

The schemes of students' understanding through digital argumentation in online learning during pandemic COVID-19

Marheny Lukitasari¹, Jeffry Handhika², Wasilatul Murtafiah³, Akhmad Sukri⁴

¹Department of Biology Education, Universitas PGRI Madiun, Indonesia

²Department of Physic Education, Universitas PGRI Madiun, Indonesia

³Department of Mathematic Education, Universitas PGRI Madiun, Indonesia

⁴Department of Biology Education, Universitas Pendidikan Mandalika, Indonesia

Article Info

Article history:

Received Dec 20, 2020

Revised May 11, 2021

Accepted Jun 13, 2021

Keywords:

COVID 19

Digital argumentation

Online learning

Student conception

ABSTRACT

The student conception needed to analyze problems and obtain effective solutions. It is also required to train students to think reflective and argumentative, so expressing student conception is necessary. This research aimed to describe the schemes of students' conception through digital arguments in online learning. This research was descriptive qualitative by uncovering students' digital arguments and making schemes of students' understanding based on digital arguments presented in written discussions. Research Data were from electronic discussion forums, and unstructured interviews in biology and physics. The analysis results describe that digital argumentation can use to schemes students' conception.

This is an open access article under the [CC BY-SA](https://creativecommons.org/licenses/by-sa/4.0/) license.



Corresponding Author:

Jeffry Handhika

Department of Physic Education

Universitas PGRI Madiun, Indonesia

Jalan Setia Budi, No 85 Madiun, East Java, Indonesia

Email: jhandhika@unipma.ac.id

1. INTRODUCTION

Policies during the COVID-19 pandemic have brought changes in various aspects, one of which is education and the learning process. The face-to-face learning process changes to the online learning process one of the important learning problems is to address student conception [1]–[3]. Students' preconception must be considered in instructional design and curriculum planning [4]. Students' conception is very important to reveal because it is closely related to their ability to evaluate and create in the future and select learning strategies that will give at the next meeting. Effective learning is very important in the current COVID-19 pandemic, given the limited interactions between educators and students [5]. Online learning certainly brings changes in terms of the learning process and evaluation. Put the implementation of discussions that previously face-to-face is changing to a virtual form the expression of argumentations in the form of audio-visual and digital text through the platform used in learning. The arguments in the discussion, which presented in the form of text, audio, digital audio-visual (digital arguments), certainly provide different information from the arguments presented directly [6]–[8].

Arguments are not only the delivery of arguments, but are broader, such as: discussion, persuasion, and disagreement with other people's arguments [9]–[11]. In online learning the arguments are presented in the form of digital text and audio video. In previous research [7], [12], [13], information was obtained that students felt the positive influence of scaffolded argumentation activities on online asynchronous discussions.

Students can express their argument anytime and anywhere without being limited by time. crisis of confidence in expressing opinions can be reduced. Students who have good argumentation skills will express their thoughts in understanding the problem, show logical reasons, explain, and defend their argument [14]. Misinformation has the potential to occur related to the meaning of digital arguments presented in contrast to arguments presented directly through face to face. Arguments conveyed through web meetings are less misinformed than information presented in the text. The lecturer needs to reveal the students' argumentation schemes. The student's conception can reveal from expressing their argumentation.

Learning/topics that are interesting have the opportunity to be discussed and evaluated by participants. The ability of the facilitator to make students ask questions is important in the online learning process. Digital information on students' arguments can be seen in synchronous and asynchronous forums in discussion forums through chat and discussion forums provided in e-learning. Students' conception revealed from the way students convey problems and questioning by peers conveyed by lecturers. The schematic of students' conception can use as a reference for the lecturer in managing subsequent learning.

2. RESEARCH METHOD

The method used in this research is descriptive qualitative by collecting documents: 1) The student discussion process in the form of asynchronous discussion transcripts; 2) Unstructured interviews; and 3) Assignments. Data obtained from two meetings of physics and biology courses online. Here are 11 students taking physics courses and 27 biology students. Purposive sampling is used to select the sample. Sample selection considerations are students who are active in discussing and uploading assignments. Two students who took physics and two students who took biology courses were chosen. To manage the quality of the data, triangulation methods are used, namely the method of collecting discussion data, unstructured interview data and assignments. Triangulation is done to validate active students. If students are actively discussing but not uploading assignments, the data will be reduced (not described and analyzed). the transcripts of the discussion results were synthesized using unstructured interview data and assignments. The discussion transcript synthesis results are in the form of descriptions of students' conceptions, which are then presented in schematic form. The scheme is structured based on students' initial knowledge, students' conceptual changes in the discussion process, and the final conception.

