PAPER NAME

IJOLE 1.pdf

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WORD COUNT

7549 Words

CHARACTER COUNT

45183 Characters

PAGE COUNT

17 Pages

FILE SIZE

1.1MB

SUBMISSION DATE

Dec 9, 2023 12:32 PM GMT+7

REPORT DATE

Dec 9, 2023 12:33 PM GMT+7

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International Journal of Language Education
Volume 05, Number 04, 2021, pp. 409-425
ISSN: 2548-8457 (Print) 2548-8465 (Online)
Doi: https://doi.org/10.26858/ijole.v5i4.53579

Strategies in Language Education to Improve Science Student Understanding during Practicum in Laboratory: Review and Computational Bibliometric Analysis

Siti Pupu Fauziah
Universitas Djuanda, Indonesia
Email: siti.pupu.fauziah@unida.ac.id

Irman Suherman
Universitas Djuanda, Indonesia
Email: irman.suherman@unida.ac.id

Mega Febriani Sya
Universitas Djuanda, Indonesia
Email: megafebrianisya@unida.ac.id

Martin Roestamy
Universitas Djuanda, Indonesia
Email: martin.roestamy@unida.ac.id

Amirullah Abduh
Universitas Negeri Makassar, Indonesia
Email: amirullah@unm.ac.id

Asep Bayu Dani Nandiyanto
Universitas Pendidikan Indonesia, Indonesia
Corresponding Email: nandiyanto@upi.edu

Received: 3 January 2020
Reviewed: 5 July 2021-3 August 2021
Accepted: 1 December 2021

Abstract

The purpose of this study is to explain the development of language research in science learning which can improve students' understanding during practicums in the laboratory. This research also explores the factors that contribute to increasing student understanding and bibliometric analysis using the keywords "language", "practicum", "laboratory" and "science" from 2015 to 2021. There is also an explanation of curriculum development and the influence of language in science learning. The use of technology and laboratories is an important factor in improving student literacy and language. Student characteristics, motivation, teacher-student relationships, and student psychological conditions can all be concluded to be closely interconnected. Language is a determining factor in the success of science learning during practical work in the laboratory. Therefore, the language style used by the teacher during practicum in the laboratory

should be as simple as possible to make students easy to understand. This paper also includes language barriers for students with special needs. The results of the bibliometric analysis show that the research trend on language in science learning is increasing. This paper can be used as material for consideration by readers in understanding the current conditions regarding the importance of language in science learning, especially practical learning in the laboratory.

Keywords: Bibliometric; language; practicum, laboratory; science.

Introduction

Language is a tool to convey messages from the sender to the recipient of the message. The message conveyed contains the thoughts and even feelings of the message giver. In learning, the role of language is very important where the subject matter, thoughts and understanding of teachers are transferred through the language they use (Kusumawati, 2019; Nurjaleka, 2019; Chandrawisesa et al., 2019; Sanjaya and Rosiah, 2019; Yamashita, 2020; Kusumawati, 2020; Rahayu et al., 2020; Maarif, 2021; Asmarani, 2021; Najoan, 2021). Moreover, in science subjects, the use of appropriate language is important (Dela Fuente, 2021), where science learning in schools often uses practical learning models in laboratories (Childs et al., 2015). This triggers language use to change along with changes in science and technology in society (Judiasri et al., 2019; Mardani et al., 2020; Rifai et al., 2020; Rasiban et al., 2021; Sukmara, 2021). The use of language will greatly determine the level of students' understanding of science subjects. Many scientific terms are not commonly heard by most students, so using appropriate language but not reducing the essence of scientific terms can be one strategy for using language in science subjects. Just like understanding someone's language, it is necessary to understand the language of science naturally (Markic and Childs, 2016; Childs et al., 2015), especially in practical learning in the laboratory.

