

# Testing on A Diagnostic Test-based Science Metacognition Assessment Tool using Moodle

*by* E. N Savitri

---

**Submission date:** 14-Nov-2022 12:48PM (UTC+0700)

**Submission ID:** 1953315051

**File name:** est-based\_Science\_Metacognition\_Assessment\_Tool\_using\_Moodle.pdf (284.44K)

**Word count:** 3303

**Character count:** 18002



10 (3) (2021) 168-173

Unnes Science Education Journal  
Accredited Sinta 3

<https://journal.unnes.ac.id/sju/index.php/usej>



## Testing on A Diagnostic Test-based Science Metacognition Assessment Tool using Moodle

Novi Ratna Dewi<sup>✉</sup>, Prasetyo Listiaji, Erna Noor Savitri, Arka Yanitama

DOI: <http://dx.doi.org/10.15294/usej.v10i3.52015>

Universitas Negeri Semarang, Indonesia

### Article Info

Submitted 2021-09-10  
Revised 2021-10-04  
Accepted 2021-11-04

### Keywords

Science metacognition  
Assessment tool  
Diagnostic test  
Moodle

### Abstract

Metacognition is one of the important indicators of 21st century skills as part of ways of thinking. Metacognition ability is used by students to see how cognitive activities such as remembering, learning, and problem solving can be carried out effectively. However, in fact not many assessment tools have been developed to measure metacognitive ability. On the other hand, Moodle has good potential to be used as a platform for creating test instruments. The purpose of this study was to test a diagnostic test-based science metacognition evaluation tool that had been developed with Moodle. The research method used is quantitative by testing the validity, reliability, discriminating power, and level of difficulty on the items of the evaluation tool. The results showed that the science metacognition evaluation tool that had been developed had the characteristics of being valid according to experts, good reliability (0.73), having a proportional difficulty index; and has good discrimination index. Based on the test results, it was concluded that the science metacognition evaluation tool had good characteristics in all aspects tested so that it was feasible to use it to measure students' science metacognition abilities.

### How to Cite

Dewi, N. R., Listiaji, P., Savitri, E. N., & Yanitama, A. (2021). Testing on A Diagnostic Test-based Science Metacognition Assessment Tool using Moodle. *Unnes Science Education Journal*, 10(3), 168-173.

<sup>✉</sup> Correspondence Author:  
E-mail: [noviratnedewi@mail.unnes.ac.id](mailto:noviratnedewi@mail.unnes.ac.id)

12  
p-ISSN 2252-6617  
e-ISSN 2502-6232

## INTRODUCTION

The National Education Association (NEA) recommends the importance of developing the “Four Cs” for 21st century skills, which include communication, collaboration, critical thinking and creativity (Sole and Anggraeni, 2018). These competencies are important to be taught to students in the context of core subject areas and 21st century themes. Meanwhile, the Assessment and Teaching of 21st Century Skills (ATC21S) categorizes 21st century skills into 4 categories, namely way of thinking, way of working, tools for working and skills for living in the world (Griffin et al., 2012)

First, ways of thinking include creativity and innovation, critical thinking, problem solving, decision making, and learning about learning (metacognition). Second, ways of working include communication, collaboration, and team work skills. Third, the tools for working include general knowledge and literacy of communication and information technology. Fourth, living in the world includes citizenship, life and career, personal and social responsibilities, as well as competence and cultural awareness (Saavedra & Opfer, 2012). Metacognition is one of the important indicators of 21st century skills as part of ways of thinking.

Metacognition ability is a higher-order thinking skill in which the object of thinking is the thinking process that occurs in oneself. Metacognition reflects individuals' critical awareness of how they think and learn, and their assessment of themselves as thinkers and learners (Saavedra & Opfer, 2012). This is in line with what Sholihah et al. (2018), that a learning activity will be optimal if students are able to become self-regulated learners. Self-regulated learners are responsible for their own learning progress and adapt their learning strategies to meet the demands of the task.

Sagitova (2014) suggests that “The teaching and learning process in the classroom must also allow students to recognize how they learn”. In line with Sagitova, Chalkiadaki (2018) states that “Science learning in schools is expected to facilitate students to not only acquire 21st century skills but also encourage them to become independent learners”. Metacognitive ability and its implications have become an important issue in the world of education, especially in the learning process (Zohar & Dori, 2012). This is reinforced by the demand that students must master the four dimensions of knowledge, namely factual, conceptual, procedural and metacognitive knowl-

edge.