3. RESULTS AND DISCUSSION

In the first stage, information on the discussion process conducted by students and lecturers will be presented. Lecturers give problems to students, and students give responses to the responses given to test the consistency of the arguments given. In the second stage, the lecturer provides the opportunity for students to respond (evaluation) to discussions delivered by other students. In this second stage, students' critical thinking skills should ideally be seen and able to provide criticism of arguments submitted by their peers. At each stage, the analysis is presented descriptively to profile the student's stages of thinking. The results of stages I and II are presented as follows.

3.1. Stage I. Description Discussion of the problems presented by the lecturer

In stage I the lecturer provides general problems and or general knowledge related to the material to be studied. A discussion transcript is presented in Figure 1 for the biology course as follows:

In Figure 1, student A can relate biology courses to agriculture in overcoming problems faced by humans. They provide examples of the use of insecticides to treat pests—information regarding the negative impact of insecticide use not studied in depth. From the students' responses, it can be obtained information that students have prior knowledge (preconceptions) about the biology material that they get from everyday life. Student B tries to relate biology based on his experience. Students link biology with diseases in humans. The lecturer tries to dig up information related to students' experiences by asking about the pain they have suffered and how biological scientists deal with it. In his argument, students knew that ulcer disease was caused by eating a lot of spicy food. The treatment that used ulcer medication, and students also knew that ulcers could be treated by drinking ginger, but students did not like it because they did not like it. The results of this discussion provided information that students gained knowledge from direct experience (pain experienced) and information from outside (literature) regarding the use of ginger as alternative medicine. it should be understood that [15] provides information that it is better to make students experience cognitive conflict from directly observed experiments than to reflect on experiences reported from popular papers or writings found on the internet. Figure 2 is a discussion transcript from an online forum for the physics courses.

Re: Biologi Dasar oleh Aammy Lukitani - Jumat, 25 September 2020, 16:48

Contoh nyata keterkaitan Biologi dalam menghadapi permasalahan manusia. Silahkan sampaikan pendapatmu.

Translation: What real example of the relationship between biology in dealing with human problems. Please express your opinion

Student A Jumat, 25 September 2020, 17:09

Keterkaitan biologi dalam menghadapi permasalahan manusia di kehidupan nyata menurut saya salah satu contohnya yaitu dalam pertanian, dari biologi berperan dalam penemuan obat, pertanian atau bibit unggul yang dapat meningkatkan produksi pertanian, termasuklah maaf jika ada salah kata.

Translation: One example in my opinion is in the field of agriculture, to find superior seeds so that it will increase production.

yes very, tanaman apa nak?

Translation: That's right. What the kinds of plant?

Student A Jumat, 25 September 2020, 19:32

Contohnya, tanaman jagung diberi obat pertanian insektisida andurid dalam insektisida andurid terkandung bahan spinotriam yang diperoleh dari fermentasi *Saccharopolyspora spinosa actinomycete* yang efektif untuk melawan hama perusak tanaman.

Translation: Another example, suppose a corn crop is treated with 'endure' pesticides. The pesticide contains the active ingredient spinoteram which is obtained from the fermentation of *saccaropolyspora spinosa actinomycetes* which is effective against plant-destroying pests.

Student B Jumat, 25 September 2020, 17:14

Keterkaitan biologi dalam permasalahan manusia misalnya dalam dunia kesehatan, biologi mempelajari organ2 luar dan dalam manusia juga dapat mengobati penyakit penyakit yang diderita manusia serta cara mencegah/mengobati dan pencegahannya.

Translation: Another example of Biological knowledge is supportive in the field of medicine, because it studies the external and internal organs of humans, including diseases and their treatment

Re: Biologi Dasar oleh Morfery Lukitani - Jumat, 25 September 2020, 17:35

Fitriana, sakit apa yang pernah kamu alami dan bagaimana mengatasinya?