Science learning is the same as other learning, namely that it can guide students in developing attitudes and learning experiences (Ward et al., 2016). Good language mastery is the key to improving students' understanding of science, through students' language skills such as linguistic skills, reading and listening as well as speaking and writing (Lara-Alecio et al., 2018; Gomez et al., 2020; Afrian et al., 2020; Widodo, 2017). Science as a scientific discipline is greatly influenced by two main aspects, namely language and mathematics (Lamrani and Abdelwahed, 2020). These two things are used to understand language and understand scientific symbols as well as initial capital for studying science (mathematics) (Parvez et al., 2019). Science cannot be learned if students do not read, write, and understand numbers (literacy and numeracy) (Junge et al., 2021; Widodo, 2017; Afrian et al., 2020). Therefore, it can be described that mastering these two abilities is the main thing when starting to study science. Many studies state that literacy is very important (Ward et al., 2016; Chamdani et al., 2019).

Many students find learning science very difficult, even for smart students. The use of language in mathematical and scientific communication is difficult to understand. The language of symbols, diagrams, numbers, and data is a complex mathematical language. Therefore, mastering the language of science is important. Therefore, communication in science learning is easy. The concept of language in education functions as a medium for transferring knowledge from teachers to students (Kusumawati, 2019; Martawijaya and Radhiya, 2019; Yamashita, 2020; Mardani and Padmadewi, 2020; Sukmara, 2021; Asmarani, 2021; Haristiani and Oktarina, 2021). Apart from that, media and technology are also needed, especially in practical learning in the laboratory (Judiasri et al., 2019; Mardani et al., 2020; Rifai et al., 2020; Rasiban et al., 2021; Sukmara, 2021). Several studies state that science subjects are difficult for students to understand, namely learning biology, chemistry, mathematics, and physics (Glorifica, 2021; Olumorin et al.,

2021; Dallyono et al., 2020; Hashim et al., 2021; Husnah et al., 2021; Lathifah and Maryanti, 2021; Marasabessy, 2021; Omolafe, 2021).

Many studies have stated that language is an important aspect of science learning. Literacy and numeracy are two basic things that students must master before further learning. The ability to understand symbols, diagrams, numbers, and data can provide a better understanding of science learning, especially mathematics (Odden et al., 2021). Students' ability to master science material is described by understanding concepts, procedures, analysis, problem-solving, and language, as well as the ability to think mathematically logically through the application of self-regulated learning with a problem-based approach (Rohaeti et al., 2014; Mairing, 2020). Although there has been a lot of research on the effect of language skills in learning which is very important, literature studies on language in science learning are not yet widely available. The literature study used in this research is bibliometric analysis.

Bibliometrics is an analysis using mathematical approaches, statistics, and other measurement methods to determine and evaluate large amounts of literature data (Nandiyanto et al., 2020a). Many previous papers on bibliometric analysis are available (Hamidah et al., 2020; Amelia et al., 2019). Given the scarcity of bibliometric studies of language research trends in sains, practicum in the laboratory, this study aims to comprehensively analyze research progress and future directions in learning science language. We take a macro approach to this topic by identifying and analyzing papers in the Google Scholar database using bibliometric methods. This study organizes large amounts of data and provides valuable insights for future researchers, allowing for precise analysis of the current situation.

Research method

This research uses bibliometric analysis methods. Bibliometric analysis characterizes the description of literary works, where documents from various types of scientific works (journal articles, proceedings, and books) are analyzed regarding the relationship of existing terms, visualization, and trends in the development of language topics in science learning through a practical approach in the laboratory (Nandiyanto, et al., 2020a; Nandiyanto, et al., 2021; Nandiyanto, et al., 2020b). Bibliometric analysis is carried out in three stages, 1) data collection, 2) data selection, and 3) data analysis, description is as follows:

(i) Data collection. Data was collected using Publish or Perish software from the Google Scholar database. Using the keywords language, student, practice, laboratory and science produces 996 papers. The data collection period for this research took place from 2015 to 2021, publications came from journal articles, proceedings, and books.

