Enhancing scientific argumentation skill through partnership comprehensive literacy

D Hadianto1, V S Damaianti1*, Y Mulyati1, and A Sastromiharjo1

1Departemen Pendidikan Bahasa Indonesia, Universitas Pendidikan Indonesia, Jl. Dr. Setiabudhi No. 229, Bandung 40154, Indonesia

*vismaia@upi.edu

Abstract. This study focuses on the use of Partnership Comprehensive Literacy (PCL) as a reading strategy to support reading in science and to explore the level of students’ Scientific argument. Partnership Comprehensive Literacy consist of 4 components that address the topic of the reading activity: the statements of the content, what I think, what the texts say, and evidence of the text. This study uses a mix method to identify and improve students’ scientific argumentation skills. The instrument used is a set of questions about electricity and magnetism. In addition, the argument level rubric instrument that contains argument components is used to analyse the level of students' scientific arguments. The participants of this study were 40 college students consisting of 25 females and 15 males in the department of physics education taking a course in the fundamental of physics. The findings revealed that the students’ level argument was dominated by the use of Claim-Reasoning-Evidence (CRE). In addition, students evaluated that the use of PCL in reading activity as being challenging but an interesting process because they have to find the evidence in the texts to support their statements of what I think.

1. Introduction
Our daily life greatly depends on the reading competence of various kinds of information. This situation showed that a reading activity has a crucial position like other scientific activities. For instance, a reading activity can be aligned with laboratory activities when we consider scientific activities [1,2]. The importance of reading activity has appeared in many international standardized tests. Its purpose is to investigate the literacy competence including the reading competence of students. For example, Programme for International Student Assessment (PISA) is an international assessment program defining scientific competence in form of scientific literacy [3]. This reveals how students’ competence to read and comprehend scientific information is investigated. There is a need to train a reading strategy so as students comprehend well scientific information. The high ability of reading is proportional to high skill in problem-solving [4,5].

A reading strategy to improve reading competence is Partnership Comprehensive Literacy (PCL). It is used to investigate students’ activity in the context of before, during, and after reading [6]. It has four components: the statements of the content, what I think, what the texts say, and evidence of the text [7]. An PCL has several benefits. First, it can be used to improve comprehension through verifying concepts. Second, it provides a chance to do predictions. Last, it can be used to learn to justify findings and support ideas. This means students can construct viable arguments after doing reading activities. The arguments developed are to construct both correct and incorrect notions in strengthening interpretations and addressing misconceptions. An PCL also can be a potential tool to scaffold scientific argumentation skills. Students are engaged to connect true or false statements (claim) connected to evidence from the texts. This depicts a reading activity can be situated to support another activity. A competency of
students in producing a written argument is trained in this context. This aligns with an argument that other competencies (e.g. writing) can be synergized with reading activity [5,8].

This present study, therefore, enacts PCL as a reading strategy in science reading activity to facilitate competence in developing scientific arguments. The use of an PCL hypothesized provides positive impacts to propose scientific arguments. The research objective developed in this present study is how are the levels of students’ scientific written arguments after doing a reading activity using PCL. The novelty offered in this research is the teaching method to see the level of students' mastery of the material through the level of scientific argumentation offered. In addition, through the PCL method, teachers can improve their scientific argumentation skills. Some researchers define that scientific argumentation is as a result of validating and rejecting notions based on reasons reflecting the knowledge, procedures, and values. It also involves the construction and validation of explanations of scientific phenomena In other words, an argument proposed attempts to validate conclusions contradicting with the claim; it functioned as premises for the claim [9,10].

Many ways are conducted to scaffold students mastering argumentation skills. An inquiry instructional model implemented in the classroom can offer a place for scientific argumentation [11]. The different approach utilized to improve argumentation performance is the use of quality talk discussion or scientific argumentation skill can be taught directly through explicit argumentation instruction [12,13]. In other contexts, scientific argumentation skills can be taught through reading activities. For example, investigated science and non-science college students to read news reports in order to train argumentation skills. Findings show that science college students performed well in making scientific argumentation [14].

