PENGGUNAAN PEMBELAJARAN ARGUMENTATIF BERBASIS ISU SOSIOSAINTIFIK UNTUK MEMBANGUN KEMAMPUAN *REBUTTAL* PESERTA DIDIK SMA PADA PELAJARAN BIOLOGI

DISERTASI

Diajukan untuk Memenuhi Sebagian dari
Syarat Memperoleh Gelar Doktoral Pendidikan Ilmu Pengetahuan Alam

PROMOVENDUS

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HALAMAN PENGESAHAN DISERTASI

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PENGGUNAAN PEMBELAJARAN ARGUMENTATIF BERBASIS ISU SOSIOSAINTIFIK UNTUK MEMBANGUN KEMAMPUAN REBUTTAL PESERTA DIDIK SMA PADA PELAJARAN BIOLOGI

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PERNYATAAN

Dengan ini saya menyatakan bahwa Disertasi dengan judul "Penggunaan Pembelajaran Argumentatif Berbasis Isu Sosiosaintifik untuk Membangun Kemampuan *Rebuttal* Peserta Didik SMA pada Pelajaran Biologi" beserta seluruh isinya adalah benar-benar karya saya sendiri. Saya tidak melakukan penjiplakan atau pengutipan dengan cara-cara yang tidak sesuai dengan etika ilmu yang berlaku dalam masyarakat keilmuan. Atas pernyataan ini, saya siap menanggung resiko/sanksi yang dijatuhkan kepada saya apabila di kemudian hari ditemukan adanya pelanggaran etika keilmuan dalam karya saya ini, atau ada klaim dari pihak lain terhadap keaslian karya saya ini.

Purwakarta, Maret 2020

Yang Membuat Pernyataan

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KATA PENGANTAR

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Penelitian disertasi ini dilatarbelakangi oleh adanya kebutuhan untuk mengembangkan kemampuan *rebuttal* peserta didik sehingga kepekaan untuk mengkritisi kebenaran suatu hal dapat terasah dalam berbagai isu-isu Sosiosaintifik yang saat ini semakin berkembang di masyarakat. Harapan penulis, proses dan hasil-hasil yang diperoleh dari penelitian disertasi ini dapat memberikan manfaat yang sebesar-besarnya, baik manfaat teoritis bagi perkembangan ilmu pengetahuan dalam bidang pendidikan sains, maupun bagi perbaikan proses dan hasil pembelajaran biologi di berbagai jenjang pendidikan formal maupun informal.

Penulisan disertasi merupakan awal untuk membangun kemampuan diri untuk lebih baik di masa yang akan datang, oleh karenanya, segala bentuk saran dan masukan untuk perbaikan disertasi akan diterima dengan penuh kesyukuran. Semoga hal-hal baik dari disertasi ini akan memberikan manfaat dan keberkahan, serta segala kekeliruannya dapat dijadikan pelajaran agar jadi koreksi di masa yang akan datang. Semoga Allah SWT mengizinkan seluruh proses untuk mencapai titik ini sebagai salah satu amal shaleh yang memberikan manfaat di dunia dan akhirat. Aamiiin yaa mujibassaailiin.

Purwakarta, Mei 2020
Penulis

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Purwakarta, Mei 2020
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ABSTRAK

Penggunaan Pembelajaran Argumentatif Berbasis Isu Sosiosaintifik untuk Membangun Kemampuan *Rebuttal* Peserta Didik SMA pada Pelajaran Biologi

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Rebuttal memiliki peranan penting untuk membangun kepekaan terhadap kebenaran pendapat atau *claim* pihak lain, kemudian mengambil keputusan dalam menyikapi pendapat tersebut. Kemampuan *rebuttal* berbasis isu Sosiosaintifik dalam pelajaran Biologi selama ini tidak banyak dilatihkan dalam ruang-ruang kelas melalui proses pembelajaran. Penelitian ini bertujuan untuk membangun kualitas kemampuan *rebuttal* menggunakan pembelajaran Argumentasi Dialogis, pendekatan *Scientific Writing Heuristic* (SWH), dan gabungan dari Argumentasi Dialogis dan SWH berbasis isu Sosiosaintifik pada pelajaran Biologi. Metode yang digunakan dalam penelitian adalah *mixed method embedded experimental model* dengan partisipan terdiri dari 119 orang peserta didik kelas XII di tiga kelas IPA sebuah SMA negeri di Purwakarta. Instrumen penelitian meliputi tes soal konsep Biologi (mutasi, evolusi, dan bioteknologi), tes soal *rebuttal*, pedoman wawancara, lembar observasi, dan lembar angket. Data dianalisis menggunakan *Toulmin Argumentation Pattern (*TAP) yang telah dimodifikasi. Hasil penelitian yang diperoleh adalah: 1) Perubahan tipe *rebuttal* peserta didik terdiri atas empat tipe yaitu yang tidak mau berubah (*inert*), *rebuttal* yang berbalik dukungan (*contrary*), *rebuttal* yang berada di dua posisi (*under two position*), dan *rebuttal* yang tidak memihak (*impartial*); 2) Terjadi perubahan profil level struktur *rebuttal* yang dicapai peserta didik pada awalnya berada pada level 1 dan level 2, kemudian bergeser menjadi level 2 dan level 3, artinya struktur umum *rebuttal* yang dibangun terdiri atas *claim*, data, dan *warrant* dengan kekuatan bukti didominasi oleh penilaian pribadi, dan atau data yang salah, dan atau *misleading*; 3) Peningkatan penguasaan pelajaran Biologi menunjukkan tidak terjadi perubahan yang signifikan dengan pemberian pembelajaran pendekatan SWH dan Gabungan, namun memberikan perubahan signifikan menggunakan pembelajaran Argumentasi Dialogis pada materi bioteknologi. Kesimpulan penelitian adalah kualitas *rebuttal* dapat meningkat dengan menggunakan pembelajaran argumentatif menggunakan Argumentasi Dialogis, pendekatan SWH, dan gabungan Argumentasi Dialogis + SWH.

Keyword: Argumentasi ilmiah, *Rebuttal*, Isu Sosiosaintifik, Biologi, Argumentasi Dialogis*, Scientific Writing Heuristic Approach*.

