# Claim and warrant: a contextual physics learning strategy to enhance studens' argumentation skills

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# Claim and warrant: a contextual physics learning strategy to enhance studens' argumentation skills

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**Abstract.** Students' argumentation skills both in the learning process and assessment to realize the transformation of the production of quality claim and warrant are very important to be implemented. This study is trying to analyze the process of students' argumentation skills transformation through a contextual physics learning strategy called "Claim and Warrant". This study used descriptive survey method with eleven grade student in Bandar Lampung as the population. Beside that, cluster random sampling technique was used to specify the sample. A complex problems as an exercise were given to thirty two senior high school students in order to produce alternative statements and the basis of theoretical-evidence relations. The data were obtained through reasoned multiple choice tests with feedback andanalyzed through a feedback-assessment process. The results showed the increasing of students' argumentation skills in form of production of alternative statements and counter.

## 1. Introduction

Practicing argumentation skills in learning physics becomes an alternative approach in improving student reasoning. Related to this, a set of learning and assessment tools are needed that can facilitate the training of students' argumentation skills. Some experts argue: (1) argumentation skills need to be encouraged in learning science [1]; (2) practicing argumentation skills encourages students to increase scientific reasoning [2]; (3) train students to think critically as an important component of science learning [3]; (4) argumentative skills as an alternative understanding of scientific theory [4]; (5) hypothetico-deductive argumentation skills are recognized as the essence of scientific reasoning [5]; and (6) alternative statements as a refinement of theory and data coordination [4].

Argumentation skills that are consistently trained in the learning and assessment processes enrich students' ability to distinguish theories from data. The consistency of understanding physics concepts can be done by practicing various physics concepts in the form of real problems [6]. Furthermore it can be said that the emphasis on practicing argumentation skills in the learning process guarantees the transformation of argumentation skills. One of the physics material that is able to train students to be skilled in producing quality arguments is fluid material. The learning achievement of fluid material is the disclosure of facts and phenomena that are around students. But in reality students have difficulty following the learning of fluid material physics caused by: (1) the weakness of students predicting, observing and explaining fluid phenomena [7]; (2) students have difficulty applying their understanding

to solve complex problems (combining concepts and calculations) [8]; (3) students having difficulty solving problems related to static fluid phenomena in daily life [9] (4) the concept of static fluid is a concept that is quite important in the curriculum but students have difficulty applying the concept of static fluid in various problems [10], (5) the quality of science learning is low [11] and (6) students have difficulty analyzing argumentation structure [12].

Ideally, the ability to reorganize knowledge of fluid concepts is based on the ability to comprehend concepts and scientific processes completely. In line with the opinion [7] that understanding of the concept is motivated by initial knowledge, ontological and epistemological beliefs and students' motivational factors. It is also necessary to accustom students to solve problems by connecting mathematical language with relevant theories [13]. The importance of training students' argumentation skills both in the learning process and assessment to realize the transformation of the production of quality claims and warrant needs to immediately find a clear solution to solve it. The alternative solutions can be done by facilitating students: (1) student-centered learning; (2) various alternative problems; (3) minds on activities; (4) the activity of physically interpreting a physics phenomenon; and (5) communicating scientific reasoning. These alternative solutions need to be integrated in a contextual problem to make it easier to realize the enrichment of the quality claim and warrant transformation process. Based on literature studies and analysis of problems in the field, researchers have conducted studies to identify the process of enriching the transformation of quality claim and warrant argumentation skills. The formulation of the problem in this research is how is the process of enriching the transformation of students' argumentation skills in fluid material through the production of quality claims and warrants?

## 2. Method

The process of enriching the transformation of argumentation skills (claim and warrant) is a further study of the structure of the argumentation skills developed. The broader goal of producing a pattern of processes enriching the transformation of argumentation skills (claim and warrant) in physics learning in terms of students' consistency in producing statements.