The Comprehensive Literacy Partnership Model (PCL) is a literacy model that allows teachers to enhance every literacy foundation which includes the interpretation, understanding, and organization of ideas. The objective of comprehensive literacy is for all students to optimally reveal their literacy potential [15]. Comprehensive literacy builds on learners' initial knowledge, instills a link between reading and writing, reflects that understanding is critical to critical thinking, provides real-world literacy opportunities, and provides distinct instruction. The Comprehensive Literacy Partnership Model focuses on three characteristics in its implementation, namely collaborative learning communities, coaching and mentoring, and intervention through guided reading [16,17].

2. Method
This present study uses mix method [6] in which it allowed us to assess scientific written arguments and investigate students’ perceptions dealing with the use of PCL. Participants were 40 college students consisting of 25 females and 15 males at the department of physics education taking a fundamental physics course. The average age of participants was 18.42 years old (SD=0.59). All participants were Indonesian native speakers.

The course runs 14 weeks in which each meeting takes 100 minutes for students to do the learning process. The material texts for reading activity encompass diverse concepts of physics from electrostatics to the source of the magnetic field (i.e. seven chapters). This activity was conducted within 14 meetings for 14 weeks. There were two instruments developed in this present study. The first instrument is five open-ended items for assessing scientific written arguments in content units: electric charge and electric field, electric currents, direct current (dc) circuits, and magnetism. Its validity was determined by content validation by three experts in physics. After several revised processes, the instruments were declared valid. This instrument is tested at the fifteenth meeting. The second instrument is six questions of the interview.

We analysed data on students’ written arguments and interviews using a different method. First, we focused on analysing written works made by students. To assess this, we developed a rubric framework to categorize or code the level of scientific written arguments. The structure of written arguments considered refers to the structure of scientific arguments proposed consisting of claim [7], reasoning, and evidence (CRE). This is chosen because of its simplicity in presenting written arguments. This encompasses three components. The structure of arguments in the rubric frameworks is divided into 5 levels, from level 1 to level 5.
3. Result and Discussion

The open-ended tests encompass two physics concepts, namely electricity, and magnetism. We make a title for each item test developed: the motion of change, type of wire, dimmer or brighter, bending of a flagpole, and the longest path. According to Table 1, the level of scientific written arguments is dominated by level 3, in which students propose a claim, construct evidence, and explain the connection between the evidence and claim using reasoning. The proportion of students attaining this level is more than three-fourth of total students for each open-ended test. Meanwhile, the proportion of students developing level 2 is between 7.5% and 25% of the whole. Students just propose a claim supported by a piece of evidence in this context. Interestingly, only one participant develops level 4 in the context of the dc circuit while no one presents level 1 and level 5. Like data in Table 1, level 3 dominates the level of non-scientific written argument and only two students develop level 2 in the context of non-scientific written argument.

| No | Title of item test | Level of Scientific written arguments |
|----|-------------------|-------------------------------------|
|    |                   | 1  | 2  | 3    | 4 | 5 |
| 1  | Motion of charge  | 0  | 5(12.5%) | 30(75%) | 0 | 0 |
| 2  | Type of wire      | 0  | 4(10%)   | 31(77.5%) | 0 | 0 |
| 3  | Dimmer or brighter| 0  | 4(10%)   | 29(72.5%) | 1(2.5%) | 0 |
| 4  | Bending of a flagpole | 0 | 3(7.5%) | 31(77.5%) | 0 | 0 |
| 5  | The longest path  | 0  | 5(12.5%) | 31(77.5%) | 0 | 0 |

Table 2. The proportion of non-scientific written arguments

| No | Code of item test | Level of non-scientific written arguments |
|----|-------------------|-------------------------------------|
|    |                   | 1  | 2  | 3    | 4 | 5 |
| 1  | Motion of charge  | 0  | 1(2.5%) | 4(10%) | 0 | 0 |
| 2  | Type of wire      | 0  | 0 | 5(12.5%) | 0 | 0 |
| 3  | Dimmer or brighter| 0  | 1(2.5%) | 5(12.5%) | 0 | 0 |
| 4  | Bending of a flagpole | 0 | 0 | 6(15%) | 0 | 0 |
| 5  | The longest path  | 0  | 0 | 4(10%) | 0 | 0 |