Metacognition as a 21st century skill is very important to learn to form independent students which is the ultimate goal of learning as proclaimed in the National Research Council of The National Academies. Skills such as adaptability, communication skills, problem-solving skills, self-development, and systems thinking are closely related to students' metacognitive abilities in learning, so they need to be taught to face today's global demands (Asy'ari et al., 2018). Metacognition is used to see how cognitive activities such as remembering, learning, and problem solving are carried out effectively (Asy'ari et al., 2018). Metacognition plays a very important role in the learning process because it must be done before, during, and after teaching (Wen, 2012).

On the other hand, assessment is a very important subsystem in every education system because it is used to measure the achievement of learning objectives and reflects how far the development and progress of learning outcomes (Ariyanti et al., 2018). The need for higher order thinking skills, including metacognition, is very important, this is supported by the fact that students in Indonesia were ranked in the top 10 bottom out of 65 countries in 2011, ranking 69 out of 75 countries in the world in 2015 according to the results of the PISA study (Programme for International Student Assessment) which focuses on reading literacy, mathematics, and science (Asy'ari et al., 2018).

The appropriate assessment to measure students' metacognitive abilities is an assessment oriented to the metacognitive ability itself (Asy'ari et al., 2018). An assessment that can be integrated into active learning by measuring metacognitive and cognitive abilities is a diagnostic test (Pantiwati, 2015).

Assessment in today's digital era has led to the use of Information and Communication Technology (ICT) as a means of communicating and obtaining information in all fields, especially in the field of education. One form of using ICT in learning can be seen in the existence of alternative learning carried out during the Covid-19 emergency, namely through online learning (Firman & Rahman, 2020)

One of the applications used to support the assessment is Moodle. Moodle (Modular Object-Oriented Dynamic Learning Environment) is an open source software used to create free online learning, collaborative interactions, and student-centered online learning environments with various learning support features (Bariah, 2017). Moodle can make it easier for teachers to develop

instruments in assessments and check the results effectively (Pratama & Salirawati, 2018).

Research on diagnostic tests, metacognition assessments, and Moodle has been carried out from year to year, including the research of Pantiwati & Husamah (2017), which states that there is an effect of diagnostic tests in active learning on students' metacognitive awareness and cognitive abilities. Sholihah et al. (2018), examines the metacognitive skills of SMA 29 giri Batu students in biology subjects by using instruments in the form of essay test questions, interview guides for metacognitive skills, and metacognitive skill observation sheets.

The research conducted by Bariah (2017), states that through a feasibility test, evaluation and online assignments based on e-learning with Moodle are feasible to use with very good qualifications so that it can be interpreted that online evaluation and assignments based on e-learning with Moodle are feasible to use. Schweighofer et al. (2019) regarding the development of an integrated quiz application Moodle is able to build interactive and random quizzes, allows students to self-assess their performance, and teachers can automatically assess student learning success.

Based on several previous research studies, assessments using Moodle have been carried out, but have not been carried out in the development of diagnostic and metacognitive tests. On the other hand, research on diagnostic and metacognitive tests has been carried out, but has not been developed using Moodle. Thus, it is necessary to develop a diagnostic test-based metaagonist assessment tool using Moodle. The assessment tool that has been developed also needs to be tested so that it is feasible to use it to measure metacognitive ability.

**METHOD**

The research method used is a quantitative method by testing items on a science metacognition assessment tool based on a diagnostic test. The assessment tool has been previously developed using Moodle consistir of 60 multiple choice questions. The aspects of the test consist of validity, reliability, level of difficulty, and discriminating index. Research samples are 70 students of the Science Education Study Program.

**Validity Test**

Testing the validity of the items was carried out by involving assessment experts and media experts. The experts gave a rating of 1 to 4 on each item quality indicator of the product. Prod-

uct quality was determined by score according to Aiken's V formula (equation 1) and the criteria in Table 1 (Arikunto, 2012)

$$V = \frac{\sum s}{(n(c-1))} \tag{1}$$

Where *V* is validation score, *s* is *r-lo*, *r* is score form expert, *lo* is minimum score, *n* is amount of expert, and *c* is maximum score.