(ii) Data selection. Data selection was carried out to obtain data that was following the research objectives. The publications selected used important criteria such as the year of publication. Therefore, the publications obtained from the 996 papers collected were 922 papers. A database containing a collection of articles and their identity components is stored in (*csv) and (*ris) formats. The data was then imported into Microsoft Excel in (*csv) format for further analysis.

(iii) Data analysis. Data analysis was carried out using VOSviewer software to use three forms, namely Network, Overlay, and Density Visualization.

Further information about bibliometric analysis can be found in several previous literature (Nandiyanto, et al., 2020a; Azizah et al., 2021).

Results and discussion

Definition of practicum and laboratory

Practicum is scientific learning carried out by conducting experiments directly, and interacting directly with learning material or data sources (Ulfa, 2016; Suryaningsih, 2017; Nisa, 2017; Anggun, 2019). Students who take part in practicum are expected to have technical abilities (Prayitno, 2017; Lepiyanto, 2017). Through practical learning, students are directed to be able to plan, prepare, carry out, and even observe and discover directly what is being done. Therefore, they can assess whether the experiment was successful or not. The laboratory is a very important facility in supporting the implementation of practicum (Salmon and Harpad, 2018; Kahar, 2018). Practicum in the laboratory in science learning will support students' complete learning (Lutfi and Hidayah, 2020). The following are several definitions of practicums and laboratories in science learning:

(i) Practicum is a learning model that can provide direct learning experiences to students.
(ii) Practicum is a learning experience where students interact with learning materials and resources directly in a learning environment.
(iii) Practicum is a learning method that can provide students with learning experiences. Therefore, they can more quickly remember, comprehend, and understand subject matter.
(iv) Practicum is a way of studying subject matter using experiments, where students must prepare, implement, observe, control, and draw conclusions.
(v) Practicum is a scientific learning model, where in its implementation a practicum guide validation sheet is used.

Apart from that, Kahar (2018) stated that laboratories are an important component in helping knowledge and skills in practical learning. Practical learning in the laboratory is professionally oriented learning (Baranov, 2016). This shows that practical and laboratory learning are an inseparable unit.

Strategies in language for science student understanding during practicum in laboratory

Language as a communication tool for students to understand concepts and theories. Language is a fundamental aspect of human civilization, which supports communication, thought, culture, and society. In addition, the importance of language in aspects of personal development, social interaction, teaching and learning, and scientific progress (Beckner et al., 2009). The emergence of digital technology, advances in student practicum models and their significant impact on education show great potential to increase students' intellectual adaptability, acquire new knowledge and skills, and support their contribution in the digital era in the development of science (Behnamnia et al., 2020). Many institutions focus on increasing students' active learning to improve academic performance, including using effective language methods in practicum activities (Yang, 2017). According to several literatures, the integration of language technology into the educational process during practicum will be able to increase student effectiveness. The combination of active learning and technology with modern linguistic concepts in practicum is developing significantly (Park and Howell, 2015). All of them have the same goal, namely to actively involve students in the learning and enrichment process in the laboratory.

Curriculum Development for Practicum

The curriculum is a structured framework of learning materials that describes students' learning experiences from beginning to end, equipped with learning methods and models as well as assessment plans that will be carried out (Widiaty et al., 2020; Rosina et al., 2021; Maryanti and Nandiyanto, 2021; Maryanti et al., 2021). Curriculum elements consist of goals, objectives, content, and learning experiences which are intended to describe students' learning experiences (Wahyuni, 2016), function as a road map for the teaching and learning process, and ensure that learning objectives are achieved properly.

Curriculum development is the process of making plans and designing the structure of what will be learned by students and delivered by teachers, then described completely or comprehensively in an educational program or course (DeLuca et al., 2010; Widiaty et al., 2020). Curriculum development discusses content, objectives, methods, assessment, and learning resources that will be used in learning (Maryanti & Nandiyanto, 2021). Providing comprehensive and comprehensive learning experiences for students is the goal of curriculum development. This is also done specifically in practical learning. There must be a curriculum specifically designed for practical learning in the laboratory. In terms of stages and content, it will not be much different from curriculum development for education courses. However, specifically, the stages of developing a practical learning curriculum in the laboratory (Syamsu, 2018) are as follows:

(i) Instructional objectives: When determining learning objectives, three aspects must be taken into account, namely 1) student needs, 2) community needs and 3) learning content. These learning objectives are described in competency standards and basic competencies.

