

# **An Overview of How STEM-LW (Local Wisdom) Research Influences Character Over Time: An In-Depth Review with Bibliometric Analysis**

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*The use of STEM approaches based on local wisdom is a trend in itself in the multicultural country of Indonesia. The collaboration between the two became one of the builders in strengthening character building strategies with the STEM-LW relationship. This study aims to see the direction of the trend of STEM-LW character research over time. This research is an in-depth literature study research using bibliometric analysis techniques. The stages in the implementation include preparation, data collection, data management, data extraction, data visualization, and data conclusion drawing. Analysis techniques using manual investigations and bibliometric analysis with the help of supporting software Publish or Perish, Reference Manager Zotero, and VOS viewers. The results showed of 750 total publications in the period 2007-2002 which came from 3 indexers. The total articles after submission were 467 articles that met the requirements with STEM-LW character keyword. journal articles are predominantly from Indonesia with three developmental periods, namely the pioneer period, the development period, and the stable period. Development being the top item that appears most often in the article, and perception is the relevant palng item. The direction of STEM-LW character research is towards education, including development, analysis and implementation in learning. Development research trends are in item analysis, effectiveness, ability, impact, creativity, and stem approach. The clusters that are most often used as side topics in research are class I and II. No impact emphasizes STEM-LW on character.*

*Keywords: bibliometrics, depth review, STEM-LW, character*

## INTRODUCTION

STEM education in advanced industrial countries and in ASIA is making efforts to develop and provide innovative solutions, especially to global issues directly related to the 2030 Sustainable Development Goals approved by the United Nations. As the Industrial Revolution 4.0 gains momentum and affects every aspect of our daily lives, the boundaries between STEM (Science, Technology, Engineering and Mathematics) disciplines and non-STEM are becoming increasingly biased (Harun et al., 2021; Boon Ng, 2019). In time the education sector began to rethink the boundaries of traditional curricula whereby knowledge and skills are segregated into subjects.

The development of STEM (Science, Technology, Engineering, Mathematics) approach research in education is growing over time. STEM is becoming a popular approach to education at various levels (Eroğlu & Bektaş, 2022; Alea et al., 2020). STEM is used to achieve a cognitive, affectively, and psychomotor learning objective. STEM approaches in learning support improved achievement and learning outcomes (Agung et al., 2022; Salazar-Mattews, 2020; Yıldırım & Selvi, 2016), science literacy (Krisantia, 2021; Herwandi et al., 2021; Parno et al., 2019; Shaffer et al., 2019), understanding of concepts in the cognitive realm of different ages (de Santana et al., 2022). STEM is also able to significantly influence the skills and knowledge of learners. STEM can also significantly influence learners' skills and knowledge (Han et al., 2021; Allina, 2018).

Local wisdom is one of the cultural treasures of a community that must be preserved. Apart from being an element of a culture, it is able to be a means of supporting and improving the educational and social processes of the community (Suprpto et al., 2021; Suastra, 2017). The use of local wisdom in the educational and social process is expected to be able to make people more accepting of knowledge (Dewinta et al., 2021). Many types of cultural elements can be used as examples of local wisdom. The examples of local wisdom include philosophies, life principles, literature, art, and other cultural elements that characterize a population of residents (Prasadi et al., 2020; Mohajan, 2018). A community in a certain environmental scope must have local wisdom that is highlighted based on existing categories.

Local wisdom should be used in the educational process, both formal and informal. The use of local wisdom in the learning process exerts a lot of influence on the individual in aspects of attitudes that are reflected in character, such as tolerance (Arliman, 2018; Junianti & Hariyanto, 2021), care for the environment (Speldewinde, 2022; Casto, 2022), scientific and social attitudes (Fortus et al., 2022; Iriaji & Rochbeind, 2021), and other character education (Abidin, 2019; Haryandi et al., 2021; Rokhman et al., 2014). Various skills are also trained by the use of local wisdom, namely critical thinking (Fadilah, 2022; Junianti & Hariyanto, 2021; Pageh & Permana, 2020; Puchumni et al., 2019; Suastra, 2017), Cooperation (Haka et al., 2020; Sümen & Çalisici, 2016), and troubleshooting (Permana & Jayanta, 2019; Rummel & Spada, 2005). The use of local wisdom will be maximized if it collaborates with a certain learning model or approach.

STEM approaches based on local wisdom will be a maximal-based approach or a perfect match in supporting the learning process. The collaboration between the two has been researched as educational research and cultural development. The collaboration of the two in rehearsing characters was researched in many studies such as Mardiasuti et al. (2021); Mann et al. (2021); Prasadi (2020); Abidinsyah et al. (2019); Pimthong & Williams (2018); Handriyan et al. (2018); Yıldırım & Selvi (2016). Based on the results of this study, the use of STEM with local wisdom, from now on referred to as STEM-Lw, has been able to train various types of characters based on the values of local wisdom.

This research aims to understand the development of STEM-Lw research in training character. The picture is taken from the development of the research period, the type of research, the analysis of index results, the country of origin of local wisdom, the types of local wisdom, the most popular authors, types of characters developed/trained, network visualization, overlay visualization overtime, density visualization, and the trend of development of STEM-LW research in influencing character.