ABSTRACT

The Use of Argumentative Learning Based on Socio-Scientific Issues to Build the Rebuttal Abilities of High School Students in Biology

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Rebuttal has an important role to build sensitivity to the truth of opinions or claims of other parties, then take decisions in addressing these opinions. Social skills based on socio-scientific issues in Biology lessons so far have not been much trained in classrooms through the learning process. This study aims to build quality rebuttal skills using Dialogical Argumentation learning, Scientific Writing Heuristic (SWH) approach, and a combination of Dialogical Argumentation and SWH based on socio-scientific issues in Biology. The method used in this study is a mixed method embedded experimental model with participants consisting of 119 XII grade students in three science classes of a state high school in Purwakarta. Research instruments include Biology concept questions (mutation, evolution, and biotechnology), rebuttal test questions, interview guidelines, observation sheets, and questionnaire sheets. Data were analyzed using the modified Toulmin Argumentation Pattern (TAP). The results obtained are: 1) Changes in rebuttal type of students consists of four types, namely those who do not want to change (inert), rebuttal which turns back (contradictory), rebuttal who are in two positions (under two positions), and rebuttal that does not impartial (impartial); 2) There was a change in the profile level of the rebuttal structure achieved by students initially at level 1 and level 2, then shifted to level 2 and level 3, meaning that the general structure of rebuttal that was built consisted of claims, data, and warrant with the strength of evidence dominated by personal assessment, and / or incorrect data, and or misleading; 3) Increased mastery of Biology lessons showed no significant changes by providing learning of the SWH and Combined approaches, but provided significant changes using Dialogical Argumentation learning on biotechnology materials. The conclusion of the research is rebuttal quality can be improved by using argumentative learning using Dialogical Arguments, SWH approaches, and combined Dialogical Arguments + SWH.

Keywords: Scientific Argumentation, Rebuttal, Socio Scientific Issues, Biology, Dialogical argument, Scientific Writing Heuristic Approach.

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Acar, O., Turkmen, L., & Roychoudhury, A. (2010). Student difficulties in socio-scientific argumentation and decision-making research findings: Crossing the borders of two research lines. *International Journal of Science Education*, *32*(9), 1191–1206. https://doi.org/10.1080/09500690902991805

Akkus, R., Gunel, M., & Hand, B. (2007). Comparing an Inquiry-based approach known as the Science Writing Heuristic to traditional science teaching practices: Are there differences? *International Journal of Science Education*, *29*(14), 1745–1765. https://doi.org/10.1080/09500690601075629

Amalia, N. F., Widodo, A., & Rochintaniawati, D. (2018). Kompleksitas Argumentasi Berbasis Isu Sosiosaintifik pada Jenjang SD, SMP, dan SMA. *Assimilation: Ondonesian Journal of Biology Education*, *1*(1), 29–32. Retrieved from http://ejournal.upi.edu/index.php/asimilasi%0AKompleksitas

Anisa, A. (2017). Argumentation Quality of Socio-scientific Issue between High School Students and Postgraduate Argumentation Quality of Socio-scientific Issue between High School Students and Postgraduate Students about Cancer. *Journal of Physic*, *895 (2017)*. https://doi.org/10.1088/1742-6596/895/1/012160

Anisa, A., Widodo, A., & Riandi, R. (2017). Argumentation Quality of Socio-scientific Issue between High School Students and Postgraduate Students about Cancer. In *Journal of Physics: Conference Series* (Vol. 895). https://doi.org/10.1088/1742-6596/895/1/012160

Anisa, A., Widodo, A., Riandi, R., & Muslim, M. (2019). Exploring high school student's argumentation structure through ecology: A case study. In *Journal of Physics: Conference Series* (Vol. 1157). https://doi.org/10.1088/1742-6596/1157/2/022091

Asterhan, C. S. C., & Schwarz, B. B. (2016). Argumentation for Learning: Well-Trodden Paths and Unexplored Territories. *Educational Psychologist*, *51*(2), 164–187. https://doi.org/10.1080/00461520.2016.1155458

Bahagiawati. (2003). Penggunaan Bacillus Thuringiensis sebagai biolarvasida. *Buletin AgroBio*, *5*(1), 21–28.

Bathgate, M., Crowell, A., Schunn, C., Cannady, M., & Dorph, R. (2015). The Learning Benefits of Being Willing and Able to Engage in Scientific Argumentation. *International Journal of Science Education*, *37*(10), 1590–1612. https://doi.org/10.1080/09500693.2015.1045958

Berland, L. K., & Hammer, D. (2012). Framing for Scientific Argumentation. *Journal of Research in Science Teaching*, *49*(1), 68–94. https://doi.org/10.1002/tea.20446

Berland, L. K., & McNeill, K. L. (2010). A learning progression for scientific argumentation: Understanding student work and designing supportive instructional contexts. *Science Education*, *94*(5), 765–793. https://doi.org/10.1002/sce.20402

Bishop, B. A., & Anders, C. W. (1986). Student Conception of Natural Selection and its Role in Evolution. *The Institute for Reasearch on Teaching*, (165), 1–27. https://doi.org/10.1017/CBO9781107415324.004

Braund, M., Scholtz, Z., Sadeck, M., & Koopman, R. (2013). First steps in teaching argumentation: A South African study. *International Journal of Educational Development*, *33*(2), 175–184. https://doi.org/10.1016/j.ijedudev.2012.03.007

Brizee, A. (2017). Rebuttal Section. Retrieved January 31, 2020, from https://owl.purdue.edu/owl/general_writing/common_writing_assignments/argument_papers/rebuttal_sections.html

Browning, M. E., & Lehman, J. D. (1988). Comments and Criticism Comment on " Identification of Student Misconceptions in Genetics Problem Solving via Computer Program ." *Journal of Research in Science Teaching*, *25*(9), 747–761.

Carlin, J. L. (2011). Mutations Are the Raw Materials of Evolution. *Nature Education*, *3*(10), 10.

Carrascal, B. (2011). Authority Arguments in Academic Contexts in Social Studies and Humanities. *Proceedings of the 8th International Conference of the Ontario Society for the Study of Argumentation (OSSA), May 18-21*, 1–17.

Cetin, P. S. (2014). Explicit argumentation instruction to facilitate conceptual understanding and argumentation skills. *Research in Science and Technological Education*, *32*(1), 1–20. https://doi.org/10.1080/02635143.2013.850071

Chen, J., Lin, H., Hsu, Y., & Lee, H. (2011). Data and Claim: The Refinement of Science Fair Work through Argumentation. *International Journal of Science Education, Part B*, *1*(2), 147–164. https://doi.org/10.1080/21548455.2011.582707

Chen, Y. C., Hand, B., & Park, S. (2016). Examining Elementary Students' Development of Oral and Written Argumentation Practices Through Argument-Based Inquiry. *Science and Education*, *25*(3–4), 277–320. https://doi.org/10.1007/s11191-016-9811-0

Chen, Y. C., Park, S., & Hand, B. (2016). Examining the Use of Talk and Writing for Students' Development of Scientific Conceptual Knowledge Through Constructing and Critiquing Arguments. *Cognition and Instruction*, *34*(2). https://doi.org/10.1080/07370008.2016.1145120

Chin, C. C., Yang, W. C., & Tuan, H. L. (2016). Argumentation in a Socioscientific Context and its Influence on Fundamental and Derived Science Literacies. *International Journal of Science and Mathematics Education*, *14*(4), 603–617. https://doi.org/10.1007/s10763-014-9606-1

Chin, C., & Osborne, J. (2010). Supporting argumentation through students' questions: Case studies in science classrooms. *Journal of the Learning Sciences*, *19*(2), 230–284. https://doi.org/10.1080/10508400903530036

Choi, A., Klein, V., & Hershberger, S. (2015). Success, Difficulty, and Instructional Strategy To Enact an Argument-Based Inquiry Approach: Experiences of Elementary Teachers. *International Journal of Science and Mathematics Education*, *13*(5), 991–1011. https://doi.org/10.1007/s10763-014-9525-1

Christenson, N., & Chang Rundgren, S. N. (2015). A framework for teachers assessment of socio-scientific argumentation: An example using the GMO issue. *Journal of Biological Education*, *49*(2), 204–212. https://doi.org/10.1080/00219266.2014.923486

Chu, Y., & Reid, N. (2012). Genetics at school level : addressing the difficulties. *Research in Science & Technological Education*, *30*(3), 285–309.