(ii) Selection of learning experiences. This stage begins with understanding the characteristics of each lesson and then starting to design the learning experience that will be given to students. This learning experience refers to competency standards and basic competencies that have been previously formulated.

(iii) Organization of learning experiences. A curriculum structure is needed to help students learn more easily. The accuracy of building a curriculum structure will have an impact on achieving learning objectives.

(iv) Evaluating. This is the final stage in curriculum development. The purpose of evaluation in curriculum development is to obtain an overview of the success and suitability of the curriculum developed with learning objectives. This stage is also carried out to find problems that occur in learning.

Student Demography for supporting practicum: Motivation and psychological condition student

Language has a close relationship with students' conditions and the learning environment. Teacher and student interaction is established because there is good communication in the classroom. This causes the development of students' abilities as a form of learning outcome (Peeters, 2018). Therefore, the use of language in education has become a popular study and is widely applied in schools (Koller, 2018). Students' language skills in learning help them to more easily understand lesson material, write, and read. Indirectly, it ultimately has an impact on students' educational success (Mirrahimi et al., 2011). The higher the student's language skills, the higher the student's self-confidence in participating in learning because the student's ability to

understand the lesson material increases. Therefore, students are more motivated to continue learning. Student learning motivation is an important factor in determining student educational success. This is because student learning motivation can make students more enthusiastic about responding, condition students, and determine the quality of students learning (Sulihin et al., 2020). Especially in practical learning in the laboratory, strong motivation will provide positive energy for successful learning.

The student's psychological condition is the student's condition. Many students sometimes have psychological disorders due to disadvantaged social conditions in their families. However, the relationship between family social conditions and students' emotional health is not yet clearly known, which in turn has an impact on their language skills. Environmental and internal factors in children cause the development of children's language skills. The family relationships that are built will have an impact on emotional health problems. Apart from that, peer relationships can also be a language barrier for a child (Griffiths et al., 2020). Other research also shows that the use of diction in conveying information describes a person's social-emotional condition. The recipient of the message will feel emotionally close to the speaker. Based on psychoanalysis, the subconscious expresses itself through language. Similar assumptions are also present in much sociolinguistic research, narrative analysis, and communication research (Pennebaker et al., 2003).

Other research on the relationship between teacher language style and student self-efficacy is described through three things, namely persuasion, social, and verbal. Experts increasingly agree that cultural, linguistic, and social factors have an impact on learning. Language style influences a communication event. For example, when a teacher teaches in class, he must use a language style that is appropriate to the students' existing psychosocial conditions. Therefore, the learning material can be well received. The better the language style used, the better other people will accept it. The psychological impact can be in the form of motivation, self-efficacy, and the creation of good interpersonal relationships, and vice versa (Gunawan and Kadir, 2017).

Technology in the laboratory to improve the way of language in delivering subjects in science

One technology that is widely used to encourage active participation is the application of the Student Response System (SRS) (Turan and Meral, 2018), which allows real interaction between teachers and students, provides opportunities for direct feedback during practicums and increases student involvement (Metwally, et al., 2021). Teachers can gauge students' understanding and adjust their teaching strategies and styles accordingly. This system is known by various terms, such as classroom communication systems, audience response systems, clickers, student response systems, and voting systems.