## **METHOD**

The methodology in this study is a literature review method with in-depth analysis accompanied by bibliometric analysis. In addition to manual data extraction, data collection is carried out using supporting software, Publish or Perish, zotero, and VOSviewers. Supporting applications are used in data collection, bibliography references and depictions of the research landscape from the studies carried out.

This study method uses the stages of preparation, data collection, data management, data extraction, data visualization, and data conclusion drawing.

### **Data Preparation**

At this stage, the researcher makes preparations in the form of preparation of supporting applications and taking keywords in the study. The supporting applications prepared are publish or perish, Zotero and VOSviewers. The publish or perish application collects journal articles that will be processed using keyword search. Zotero serves as the library list management of the perish publisher application and as a place to filter the journal articles collected. VOSviewers is a visualization landscape of collected and filtered data. VOSviewers will show you an overview of the relationships that may be present in this study. The keywords used in this study were “STEM”, “Local wisdom”, “character”. Keywords are used in the next process, namely data collection.

### **Data Collection**

At the data collection stage, it is carried out with the help of the PoP application with settings in the form of a search engine using the Google Scholar database, with the type of article publication in journals and the period of 2017 to 2022, data is collected by typing keywords in the form of “STEM”, “Local wisdom”, “character”. The data collected in this process will be continued by saving the results in RIS file format.

### **Data Management**

Data saved in RIS format is entered into zotero software to filter existing journal articles. The standard in filtering is to eliminate articles that are not eligible such as not having a year, not having a publisher, not having a journal, and not being included in the keywords used. After this process the selected and eligible articles are saved again in the RIS file for later downloading one by one.

### **Data Extraction**

Downloaded journal articles are extracted individually to see studies of STEM, local wisdom and character. Data extraction is carried out manually, where the journals designated as eligible items.

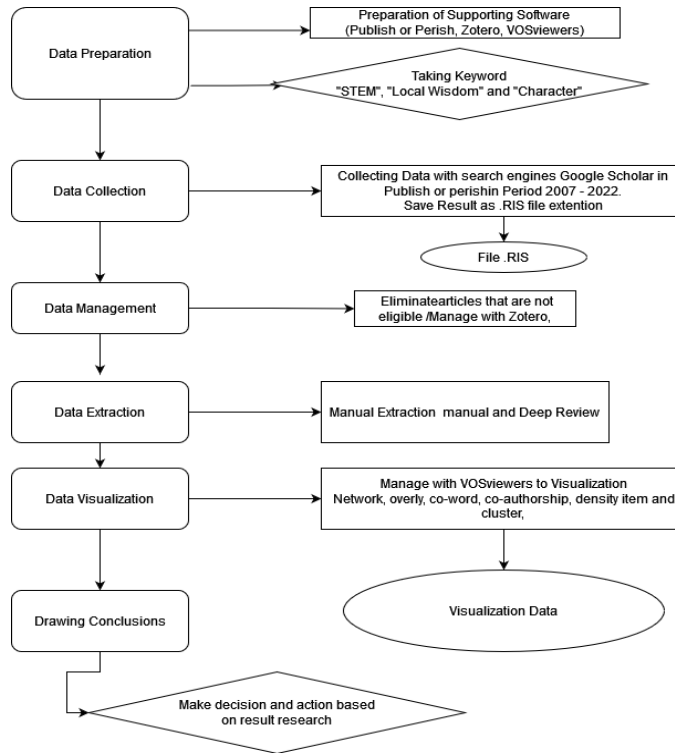
### **Data Visualization Analysis**

Downloaded journal articles are extracted individually to see studies of STEM, local wisdom and character. Data extraction is carried out manually, where journals that have been designated as items that contain data are presented in the form of tables, diagrams, and visual landscape images. Visualization and data analysis were carried out with bibliometric analysis to see an overview of the research topic. This bibliometric analysis process uses a VOSviewers support application condition.

### **Drawing Conclusion**

At the conclusion stage, data from the results of collection, management, extraction, visualization, and analysis are evaluated based on each analysis's objectives to see the research's big picture. In this tahao, the researcher will propose several things related to the state of the existing data. The stages in this study will be described in the details of the flow chart in Figure 1.

**FIGURE 1  
RESEARCH STEP CHART BASED ON THE TOPICS**



**Findings and Discussions**

Based on the data that has been collected, the research data is presented in the form of tables, diagrams, and figures which will be explained in detail below:

**The Publication Findings Based on the Topic**

Based on the results of the collection through Publish or Perish, the keywords “STEM”, “Local Wisdom”, “Character” with the category of article journals from 2007 to 2022 from sources indexed by Google Scholar, Scopus, and Crossref. Based on the results of the data collection, data on the number of article findings was obtained based on the Google Scholar, Scopus, and Crossref indices. Data shown in Table 1.

**TABLE 1  
PUBLICATIONS FINDINGS DATA BASED ON THE TOPICS IN DIFFERENT RESOURCES  
OF PUBLISH OR PERISH**

Keyword	Result	Platform Journal Database		
		Google Scholar	Scopus	Crossref
“STEM”, “Local Wisdom”, “Character”	Publication Years	2007-2022	2007-2022	2007-2022
	Citations Years	11(2007-2022)	11(2007-2022)	11(2007-2022)
	Papers	648	24	78
	Citations	7995	168	389
	Citation/Year	726,83	23,64	78,41

	Cite/Paper	12,32	9,83	3,87
	Authors/paper	1,96	1,00	0,99
	h-index	38	16	22
	g-index	94	12	33
	hI-norm	34	18	22
	hI-Annual	3,00	0,97	11,02
	hA-index	18	6	14

Based on the data in Table 1 of the 3 source indices in PoP, the total publications in the form of overall scientific journal articles were 750 articles. The Google Scholar platform has a total of 648 articles, scopus 24 articles, and crossref as many as 78 articles.