Translation: Fitriana, What pain have you experienced and how to

Student B Sabtu, 26 September 2020, 12:43

Sin menanggapi busaya pernah mengalami sakit magh atau asam lambung, biasanya penyakit itu disebabkan oleh pola makan yg tidak teratur, sering memakan makanan yg terlalu pedas dan terlalu masam, sehingga mengakibatkan asam lambung naik, gejala yg saya alami biasanya sakit perut yg berkepanjangan, hal itu bisa diurangi dengan minum obat magh atau bisa juga dengan bahan alami seperti jahe, atau juga bisa dengan mengunyah permen karet tp kalau yg jahe kaya belum pernah mencobanya busabunya saya tidak suka jahe.

Translation: I've had stomach ulcers or stomach acid. Can be caused by an irregular diet, often eating spicy and sour. This causes stomach acid to rise with symptoms of prolonged stomach pain. According to information, it can be overcome by drinking ginger or chewing gum. But I've never drank it, because I don't like ginger.

Figure 1. Discussion of basic problems given by the lecturer of the biology courses

Perbedaan Besar Perpindahan, perpindahan, jarak dan posisi oleh Jilly Handika - Senin, 21 October 2020, 10:42

Translation: Describe the difference in displacement, displacement, distance

Student C Senin, 21 October 2020, 10:55

Translation:

1. The amount of displacement is the change in face measured from the starting point to the end point that the object reaches in the presence of direction.
2. Transfer is the starting position to the final position.
3. Distance is the total length of the track.
4. Position is a vector condition with the position of one point to another and is described by coordinates

Student D Senin, 21 October 2020, 10:58

Translation: Displacement is the change in position whereas distance is the length of the path the particle traverses. The displacement size is the value of the displacement itself.

Figure 2. Discussion of basic problems given by the lecturer in physics courses

In the discussion of Figure 2, student C obtained information from the literature related to the concepts of position, distance, and displacement. In physics courses, the implementation of learning is different from biology. In fundamental physics courses, students are reviewing material from various sources. The arguments given tend to be identical to the conceptions presented. Regarding the concept of

displacement, students are still unable to provide accurate information. Information regarding magnitude of displacement rates is difficult to obtain from experiences in everyday life the concept of magnitude of displacement obtained by understanding the language of mathematics and physics well. Students use their initial knowledge regarding displacement and equate the definition of displacement with the magnitude of displacement. Student D gave the right response to the questions given. The difference in response between students C and D related to the source of literature studied and the level of understanding. Problems about distance and displacement have been researched and gave the same results [16], where one of the reasons is that students do not understand the concepts of vector and scalar quantities. For the concept of displacement magnitude, not many researchers have revealed it.

3.1.1. Discussion of description I

Based on Figures 1 and Figure 2, the schematic described that students' preconceptions come from the surrounding environment, experiences, and learning resources. The preconceptions obtained from the surrounding environment tends to provide a varied response. The preconceptions brought from the environment and experiences tend to stick and answered with certainty with simple communication language. Preconceptions serve as a platform on which students interpret their world. Unfortunately, in many cases, the preconceptions obtained are often different from scientific agreement [17], [18]. The information obtained from the references tends to be uniform. Students' conceptions need further testing whether the student understands the arguments presented well or memorizes the concepts from existing sources. Schematic description can see in Figure 3.

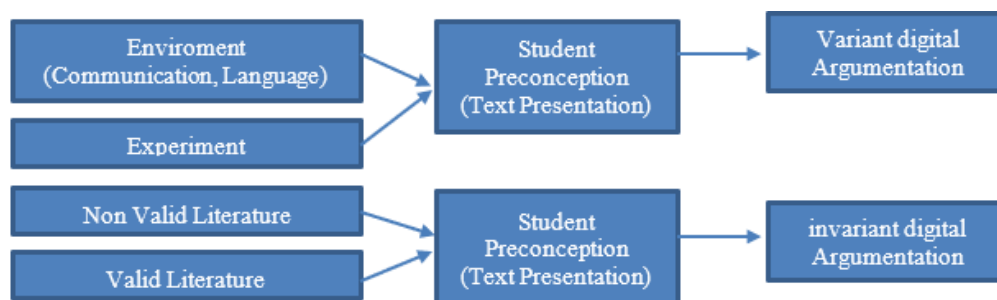


Figure 3. Schematically describes students' preconceptions obtained from the environment, experiences, and literature