### *2.1. This study used descriptive survey method*

The process pattern enriches the transformation of argumentation skills using the key structure of the modified Toulmin argument scheme in the framework of analyzing: 1) integration of claims based on physics phenomena supported by data; and (2) warrant production as a manifestation of claims related to relevant theories. Data obtained from high school students in the Bandar Lampung City Region with the number of research samples is class XI 32 students. Data analysis using qualitative descriptive based on the pattern of the process of enriching the transformation of argumentation skills produced by students. The analysis refers to: 1) knowledge building statements; 2) the statement creates student learning; and 3) statements promoting students' ability to justify the relationship between data and claim [13].

## 3. Result and discussion

Students' skills in developing scientific statements based on the phenomena presented in the learning process can be practiced gradually using the structure of arguing skills. The argumentation skills structure is built through the development of statement models based on: alternative explanations, data based explanations and explanatory evaluation models based on relevant information and theories. Related to this, the argumentation skills structure contains an inseparable part of science learning [14]. An emphasis on the structure of arguing skills in the learning process guarantees the transformation of students' argumentation skills. In addition, argumentation skills become a means for students to understand content and processes in scientific learning.

The students’ argumentation skills presented in this paper are focused on how the process patterns enrich the claim and warrant transformation. It also includes a unique process of transformation of claims and warrant which shows the opportunity for students to participate in developing their thinking

skills. The use of an argumentation assessment instrument facilitates the development of the production of student argumentation supported by the statement that the disclosure of facts implicit in the problem as the foundation of building science, as a rational activity produces arguments to support knowledge.

Following are the results of the analysis related to the transformation of claim and warrant. Integrating the argumentation skills structure with the assessment process prioritizes the core activities of the practice of science into the needs of students to express knowledge other than content.

*3.1 Claim transformation is reviewed on the accuracy of data / evidence adequacy*

Transforming claims in terms of the accuracy of the adequacy of the evidence intended to improve the production of student argumentation as one of the objectives of practicing argumentation skills in learning. The learning process that leads to transformation stabilizes the understanding of the content of floating material and sinks through various changes in the phenomena presented in the problem, the development of the argumentation skill structure that is expected to emerge from students' thoughts stemming from future physics learning. Transformation has a basic meaning as a continuous slow change so that students' higher-order thinking skills in the future will be better than in the present. So, the that the argumentation skills are a concern to learn [15].

The positive processes that reinforce each other and sharpen the meaning of the process of enriching the transformation of argumentation skills achieved by students are presented in Figures 1 and 2. Based on the pictures can be represented by the accuracy of student statements that focus on the ability to produce the structure of statements given with the problems presented "for example: Figure 1: Students are able to write down the requirements of floating objects, sinking and floating by only presented pictures of the phenomena of floating and sinking objects. Students in Figure 1 are given the opportunity to produce statements based on the pictures given by the teacher (facilitating students: performing activities to interpret a physical phenomenon), the teacher repeatedly reminded students to reveal the physical meaning of the images presented are not only limited to mathematical equations (representation of activities minds on) but in reality students are only able to write mathematical equations. The tendency of students to move and do what is in their mind's memory that learning physics cannot be separated from the mathematical equations presented in Figure 1.

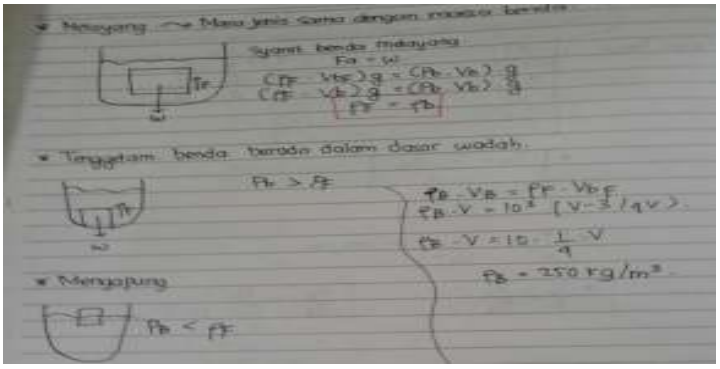


**Figure 1.** The examples of student's claim accuracy.

Figure 1 gives the fact that students respond more quickly to the stimulus displayed by the teacher in the form of mathematical language. This stimulus development phase illustrates student cognition still in the sense of perception not yet leading to language processing abilities associated with complex cognitive functions (a representation of the activity of communicating scientific reasoning). The effect of the stimulus given to the problem of Figure 1 should be given a response not only to the mathematical solution but also includes functional validation. Functional validation is used to express the idea that stimulus is needed to ensure the cognitive function of students functioning optimally. The complex statements that students should produce so that functional validation is illustrated is: "(1) a floating object has a buoyant force acting at this fluid volume the same as a buoyant force acting on an object