The Google Scholar platform year of coverage consisting from 2007 to 2022 has a total of 648 paper articles in journals with a total of 7995. The number of citations per year shows a large number of 726.83 and the number of citations per paper is 12.32. The average number of authors per paper is 1.96 with a large h-index of 38 and a g index of 94. Previous figures show that the number of papers related to STEM-LW research is based on existing databases.

According to the Scopus database, the number of papers in the same time span is only 24 papers that have the keyword STEM-LW character. The total size of citations is 168 and citations per year reach 23.64. The number of citations per paper is also quite low, reaching only 9.83 with an average number of authors per paper is 1.00. In addition, the h-index and g-index values are quite high, indicating that ahwa scopus articles indexed by Scopus have a good reputation. The crossref platform has a total of 78 papers with the number of citations being 389 citations. The number of citations per year reached 78.41, and citations per paper reached 3.87 citations per paper and 0.99 authors per paper. The h-index and g-index values are also fairly high, with nails of 22 and 33, respectively.

In the google scholar paper database, there tend to be more, and the citation value is also much higher. This is because the Google Scholar platform is widely known in scientific publications or in academics. In addition, the high value is also influenced by the popular search engines of a country. In Indonesia, Google is the top search engine or developer application platform. This has caused Google Scholar to become one of the number 1 platforms to search for literature / scientific studies.

The Scopus platform has become known to academics as an article indexer or scientific journal. Scopus is also used as a reputational measure of a scientific paper. Although indexing platforms such as ERIC, SINTA, and others exist, scopus is still considered superior, especially in scientific research studies. However, based on existing data, scopus has the platform with the least number of articles, namely only 24 journal articles, and is lower than Google Scholar.

In addition to scopus and google scholar, crossref indexes taken from crossref databases published or perish are less popular than other indices. Covering this, the paper on this index is not at all non-existent, it's just that there are fewer of them than google scholars. Google scholar is the most popular platform and is included in the ranks of journal indexers. It is also stated in many literature studies with the same methodology that Google Scholar is in the top rankings in searches for articles.

After passing the data extraction process, the data processing process proceeds to the filtering stage of journal articles in a character-related publication of STEM-LW. Using zotero support applications filters journal articles in the form of non-publisher articles, magazines, and articles without journals. The filtering process only leaves journal articles from research that have indexed journals and publishers. The process of improving the data can be seen in table 2 below.

**TABLE 2**  
**REFINEMENT OF THE RESULT ARTICLE OF THE FINDINGS ON STEM-LW CHARACTER**

Refining Indicators	Total article after refining		
	Google Scholar	Scopus	Crossreff
Finding articles with Publish or Perish (RIS File)	648 items	24 items	78items
Remove publications non-article journal from zotero and manual. investigation/extraction data	421 items	20items	65items
Eliminate articles without the STEM-Local wisdom-character keyword	391 items	14 items	62items

**Result of Refinement and Filtering Article STEM-LW Character**

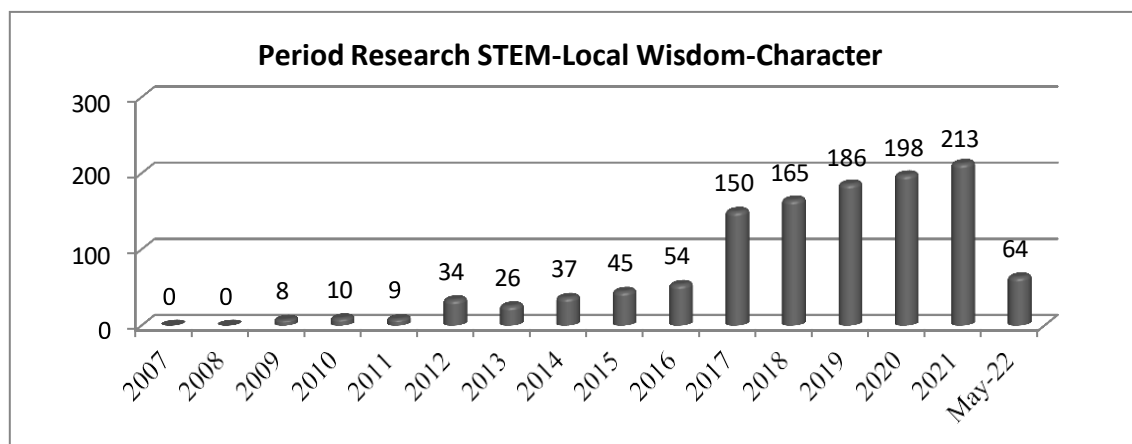
The process of filtering articles using zotero is sorted and sorted by article type and the presence or absence of journals and publishers on the article. the process of improvement and screening is carried out with the help of the zotero application as a reference manager and manual investigation.

