carried out by the teacher employing the teacher accompanying the students . Thus , the teacher directs the students in this inquiry learning process . Before carrying out the learning process the teacher makes a lesson plan and modules based on the class . This is reinforced by literature that in the learning process , children with intelligence barriers require repetition and assistance (Aini, 2019). Based on the research that has been carried out, the results show that in the activity of recognizing color through painting on tote bags, there are still many students who do not know color, especially students who are still in small classes. For students with intellectual

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disabilities who are already in junior and senior high school levels, most of them already know the names of the colors (shown by the teacher).

The learning was carried out through this tote bag painting activity by students with intellectual disabilities. At low-level students, many students are not yet confident in learning. At the junior high school level, students appear to be quite orderly in their learning. Students look active and still enthusiastic about participating in learning activities. High school students also appear to be orderly in participating in learning activities. However, there are still some students whose focus is diverted. Students can also follow the teacher's directions when painting. After painting, the students take turns washing their hands one by one. Each student has different and unique potential. This difference can be seen in students who have a mindset and imagination in the work they produce. Therefore, learning activities need to be selected and designed to provide opportunities and creative freedom to develop creativity (Hidayat *et al*., 2020).

Finally, this study can give additional ideas regarding students with special needs. This also gives additional information to the current literature (Juhanaini *et al.,* 2022; Irawan, 2021; Maryanti, 2021; Apriyanti, 2023; Adesokan *et al.,* 2022; Manullang *et al.,* 2021; Maryanti *et al.,* 2021).

5. CONCLUSION

Learning activities that have been carried out on children with mild intellectual disabilities at special needs schools. In learning activities, students are generally active and can pay attention to the teacher's explanations and directions in an orderly manner. However, it appears that some students are less active in participating in the learning. This research also aims to find out the results of the implementation of inquiry learning strategies in learning activities to recognize color changes in children with intellectual disabilities. The research results show that learning activities to recognize color changes in children with intellectual disabilities through inquiry learning strategies can be implemented if the learning process is carried out appropriately and follows students' needs. Therefore, color change trials carried out using the inquiry method produced good results. It is hoped that this article will provide information for readers in carrying out learning activities to recognize color changes in children with intellectual disabilities through inquiry learning strategies.

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7. AUTHORS' NOTE

The authors declare that there is no conflict of interest regarding the publication of this article. The authors confirmed that the paper was free of plagiarism.

8. REFERENCES

Abramov, I., and Gordon, J. (1994). Color appearance: On seeing red—or yellow, or green, or blue. *Annual Review of Psychology*, *45*(1), 451-485.

Adesokan, A., Abdulkareem, K.O., and Adesokan, T.T. (2022). Assessment of factors responsible for child abuse among students with intellectual disabilities. *ASEAN Journal of Community and Special Needs Education*, *1*(2), 89-96.

Ahmed, S., Venigalla, H., Mekala, H. M., Dar, S., Hassan, M., and Ayub, S. (2017). Traumatic brain injury and neuropsychiatric complications. *Indian journal of psychological medicine*, *39*(2), 114-121.

Aini, H.N. (2019). Peningkatan kemampuan pemahaman materi benda dan sifatnya melalui penerapan metode inkuiri pada siswa tunarungu kelas IV di SLB Islam Qothrunnada Bantul Yogyakarta. *Widia Ortodidaktika*, *8*(5), 488-496.

Apriyanti, V.P. (2023). Learning abilities of students with intellectual disabilities for cooking Indonesian traditional food "opak bakar": From step by step experiment to the analysis. *Indonesian Journal of Community and Special Needs Education, 3*(1). 43-54.

Bae, G. Y., Olkkonen, M., Allred, S. R., and Flombaum, J. I. (2015). Why some colors appear more memorable than others: A model combining categories and particulars in color working memory. *Journal of Experimental Psychology: General*, *144*(4), 744.