**Table 1.** Criteria of validation by expert validation (Arikunto, 2012)

V score	Criteria
< 0.87	Not valid
> 0.87	Valid

The purpose of this analysis is to determine the feasibility of the contents of the assessment instrument (Fadillah, 2017). This is based on the results of the assessment of *n* experts on an item in terms of the extent to which the item represents the construct being measured (Hendryadi, 2017).

**Reability Test**

The reliability of the test score used to determine the level of precision and consistency of the test scores. Test the reliability of the instrument on science metacognitive ability using reliability analysis with the Cronbach Alpha technique in accordance with Equation 2.

$$r = k / (k-1) \{ 1 - [\sum \sigma b]^2 / [\sigma t]^2 \} \tag{2}$$

Where *r* is instrument reability coefficient, *k* is amount of question item,  $\sum \sigma b^2$  total variance of items, and  $\sigma t^2$  is total variance.

**Difficulty Index Test**

Arikunto (2015) explains that the difficulty index is a number that indicates the difficulty of a question, where the difficulty index is between 0.01-1.00, this difficulty index indicates the level of difficulty of the question. This study uses the calculation of the difficulty index with equation 3 (Arikunto, 2012).

$$P = B / JS \tag{3}$$

Where *P* is difficulty index, *B* is the number of students who answered the question correctly, and *JS* is the total number of students in the test. The criteria for the difficulty index of the questions can be seen in Table 2.

**Table 2.** The criteria for the difficulty index

Difficulty index	Criteria
P < 0,30	Difficult
0,30 ≤ P ≤ 0,70	Medium
P > 0,70	Easy

**Discrimination Index**

One of the objectives of the discrimination index analysis is to determine whether an item is able to distinguish between high-skilled trainees and low-skilled trainees (Bagiyono, 2017). Discrimination index is symbolized by the symbol DP. The calculation of the discrimination index of questions uses equation 4 (Arikunto, 2012).

$$D = BA/JA - BB/JB \tag{4}$$

Where  $J$  is the number of participants in the test,  $J_A$  is the number of participants in the upper group,  $J_B$  is the number of participants in the lower group,  $B_A$  is the number of participants in the upper group who answered the question correctly, and  $B_B$  is the number of participants in the lower group who answered the question correctly.

The question used is a question that has a discrimination index value of 0.20. Criteria for discrimination index of questions can be seen in Table 3.

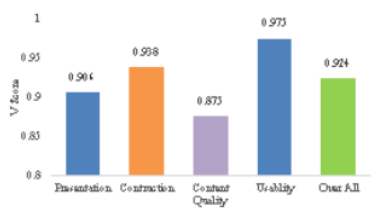
**Table 3.** Criteria of discrimination index

Discrimination index	Criteria
0,40 up	Very good
0,30-0,39	Good
0,20-0,29	Standard
0,19 down	Bad

**RESULT AND DISCUSSION**

**Validity Test**

The results of expert validation on the science metacognition assessment tool are shown in Figure 1. These results show that all validated aspects obtained a V score of more than 0.87. So, it can be said that the diagnostic test-based science metacognition evaluation tool is valid in the aspects of presentation, construction, content, and use (Arikunto, 2012). The validation scores for each indicator are detailed in Table 4.



**Figure 1.** Result of validity test

From the results of the analysis of the validity of each item, there are questions that get a V score of 1.00 for all aspects (the questions are

shown in Figure 2).



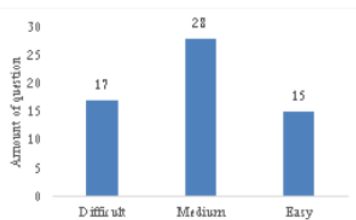
**Figure 2.** Question with V score = 1,00 for all aspect

**Reliability Test**

Reliability shows how much the test instrument can be trusted. A test is said to have high reliability if it gives a constant result. The results of the reliability test analysis using reliability analysis with the Alpha Cronbach technique obtained an r value of 0.73. The results of the r value indicate that the assessment tool has high reliability (Livingston, et al., 2018).

**Difficulty Index Test**

The results of the difficulty index test for each item are presented in Figure 3.



**Figure 3.** Distribution of the level of difficulty of the questions.

It can be seen in Figure 3 that the difficulty index of the questions obtained is proportional where the distribution of the questions with the medium level is the most, while the difficult and easy questions have relatively the same amount. The proportional difficulty index shows that the assessment tool developed is feasible to use (Soraya, et al., 2021).