As a result of the process of refinement and filtering, there was an elimination of articles from the google scholar database was 257 articles, 10 from scopus and 16 from crossreff. The results of this process show that articles obtained from indexers through PoP are still not eligible for use in the bibliometrics analysis process. The investigation and manual data extraction must be carried out to select quality articles in the review stage. According to research from Haryandi et al. (2021), an in-depth study and bibliometric analysis is sent to a source with a good reputation of the article and publisher as whaeli.l The better the reputation of the journal and the article reviewed, the more widely known the research will be (Al Husaeni & 2022; Usmayanti & Sofyana, 2022; Haryandi et al., 2021). Therefore, the investigation and manual extraction can help improve the quality of journal articles.

**The Division of Period for the Development of Research STEM-LW Character**

The time period of research development of stem-LW characters is divided into three stages of time including the pioneer period, the developer period and stable period. Result of annual research developments from the research of STEM- LW character can be seen in figure 2 and classifications of different periods of research development can be seen in table 2,

**FIGURE 2**  
**NUMBER OF PUBLICATIONS IN THE FIELD STEM-LOCAL WISDOM**



**TABLE 3**  
**DIVISION OF RESEARCH PERIOD STEM-LW**

Period Name	Years period
Pioneer research	2009-2011
Developer research	2012- 2016
Stable research	2017- >2022

**Classification of Research Period Based STEM-LW Character**

The classification of research developmental periods from STEM-LW is included in three important periods in research development. The development of the research is divided based on year data and data on the number of research articles published during that time / year. In this study, the number of published articles is a summation based on the google scholar, scopus and crossref databases added up after the manual extraction process and from zotero based on the year of publication.

The result of the division of this period into, the pioneer period where the pioneer period began to be published in 2009 to 2011. The year 2012 to 2016 is a period of development from research to reaching a period of stability in 2017 to May 2022. The division of these three periods is based on the number of publication frequencies of existing articles by comparing the gaps of each year with the years before and after.

The division of this period aims to determine the level of interest and popularity of the themes raised in the world of research. This division of the period can also be used as a trace of research history and article pioneers on STEM-LW characters. Classification is also a way for researchers to record traces of research history from STEM-LW character.

**TABLE 4**  
**ANALYSIS OF TERM-OCCURRENCE STEM-LW CHARACTER**

Item	Occurrence	relevance score	Item	Occurrence	relevance score
development	39	0,2	influence	5	4,6
education	25	1,9	junior high school student	5	4,6
analysis	23	3,0	persepsi	5	41.632,0
local wisdom	23	0,2	physics	5	2,5
mathematics	21	3,6	teaching	5	5,4
technology	21	3,6	blended	4	21.437,0
engineering	17	0,0	case	4	6,0
indonesia	17	0,5	content	4	11.328,0
effect	16	2,4	creativity	4	0,4
problem	16	4,0	critical thinking skills	4	5,1
covid	11	5,4	culture	4	0,0
teacher	11	3,9	discovery	4	12.995,0
context	10	3,2	e module	4	0,3
research	10	3,2	evaluation	4	5,1
application	9	0,3	higher education	4	11.603,0
effectiveness	9	3,3	identification	4	13.692,0
pandemic	9	0,5	integration	4	3,4
study	9	3,5	journal	4	0,6
approach	8	3,3	method	4	5,3
critical thinking skill	8	5,5	outcome	4	0,4
steam	8	3,4	science education	4	13.224,0

stem approach	8	3,2	science technology engineering	4	13.595,0
stem education	8	6,0	scientific attitude	4	4,1
case study	7	4,6	scientific literacy	4	6,8
design	7	5,0	secondary school	4	5,1
elementary school	7	3,5	students problem	4	6,6
impact	7	1.365,0	tool	4	5,0
learning model	7	5,6	use	4	6,1
management	6	4,2	21st century	3	6,4
media	6	4,8	animation learning media	3	5,6
motivation	6	2,5	environmental education	3	4,9
review	6	3,6	ethno stem	3	10.538,0
society	6	4,6	health	3	10.287,0
thailand	6	4,8	hot	3	11.738,0
assessment	5	5,7	indigenous knowledge	3	13.568,0
environment	5	5,2	learning styles	3	6,9

### Analysis Term-Occurrence Research Based on STEM- LW Research

The results of data extraction based on journal articles, followed by the analysis stage using the research landscape with the VOSviewers application to find the frequency of words appearing in article titles in publications with STEM- LW topic characters. Using the settings create a map using text data>read data from reference manager>select source>field from title field>full counting>minimum number of occurrences is 3 times>numbers of term to be selected 72>verify term selected>result.

Based on the analysis results from VOS viewers with a minimum of kat appearing in the title 3 times, 77 words / items appeared in the visualization results. The words that appear the most and are in the top 20 categories are development, education, analysis, local wisdom, mathematics, technology, engineering, Indonesia, effect, problem, covid, teacher, context, research, application, effectiveness, pandemic, and study.

Words with a high frequency of appearing in the study's title do not have a comparable relevance value. The term perception sequentially holds words that have a high relevance value, superior to the independent learning program, comparison model discovery, blended, pre service biology teacher, experiment, guided inquiry, melde, medium enterprise, portable purchase display, creative thinking skill, microbiology, indonesian curriculum, comparison, multimedia development, senior high school, and development.