The implementation of SRS has produced many benefits, including increasing the effectiveness of learning during practicum. SRS has been proven to have a positive impact on several learning outcomes, especially student engagement in the classroom and during practicum (Lee, et al., 2015). SRS has motivated students to actively participate in class discussions and practicums. When using SRS, students tend to focus more on carrying out the practicum because they are often asked to answer questions during the practicum process. Apart from that, SRS also helps teachers evaluate each practical step taken to obtain achievement indicators. Regarding its effect on student achievement, there is some scientific evidence regarding the effect of SRS on student performance in practicums. Several studies report that the use of SRS during practicum can improve students' cognitive aspects. However, this does not necessarily mean that the use of SRS provides a significant improvement in the overall learning process.

Technology literacy and the effect of language

Technological literacy and the influence of language are important abilities that enable someone to communicate well, understand data and information, and analyze in more detail, so they can interact well in society. Increasing technological literacy has a relationship with language arts skills (Judson, 2010). Here are ways to improve one's technological literacy and language influence:

(i) Provision of technological facilities. Directly, a person's ability to use technology will increase when that person has technological equipment (Rahman, et al., 2021). The availability of technological facilities makes someone learn how to use them.

(ii) Read regularly. Increasing language literacy through regular reading (Teguh, 2020). Reading regularly means a person will have a large and broad vocabulary. Therefore, this will automatically broaden understanding of something.

(iii) Discussion and debate. Ways to improve speaking, listening, and understanding skills from other people through various points of view can be done through discussion and debate. (Wagu and Riko, 2020).

(iv) Writing. Writing is one way to improve communication skills in written form (Karlina, 2017).

(v) Text analysis. Another way to improve your ability to understand the subject matter well. Data identification, analysis, and evaluation activities are one way to improve the ability to understand the material (Pratama, 2016).

(vi) Attend language classes (courses). One way to improve technological and language literacy is through learning experiences.

(vii) Practice. Direct practice is one way to increase technological and language literacy, expanding understanding of language use in the context of verbal and nonverbal communication.

Practicum and Language competencies for special needs

Students with special needs require special attention that is different from students in general (Maryanti, et al., 2021). Apart from that, students with disabilities have many obstacles that must be taken into account. Therefore, is the challenge for how practicum activities are carried out? What kind of language competencies should practicum mentors have? For example, for students who have barriers to speaking, it will be difficult to ensure communication runs effectively (Prelock et al., 2008). People with writing and reading disabilities such as dyslexia or cerebral palsy experience difficulties in spelling words or understanding written text (Roitsch and Watson, 2019; Abidin et al., 2021). Some students with special needs may also have difficulty understanding complex sentences, so information presented with pictures, symbols, or other simpler forms will help them (Booth et al., 2000), as well as autistic students (Gittins et al., 2018).

A reading program that has been used in several schools with an electronic-based approach designed to teach reading skills to students with various intellectual disabilities. Accessible Literacy Learning (ALL) combines synthetic and analytical approaches in teaching reading and is designed according to the needs of students with special needs, or augmentative and alternative

communication (AAC) devices, or other assistive technologies (Baxter et al., 2012). So an inclusive approach is the main thing that needs to be done to overcome the language barriers faced by students with special needs.

Results in bibliometric analysis: metrics, annual publication report, article trends, co-occurrence analysis

Metric results

All publications examined in this study were published between 2015 and 2021. Metadata found 922 papers. Google Scholar has indexed 57 language publications in science learning.

Publication trend

Figure 1 displays the cumulative and annual publication trends of language in science research from 2015 to 2021. The average number of publications per year during this period is as follows: 217 in 2021, 173 in 2020, 183 in 2019, 130 in 2018, 94 in 2017, 68 in 2016 and 57 in 2015. These figures represent the respective percentages, namely 23.54%, 18.76%, 19.85%, 14.10%, 10.20%, 7.38% and 6.18%. Based on data, the number of publications each year about language in science learning continues to increase. The highest number of publications recorded occurred in 2021 and the lowest in 2015.