The information obtained from the literature produces digital arguments that are uniform in nature [19], [20]. In Figure 2, students express their argument according to the textual knowledge obtained from learning sources. In Figure 1, students' preconceptions come from experience and the environment; the arguments are given variants and presented with communication [14], [21]. Delivering information with communication language provides information to the teacher that these students can communicate their knowledge well. They understand the information that is certainly better than textual knowledge, although the truth that conveyed still requires further testing. In Figure 2, the accuracy of arguing depends on the reference source read and the level of understanding. Correct conception is more dominant obtained from valid literature. The preconceptions obtained are often different from scientific agreement [17], therefore it is necessary to add learning activities in the form of making a summary of the material to be studied.

3.2. Phase II. Problems presented by students and peer problem responses

In stage II, students will analyze how they present problems and respond to their friends' problems. In the discussion forum, students asked to raise problems or respond to their group colleagues' problems. Descriptions of student problems and responses to problems presented in virtual arguments presented in Figure 4.

Student A KEL 1
mat, 9 Oktober 2020, 08:22

izin menanggapi bu.saya perwakilan dari kelompok 6 yang beranggatakan

1.Tiara citra
2.Ferry Febita
3.Izza umi
4.Irna nuriska

Translation: Permission to respond Ma'am, I am a representative from group 6 consisting of: 1. Tiara Citra, 2. Ferry Febita, 3. Izza Umi, 4. Irna Nuriska, will answer question number 2, namely how do animal and plant cells work? The workings of animal cells and collision cells are that we know that sets are formed of neatly structured organelles with their respective functions. Therefore, to maximize cell growth, each part structure in the organelle has a different role, all parts can work together to maintain formation of cells in order to remain optimal. In essence, the workings of animal and plant cells are to work together in maximizing cell growth, maintaining cell formation so that it remains optimal with the function of each cell's organelle. Thank you, sorry if there is a word wrong.

Akan menjawab soal nomor 2 yaitu Bagaimana cara kerja sel hewan dan sel tumbuhan?

Cara kerja dari sel hewan dan sel tumbuhan yaitu, kita tahu sel terbentuk atas organel yang terstruktur rapi dengan fungsinya masing-masing,maka dari itu, untuk memaksimalkan pertumbuhan sel, setiap struktur bagian pada organel memiliki peranan yang berbeda.seluruh bagian bisa bekerja sama untuk merawat pembentukan sel agar tetap optimal.intinya cara kerja dari sel hewan dan tumbuhan adalah saling bekerja sama dalam memaksimalkan pertumbuhan sel,merawat pembentukan sel agar tetap optimal dengan fungsi organel sel masing-masing.

Terimakasih,maaf jika ada salah kata

Student B KEL 1
yanik - Jumat, 9 Oktober 2020, 08:14

izin menanggapi bu.saya fitriana mewakili dari kelompok 3 ingin menjawab pertanyaan no.2

Antara sel tumbuhan dan sel hewan memiliki dinding sel yg sebagian besar organel yg sama,namun juga memiliki organel yg beda antara lain:

1.sel tumbuhan memiliki dinding sel yg berfungsi sebagai proteksi tubuh dan menjaga bentuk sel sedangkan hewan tidak
2.sel tumbuhan memiliki plastida yg berfungsi sebagai pembentuk klorofil,sedangkan sel hewan tidak
3.sel tumbuhan memiliki vakuola sebagai penyimpan cadangan makanan.sedangkan hewan tidak kalau ada sangat kecil
4.sel hewan memiliki sentriol berfungsi saat pembelahan sel,sedangkan sel tumbuhan tidak
5.sel hewan memiliki lisosom yg berfungsi sebagai pencernaan dalam sel,sedangkan sel tumbuhan tidak

Sekian dari saya trimakasih,mohon maaf bila ada kata yg kurang tepat.terimakasih.