### Visualization Network and Terms Landscape Research STEM-LW Character

The data extraction results carried out manually or assisted by the VOSviewers application produce image data from network term visualization, overlay visualization, and density visualization. Visualization has data shown in Figures 3-5.





**TABLE 5**  
**COMPARISON ITEMS ANALYSIS BASED ON THE TOPIC RESEARCH**

No	Cluster Color	Item in Cluster		
I	Red	Animation learning media. Assessment Case Comparison Creative thinking skill Critical thinking skill Development E module Effect Elementary school Ethno-STEAM Skill	Indonesian school Learning Local wisdom Management Model Outcome Physic Preservice biology teacher Primary school student Project Research scientific literacy Secondary school	Study Teaching material Thailand Tools Utilization Stem Approach Student Student critical thinking Chemistry Hot Impact implementation
II	Green	Art Arts century skill engineering ethno science Indonesian curriculum technology	Mathematics Microbiology Multimedia Development Reviews Science Science attitude Student creative thinking	Science educations Science technology engineering STEAM STEM STEM educations Student worksheet
III	Blue	Ability Analysis Android Creativity Junior high school	Media Method Motivation Role Literature review	Self-efficacy Student problem Term Schoology Science subject
IV	Yellow	Application Approach Discovery Indigenous knowledge Influence	Learning model Pre service teaching Science environmental technology	Society Teaching Type Use
V	Purple	Blended Effectiveness Evaluation Indonesia STEM implementation Teacher belief	Javanese learning material local wisdom curriculum perbandingan mode discovery learning school	

Based on table 5, the clusters are described in the existing data visualization stage. The total number of clusters is as many as 12 clusters. The presentation of data in the table is limited to 5 clusters, namely clusters 1 to 6 with cluster colors of red, green, blue, yellow and purple. These clusters are the top clusters with the terms that have the most connections between each other.

Terms in the same cluster are characterized as having many relationships in the same study and being researched in one joint research title. The cluster level indicates how strong the relationship between terms between clusters is. Cluster I has a stronger relationship with cluster II compared to the relationship between cluster I and cluster III. Term/items in cluster I with a total of 38 items including Animation learning media, Assessment, Case, Comparison, Creative thinking skill, Critical thinking skill, Development, E module, Effect, Elementary school, Ethno-STEAM, Indonesian school, Learning, Local wisdom, Management, Model, Outcome, Physic, Pre service biology teacher, Primary school student, Project, Scientific research literacy, Secondary school, Skill, Study, Teaching material, Thailand, Tools, Utilization, Stem approach, Student, Student critical thinking, Chemistry, Hot, Impact, implementation, have a strong relationship with each other.

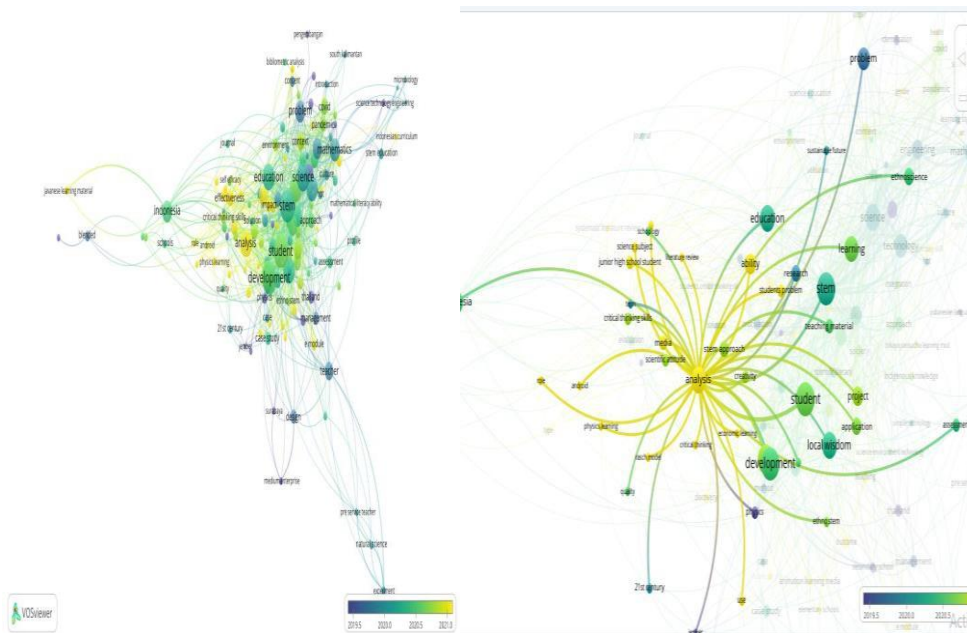
Cluster I also has the strongest relationship with cluster II (green) with items including Art, Arts, century engineering skills, ethnosience, Indonesian curriculum, technology, mathematics, Microbiology, Multimedia development, Reviews, Science, Science attitude, Student creative thinking Science

educations, Science technology engineering, STEAM, STEM, STEM educations, Student worksheets. Items from clusters I and II are where local wisdom, character and STEM are located. This shows that these three items have many joint publications in research publications.

Using item and network analysis helps researchers see which studies are frequently and rarely conducted. Research that is rarely done will give our research a greater disciplinary rate compared to already frequent research. Therefore, the selection of items based on network visualization is one of the decision supporters before conducting further research on a research theme.