To conduct a microanalysis of structures of written argument, we present representative samples. The choice of samples was chosen to represent each level of scientific written arguments (see Table 3). Each sample is monological argumentation [18,19], because students propose unidirectional written arguments to respond to each problem. For instance, observe how participant-5 (P-5) proposes level 2. The claim is supported by evidence/data using the conjunction “because”. Moreover, participant-11 (P-11) presents a scientific principle as reasoning (R) [9,10] to explain the connection between claim and evidence. There is no conjunction used to link among claim, evidence, and reasoning in this context. Interestingly, participant-2 (P-2) proposes level 4 in which his argument is constructed by combining core and additional arguments. The first sentence functions as an additional argument to justify the second sentence as a core argument. Both first reasoning and second reasoning show two scientific principles; current in a circuit depends on resistance.
Table 3. The sample of scientific written arguments (e.g. subtitle: dimmer or brighter)

| Level | Example of arguments | Analyzed based on CRE | Representations of elements |
|-------|----------------------|-----------------------|-----------------------------|
| 2     | The light bulb A will light up dimmer in the circuit because of the loss of light bulb B from the circuit (P-5) | • Claim (C): The light bulb A will light up dimmer  
• Evidence (E): The loss of light bulb B from the circuit | ![Diagram](c-e) |
| 3     | The light bulb B loses from the circuit causing a decrease of the current through bulb A, light bulb A dims as its implication | • Claim (C): light bulb A dims as its implication  
• Evidence (E): The light bulb B loses from the circuit  
• Reasoning (R): a decrease of the current through bulb A | ![Diagram](c-r-e) |
| 4     | In a parallel circuit, the resistance increases, the increase of parallel resistance raises the total resistance in the circuit. The increase of the total resistance decreases the total current in the circuit, this current through light bulb A, so light bulb A is dimmer as a result of the loss of light bulb B (P-2) | Core argument:  
• Claim (C): light bulb A is dimmer  
• Evidence (E): a result of the loss of light bulb B.  
• Reasoning (R): the total current in the circuit decreases  
Additional Argument:  
• Reasoning (R): the total resistance in the circuit increases  
• Claim (C): In a parallel circuit, the resistance increases | ![Diagram](c-r-f) |

More importantly, some written arguments do not represent scientific concepts so we present a sample of representative arguments to be analysed microscopically (see Table 4). The analysis is carried out by considering two sides: the structure of the argument and the scientific concept. For instance, participant-27 (P-27) develops level 2 to present a claim supported by evidence. Based on the structure of argument perspectives, it is similar to scientific written arguments. Unfortunately, the claim proposed is not scientific so this argument is categorized as a non-scientific argument. The use of the conjunction “because” is used to connect between claim and evidence. Meanwhile, participant-32 (P-32) develops comprehensive arguments consisting of claims, reasoning, and evidence. Based on the lens of scientific arguments, the reasoning proposed is not appropriate to a scientific concept or scientific principle (i.e. an increase of current depends on the increase of resistance in the circuit). We, therefore, code this argument as a non-scientific written argument.
Table 4. The sample of non-scientific written arguments (e.g. subtitle: dimmer or brighter)

| Level | Example of arguments                                                                 | Analyzed based on CRE                                                                 | Representations of elements |
|-------|--------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------|-----------------------------|
| 2     | The light bulb A will be brighter because the number of light bulbs decreases in the circuit (P-27). | • Claim (C): The light bulb A will be brighter.  
• Evidence (E): the number of light bulbs decreases in the circuit | ![Image of representation] |
| 3     | Bulb A lights up brighter than before because the current passing through the lamp increases as a result of removing lamp B from the circuit | • Claim (C): Bulb A lights up brighter than before  
• Evidence (E): as a result of removing lamp B from the circuit  
• Reasoning (R): current passing through the lamp increases | ![Image of representation] |

The role of an PCL in developing a level of scientific arguments is influenced by the existence of its components. All components construct a specific goal and intention (i.e. reading belief) and critical texts (i.e. writing belief) when students have to read, find, and analyse evidence. Consequently, all activities in science reading facilitated through these components bring the skills required to develop written arguments. In fact, three fourth of students contributing to developing written arguments can propose claim-reasoning-evidence (CRE) scientifically. Based on these data, we can assert that students succeed to comprehend the structure of written arguments and physics concepts in the texts [11,12].