Translation: Permission to respond Ma'am, I am Fitriana representing group 3 would like to answer question number 2.Between plant cells and animal cells have cell walls which are mostly the same organelles, but also have different organelles, among others:
1. Plant cells have cell walls that function as protection for the body and maintaining the shape of the cell while animals do not
2. Plant cells have plastids which function as chlorophyll-forming cells while animal cells do not
3. Plant cells have vacuoles as food reserves while animals do not, if any are very small
4. Animal cells have a central function during cell division, whereas plant cells do not
5. Animal cells have lysosomes that function as digestion in cells, whereas plant cells do not.
That's all from me, thank you, apologize if there are words that are not quite right. Thank you.

Figure 4. Response to peer problems by students A and B

In Figure 4, student A has not systematically explained the workings of animal and plant cells. The linkup space and questions submitted by colleagues have not been described in the questions. Student B can explain in detail the differences between plant and animal cells and explain their similarities.

Provide a statement that what is expected, as stated in the "Introduction" chapter can ultimately result in "Results and Discussion" chapter, so there is compatibility. Moreover, it can also be added the prospect of the development of research results and application prospects of further studies into the next (based on result and discussion). Figure 5a shows that student C still has problems distinguishing the concepts of Velocity and speed; student D still has difficulties distinguishing between instantaneous and average velocity. The issue of the concepts of velocity and displacement has been widely discussed [22], [23], one of the main factors is that in the previous levels of learning, information was received that the two concepts tend to be equated. If it is related to stage I, student D has understood well the concept of vectors in physical quantities, while student C still has problems in understanding these problems.

The questions asked by student C also provided information that he wanted to gain more in-depth knowledge regarding the difference in speed (scalar) and velocity (vector). Student D found it difficult to distinguish the concepts of mean and instantaneous velocity. In Figure 5b, student C gives a response related to the difference in the concept of instantaneous and average velocity. From the responses given by student C, it can see that the student strengthens the conclusion that student C does not yet understand the concept of vectors in physical quantities. Student D can explain the concept of speed and speed well to the questions given by student C. The problem of instantaneous and average velocity is caused by the definition of

everyday language usage which is different from the physics concept in textbooks [24]. Lecturers must be able to provide mathematical language strengthening to students.