Cinici, A. (2016). Balancing the pros and cons of GMOs: socio-scientific argumentation in pre-service teacher education. *International Journal of Science Education*, *38*(11), 1841–1866. https://doi.org/10.1080/09500693.2016.1220033

Clark, D. B., Sampson, V., Weinberger, A., & Erkens, G. (2007). Analytic Frameworks for Assessing Dialogic Argumentation in Online Learning Environments. *Educ Psychol Rev*, *19*, 343–374. https://doi.org/10.1007/s10648-007-9050-7

Committee on High-School Biology Education, N. R. C. (1989). *High-School Biology Today and Tomorrow*. (W. G. Rosen, Ed.), *High-School Biology Today and Tomorrow*. Washington, D.C.: National Academy of Sciences. https://doi.org/10.17226/1328

Corner, A., & Hahn, U. (2007). Evaluating the meta-slope: Is there a slippery slope argument against slippery slope arguments? *Argumentation*, *21*(4), 349–359. https://doi.org/10.1007/s10503-007-9047-x

Corner, A., Hahn, U., & Oaksford, M. (2011). The psychological mechanism of the slippery slope argument. *Journal of Memory and Language*, *64*(2), 133–152. https://doi.org/10.1016/j.jml.2010.10.002

Creswell, J. W. (2003). *Research Design*. Sage Publications - London. https://doi.org/10.4135/9781849208956

Cross, D., Taasoobshirazi, G., Hendricks, S., & Hickey, D. T. (2008). Argumentation: A strategy for improving achievement and revealing scientific identities. *International Journal of Science Education*, *30*(6), 837–861. https://doi.org/10.1080/09500690701411567

Davies, M. (2011). Concept mapping, mind mapping and argument mapping: What are the differences and do they matter? *Higher Education*, *62*(3), 279–301. https://doi.org/10.1007/s10734-010-9387-6

Davis, K. S. (2003). "Change Is Hard": What Science Teachers Are Telling Us about Reform and Teacher Learning of Innovative Practices. *Science Education*, *87*(1), 3–30. https://doi.org/10.1002/sce.10037

Dawson, V., & Carson, K. (2017). Using climate change scenarios to assess high school students' argumentation skills. *Research in Science & Technological*

Education, *35*(1), 1–16. https://doi.org/10.1080/02635143.2016.1174932

Dawson, V. M., & Venville, G. (2010). Teaching strategies for developing students' argumentation skills about socioscientific issues in high school genetics. *Research in Science Education*, *40*(2), 133–148. https://doi.org/10.1007/s11165-008-9104-y

Dimova-severinova, D. M. (2016). Genesis of the legal argumentation. In *PROCEEDINGS OF UNIVERSITY OF RUSE - 2016* (Vol. 55, pp. 127–131).

Diwu, C. (2010). *Effects of a Dialogical Argumentation Instructional Model on Grade 10 Learners ' Conception of Fermentation* (36). Cape Town, South Africa: PRAESA.

Diwu, C. T., & Ogunniyi, M. B. (2012). African Journal of Research in Mathematics , Dialogical argumentation instruction as a catalytic agent for the integration of school science with Indigenous Knowledge Systems. *African Journal of Research in MST Education*, *16*(3), 37–41. https://doi.org/10.1080/10288457.2012.10740749

Donald, D. (2003). Neutral is Not Impartial : The Confusing Legacy of Traditional Peace Operations Thinking. *Armed Forces & Society*, *29*(3), 415–448. Retrieved from https://doi.org/10.1177%2F001872678603901004

Driver, R. (1998). Establishing the Norms of Scientific Argumentation in Classrooms, 287–312.

Du, F. (2017). The Analysis of Argument-Counterargument Structure in Chinese EFL Learners' Argumentative Writing. *Journal of Studies in Education*, *7*(3).

Durgndra, & Rao, C. S. (2018). Developing Students ' Writing Skills in English-A Process Approach. *Journal for Research Scholars and Professionals of Engleish Language Teaching*, *2*(6), 1–6.

Duschl, R. A., Maria-Pilar Jime´nez-Aleixandre, & Rodríguez, A. B. (2000). " Doing the Lesson " or " Doing Science ": Argument in High School Genetics. *Sci Ed*, *84*, 757–792.

Eemeren, F. H. Van, & Houtlosser, P. (2007). Scholarship at UWindsor Dialectical Pro les and Indicators of Argumentative Moves, 0–17.

Ekanara, B., Rustaman, N., & Hernawati. (2016). Studi Tentang Keterampilan Pembentukan Klaim Mengenai Isu Sosio-Saintifik Siswa Sekolah Menengah Atas pada Kelompok Budaya Sunda. *Biodidaktika*, *11*(2), 21–45.

Elizabeth Kolbert. (2017). Why Facts Don't Change Our Minds |. *The New Yorker*, 1–12. Retrieved from https://www.newyorker.com/magazine/2017/02/27/why-facts-dont-change-our-minds

Erduran, S., Kaya, E., & Cetin, P. S. (2012). Discourse, Argumentation, and Science Lessons : Match or Mismatch in High School Students' Perceptions and Understanding? *Mije*, *2*(3), 1–32.

Erduran, S., Osborne, J., & Simon, S. (2005). The role of argumentation in

developing scientific literacy. *Research and the Quality of Science Education*, (1), 381–394. https://doi.org/10.1007/1-4020-3673-6_30

Erduran, S., Ozdem, Y., & Park, J. Y. (2015). Research trends on argumentation in science education: a journal content analysis from 1998–2014. *International Journal of STEM Education*, *2*(1), 1–12. https://doi.org/10.1186/s40594-015-0020-1

Erduran, S., Simon, S., & Osborne, J. (2004). TAPping into argumentation: Developments in the application of Toulmin's Argument Pattern for studying science discourse. *Science Education*, *88*(6), 915–933. https://doi.org/10.1002/sce.20012

Erduran, S., & Yan, X. (2009). Minding Gaps in Argument.