Brigham, F. J., Scruggs, T. E., and Mastropieri, M. A. (2011). Science education and students with learning disabilities. *Learning Disabilities Research and Practice*, *26*(4), 223-232.

Burns, C. O., Lemon, J., Granpeesheh, D., and Dixon, D. R. (2019). Interventions for daily living skills in individuals with intellectual disability: A 50-year systematic review. *Advances in Neurodevelopmental Disorders*, *3*, 235-245.

Colorafi, K. J., and Evans, B. (2016). Qualitative descriptive methods in health science research. *HERD: Health Environments Research & Design Journal*, *9*(4), 16-25.

Dhamayanti, P. V. (2022). Systematic literature review: Pengaruh strategi pembelajaran inkuiri terhadap kemampuan berpikir kritis peserta didik. *Indonesian Journal of Educational Development*, *3*(2), 209-219.

DiStefano, C., Sadhwani, A., and Wheeler, A. C. (2020). Comprehensive assessment of individuals with significant levels of intellectual disability: Challenges, strategies, and future directions. *American Journal on Intellectual and Developmental Disabilities*, *125*(6), 434-448.

Elliot, A. J., and Maier, M. A. (2014). Color psychology: Effects of perceiving color on psychological functioning in humans. *Annual Review of Psychology*, *65*, 95-120.

Engel-Yeger, B., Hardal-Nasser, R., and Gal, E. (2011). Sensory processing dysfunctions as expressed among children with different severities of intellectual developmental disabilities. *Research in Developmental Disabilities*, *32*(5), 1770-1775.

García, J. C., Díez, E., Wojcik, D. Z., and Santamaría, M. (2020). Communication support needs in adults with intellectual disabilities and its relation to quality of life. *International Journal of Environmental Research and Public Health*, *17*(20), 7370.

Gil, S., and Le Bigot, L. (2014). Seeing life through positive-tinted glasses: Color–meaning associations. *PloS One*, *9*(8), e104291.

DOI: https://doi.org/10.17509/ijost.v8i3.68623
p- ISSN 2528-1410 e- ISSN 2527-8045

Griffiths, C., and Smith, M. (2016). Attuning: a communication process between people with severe and profound intellectual disability and their interaction partners. *Journal of Applied Research in Intellectual Disabilities*, *29*(2), 124-138.

Gupta, R., and Sen, N. (2016). Traumatic brain injury: A risk factor for neurodegenerative diseases. *Reviews in the Neurosciences*, *27*(1), 93-100.

Hamdani, B. (2020). Enhancing vocabulary among EFL young learners through picture-word inductive model. *IJOEEL: International Journal of English Education and Linguistics*, *2*(1), 9-16.

Hamidah, U. (2020). Pengaruh model pembelajaran langsung terhadap peningkatan kosa kata warna anak tunagrahita ringan kelas 4 di SLB Muhammadiyah Lamongan. *Jurnal Ilmiah Pendidikan Guru Sekolah Dasar*, *4*(2), 181-196.

Hidayat, A., Sa'diyah, M., and Lisnawati, S. (2020). Metode pembelajaran aktif dan kreatif pada madrasah diniyah takmiliyah di kota Bogor. *Edukasi Islami: Jurnal Pendidikan Islam*, *9*(01), 71-86.

Hidayati, S., Robingatun, R., and Saugi, W. (2020). Meningkatkan kemampuan mengenal warna melalui kegiatan mencampur warna di TK kehidupan elfhaluy Tenggarong. *Yaa Bunayya: Jurnal Pendidikan Anak Usia Dini*, *4*(1), 23-37.

Humphrey-Darkeh, A., Kusi, F., Owusu-Sekyere, K., and Adu-Gyamfi, M. (2023). Inquiry-based teaching method to create conceptual understanding of measurement of temperature among students at the basic junior high school. *ASEAN Journal for Science Education*, *2*(2), 95-106.