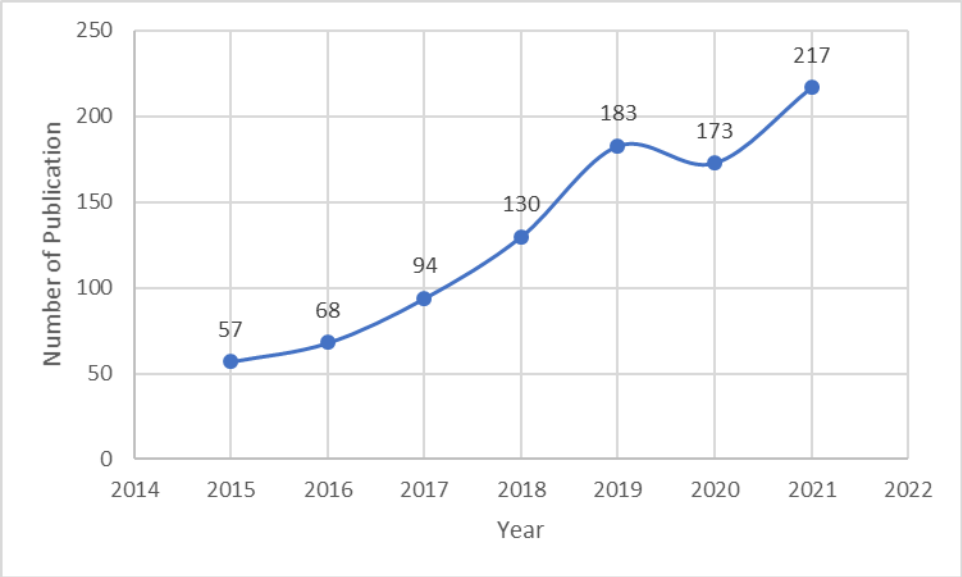

Figure 1. Annual publication report on language in science research based on Google Scholar data

Article trend

Citations are very important in academic writing and research. As a principle of academic integrity by giving awards to scientists, supporting research arguments, and developing a solid foundation in scientific literature (Jomaa and Bidin, 2017). Citations also describe the relationship between one topic and another, as well as its impact on the quality of publications in a particular field. relationship between authors, research groups, research topics, and countries (Cao et al., 2016). Bibliometric analysis provides an overview of overall quality as a tool for evaluating scientific journals (Agarwal et al., 2016; Roldan-Valadez et al., 2019). This research presents the ten articles with the highest citations (see Table 3).

Table 3. Top nine most cited articles

No	Cites	Title
1	170	Standard-based science education and critical thinking
2	174	Perceptions of senior-year ELT students for flipped classroom: A materials development course
3	178	Teaching English speaking skills to the Arab students in the Saudi school in Kuala Lumpur: Problems and solutions
4	209	The Role of Teachers' Classroom Discipline in Their Teaching Effectiveness and Students' Language Learning Motivation and Achievement: A Path Method.
5	245	Guide to teaching computer science
6	254	Representing student argumentation as functionally emergent from scientific activity
7	266	Virtual Physics Laboratory Application Based on the Android Smartphone to Improve Learning Independence and Conceptual Understanding.
8	356	Physical experience enhances science learning
9	780	Learning and teaching online during Covid-19: Experiences of student teachers in an early childhood education practicum
10	1115	Effective educational videos: Principles and guidelines for maximizing student learning from video content

Co-occurrences analysis

The number of occurrences of an event using co-occurrence analysis (Kim et al., 2020). Co-occurrence analysis in research is used to see the frequency of appearance of a term in publications about language in science learning, and laboratory practicums using VOSviewer. Each event is depicted through two forms of visualization, namely network visualization (figure 2) and overlay visualization (figure 3).

Figure 2 shows network visualization in science learning research during practical work in the laboratory. The terms found in language research in science learning during laboratory practicums were limited to a minimum of 6 occurrences, so 221 terms were found. The 221 terms are separated into 6 clusters. The following is a brief description of the main themes and patterns in each cluster.

Cluster 1, highlighted in red, centers on the keyword “student” and shows a total strength of 4221 relationships and 604 occurrences. This cluster includes terms such as “science learning”, “English” and “education”. Cluster 1 illustrates that education facilitates a formal structure for learning science with language. Mastery of English is very important in improving communication skills.