Erkol, M., Kişoğlu, M., & Büyükkasap, E. (2010). The effect of implementation of science writing heuristic on students' achievement and attitudes toward laboratory in introductory physics laboratory. *Procedia - Social and Behavioral Sciences*, *2*(2), 2310–2314. https://doi.org/10.1016/j.sbspro.2010.03.327

Facione, N. C., & Facione, P. A. (2008). Critical Thinking and Clinical Judgment, 1–9.

Fang, S. C., Hsu, Y. S., & Lin, S. S. (2019). Conceptualizing Socioscientific Decision Making from a Review of Research in Science Education. *International Journal of Science and Mathematics Education*, *17*(3), 427–448. https://doi.org/10.1007/s10763-018-9890-2

Floridi, L. (2009). Logical fallacies as informational shortcuts. *Synthese*, *167*(2), 317–325. https://doi.org/10.1007/s11229-008-9410-y

Foong, C. C., & Daniel, E. G. S. (2013). Students' Argumentation Skills across Two Socio-Scientific Issues in a Confucian Classroom: Is transfer possible? *International Journal of Science Education*, *35*(14), 2331–2355. https://doi.org/10.1080/09500693.2012.697209

Ford, M. (2008). Disciplinary authority and accountability in scientific practice and learning. *Science Education*, *92*(3), 404–423. https://doi.org/10.1002/sce.20263

Freeley, A. J., & Steinberg, D. L. (2009). *Argumentation and Debate*. (M. Eckman, K. Gengler, & K. Afelbaum, Eds.), *Wadsworth Cengage Learning* (Twelfth Ed). Boston, USA: Wadsworth Cengage Learning.

Gayon, J. (2016). From Mendel to Epigenetics. *Comptes Rendus - Biologies*, *339*(7–8), 225–230. https://doi.org/10.1016/j.crvi.2016.05.009

Godden, D. M., & Walton, D. (2007). Advances in the Theory of Argumentation Schemes and Critical Questions. *Informal Logic*, *27*(2000), 1–24. https://doi.org/10.4018/jcini.2012070103

Goodman, L. (2015). *Effects of a Dialogical Argumentation Instructional Model on science selected Western Cape Schools teachers ' understanding of capacitors in Name of Candidate Student Number A research proposal submitted in fulfillment of the requirements for the award of*.

Gottfredson, L. S. (2009). Logical fallacies used to dismiss the evidence on intelligence testing. *Correcting Fallacies about Educational and Psychological Testing.* https://doi.org/10.1037/11861-001

Hahn, A. H. (2016). Teaching persuasion through personal advocacy. *Communication Teacher*, *30*(1), 33–38. https://doi.org/10.1080/17404622.2015.1102309

Haigh, M., Wood, J. S., & Stewart, A. J. (2016). Slippery slope arguments imply opposition to change. *Memory and Cognition*, *44*(5), 819–836. https://doi.org/10.3758/s13421-016-0596-9

Hancock, T. S., Friedrichsen, P. J., Kinslow, A. T., & Sadler, T. D. (2019). Selecting Socio-scientific Issues for Teaching. *Science & Education*, *28*(6–7), 639–667. https://doi.org/10.1007/s11191-019-00065-x

Hand, B., Hohenshell, L., & Prain, V. (2007). Examining the effect of multiple writing tasks on year 10 biology students' understandings of cell and molecular biology concepts. *Instructional Science*, *35*(4), 343–373. https://doi.org/10.1007/s11251-006-9012-3

Hand, B., & Norton-Meier, L. (2011). *Voice from the Classroom*. Sense Publisher.

Hand, B., Norton-Meier, L. A., Gunel, M., & Akkus, R. (2016). Aligning Teaching to Learning: A 3-Year Study Examining the Embedding of Language and Argumentation into Elementary Science Classrooms. *International Journal of Science and Mathematics Education*, *14*(5), 847–863. https://doi.org/10.1007/s10763-015-9622-9

Harland, T., Wald, N., & Randhawa, H. (2017). Student peer review: enhancing formative feedback with a rebuttal. *Assessment and Evaluation in Higher Education*, *42*(5), 801–811. https://doi.org/10.1080/02602938.2016.1194368

Hattie, J. (1999). Influences on student learning. *Inaugural Lecture*, *2*(August), 1–25.

Hattie, J., & Timperley, H. (2007). The power of feedback. *Review of Educational Research*, *77*(1), 81–112. https://doi.org/10.3102/003465430298487

Hawkins, J. (2015). Countering critique: Expressing the value of the arts through the artistic rebuttal project. *Journal of Arts Management Law and Society*, *45*(2), 100–118. https://doi.org/10.1080/10632921.2015.1040103

Hefter, M. H., Berthold, K., Renkl, A., Riess, W., Schmid, S., & Fries, S. (2014). Effects of a training intervention to foster argumentation skills while processing conflicting scientific positions. *Instructional Science*, *42*(6), 929–947. https://doi.org/10.1007/s11251-014-9320-y

Helmi, H., Rustaman, N. Y., Tapilouw, F. S., & Hidayat, T. (2019). Perubahan Miskonsepsi Siswa pada Perkuliahan Evolusi Melalui Dual Situated Learning Model. *Bioedukasi*, *12*(2), 176–180. https://doi.org/10.20961/bioedukasi-uns.v

Henderson, J. B., McNeill, K. L., González-Howard, M., Close, K., & Evans, M. (2018). Key challenges and future directions for educational research on scientific argumentation. *Journal of Research in Science Teaching*, *55*(1), 5–

18. https://doi.org/10.1002/tea.21412

Hitchcock, D. (2006). Good reasoning on the Toulmin model. *Arguing on the Toulmin Model: New Essays in Argument Analysis and Evaluation*, (2005), 203–218. https://doi.org/10.1007/978-1-4020-4938-5_13

Hjörleifsson, S., Árnason, V., & Schei, E. (2008). Decoding the genetics debate: Hype and hope in Icelandic news media in 2000 and 2004. *New Genetics and Society*, *27*(4), 377–394. https://doi.org/10.1080/14636770802485467

Hohenshell, L. M., & Hand, B. (2006). Writing-to-learn strategies in secondary school cell biology: A mixed method study. *International Journal of Science Education*, *28*(2–3), 261–289. https://doi.org/10.1080/09500690500336965

Horng, R. Y., Lu, P. H., Chen, P. H., & Hou, S. H. (2013). The effects of argument stance on scientific knowledge inquiry skills. *International Journal of Science Education*, *35*(16), 2784–2800. https://doi.org/10.1080/09500693.2012.671558

Hsu, P. D., Lander, E. S., & Zhang, F. (2014). Development and applications of CRISPR-Cas9 for genome engineering. *Cell*, *157*(6), 1262–1278. https://doi.org/10.1016/j.cell.2014.05.010

Hubler, T., Adams, P., & Scammell, J. (2015). Laboratory Activities to Support Srudent Understaning of the Molecular Mechanisms of Mutation & Natural Selection. *The American Biology Teacher*, *77*(2), 135–139. https://doi.org/10.1525/abt.2015.77.2.9

Idris, M., & Mohammed, A. (2017). *Dialogic Teaching for ELT Undergraduate Students' Speaking Skills*. Sudan University of Sciences and Technology College of Graduate Studies.