**Discrimination Index**

Questions can be said to be good if the questions are able to distinguish students with high and low abilities. Based on the value of discrimination index, questions that have discrimination index on bad criteria indicate that the questions cannot be used to distinguish students in the up-

**Table 4.** Validation score for each indicator

Aspects	Indicators	V Score
Presentation	Presentation of complete questions in accordance with basics competency	0.911
	Each question must have one correct answer, with homogeneous and logical answer choices in terms of material	0.904
	The subject matter does not provide clues to the correct answer	0.899
	Does not contain statements that are double negative	0.908
	The questions in the assessment are contextual and formulated in a clear, concise, and firm manner	0.944
Construction	The suitability of the questions with the level of students' knowledge and indicators of metacognition	0.932
Content Quality	Able to encourage students to use metacognitive knowledge and strategies	0.859
	Able to measure students' metacognitive ability	0.891
Usability	Objective	0.978
	Ekonomic and Flexible	0.972

per and lower classes (El-gohary, et. al, 2018). Questions on these criteria also cannot be used to test students' metacognitive abilities. The results of the discrimination index of questions that have been analyzed and presented in Table 5. These results show 53 of 60 questions can be used because they do not have bad discriminating index.

**Table 5.** Distribution of discrimination index

Criteria	Amount of question	Decision
Very good	21	Used
Good	17	Used
Standard	15	Used
Bad	7	Not used

## CONCLUSION

Testing of the diagnostic test-based science metacognition assessment tool obtained the expected results. The assessment tool is declared valid by the expert, has good reliability, and has a proportional level of difficulty. 53 questions have standard to good distinguishing power so that they are suitable for use. Based on the test results, 53 of the 60 science metacognition assessment questions are suitable to be used to measure scientific metacognition ability. Furthermore, it is necessary to conduct research to measure the ability of science metacognition using the evaluation tool that has been developed.

## ACKNOWLEDGMENT

Thank you to Ministry of Education, Culture, Research and Technology, Indonesia for funding of this research.

## REFERENCES

- Arikunto, S. (2012). *Dasar-Dasar Evaluasi Pendidikan Edisi 2*. Jakarta: Bumi Aksara
- Arikunto, S. (2015). *Dasar-dasar evaluasi pendidikan*. Jakarta: Bumi Aksara.
- Ariyanti, Hasanuddin, & Abdullah. (2018). Analisis Kelayakan Pengembangan Alat Evaluasi Pembelajaran Berbasis E-learning Dengan Moodle Pada Pembelajaran Biologi. *Jurnal EduBio Tropika*, 6(1), 1-8.
- Asy'ari, M., Ikhsan, M., & Muhali, M. (2018). Validitas instrumen karakterisasi kemampuan metakognisi mahasiswa calon guru fisika. *Prisma Sains: Jurnal Pengkajian Ilmu dan Pembelajaran Matematika dan IPA IKIP Mataram*, 6(1), 18-26.
- Bagiyono, B. (2017). Analisis Tingkat Kesukaran dan Daya Pembeda Butir Soal Ujian Pelatihan Radiografi Tingkat 1. *Widyanuklida*, 16(1), 1-12.
- Bariah, S.H. (2017). Pengembangan Evaluasi dan Penugasan Online Berbasis E-Learning dengan Moodle pada Mata Kuliah Media Pembelajaran Ilmu Komputer. *Prosiding Seminar Nasional Pendidikan Teknik Informatika (SENAPATI) Ke-8*, 61-66.
- Chalkiadaki, A. (2018). A systematic literature review of 21st century skills and competencies in primary education. *International Journal of Instruction*, 11(3), 1-16.
- El-gohary, T. M., Ibrahim, S. R., & Abdelkader, S. M. (2018). Difficulty and discrimination indices of sample of typical multiple choice questions administered to students at different levels showed atypical values. *International Journal of ChemTech Research*, 11(05), 348-352.
- Fadillah, E. N. (2017). Pengembangan instrumen penilaian untuk mengukur keterampilan proses sains siswa SMA. *Didaktika Biologi: Jurnal Penelitian Pendidikan Biologi*, 1(2), 123-134.
- Firman, F., & Rahayu, S. (2020). Pembelajaran online di tengah pandemi covid-19. *Indonesian Journal*