Cluster 2, highlighted in green, is centered on the keyword “language” and shows a total strength of 3159 relationships and 437 occurrences. This cluster includes terms such as “module”, “laboratory”, and “science skills”. Cluster 2 illustrates that the existence of laboratories and language practicum learning modules is very important. Apart from that, there is a relationship between language and science skills.

Cluster 3, highlighted in blue, is centered on the keyword “technology” and shows a total strength of 502 relationships and 61 occurrences. This cluster includes terms such as “engineering”, “STEM” and “virtual lab”. Cluster 3 shows that as technology develops it will be linked to the development of virtual labs. This is a sign of the progress of knowledge from engineering and STEM.

Cluster 4, highlighted in yellow, is centered on the keyword “laboratory” and shows a total relationship strength of 2105 and occurrences of 289. This cluster includes terms such as “symbolic language”, “video” and “integration”. Cluster 4 illustrates that a language laboratory can integrate science learning through videos that display language symbols to make learning easier.

Cluster 5, highlighted in purple, is centered on the keyword “analysis” and shows a total relationship strength of 457 and occurrences of 62. This cluster includes terms such as “augmented reality”, “application” and “practical work”. Cluster 5 describes the relationship between applications that can support practicums and even a work system regarding augmented reality

Cluster 6, highlighted in light blue, centers on the keyword “communication” and shows a total relationship strength of 156 and occurrences of 22. This cluster includes terms such as “lab report” and “information”. Cluster 6 explains that the relationship between communication and information in practical learning in the laboratory can be made in a laboratory report

Figure 3 depicts a cluster analysis using keyword terms to identify the most commonly used research subjects worldwide. Overlay visualization was used to illustrate emerging themes based on the year of publication. Especially in 2021, terms that appear such as "scientific literacy", "covid", and "practicum activity" are marked with yellow circles.