There is an interesting fact when we elaborate level 2 of written arguments based on micro-analysis perspectives. Both scientific and non-scientific arguments consist of claims and evidence. There are similarities of representation of arguments developed in which the use of conjunction frequently used to support a claim using evidence. Students tend to shift the fact that occurred in the problems to be evidence. This means when they propose a true claim, the arguments will be a scientific argument. In contrast, a false claim supported by the fact will be a non-scientific argument. This characteristic opens a comprehension that there is a possibility; in which students do not comprehend scientific concepts or principles when they propose level 2. If we connect this hypothesis to PCL, it is clear that students do not understand the statement of the content and find evidence in the texts. In other words, students do not interpret statements critically in the context of the related physics concepts [20]. This also shows that to develop or communicate written arguments, requires a conceptual understanding of content-specific.

How we can interpret a microanalysis of level 3 showing comprehensive arguments in presenting claim-reasoning-evidence (CRE). In considering the scientific written argument, students propose a true claim in relation to the problem provided; this claim is followed by reasoning depicting scientific concepts or principles to link between claim and evidence. At this stage, we comprehend that students proposing true claims have a conceptual understanding of physics concepts; maybe students just comprehend basic concepts such as ohm’s law (e.g. dimmer or brighter). In contrast, we have an interesting fact of non-scientific written arguments, in which students confidently propose false claims. This then is followed by an explanation of the false scientific principles. There are two possibilities in this context. First, students do not comprehend scientific concepts but they have the capability in developing the structure of written arguments. Second, students might experience a misconception because they confidently propose non-scientific principles. In fact, the role of an PCL in this reading activity significantly affects students to interpret critically and to reduce misconceptions as to its function.

Interestingly, the finding depicts that only one participant constructs level 4 presenting a complex written argument. Constructing complex written argument requires strong content knowledge in content-specific. The deep comprehension in content specific determines the better quality and
complexity of written arguments proposed [21,22]. Despite owning various comprehensions of scientific concepts, the skill to interpret and apply the scientific principles to other or different contexts is required to develop complex arguments. One of the functions of an PCL is to urge students can apply diverse scientific principles to new contexts [17,23]. The use of a PCL in this context has little contribution to support complex arguments, in which students have limited additional arguments to support core arguments proposed.

Last, we find that students voice positive tones toward the use of a PCL in science reading activity. A PCL provides new nuances to students to comprehend and interpret critically texts. There is a fact where students spend much time and are difficult to find evidence. Consequently, they feel an impressive experience and are motivated to implement the ways PCL focuses on key concepts in comprehending texts [24]. Finally, we consider three prominent points based on students’ perceptions in relation to the use of a PCL in science reading. It can urge the acquisition of content of knowledge, develop the structure of written arguments, and improve motivation and students’ self-confidence. Indirectly this shows that reading activity is required as an activity in the science classroom.

4. Conclusion
This research has provided a new understanding of how to use PCL as an epistemic activity in facilitating and mediating the development of students’ scientific arguments. It is clear that the importance of PCL in bridging the understanding of scientific concepts or principles in physics is needed to develop argumentation skills. In other words, PCL engages students to learn further because the PCL method involves students in reading critically, interpreting texts, and supporting and defending claims with evidence. This study has made a critical effort on how to use PCL in developing scientific argumentation skills. This study contributes to alternative methods for teachers and teacher educators in reading strategies to improve students' scientific argumentation skills in the classroom.

5. Acknowledgments
The author would like to thank the ministry of education for funding education, and also to the faculty staff who were involved in this research, so that this research can be carried out well.

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