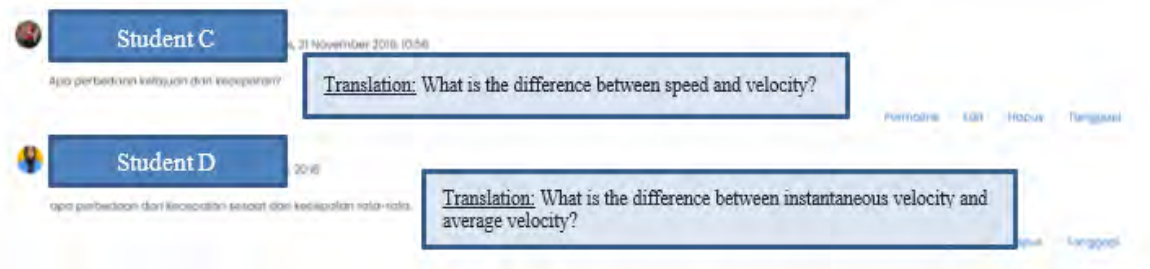


Figure 5a. Responses delivered by students C and D in the discussion

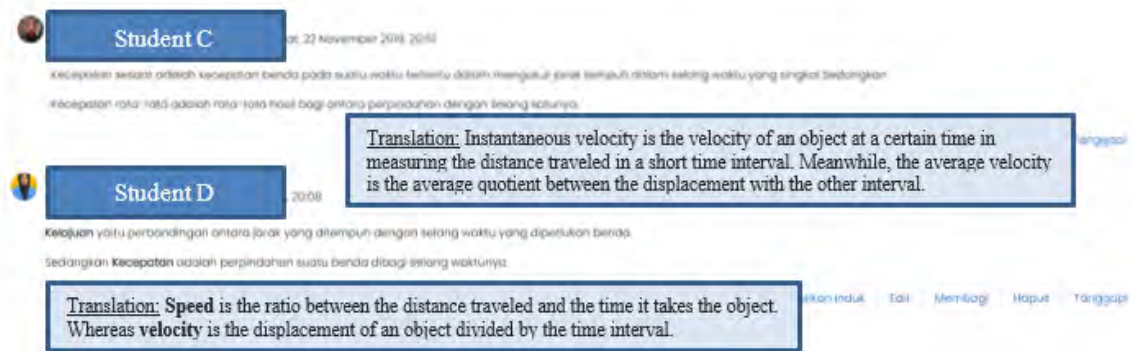


Figure 5b. Responses delivered by students C and D in the discussion

3.2.1. Discussion of description II

Based on the description of stage II data, the way students ask questions and express opinions can show their conceptions. The conception obtained from the stage 2 discussion strengthens the results of the stage I discussion. Incorrect conceptions caused by understanding some of the concepts cause students to experience difficulty understanding the next material. The student conception scheme can see in Figure 6.

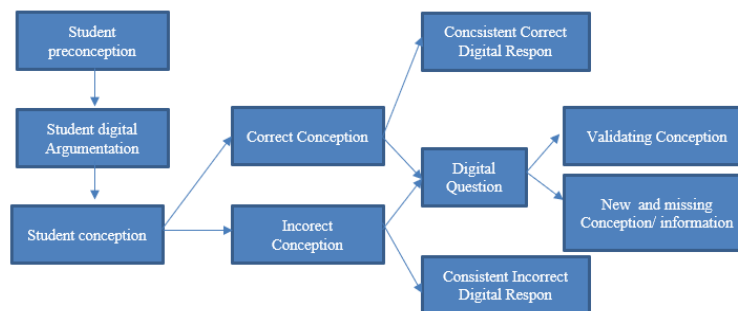


Figure 6. Student's Conception Schema

Based on the schematic in Figure 6, it can be seen that students who have incorrect conceptions are consistently wrong in providing arguments, students who have correct conceptions provide arguments for correct conceptions. In giving questions, students who have an incorrect or correct conception ask questions about the lack of understanding. Students who have incorrect conceptions try to test their conceptions by asking questions. Questions can arise because these students get information from the discussion processes

[25]. Students who have the correct conception give questions about new information obtained and information they did not previously understand. The discussion process can assist lecturers in profiling and making student conception schemes. The discussion process can also help students test their conceptions.

4. CONCLUSION

Based on the discussion of stages I and II, stage I obtained that digital arguments can reveal the student's conception through the discussion process. The sources of conception can identify based on the arguments given. Based on scheme 1, it can see that the source of students' conceptions is obtaining from the environment, communication processes, and learning resources. The sources of conception obtained from the environment and communication processes tend to be variants, while the literature sources tend to be invariant. Sources of conception obtained from various sources can be tested through instructions to make questions and provide discussion responses to colleagues' questions. The correct conception is consistent from stage I to stage II, and vice versa. The questions that are asked in the discussion process lead to testing the conceptions owned and strengthening new information.

ACKNOWLEDGEMENTS

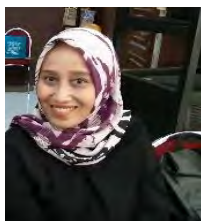
This research was funded by *Penelitian Terapan Unggulan Perguruan Tinggi (PTUPT) 2021*, a grant under Ministry of Research, Technology, and Higher Education of Indonesia (Ristek-BRIN). We acknowledge Kementerian Pendidikan dan Kebudayaan (Kemendikbud) and Universitas PGRI Madiun (UNIPMA) for supporting this research.