because the fluid surrounding the area is the same. Because the volume of fluid is in equilibrium, the amount of force acting must be zero. So that the buoyancy force is equal to the weight of the fluid volume down. Complex statements that should be produced encourage students to form the concept of "floating objects". Recognition of the stimulus presented shows that student memory is only limited to introspective reports. Based on this the teacher needs to increase the production of argumentative quality skills by providing feedback on the statements produced in Figure 1 and repeated exercises (Figure 2). The development of the repetition strategy influences the growth of students' memory capacity for contextual events.

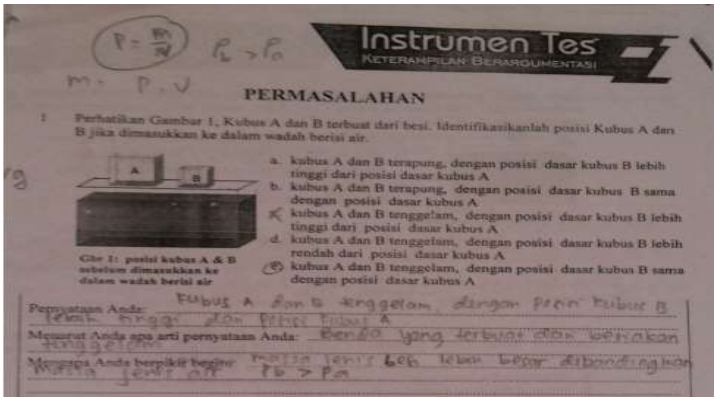


**Figure 2.** The example of transformation of the student's claim accuracy.

The transformation claim (Figure 1 to Figure 2) emphasizes the production of the statement on how "information is represented", where students have been able to verify the statement "position of objects A and B made of iron if placed in a container filled with water". In a condition students are asked to state the position of the two objects in a container filled with water on the other hand students are forced to describe mathematically and to make sense of it physically from mathematical equations that appear based on pictures. Related to this the students have been able to use proportionally structured propositions. Students' ability to access information more efficiently by utilizing existing information to be stored and retrieved when needed. In this case the abstract representations students have help students arrange conceptual categories of "sinking objects". In addition, the process of abstraction of verbal and visual information is an important attribute in the processing of students' transformation claims

The success of the claim transformation (Figure 2) represents all the results of the thoughts produced by students, it can be seen that students' cognition grows perfectly (claim transformation has occurred). That is, students already have better abilities in organizing things that students must remember / produce. In addition, these results illustrate that the teacher has paid special attention to basic cognitive abilities (Figure 1) which involve the acquisition of information from the environment and student experience and try to help students manipulate information in student memory. The teacher's success in analyzing aspects that have not been met in producing claims creates a learning process that involves the activeness of high-level thinking of students.

### *3.2. Warrant transformation is reviewed in terms of the accuracy of the data/evidence relationship and the claim*

Warrant transformation is based on the accuracy of the production of statements produced by students not in terms of how hard mathematical activity works but rather how efficiently statements are produced. Efficient statement in question illustrates the existence of general factors that contribute (a combination of mathematical ability, verbal and spatial). The efficiency statement processes that enrich and sharpen the meaning of warrant transformation achieved by students are presented in Figures 3 and 4.