Iordanou, K. (2013). Developing Face-to-Face Argumentation Skills: Does Arguing on the Computer Help? *Journal of Cognition and Development*, *14*(2), 292–320. https://doi.org/10.1080/15248372.2012.668732

Iwuanyanwu, P. N. (2019). Teaching Pre-service Teachers who Perceive Fear and Ignorance of Chemicals : Why Should this be a Concern to Chemistry Teachers ? *International Journal of Scientific Research in Education*, *12*(March), 15–33.

Jakwerth, P. M., Stancavage, F. B., Reed, E. D., Stancavage, F. B., Champagne, A., Dabbs, P., & Hedges, L. (1999). *An Investigation of Why Students Do Not Respond to Questions*. *Commissioned by the NAEP Validity Studies (NVS) Panel March*. California.

Jiménez-aleixandre, M. P. (2007). Designing Argumentation Learning Environments. In *Argumentation in Science Education* (pp. 91–115). Springer.

Jimenez-Aleixandre, M., Rodrigues, A., & Duschl, R. (2000). "Doing the Lesson" or "Doing Science": Arguments in High School Genetics. *Science Education*, *84*, 757–792.

Kane, S. N., Mishra, A., & Dutta, A. K. (2017). The Effect of Generate Argument' Instruction Model to Increase Reasoning Ability of Seventh

Grade Students on Interactions of Living Thing with their Environment. *IOP Conf. Series: Journal of Physics*, *812*(1), 0–6. https://doi.org/10.1088/1742-6596/812/1/012042

Karisan, D., & Topcu, M. S. (2016). Contents exploring the preservice science teachers' written argumentation skills: The global climate change issue. *International Journal of Environmental and Science Education*, *11*(6), 1347–1363. https://doi.org/10.12973/ijese.2016.350a

Keith Roy Langenhoven, Ogunniyi, M., Fakudze, C., & Riffel, A. D. (2016). *The sustainability of teaching integrated science- indigenous knowledge lessons using dialogical argumentation*. *National Association for Research in Science Teaching*. https://doi.org/10.4324/9780203906804

Kelly, M. A., & West, R. L. (2017). Argument complexity : Teaching undergraduates to make better arguments. *Psychology Teaching Review*, *23*(2), 20–31.

Kemendikbud, R. Silabus Biologi 2016 (2016). Indonesia: Kemendikbud RI.

Keskin, M. Ö., Samanci, N. K., & Yaman, H. (2013). Argumentation based bioethics education : Sample implementation on Genetically Modified Organisms (GMOs) and genetic screening tests. *Educational Research and Reviews*, *8*(16), 1383–1391. https://doi.org/10.5897/ERR2013.1534

Khishfe, R. (2012). Relationship between nature of science understandings and argumentation skills: A role for counterargument and contextual factors. *Journal of Research in Science Teaching*, *49*(4), 489–514. https://doi.org/10.1002/tea.21012

Khishfe, R., Alshaya, F. S., BouJaoude, S., Mansour, N., & Alrudiyan, K. I. (2017). Students' understandings of nature of science and their arguments in the context of four socio-scientific issues. *International Journal of Science Education*, *39*(3), 299–334. https://doi.org/10.1080/09500693.2017.1280741

Kilinc, A., Demiral, U., & Kartal, T. (2017). Resistance to dialogic discourse in SSI teaching: The effects of an argumentation-based workshop, teaching practicum, and induction on a preservice science teacher. *Journal of Research in Science Teaching*, *54*(6). https://doi.org/10.1002/tea.21385

Kim, I. H. (2014). Development of reasoning skills through participation in collaborative synchronous online discussions. *Interactive Learning Environments*, *22*(4), 467–484. https://doi.org/10.1080/10494820.2012.680970

Kim, M., & Roth, W.-M. (2018). Dialogical argumentation in elementary science classrooms. *Cultural Studies of Science Education*. https://doi.org/10.1007/s11422-017-9846-9

Kim, S. M., & Hannafin, M. J. (2016). Synergies: effects of source representation and goal instructions on evidence quality, reasoning, and conceptual integration during argumentation-driven inquiry. *Instructional Science*, *44*(5). https://doi.org/10.1007/s11251-016-9381-1

Knight, A. M., & Mcneill, K. L. (2015). Comparing Students ' Individual Written

and Collaborative Oral Socioscientific Arguments. *International Journal of Environmental and Science Education*, *10*(5), 623–647. https://doi.org/10.12973/ijese.2015.258a

Koeneman, M., Goedhart, M., & Ossevoort, M. (2013). Introducing Pre-university Students to Primary Scientific Literature Through Argumentation Analysis. *Research in Science Education*, *43*(5), 2009–2034. https://doi.org/10.1007/s11165-012-9341-y

Kolarova, T. (2009). The attitude of 17–18 years old students to socio-ethical issues of genetic engineering. *Biotechnology and Biotechnological Equipment*, *23*, 58–62. https://doi.org/10.1080/13102818.2009.10818365

Krathwohl, D. R. (2002). A Revision of Bloom's Taxonomy: An Overview. *Theory into Practice*, *41*(4), 212–219. Retrieved from http://net.educause.edu/ir/library/pdf/eli08105a.pdf

Kristianti, T., Widodo, A., Suhandono, S., & Indonesia, U. P. (2019). the Conceptual Change Assessment Based on Questions in Case Study of Dna / Rna and Intron Topics, *4*(1), 31–37.

Kuhn, D. (2001). How do people know ? *Psychological Science*, *12*(1), 1–8.

Kuhn, D. (2010). Teaching and learning science as argument. *Science Education*, *94*(5), 810–824. https://doi.org/10.1002/sce.20395

Kuhn, D., & Crowell, A. (2011). Dialogic argumentation as a vehicle for developing young adolescents' thinking. *Psychological Science*, *22*(4), 545–552. https://doi.org/10.1177/0956797611402512

Kuhn, D., & Udell, W. (2003). The developemtn of argument skills. *Child Development*, *74*(5), 1245–1260.