REFERENCES

- [1] J. Handhika, C. Cari, A. Soeparmi, and W. Sunarno, "Student conception and perception of Newton's law," *AIP Conf. Proc.*, vol. 1708, no. 070005, pp. 1-5, 2016, doi: 10.1063/1.4941178.
- [2] N. Suprpto, T. S. Chang, and C. H. Ku, "Conception of learning physics and self-efficacy among Indonesian university students," *J. Balt. Sci. Educ.*, vol. 16, no. 1, pp. 7-19, 2017.
- [3] P. A. Alexander, F. I. Winters, S. M. Loughlin, and E. M. Grossnickle, "Students' conceptions of knowledge, information, and truth," *Learn. Instr.*, vol. 22, no. 1, pp. 1-15, 2012.
- [4] S. A. N. Van Riesen, H. Gijlers, A. A. Anjewierden, T. De Jong, and H. Gijlers, "The influence of prior knowledge on the effectiveness of guided experiment design," *Interact. Learn. Environ.*, vol. 0, no. 0, pp. 1-17, 2019.
- [5] M. Adnan, "Online learning amid the COVID-19 pandemic: Students perspectives," *J. Pedagog. Res.*, vol. 1, no. 2, pp. 45-51, 2020, doi: 10.33902/jpsp.2020261309.
- [6] F. Bex and D. Walton, "Combining explanation and argumentation in dialogue," *Argument & Computation*, vol. 7, no. 1, pp. 55-68, 2016.
- [7] K. L. Kelly, "Emergent Arguments: Digital Media and Social Argumentation," Diss., University of Oregon, 2016.
- [8] M. Lukitasari, J. Handika, W. Murtafiah, and A. R. Nurhikmawati, "Examining students' Self-Assessment of Digital Argumentation (SADA) in e-biology class: A Rasch analysis," *JPBI (Jurnal Pendidik. Biol. Indones.)*, vol. 6, no. 2, pp. 209-216, 2020, doi: 10.22219/jpbi.v6i2.11919.
- [9] Y. C. Fan, T. H. Wang, and K. H. Wang, "Studying the effectiveness of an online argumentation model for improving undergraduate students' argumentation ability," *J. Comput. Assist. Learn.*, vol. 36, no. 4, pp. 526-539, 2020, doi: 10.1111/jcal.12420.
- [10] A. Stiegelmayr and M. Mieskes, "Using argumentative structure to grade persuasive essays," in *International Conference of the German Society for Computational Linguistics and Language Technology*, 2018, vol. 10713-LNCS, pp. 301-308, doi: 10.1007/978-3-319-73706-5_26.
- [11] G. Melchior, *Skeptical Arguments and Deep Disagreement*, *Erkenntnis*, 2021. [Online]. Available: <https://link.springer.com/content/pdf/10.1007/s10670-021-00433-6.pdf>.
- [12] H. S. Kim and E. G. Oh, "Scaffolding argumentation in asynchronous online discussion: Using students' perceptions to refine a design framework," *Int. J. Online Pedagog. Course Des.*, vol. 8, no. 2, pp. 29-43, 2018, doi: 10.4018/IJOPCD.2018040103.
- [13] Y. W. Lam, K. F. Hew, and K. F. Chiu, "Improving argumentative writing: Effects of a blended learning approach and gamification," *Lang. Learn. Technol.*, vol. 22, no. 1, pp. 97-118, 2018.
- [14] J. Handhika, C. Cari, A. Suparmi, and W. Sunarno, "External Representation to Overcome Misconception in Physics," in *International Conference on Mathematics, Science, and Education*, vol. 1, no. 1, 2015, pp. 1-4.
- [15] M. Marušić and J. Sliško, "Influence of Three Different Methods of Teaching Physics on the Gain in Students' Development of Reasoning," *Int. J. Sci. Educ.*, vol. 34, no. 2, pp. 301-326, 2012, doi: 10.1080/09500693.2011.582522.
- [16] J. Handhika, et al., "The Students Conception About Kinematics: Displacement and Distance Concept Jeffrey," in *Proceedings of the Annual Conference on Social Sciences and Humanities*, no. 85, 2018, pp. 142-146.
- [17] N. Wakhidah and E. Erman, "Using Information Search Strategy to Reconstruct Students' Biology Prior Knowledge," *Jurnal Penelitian dan Pembelajaran IPA*, vol. 7, no. 1, pp. 84-104, 2021.