- of *Educational Science (IJES)*, 2(2), 81-89.
- Griffin, P., Care, E., Vista, A., & Scoular, C. (2014). Using Innovative Measurement Tools Based On Big Data Analytics To Assess Collaborative Problem-Solving Skills And Improve Teaching Strategies In Essential Skills For 21st Century Education. In *Edulearn14 Proceedings*, 6364-6375.
- Hendryadi, H. (2017). Validitas isi: tahap awal pengembangan kuesioner. *Jurnal Riset Manajemen Dan Bisnis (JRMB) Fakultas Ekonomi UNLAT*, 2(2), 169-178.
- Livingston, S. A., Carlson, J., Bridgeman, B., Golub-Smith, M., & Stone, E. (2018). Test reliability-basic concepts. *Research Memorandum No. RM-18-01*. Princeton, NJ: Educational Testing Service.
- Pantiwati, Y., & Husamah, H. (2017). Self and peer assessments in active learning model to increase metacognitive awareness and cognitive abilities. *International Journal of Instruction*, 10(4), 185-202.
- Pratama, I., & Salirawati, D. (2018). Pengembangan Penilaian Pembelajaran E-learning Berbasis Moodle Pada Materi Stoikiometri Untuk Siswa Kelas X SMA/MA. *Jurnal Pembelajaran Kimia*, 7(1), 33-38.
- Saavedra, A. and Opfer, V. (2012). *Teaching and Learning 21st Century Skills: Lessons from the Learning Sciences*. A Global Cities Education Network Report. New York: Asia Society.
- Sagitova, R. (2014). Students' Self-Education: Learning to Learn across the Lifespan. *Procedia – Social and Behavioral Sciences*, 152(843), 272–277.
- Schweighofer, J., Taraghi, B., & Ebner, M. (2019). Development of a Quiz–Implementation of a (Self-) Assessment Tool and its Integration in Moodle. *International Journal of Emerging Technologies in Learning (IJET)*, 14(23), 141-151.
- Sholihah, M., Zubaidah, S., & Mahanal, S. (2018). Keterampilan Metakognitif Siswa SMA Negeri Batu Pada Mata Pelajaran Biologi. *Prosiding Seminar Nasional Biologi*, 1669-1676.
- Sole, F. B., & Anggraeni, D. M. (2018). Inovasi Pembelajaran Elektronik dan Tantangan Guru Abad 21. *Jurnal Penelitian dan Pengkajian Ilmu Pendidikan: e-Saintika*, 2(1), 10-18.
- Soraya, S., Shabani, A., Kamalzadeh, L., Kashaninasab, F., Rashedi, V., Saeidi, M., ... & Asadi, S. (2021). Predictability of Discrimination Coefficient and Difficulty Index of Psychiatry Multiple-Choice Questions. *Journal of Iranian Medical Council*.
- Wen, Y. H. (2012). A study on metacognition of college teachers. *The Journal of Human Resource and Adult Learning*, 8(1), 80.
- Zohar, A. & Dori, Y.J. (2012). Introduction. In A. Zohar and Y.J. Dori (Eds.), *Metacognition in Science Education, Trends in Current Research, Contemporary Trends and Issues in Science Education*, 1-19. New York: Springer.

# Testing on A Diagnostic Test-based Science Metacognition Assessment Tool using Moodle

## ORIGINALITY REPORT

20%

SIMILARITY INDEX

18%

INTERNET SOURCES

12%

PUBLICATIONS

%

STUDENT PAPERS

## PRIMARY SOURCES

1	<a href="http://download.atlantispress.com">download.atlantispress.com</a> Internet Source	3%
2	<a href="http://ojs.unimal.ac.id">ojs.unimal.ac.id</a> Internet Source	2%
3	<a href="http://repository.uinbanten.ac.id">repository.uinbanten.ac.id</a> Internet Source	1%
4	<a href="http://journal-center.litpam.com">journal-center.litpam.com</a> Internet Source	1%
5	<a href="http://jurnal.untidar.ac.id">jurnal.untidar.ac.id</a> Internet Source	1%
6	<a href="http://pasca.unila.ac.id">pasca.unila.ac.id</a> Internet Source	1%
7	Dedy Triono, Riyanarto Sarno, Kelly R. Sungkono. "Item Analysis for Examination Test in the Postgraduate Student's Selection with Classical Test Theory and Rasch Measurement Model", 2020 International Seminar on Application for Technology of	1%