Kuhn, D., & Udell, W. (2011). The Development of Children's Argument Skills, *74*(5), 1245–1260. https://doi.org/10.1111/1467-8624.00605

Kyriakides, L., Christoforou, C., & Charalambous, C. Y. (2013). What matters for student learning outcomes: A meta-analysis ofstudies exploring factors of effective teaching. *Teaching and Teacher Education*, *36*, 143–152. https://doi.org/10.1016/j.tate.2013.07.010

Larrain, A., Freire, P., & Howe, C. (2014). Science Teaching and Argumentation: One-sided versus dialectical argumentation in Chilean middle-school science lessons. *International Journal of Science Education*, *36*(6), 1017–1036. https://doi.org/10.1080/09500693.2013.832005

Lee, Y. C. (2010). Developing Decision Making Skills for Socio Scientifis Issues. *Journal of Biological Education*, *41*(4), 170–177.

Lin, Y. R., & Hung, J. F. (2016). The analysis and reconciliation of students' rebuttals in argumentation activities. *International Journal of Science Education*, *38*(1), 130–155. https://doi.org/10.1080/09500693.2015.1134848

Macagno, F. (2008). Dialectical Relevance and Dialogical Context in Walton's Pragmatic Theory. *Informal Logic*, *28*(2), 102. https://doi.org/10.22329/il.v28i2.542

Macagno, F. (2012). The argumentative uses of emotive language. *Sistemi Intelligenti*, *24*(3), 433–454. https://doi.org/10.1422/38984

Macagno, F. (2014a). Manipulating Emotions: Value-Based Reasoning and Emotive Language. *Argumentation and Advocacy*, *51*(2), 103–122. https://doi.org/10.1080/00028533.2014.11821842

Macagno, F. (2014b). Presupposing Redefinitions. *Rhétorique et Cognition - Rhetoric and Cognition*, 249–278.

Macagno, F. (2016). Argument relevance and structure. Assessing and developing students' uses of evidence. *International Journal of Educational Research*, *79*, 180–194. https://doi.org/10.1016/j.ijer.2016.07.002

Macagno, F., & Konstantinidou, A. (2013). What Students' Arguments Can Tell Us: Using Argumentation Schemes in Science Education. *Argumentation*, *27*(3), 225–243. https://doi.org/10.1007/s10503-012-9284-5

Macagno, F., & Walton, D. (2008). Persuasive Definitions: Values, Meanings and Implicit Disagreements. *Informal Logic*, *28*(3), 203. https://doi.org/10.22329/il.v28i3.594

Macagno, F., & Walton, D. (2010). Dichotomies and Oppositions in Legal Argumentation. *Ratio Juris*, *23*(2), 229–257. https://doi.org/10.1111/j.1467-9337.2010.00452.x

Macagno, F., & Walton, D. (2019). Emotive_Meaning_in_Political_Argumentati.pdf. *Informal Logic*, *Vol.39*(No.3), 229–261.

Macagno, F., & Walton, D. N. (2011). Reasoning from paradigms and negative evidence. *Pragmatics & CognitionPragmatics and Cognition*, *19*(1), 92–116. https://doi.org/10.1075/pc.19.1.04mac

Martín-Gámez, C., & Erduran, S. (2018). Understanding argumentation about socio-scientific issues on energy: a quantitative study with primary pre-service teachers in Spain. *Research in Science and Technological Education*, *36*(4). https://doi.org/10.1080/02635143.2018.1427568

Martin, A. M., & Hand, B. (2009). Factors affecting the implementation of argument in the elementary science classroom. A longitudinal case study. *Research in Science Education*, *39*(1), 17–38. https://doi.org/10.1007/s11165-007-9072-7

Mcneill, K. L., & Krajcik, J. (2009). Journal of the Learning Synergy Between Teacher Practices and Curricular Scaffolds to Support Students in Using Domain-Specific and Domain-General Knowledge in Writing Arguments to Explain Phenomena. *Journal of The Learning Sciences*, *18*(November 2014), 37–41. https://doi.org/10.1080/10508400903013488

Mohammad, E. G. (2007). *Using the science writing heuristic approach as a tool for assessing and promoting students' conceptual understanding and perceptions in the general chemistry laboratory*. *ProQuest Dissertations and Theses*. Iowa State University. Retrieved from http://search.proquest.com.ezaccess.library.uitm.edu.my/docview/304860732

?accountid=42518

Mongin, P. (2001). The impartial observer theorem of social ethics. *Economics and Philosophy*, *17*(2), 147–179. https://doi.org/10.1017/S0266267101000219

Mueller, M., & Yankelewitz, D. (2014). Fallacious argumentation in student reasoning : Are there benefits ?, *2*(1), 27–38.

Muğla, A. E.-Y. (2018). Advantages and Disadvantages of Socioscientific. *International Online Journal of Education and Teaching (IOJET)*, *5*(2), 361–374.

Muslim. (2015). Implementasi Model Pembelajaran Argumentasi Dialogis dalam Pembelajaran Fisika untuk Meningkatkan Kemampuan Argumentasi Ilmiah Siswa SMA. *Jurnal Penelitian Dan Pengembangan Pendidikan Fisika*, *1*(2), 13–18.

Mustafa Sami Topçu, & Esin Şahin-Pekmez. (2009). Turkish middle school students' difficulties in learning genetics concepts. *Journal of Turkish Science Education*, *6*(2), 55–62.

NGSS-NSTA. (2014). Science and Engineering Practices. https://doi.org/10.1007/978-94-6209-497-0_75

Nuryandi, A., & Rusdiana, D. (2015). Penerapan Dialogical argumentation instructional model (DAIM) untuk Meningkatkan Pemahaman dan Kemampuan Argumentasi Siswa SMA pada Materi Listrik Statik. *Jurnal Penelitian Pendidikan UPI*, *15*(3), 1–8.

Nusantari, E. (2012). Konsep Genetika Pada Siswa , Mahasiswa ,. *Jurnal Ilmu Pendidikan*, *18*(2), 244–252.

Nussbaum, E. M., & Schraw, G. (2007). Promoting argument-counterargument integration in students' writing. *Journal of Experimental Education*, *76*(1), 59–92. https://doi.org/10.3200/JEXE.76.1.59-92

Okada, A., & Shum, S. B. (2008). Evidence-based dialogue maps as a research tool to investigate the quality of school pupils' scientific argumentation. *International Journal of Research and Method in Education*, *31*(3), 291–315. https://doi.org/10.1080/17437270802417184

Onoda, R., Miwa, S., & Akita, K. (2011). Highlighting Effect: The Function of Rebuttals in Written Argument, (2009), 175–180.