The analysis is in the form of an analysis of the research development based on time or year. The visualization results of the development over time can be seen in figure 4 in overlay visualization.

**FIGURE 4  
OVERLAY VISULIZATION STEM-LW CHARACTER RESEARCH**



According to Figure 4, which shows the development of research trends from time to time, the purple color symbolizes the research that has often been done in previous years. The gradation of colors towards the youngest color, yellow, is the latest research trend ever carried out. Old research trends include item identification, implementation, problem, and comparison research.

Research items currently trending until 2022 are items on analysis, effectiveness, ability, impact, creativity, stem approach, use, media, android, use, science subject, discovery, and e-module. The latest research trends can help new researchers choose the direction of research trends so that they are not timeless.

Bibliometrics analysis with landscape depictions can assist researchers in making decisions and determining variables appropriate to the development of research in that theme. One of the advantages of the results of this visualization is that researchers have the opportunity to get high citations in recent studies (Al Husaeni, 2022; Nyirahabimana et al., 2022; Putra, 2021; Haryandi et al., 2021; Mardiasuti et al., 2021).



approach. The clusters that are most often used as side topics in research are class I and II. No impact emphasizes STEM-LW on character.

## REFERENCES

- Abidin, M.Z. (2019). Strengthening kinship system through local wisdom. *Indonesian Journal of Social Sciences Volume, 11*(02), 7–15. Retrieved from <https://journal.unair.ac.id/download-fullpapers-ijssac3b69f63ffull.pdf>
- Abidinsyah, A., Ramdiah, S., & Royani, M. (2019). The implementation of local wisdom-based learning and hots-based assessment: Teacher survey in Banjarmasin. *Journal of Biological Education Indonesia (Jurnal Pendidikan Biologi Indonesia)*, 5(3), 407–414. Retrieved from <https://eric.ed.gov/?id=EJ1342208>
- Agung, I.D.G., Suardana, I.N., & Rapi, N.K. (2022). E-Modul IPA dengan model stem-PJBI berorientasi pendidikan karakter untuk meningkatkan hasil belajar siswa. *Jurnal Ilmiah Pendidikan dan Pembelajaran*, 6(1), 120–133. <https://doi.org/10.23887/jipp.v6i1.42657>
- Al Husaeni, D.F., & Nandiyanto, A.B.D. (2022). Bibliometric using vosviewer with publish or perish (using google scholar data): From step-by-step processing for users to the practical examples in the analysis of digital learning articles in pre and post Covid-19 pandemic. *ASEAN Journal of Science and Engineering*, 2(1), 19–46. <https://doi.org/10.17509/ajse.v2i1.37368>
- Alea, L.A., Fabrea, M.F., Roldan, R.D.A., & Farooqi, A.Z. (2020). Teachers' Covid-19 awareness, distance learning education experiences and perceptions towards institutional readiness and challenges. *International Journal of Learning, Teaching and Educational Research*, 19(6), 127–144. <https://doi.org/10.26803/ijlter.19.6.8>
- Allina, B. (2018). The development of STEAM educational policy to promote student creativity and social empowerment. *Arts Education Policy Review*, 119(2), 77–87.
- Arliman, L. (2018). Eksistensi hukum lingkungan dalam membangun lingkungan sehat di Indonesia. *Lex Librum: Jurnal Ilmu Hukum*, 5(1), 761–770. <http://dx.doi.org/10.46839/ljih.v5i1.116>
- Ata Akturk, A., Demircan, H.Ö., Senyurt, E., & Çetin, M. (2017). Turkish early childhood education curriculum from the perspective of stem education: A document analysis. *Journal of Turkish Science Education*, 14(4), 16–34. Retrieved from <https://eric.ed.gov/?id=EJ1344494>
- Atmojo, S.E., Rusilowati, A., Dwiningrum, S.I.A., & Skotnicka, M. (2018). The reconstruction of disaster knowledge through thematic learning of science, environment, technology, and society integrated with local wisdom. *Jurnal Pendidikan IPA Indonesia*, 7(2), 204–213. <https://doi.org/10.15294/jpii.v7i2.14273>
- Becker, K.H., & Park, K. (2011). Integrative approaches among science, technology, engineering, and mathematics (STEM) subjects on students' learning: A meta-analysis. *Journal of STEM Education: Innovations and Research*, 12(5). Retrieved from <https://www.jstem.org/jstem/index.php/JSTEM/article/view/1509>
- Boon Ng, S. (2019). *Exploring STEM competences for the 21st century*. Retrieved from <https://hdl.handle.net/20.500.12799/6641>
- Casto, A.R. (2022). A re-envisioned multicultural stem education for all. *Education Sciences*, 12(11), 792. <https://doi.org/10.3390/educsci12110792>
- Çevik, M. (2017). Content Analysis of Stem-Focused Education Research in Turkey. *Journal of Turkish Science Education*, 14(2), 12–26. Retrieved from <https://eric.ed.gov/?id=EJ1344281>
- de Santana, A.N., Roazzi, A., & Nobre, A.P.M.C. (2022). The relationship between cognitive flexibility and mathematical performance in children: A meta-analysis. *Trends in Neuroscience and Education*, 28, 100179. <https://doi.org/10.1016/j.tine.2022.100179>
- Dewinta, A., Nur, F., Sri, S., Imaniar, P., & Tahira, A.Z. (2021). Development of teaching material local wisdom-based “pati” in elementary school. *Asian Pendidikan*, 1(2), 59–64. <https://doi.org/10.53797/aspn.v1i2.10.2021>