# Information and Communication (iSemantic), 2020

Publication

---

8	<a href="http://www.atlantis-press.com">www.atlantis-press.com</a> Internet Source	1 %
9	<a href="http://ojs.uho.ac.id">ojs.uho.ac.id</a> Internet Source	1 %
10	<a href="http://repository.uin-suska.ac.id">repository.uin-suska.ac.id</a> Internet Source	1 %
11	<a href="http://eprints.walisongo.ac.id">eprints.walisongo.ac.id</a> Internet Source	1 %
12	<a href="http://repository.lppm.unila.ac.id">repository.lppm.unila.ac.id</a> Internet Source	1 %
13	Hussain Alkharusi. "Psychometric properties of the teacher assessment literacy questionnaire for preservice teachers in Oman", <i>Procedia - Social and Behavioral Sciences</i> , 2011 Publication	<1 %
14	<a href="http://hdl.handle.net">hdl.handle.net</a> Internet Source	<1 %
15	Danny Naufal Pratama, Oktariani Nurul Pratiwi, Edi Sutoyo. "Classification of Questions Based on Difficulty Levels using Support Vector Machine and Naïve Bayes Algorithms for Imbalanced Class", 2021 4th	<1 %

# International Conference of Computer and Informatics Engineering (IC2IE), 2021

Publication

---

16

A S U Putra, I Hamidah, Nahadi. "The development of five-tier diagnostic test to identify misconceptions and causes of students' misconceptions in waves and optics materials", Journal of Physics: Conference Series, 2020

Publication

---

<1 %

17

[eric.ed.gov](http://eric.ed.gov)

Internet Source

---

<1 %

18

"Assessment and Teaching of 21st Century Skills", Springer Science and Business Media LLC, 2018

Publication

---

<1 %

19

A Rusilowati, Supriyadi, I Hidayah, Z Abidin. "Development of simulation integrated learning model with mikir approach to school for disaster mitigation", Journal of Physics: Conference Series, 2021

Publication

---

<1 %

20

Connie Connie, Eko Risdianto, Meizul Zuki, Adi Asmara. "Implementation of E-Learning in Learning Management Education Innovation During The Covid-19 Pandemic", Tadbir : Jurnal Studi Manajemen Pendidikan, 2021

Publication

---

<1 %

21	Fatmawati Sabur, Mulyadi Nur. "Feasibility Test of Raspberry Pi Based Spectrum Analyzer and Transfer Level Register-Software Defined Radio as Learning Media for Frequency Measurement", AL-ISHLAH: Jurnal Pendidikan, 2022 Publication	<1 %
22	<a href="https://repository.unja.ac.id">repository.unja.ac.id</a> Internet Source	<1 %
23	T F Dholo, H Firman, I Kaniawati, D Rusdiana. "Profile of critical thinking skills of pre-service physics teachers: a preliminary study", Journal of Physics: Conference Series, 2019 Publication	<1 %
24	<a href="https://archives.palarch.nl">archives.palarch.nl</a> Internet Source	<1 %
25	<a href="https://etuce.homestead.com">etuce.homestead.com</a> Internet Source	<1 %
26	<a href="https://lib.unnes.ac.id">lib.unnes.ac.id</a> Internet Source	<1 %
27	<a href="https://media.neliti.com">media.neliti.com</a> Internet Source	<1 %
28	"Metacognition in Science Education", Springer Science and Business Media LLC, 2012 Publication	<1 %

29

Ni Nyoman Sri Putu Verawati, Hikmawati Hikmawati, Saiful Prayogi. "The Effectiveness of Inquiry Learning Models Intervened by Reflective Processes to Promote Critical Thinking Ability in Terms of Cognitive Style", International Journal of Emerging Technologies in Learning (ijET), 2020

Publication

---

<1 %

30

Nuryani Dwi Astuti, Widowati Pusporini. "Improving 7th-grade junior high school mathematics achievement through numbered heads together", Psychology, Evaluation, and Technology in Educational Research, 2021

Publication

---

<1 %

---

Exclude quotes      On

Exclude matches      < 3 words

Exclude bibliography      On