Ormond, K. E., Mortlock, D. P., Scholes, D. T., Bombard, Y., Brody, L. C., Faucett, W. A., … Young, C. E. (2017). Human Germline Genome Editing. *American Journal of Human Genetics*, *101*(2), 167–176. https://doi.org/10.1016/j.ajhg.2017.06.012

Osborne, J. F., Henderson, J. B., MacPherson, A., Szu, E., Wild, A., & Yao, S. Y. (2016). The development and validation of a learning progression for argumentation in science. *Journal of Research in Science Teaching*, *53*(6), 821–846. https://doi.org/10.1002/tea.21316

Ozdem, Y., Ertepinar, H., Cakiroglu, J., & Erduran, S. (2013). The Nature of Pre-

service Science Teachers' Argumentation in Inquiry-oriented Laboratory Context. *International Journal of Science Education*, *35*(15), 2559–2586. https://doi.org/10.1080/09500693.2011.611835

Pabuccu, A., & Erduran, S. (2017). Beyond rote learning in organic chemistry: the infusion and impact of argumentation in tertiary education. *International Journal of Science Education*, *39*(9), 1154–1172. https://doi.org/10.1080/09500693.2017.1319988

Pollock, J. L. (1974). *Knowledge and Justification*. Princeton University Press, new Jersey.

Pollock, J. L. (1984). *The Foundations of Philosophical Semantics*. Princeton University Press, new Jersey.

Prakken, H. (2010). An abstract framework for argumentation with structured arguments. *Argument and Computation*, *1*(2), 93–124. https://doi.org/10.1080/19462160903564592

Rahayu, D. P., & Widodo, A. (2019). The profile of scientific argumentation skill student's using "Toulmin argumentation pattern" analysis in the solving energy problem on the students of class VII. *ACM International Conference Proceeding Series*, *Part F1481*, 161–165. https://doi.org/10.1145/3318396.3318421

Rahmadani, W., Harahap, F., & Gultom, T. (2018). Analisis Faktor Kesulitan Belajar Biologi Siswa Materi Bioteknologi di SMA Negeri Se-Kota Medan. *Jurnal Pendidikan Biologi*, *6*(2), 279–285. https://doi.org/10.24114/jpb.v6i2.6546

Rastogi Verma, S. (2013). Genetically Modified Plants: Public and Scientific Perceptions. *ISRN Biotechnology*, *2013*, 1–11. https://doi.org/10.5402/2013/820671

Reed, C., & Walton, D. (2007). Argumentation schemes in dialogue. *Dissensus and the Search for Common Ground*, (2007), 1–11. Retrieved from http://www.dougwalton.ca/papers in pdf/07OSSAchris.pdf

Reiss, M. J. (2018). Biology education: The value of taking student concerns seriously. *Education Sciences*, *8*(130). https://doi.org/10.3390/educsci8030130

Rieke, S. (2013). Argumentation and Critical Decision Making Eighth Edition Rieke Sillars, (March).

Riffel, A. D. (2015). An Insight into a School's Readiness to Implement a CAPS Related Indigenous Knowledge Curriculum for Meteorological Sciences. *Universal Journal of Educational Research*, *3*(11), 906–916. https://doi.org/10.13189/ujer.2015.031117

Roviati, E., Widodo, A., Purwianingsih, W., & Riandi, R. (2017). Perceptions of Prospective Biology Teachers on Scientific Argumentation in Microbiology Inquiry Lab Activities. *Journal of Physics: Conference Series*, *895*(1), 0–6. https://doi.org/10.1088/1742-6596/895/1/012132

Sadler, T. D. (2004a). Informal reasoning regarding socioscientific issues: A

critical review of research. *Journal of Research in Science Teaching*, *41*(5), 513–536. https://doi.org/10.1002/tea.20009

Sadler, T. D. (2004b). Moral sensitivity and its contribution to the resolution of socio-scientific issues. *Journal of Moral Education*, *33*(3), 339–358. https://doi.org/10.1080/0305724042000733091

Sadler, T. D., Barab, S. A., & Scott, B. (2007). What do students gain by engaging in socioscientific inquiry? *Research in Science Education*, *37*(4), 371–391. https://doi.org/10.1007/s11165-006-9030-9

Sadler, T. D., & Donnelly, L. A. (2006). Socioscientific argumentation: The effects of content knowledge and morality. *International Journal of Science Education*, *28*(12), 1463–1488. https://doi.org/10.1080/09500690600708717

Sandoval, W. A., & Millwood, K. A. (2005). The quality of students' use of evidence in written scientific explanations. *Cognition and Instruction*, *23*(1), 23–55. https://doi.org/10.1207/s1532690xci2301_2

Schen, M. (2013). A comparison of biology majors written arguments across the curriculum. *Journal of Biological Education*, *47*(4), 224–231. https://doi.org/10.1080/00219266.2013.788542

Sezen-Barrie, A., Shea, N., & Borman, J. H. (2017). Probing into the sources of ignorance: science teachers' practices of constructing arguments or rebuttals to denialism of climate change. *Environmental Education Research*, 0–21. https://doi.org/10.1080/13504622.2017.1330949

Shivers, J., Levenson, C., & Tan, M. (2017). visual literacy, creativity and the teaching of argument. *Learning Disabilities: A Contemporary Journal*, *15*(1), 67–84.

Simon, S., Erduran, S., & Osborne, J. (2006). Learning to teach argumentation: Research and development in the science classroom. *International Journal of Science Education*, *28*(2–3), 235–260. https://doi.org/10.1080/09500690500336957

Simonneaux, L. (2013). Troy D. Sadler (ed.): Socio-Scientific Issues in the Classroom: Teaching, Learning and Research. *Science & Education*, *22*(3), 723–728. https://doi.org/10.1007/s11191-012-9472-6

Sinnot-Armstrong, W., & Fogelin, R. (1980). *Understanding Arguments*. *Teaching Philosophy* (Ninth Edit, Vol. 3). Stamford, CT USA: Cengage Learning. https://doi.org/10.5840/teachphil19803318

Suminar, I., Muslim, & Liliawati, W. (2017). Integrated argument-based inquiry with multiple representation approach to promote scientific argumentation skill. In *AIP Conference Proceedings* (Vol. 1848, pp. 0500021–0500026). https://doi.org/10.1063/1.4983958

Susanne, C. (2014). Bioethics and modern techniques in genetics, (September), 37–41. https://doi.org/10.1080/11287462.1997.10800716

Sutarno. (2016). Rekayasa Genetika dan Perkembangan Bioteknologi di Bidang Peternakan. In *Biology Education Conference* (Vol. 13, pp. 23–27).

Syerliana, L., Muslim, & Setiawan, W. (2018). Argumentation skill profile using "toulmin Argumentation Pattern" analysis of high school student at Subang on topic hydrostatic pressure. *Journal of Physics: Conference Series*, *1013*(1). https://doi.org/10.1088/1742-6596/1013/1/012031

Syukur, C. (2005). Pengelolaan Plasma Nutfah Penelitian dan Pengembangan Perkebunan. In *Lokakarya Nasional Pengelolaan dan Perlindungan Sumber Daya Genetik di Indonesia: Manfaat Ekonomi untuk Mewujudkan Ketahanan Nasional Sedangkan* (pp. 119–123).