Irawan, A.R. (2021). Handwashing ability assessment for students with intellectual barriers. *Indonesian Journal of Community and Special Needs Education, 1*(1), 9-10.

Juhanaini, J., Sholihat, L.F., Maryanti, R., Budiman, R.A., and Armindony, F.F. (2022). Media learning patch board in science learning energy change materials for children with intellectual disabilities. *Indonesian Journal of Teaching in Science*, *2*(2), 139-146.

Kilincaslan, A., Kocas, S., Bozkurt, S., Kaya, I., Derin, S., and Aydin, R. (2019). Daily living skills in children with autism spectrum disorder and intellectual disability: A comparative study from Turkey. *Research in Developmental Disabilities*, *85*, 187-196.

Lee, Y. J., Park, H. J., and Recchia, S. L. (2015). Embracing each other and growing together: redefining the meaning of caregiving a child with disabilities. *Journal of Child and Family Studies*, *24*, 3662-3675.

Lusidawaty, V., Fitria, Y., Miaz, Y., and Zikri, A. (2020). Pembelajaran IPA dengan strategi pembelajaran inkuiri untuk meningkatkan keterampilan proses sains dan motivasi belajar siswa di sekolah dasar. *Jurnal Basicedu*, *4*(1), 168-174.

Manullang, T.I.B., Nandiyanto, A.B.D., Suryadi, A., Rochyadi, E., Haerudin, D. Muspita, R.Sumiroh, E., Manullang, L.S. (2021). Improving students with intellectual disabilities science process skills through photosynthesis experiment in enhancing climate change awareness. *Journal of Engineering, Science and Technology*, *16*(3), 2368-2377.

DOI: https://doi.org/10.17509/ijost.v8i3.68623
p- ISSN 2528-1410 e- ISSN 2527-8045

Maryanti, R. (2021). Assessment of mathematical abilities of students with intellectual disabilities during the covid-19 pandemic. *Indonesian Journal of Community and Special Needs Education, 1*(2), 47-52.

Maryanti, R., Hufad, A., Nandiyanto, A.B.D., Tukimin, S. (2021). Teaching heat transfer on solid-to-liquid phase transition phenomena to students with intellectual disabilities. *Journal of Engineering, Science and Technology*, *16*(3), 2245-2259

Maryanti, R., Nandiyanto, A.B.D., Hufad, A., and Sunardi, S. (2021). Science education for students with special needs in Indonesia: From definition, systematic review, education system, to curriculum. *Indonesian Journal of Community and Special Needs Education, 1*(1), 1-8.

Mastropieri, M. A., Scruggs, T. E., and Magnusen, M. (1999). Activities-oriented science instruction for students with disabilities. *Learning Disability Quarterly*, *22*(4), 240-249.

Maulidiyah, F. N. (2020). Media pembelajaran multimedia interaktif untuk anak tunagrahita ringan. *Jurnal Pendidikan*, *29*(2), 93-100.

Nassau, K. (1980). The causes of color. *Scientific American*, *243*(4), 124-155.

Nurhayati, E., and Homdijah, O. S. (2020). Penggunaan brain gym untuk meningkatkan konsentrasi belajar anak dengan hambatan kecerdasan ringan. *Jassi Anakku*, *21*(1), 13-20.

Ogunjimi, M.O., and Gbadeyanka, T.A. (2023). Effect of guided inquiry and explicit-instructional strategies on lower basic students' academic performance in mathematics. *Indonesian Journal of Teaching in Science*, *3*(1), 23-32.

Prasetiyo, M. B., and Rosy, B. (2021). Model pembelajaran inkuiri sebagai strategi mengembangkan kemampuan berpikir kritis siswa. *Jurnal Pendidikan Administrasi Perkantoran (JPAP)*, *9*(1), 109-120.

Pratama, Y., Dwirahayu, G., and Satriawati, G. (2020). Analisis penerapan model inquiry dalam pembelajaran matematika di SLB 4 Jakarta. *ALGORITMA: Journal of Mathematics Education*, *2*(1), 15-28.