- [18] V. Viyanti, C. Cari, W. Sunarno, and Z. Kun Prasetyo, "Empowerment of Argumentation Skills Encourages Student Understanding of Concepts (in Indonesia)," *J. Penelit. Pembelajaran Fis.*, vol. 7, no. 1, pp. 43-48, 2016, doi: 10.26877/jp2f.v7i1.1152.
- [19] S. Robertson and L. Mullen, *Digital History and Argument*, 2017. [Online]. Available: <https://rrchnm.org/wordpress/wp-content/uploads/2017/11/digital-history-and-argument.RRCHNM.pdf>.
- [20] O. Noroozi, "The Effect of a Digital Dialogue Game on Higher Education Students' Argumentation-Based Learning," *Int. J. Educ. Pedagog. Sci.*, vol. 10, no. 12, pp. 4062-4065, 2016.
- [21] M. Tengberg and C. Olin-Scheller, "Developing Critical Reading of Argumentative Text: Effects of a Comprehension Strategy Intervention," *J. Lang. Teach. Res.*, vol. 7, no. 4, pp. 635-645, 2016, doi: 10.17507/jltr.0704.02.
- [22] A. Yildiz, "A discussion on velocity-speed and their instruction," *J. Phys. Conf. Ser.*, vol. 707, no. 1, pp. 1-8, 2016.
- [23] N. J. Kim, "Enhancing Students' Higher Order Thinking Skills Through Computer-based Scaffolding in Problem Based Learning," All Graduate Theses and Dissertations, Utah State University, 2017.
- [24] Soeharto, B. Csapo, E. Sarimanah, F. I. Dewi, and T. Sabri, "A Review Of Students' Common Misconceptions In Science And Their Diagnostic Assessment Tools," *Jurnal Pendidikan IPA Indonesia*, vol. 8, no. 2, pp. 247-266, 2019.
- [25] B. Tanujaya, J. Mumu, and G. Margono, "The Relationship between Higher Order Thinking Skills and Academic Performance of Student in Mathematics Instruction," *Int. Educ. Stud.*, vol. 10, no. 11, pp. 78-85, 2017, doi: 10.5539/ies.v10n11p78.

BIOGRAPHIES OF AUTHORS



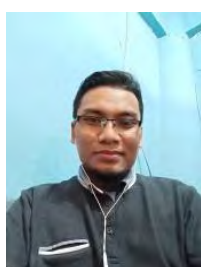
Marheny Lukitasari was born in Madiun, Indonesia. She graduated Doctoral Program from Department of Biology Education, Universitas Negeri Malang in 2014. Her research interest in metacognition, higher order thinking skills (HOTS), ICT and Lesson Study. Affiliation: Study Program of Biology Education, Faculty of Teacher Training and Education, Universitas PGRI Madiun, Indonesia. E-mail: marheny@unipma.ac.id. Phone: (+62)81230141995, ORCHID Number: 0000-0001-6545-3922, SCOPUS ID: 57201676274, SINTA ID: 6002277



Jeffry Handhika was born in Banyuwangi, Indonesia. He graduated from Department of Physics, Universitas Negeri Malang in 2006. He completed master Department of Science Education and Physics, Universitas Sebelas Maret in 2008 and 2012. And then he graduated doctoral degree in Science Education, Universitas Sebelas Maret in 2019. His research interest is in model of learning, misconception, and designing learning based on ICT. Affiliation: Study Program of Physics Education, Faculty of Teacher Training and Education, Universitas PGRI Madiun, Indonesia. E-mail: jhandhika@unipma.ac.id. ORCID Number: 0000-0001-8149-7407, SCOPUS ID: 55668704900



Wasilatul Murtafiah was born in Ngawi, Indonesia. She graduated from Department of Mathematics Education, Universitas Negeri Surabaya in 2008. He completed master Department of Mathematics Education, Universitas Negeri Surabaya in 2010. And then he graduated doctoral degree in Department of Mathematics Education, Universitas Negeri Malang in 2020. His research interest is in thinking process of mathematics teacher and students, designing learning based on ICT. Affiliation: Study Program of Mathematics Education, Faculty of Teacher Training and Education, Universitas PGRI Madiun, Indonesia. E-mail: wasila.mathedu@unipma.ac.id. Phone: (+62)85732923200, ORCID Number: 0000-0003-3539-5332, SCOPUS ID: 57201672222, WoS Researcher ID: AAG-6853-2020



Akhmad Sukri was born in Lombok Tengah, West Nusa Tenggara, Indonesia. He graduated Doctoral Program from Department of Biology Education, Universitas Negeri Malang in 2014. Affiliation: Study Program of Biology Education, FSTT, Universitas Pendidikan Mandalika, Indonesia. E-mail: akhmadsukri@ikipmataram.ac.id. Phone: (+62)81917370467, ORCID Number: 0000-0002-1588-8028, SCOPUS ID: 57211620074, SINTA ID: 5986955