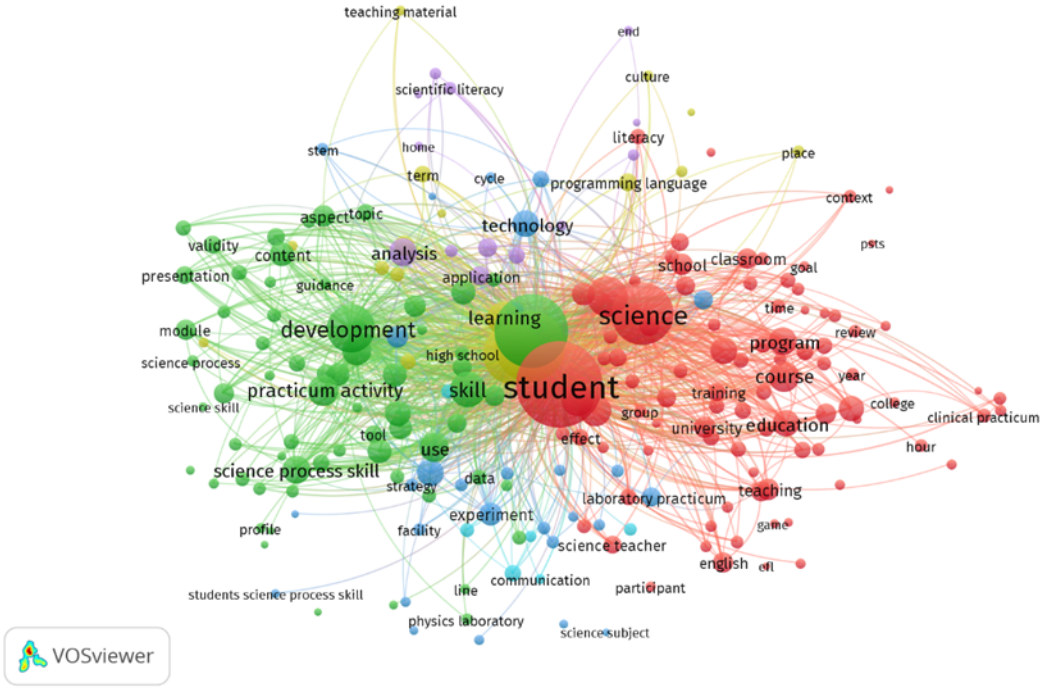

Figure 2. Network visualization from the language in science learning subject

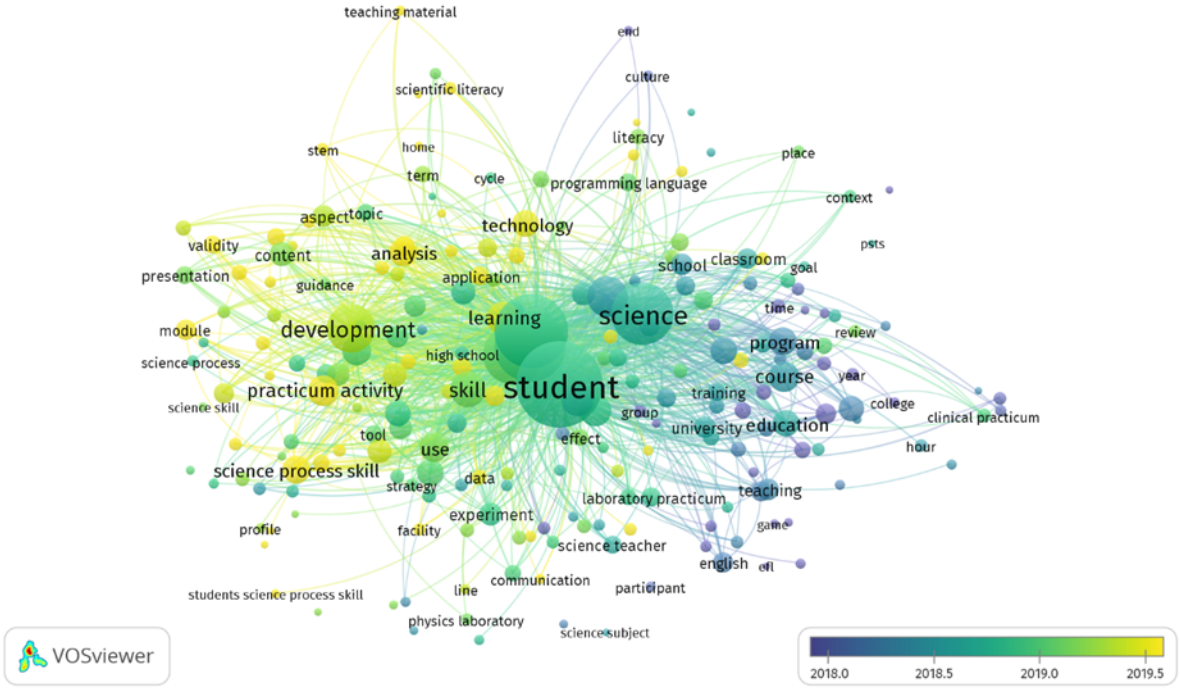

Figure 3. Overlay visualization from the language in science learning subject

Conclusion

This research examines the development trend of language research in science learning which can improve students' understanding during practicums in the laboratory, as well as several factors that can influence the learning process and bibliometric analysis (using the Google Scholar database from 2015 to 2021). Student characteristics, motivation, teacher-student relationships, and student psychological conditions can all be concluded to be closely interconnected. Language is a determining factor in the success of science learning during practical work in the laboratory. Therefore, the language style used by the teacher during practicum in the laboratory should be using a simple language style. Therefore, it is easy to understand. This article can be used as material for readers to consider in understanding the current conditions regarding the importance of language in science learning, especially practical learning in the laboratory.

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Declaration of conflicting interest

The author declares that there is no conflict of interest in this work.

Funding acknowledgements

The research received no external funding.

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