Prijanto, J. H., and De Kock, F. (2021). Peran guru dalam upaya meningkatkan keaktifan siswa dengan menerapkan metode tanya jawab pada pembelajaran online. *Scholaria: Jurnal Pendidikan Dan Kebudayaan*, *11*(3), 238-251.

Putri, S. A., and Fathoni, A. (2022). Penyusunan rencana pelaksanaan pembelajaran tematik dengan pendekatan terpadu di sekolah dasar. *Jurnal Basicedu*, *6*(4), 5898–5909.

Rahmat, A. (2022). Creating good environment and building for people with special needs: From definition to application of guiding and warning blocks. *Indonesian Journal of Community and Special Needs Education, 2*(1), 39-44.

Ramachandran, V.S., and Hubbard, E. M. (2001). Synaesthesia--a window into perception, thought and language. *Journal of Consciousness Studies*, *8*(12), 3-34.

Rashid, M. H. U., Zobair, S. A. M., Chowdhury, M. A. I., and Islam, A. (2020). Corporate governance and banks' productivity: Evidence from the banking industry in Bangladesh. Business Research, 13, 615-637.

DOI: https://doi.org/10.17509/ijost.v8i3.68623
p- ISSN 2528-1410 e- ISSN 2527-8045

Rogers, C. (2007). Disabling a family? Emotional dilemmas experienced in becoming a parent of a child with learning disabilities. *British Journal of Special Education*, *34*(3), 136-143.

Salovaara , H. (2005). An exploration of students ' strategy use in inquiry -based computer - supported collaborative learning. *Journal of computer assisted learning*, *21*(1), 39-52.

Sanjani, M. A. (2019). Pelaksanaan strategi pembelajaran inkuiri. *Jurnal Serunai Administrasi Pendidikan*, *8*(2). 40-46.

Scruggs, T. E., and Mastropieri, M. A. (1994). The construction of scientific knowledge by students with mild disabilities. *The Journal of Special Education*, *28*(3), 307-321.

Setyowati , L. (2020). Penerapan metode pembelajaran inkuiri untuk meningkatkan hasil belajar ipa tentang kegunaan benda plastik , kayu , kaca , dan kertas pada siswa tunanetra kelas iii di slb-a tpa jember. *SPEED Journal: Journal of Special Education*, *3*(2), 56-65.

Sivanandam, T. M., and Thakur, M. K. (2012). Traumatic brain injury: A risk factor for Alzheimer's disease. *Neuroscience and Biobehavioral Reviews*, *36*(5), 1376-1381.

Suradi, A., and Mawardi, M. (2020). The strategy of forming religious characters on the deaf children: Study at special schools in Rejang Lebong. *Al-Ta lim Journal*, *27*(1), 16-29.

Suryawati , E., and Osman , K. (2017). Contextual learning : Innovative approach towards the development of students' scientific attitude and natural science performance . *Eurasia Journal of Mathematics, Science and Technology Education*, *14*(1), 61-76.

Vissers, L. E., Gilissen, C., and Veltman, J. A. (2016). Genetic studies in intellectual disability and related disorders. *Nature Reviews Genetics*, *17*(1), 9-18.

Yani , G.R., and Sopandi , A.A. (2020). Meningkatkan kemampuan mengenal warna bagi anak tunagrahita ringan melalui permainan edukatif puzzle di SLB Negeri 1 Padang . *Auladuna: Jurnal Prodi Pendidikan Guru Madrasah Ibtidaiyah*, *2*(1), 69-80.

Yuliani, T., and Armaini, A. (2019). Media video animasi dalam pendidikan seks anak dengan hambatan kecerdasan ringan. *Jurnal Penelitian Pendidikan Khusus*, *7*(1), 41-46.

DOI: https://doi.org/10.17509/ijost.v8i3.68623
p- ISSN 2528-1410 e- ISSN 2527-8045