- Eroğlu, S., & Bektaş, O. (2022). The effect of 5E-based STEM education on academic achievement, scientific creativity, and views on the nature of science. *Learning and Individual Differences*, 98, 102181. <https://doi.org/10.1016/j.lindif.2022.102181>
- Fadilah, S. (2022). Development of local wisdom-based discovery learning models to improve critical thinking skills on theme growth and development of life. *ICCCM Journal of Social Sciences and Humanities*, 1(6), 24–30. <https://doi.org/10.53797/icccmjssh.v1i6.4.2022>
- Fortus, D., Lin, J., Neumann, K., & Sadler, T.D. (2022). The role of affect in science literacy for all. *International Journal of Science Education*, 44(4), 535–555. <https://doi.org/10.1080/09500693.2022.2036384>
- Haka, N.B., Anggoro, B.S., Hamid, A., Novitasari, A., Handoko, A., & Puspita, L. (2020, February). The development of biology module based on local wisdom of West Lampung: Study of ecosystem material. In *Journal of Physics: Conference Series* (Vol. 1467, No. 1, p. 012013). IOP Publishing. <https://doi.org/10.1088/1742-6596/1467/1/012013>
- Han, J., Kelley, T., & Knowles, J. G. (2021). Factors influencing student STEM learning: Self-efficacy and outcome expectancy, 21st century skills, and career awareness. *Journal for STEM Education Research*, 4(2), 117–137. <https://doi.org/10.1007/s41979-021-00053-3>
- Handriyan, A., Rosidi, I., & Subekti, H. (2018). Mengintegrasikan literasi stem dan keterampilan riset pada berbasis kearifan lokal di matakuliah bioteknologi: Studi pendahuluan. *Natural Science Education Research*, 1(2), 16–22. <https://doi.org/10.21107/nser.v1i2.4788>
- Harun, F., Suparman, Hairun, Y., Machmud, T., & Alhaddad, I. (2021). Improving students' mathematical communication skills through interactive online learning media design. *Journal of Technology and Humanities*, 2(2), 17–23. <https://doi.org/10.53797/jthkss.v2i2.3.2021>
- Haryandi, S., Ibrahim, M.A., & Juliana, E.N. (2021). Bibliometric analysis in astrophysics: Overview of education, religion, and local wisdom in 2016-2021. *IJORER: International Journal of Recent Educational Research*, 2(5), 501–514. <https://doi.org/10.46245/ijorer.v2i5.140>
- Herwandi, O., Istyadi, M., & Yulinda, R. (2021). Pengembangan bahan ajar ipa berbasis literasi sains bermuatan kearifan lokal sistem pondasi rumah lanting. *Pahlawan: Jurnal Pendidikan-Sosial-Budaya*, 17(2), 101–110. <https://doi.org/10.57216/pah.v17i2.7>
- Iriaji, I., & Rochbeind, F. (2021). Analysis of the local wisdom on character education within the transmission system of pottery culture in three pottery centres in Malang. *KnE Social Sciences*, pp. 130–144. <https://doi.org/10.18502/kss.v5i3.8534>
- Junianti, B.S., & Hariyanto, T. (2021). Interaction between bugis and javanese in overseas: Study of social interaction between bugis and javanese in the region south sangatta subdistrict, east kutai regency of Indonesia. *International Journal of Research in Social Science and Humanities (IJRSS)*, 2(3), 1–12. <https://doi.org/10.47505/IJRSS.2021.9180>
- Kelley, T.R., & Knowles, J.G. (2016). A conceptual framework for integrated STEM education. *International Journal of STEM Education*, 3, 1–11. <https://doi.org/10.1186/s40594-016-0046-z>
- Khusniati, M. (2017). Local wisdom-based science learning model through reconstruction of indigenous science to improve student's conservationist character. *Journal of Turkish Science Education*, 14(3), 16–23. Retrieved from <https://www.tused.org/index.php/tused/article/view/158>
- Krisantia, I. (2021). Students' soft skills, hard skills, and competitiveness (SHC): A suggested model for Indonesian higher education curriculum. *International Journal of Learning, Teaching and Educational Research*, 20(2), 218–234. <https://doi.org/10.26803/ijlter.20.2.12>
- Mann, L., Chang, R., Chandrasekaran, S., Coddington, A., Daniel, S., Cook, E., . . . Smith, T.D. (2021). From problem-based learning to practice-based education: A framework for shaping future engineers. *European Journal of Engineering Education*, 46(1), 27–47. <https://doi.org/10.1080/03043797.2019.1708867>
- Mardiastuti, A., Masy'ud, B., Ginoga, L.N., & Sastranegara, H. (2021, May). Describing and visualizing the progress of ethnozoology in Indonesia by using VOSviewer. In *IOP Conference Series: Earth and Environmental Science* (Vol. 771, No. 1, p. 012004). IOP Publishing. <https://doi.org/10.1088/1755-1315/771/1/012004>