Takao, A., & Kelly, G. (2003). Assessment of Evidence in University Students' Scientific Writing. *Science and Education*, *12*(4), 341–363. https://doi.org/10.1023/A:1024450509847

Tang, J. K. K., Mok, J. C. H., & Sawatdeenarunat, S. (1999). Investigating the Effect of Teaching Embedded Rebuttals on Students' Argumentative Essays: A Preliminary Study. In *NUS CELC 5th Symposium Proceedings* (pp. 106–123). Singapore: ELTWO online. Retrieved from http://blog.nus.edu.sg/eltwo/%0Asupporting

Tidemand, S., & Nielsen, J. A. (2017). The Role of Socioscientific Issues in Biology Teaching: from The Perspective of Teachers. *International Journal of Science Education*, *39*(1), 44–61. https://doi.org/10.1080/09500693.2016.1264644

Tidmarsh, J. (2016). The Future of Oral Argument. *Loyola University Chicago Law Journal*, *48*, 475. Retrieved from https://scholarship.law.nd.edu/law_faculty_scholarship/1279

Topcu, M. S., Sadler, T. D., & Yilmaz-Tuzun, O. (2010). Preservice science teachers' informal reasoning about socioscientific issues: The influence of issue context. *International Journal of Science Education*, *32*(18), 2475–2495. https://doi.org/10.1080/09500690903524779

Touchie, J. C. W. (2001). On The Possibility of Impartiality in Decision-Making. *Macquarie Law Journal*, *1*(1), 21–61.

Toulmin, S. E. (2003). *The Uses of Argument , Updated Edition* (Update edi). Cambridge, United Kingdom: Cambrige University Press.

Tschida, D. A. (2012). Massachusetts v . Environmental Protection Agency : Constructing " Certainty " as Rebuttal Massachusetts v . Environmental Protection Agency : Constructing '" Certainty "' as Rebuttal, (January 2015), 37–41. https://doi.org/10.1080/17524032.2012.719532

van Opstal, M. T., & Daubenmire, P. L. (2015). Extending Students' Practice of Metacognitive Regulation Skills with the Science Writing Heuristic. *International Journal of Science Education*, *37*(7), 1089–1112. https://doi.org/10.1080/09500693.2015.1019385

VIB. (2016). Effect of genetically modified crops on the environment. Retrieved from www.vib.be

Walton, D, & Godden, D. (2005). The nature and status of critical questions in argumentation schemes. *{T}he {U}ses of {A}rgument: {P}roceedings of a*

{C}onference at {M}c{M}aster {U}niversity, 476–484.

Walton, Douglas. (1994). Begging the question as a formal fallacy. *Synthese*, *100*, 95–131.

Walton, Douglas. (2006). *Fundamentals of critical argumentation*. *Cambridge University Press* (6th ed.). New York, USA. https://doi.org/10.1017/CBO9780511807039

Walton, Douglas. (2009). Objections , Rebuttals and Refutations. In *Argument Cultures: Procceding of OSSA 09* (pp. 1–10).

Walton, Douglas. (2014). How to Refute an Argument Using Artificial Intelligence. *Reseachgate Publication*, 1–28.

Walton, Douglas. (2015). The basic slippery slope argument. *Informal Logic*, *35*(3), 273–311. https://doi.org/10.22329/il.v35i3.4286

Walton, Douglas. (2017). The Slippery Slope Argument in the Ethical Debate on Genetic Engineering of Humans. *Science and Engineering Ethics*, *23*(6), 1507–1528. https://doi.org/10.1007/s11948-016-9861-3

Walton, Douglas, & Koszowy, M. (2017). Arguments from authority and expert opinion in computational argumentation systems. *AI and Society*, *32*(4), 483–496. https://doi.org/10.1007/s00146-016-0666-3

Walton, Douglas, & Macagno, F. (2016). A classification system for argumentation schemes. *Argument and Computation*, *6*(3), 219–245. https://doi.org/10.1080/19462166.2015.1123772

Wartofsky, M. W. (1997). Stephen Toulmin: An Intellectual Odyssey. *Humanities*, *Volume 18/*. Retrieved from http://www.neh.fed.us/newa/humanities/1997-03/wartofsk.html

Weaver, D. (2018). The Effect of the Directed Case Study Method on the Critical Thinking Skills of High School Students.

Weng, W. Y., Lin, Y. R., & She, H. C. (2017). Scaffolding for argumentation in hypothetical and theoretical biology concepts. *International Journal of Science Education*, *39*(7), 877–897. https://doi.org/10.1080/09500693.2017.1310409

Widodo, A., Waldrip, B., & Herawati, D. (2016). Students argumentation in science lessons: A story of two research projects. *Jurnal Pendidikan IPA Indonesia*, *5*(2), 199–208. https://doi.org/10.15294/jpii.v5i2.5949

Widodo, Ari. (2005). Taksonomi Tujuan Pembelajaran. *Didaktis*, *4*(2), 61–69.

Widodo, Ari, Saptarani, D., Riandi, R., & Rochintaniawati, D. (2018). Development of Students' Informal Reasoning across School Level. *Journal of Education and Learning (EduLearn)*, *11*(3), 273. https://doi.org/10.11591/edulearn.v11i3.6395

Wolfe, C. R., Britt, M. A., & Butler, J. A. (2015). Argumentation Schema and Argumentation, 183–209.

Wu, Y. T., & Tsai, C. C. (2007). High school students' informal reasoning on a

socio-scientific issue: Qualitative and quantitative analyses. *International Journal of Science Education*, *29*(9), 1163–1187. https://doi.org/10.1080/09500690601083375

Yakob, N., Yunus, H. M., & May, C. Y. (2015). Knowledge and Practices in Teaching Socio-scientific Issues Among Malaysian Primary School Science Teachers *, *5*(9), 634–640. https://doi.org/10.17265/2161-623X/2015.09.006

Yusefni, W., & Sriyati, S. (2016). Pembelajaran IPA Terpadu Menggunakan Pendekatan Science Writing Heuristic untuk Meningkatkan Kemampuan Komunikasi Tulisan Siswa SMP. *Edusains*, *8*(1), 10–17. https://doi.org/http://dx.doi.org/10.15408/es.v8i1.1562

Zeidler, D. L., & Nichols, B. H. (2009a). Socioscientific issues: Theory and practice. *Journal of Elementary Science Education*, *21*(2), 49–58. https://doi.org/10.1007/bf03173684

Zeidler, D. L., & Nichols, B. H. (2009b). Socioscientific Issues: Theory and Practice. *Journal of Elementary Science Education*, *21*(2), 49–58.

Zhao, F. F., & Schuchardt, A. (2019). Exploring students' descriptions of mutation from a cognitive perspective suggests how to modify instructional approaches. *CBE Life Sciences Education*, *18*(3). https://doi.org/10.1187/cbe.18-11-0225