- Mohajan, H.K. (2018). Qualitative research methodology in social sciences and related subjects. *Journal of Economic Development, Environment and People*, 7(1), 23–48. Retrieved from <https://www.ceeol.com/search/article-detail?id=640546>
- Nyirahabimana, P., Minani, E., Nduwingoma, M., & Kemeza, I. (2022). A scientometric review of multimedia in teaching and learning of physics. *LUMAT: International Journal on Math, Science and Technology Education*, 10(1), 89–106. Retrieved from <https://eric.ed.gov/?id=EJ1345930>
- Pageh, I.M., & Permana, A.A.J. (2020, April). Content design: E-learning module for study on cultural tourism information systems based on local wisdom. In *Journal of Physics: Conference Series* (Vol. 1516, No. 1, p. 012037). IOP Publishing. <https://doi.org/10.1088/1742-6596/1516/1/012037>
- Parno, E.S., Yuliati, L., Widarti, A.N., Ali, M., & Azizah, U. (2019). The influence of STEM-based 7E learning cycle on students critical and creative thinking skills in physics. *Int. J. Recent Technol. Eng*, 8(2), 761–769. Retrieved from [http://eprints.utm.my/id/eprint/90551/1/AnulaNingWidarti2019\\_TheInfluenceofSTEM.pdf](http://eprints.utm.my/id/eprint/90551/1/AnulaNingWidarti2019_TheInfluenceofSTEM.pdf)
- Permana, A.A.J., & Jayanta, I.N.L. (2019). Development of e-learning modules for information systems studies based on balinese local wisdom. *Journal of Education Research and Evaluation*, 3(4), 233–238. <https://doi.org/10.23887/jere.v3i4.22561>
- Pimthong, P., & Williams, J. (2018). Preservice teachers' understanding of STEM education. *Kasetsart Journal of Social Sciences*. <https://doi.org/10.1016/j.kjss.2018.07.017>
- Prasadi, A.H., Wiyanto, W., & Suharini, E. (2020). The implementation of student worksheet based on stem (science, technology, engineering, mathematics) and local wisdom to improve of critical thinking ability of fourth grade students. *Journal of Primary Education*, 9(3), 227–237. <https://doi.org/10.15294/JPE.V9I3.37712>
- Puchumni, P., Tungpradabkul, S., & Magee, R. (2019). Using information retrieval activities to foster analytical thinking skills in higher education in Thailand: A case study of local wisdom education. *Asian Journal of Education and Training*, 5(1), 80–85. Retrieved from <https://eric.ed.gov/?id=EJ1203681>
- Putra, A.N. (2021). Literature review of food tourism, culinary tourism and gastronomy tourism. *Journal of Innovation Research and Knowledge*, 1(4), 517–526. <https://doi.org/10.53625/jirk.v1i4.319>
- Rokhman, F., Hum, M., & Syaifudin, A. (2014). Character education for golden generation 2045 (national character building for Indonesian golden years). *Procedia-Social and Behavioral Sciences*, 141, 1161–1165. <https://doi.org/10.1016/j.sbspro.2014.05.197>
- Rummel, N., & Spada, H. (2005). Learning to collaborate: An instructional approach to promoting collaborative problem solving in computer-mediated settings. *The Journal of the Learning Sciences*, 14(2), 201–241. [https://doi.org/10.1207/s15327809jls1402\\_2](https://doi.org/10.1207/s15327809jls1402_2)
- Salazar-Mattews, J.C. (2020). Los cambios en la educación impulsados por la COVID-19. *RPP Noticias*, 3.
- Shaffer, J.F., Ferguson, J., & Denaro, K. (2019). Use of the test of scientific literacy skills reveals that fundamental literacy is an important contributor to scientific literacy. *CBE—Life Sciences Education*, 18(3), ar31. <https://doi.org/10.1187/cbe.18-12-0238>
- Speldewinde, C. (2022). STEM teaching and learning in Bush Kinders. *Canadian Journal of Science, Mathematics and Technology Education*, 22(2), 444–461. <https://doi.org/10.1007/s42330-022-00207-4>
- Suastra, I.W. (2017). Balinese local wisdom and their implications in science education at school. *International Research Journal of Management, IT and Social Sciences*, 4(2), 48–57. Retrieved from <https://core.ac.uk/reader/230599440>
- Sümen, Ö.Ö., & Çalisici, H. (2016). Pre-Service teachers' mind maps and opinions on stem education implemented in an environmental literacy course. *Educational sciences: Theory and Practice*, 16(2), 459–476. Retrieved from <https://eric.ed.gov/?id=EJ1101170>

- Suprpto, N., Prahani, B.K., & Cheng, T.H. (2021). Indonesian curriculum reform in policy and local wisdom: Perspectives from science education. *Jurnal Pendidikan IPA Indonesia*, 10(1), 69–80. Retrieved from <https://journal.unnes.ac.id/nju/index.php/jpii/article/view/28438>
- Usmayanti, V., & Sofyana, N.N. (2022). Opportunity and challenges MSME for the Past 6 Years: A Systematic Review. *TECHNOBIZ: International Journal of Business*, 5(1), 8–13. Retrieved from <https://ejurnal.teknokrat.ac.id/index.php/technobiz/article/view/1978>
- Yildirim, B., & Selvi, M. (2016). Examination of the effects of STEM education integrated as a part of science technology society and environment courses. *Journal of Human Sciences*, 13(3).