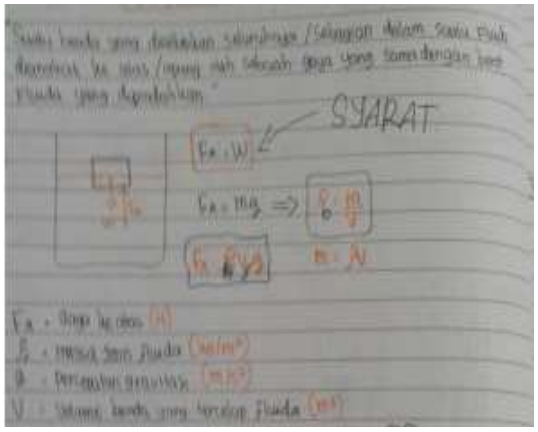


**Figure 3.** Example of practicing student warrant.

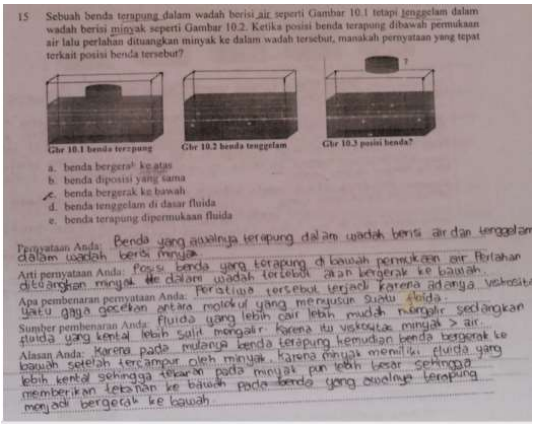


**Figure 4.** Example of transforming student warrant.

Figure 3 represents how students are able to transform for warrant indicators. Basically, the main requirement for warrant transformation is if the quality of the statement focuses on the adequacy of the statement supported by data and evidence to support the statement, and discusses it into a new statement. New statements produced are more organized and structured due to the development of organized reasoning.

The concept of floating objects in Figure 3 is a concept that is well known to most students. Student success (Figure 3) producing warrant statements that differ from other students leads to completion using specific cognitive traits, including "(1) mathematical ability (data disclosure); (2) spatial ability (ability to recognize various relationships in the form of images) -representation of the merging of mathematical abilities in the form of images; students are able to express verbal language into an illustrated image and predict the position of the direction of the force acting on the floating object accurately. (3) verbal ability (production of alternative statements (relationship of data and claim): an object which is immersed entirely in a fluid is raised by a force equal to the weight of the displaced fluid.

Student's thinking activity (Figure 3) include basic understanding of floating concepts.This process looks simple and may not have been thought of by students beforehand. However, learning experiences that involve a basic understanding of floating concepts make students understand the lesson at the time but have also provided empirical experiences. When students are confronted with various conflicts forcing students to develop their argumentative skills [16]. The ability to evaluate, decide, and combine claims and counter-claimsproduce an effective alternative claims [17]. That is, all learning phenomena presented with different dimensions and events transform statements to build students' thinking abilities. In addition, Figure 3 illustrates the adequacy of statements that have integrated mathematical, verbal and spatial abilities as a condition for warrant transformation. Students are forced to produce statements related to phenomena [18]. Student success combines these abilities as a manifestation of a number of separate but interconnected (data-claim) abilities as a positive effect of practicing argumentative skills in learning. Practice arguing skills in learning facilitating the integration of students' alternative claims and contra claims [18].

The adequacy of alternative statements produced by students is also illustrated from the production of the statements in Figure 4. Figure 4 is a statement of accuracy focusing on a deep understanding of the concepts presented (for example: objects that initially float in a container filled with water and sink in a container filled with oil). The statement in Figure 4 is able to be tested why the statement is so important and how students design the statement (for example: the position of an object floating under the surface of the water slowly settles oil in the container will move downward. This event occurs because of the viscosity which is the frictional force between molecules composing fluid). This forces students to collect data from which statements are generated (for example: liquids which are more liquid are easier to flow while viscous fluids are more difficult to flow because of the viscosity of oil is bigger

than water). Student statements (Figure 4) based on authoritative facts, Students have the ability to distinguish data and to draw evidence in order to compile statements [19]. Statements made by students must be able to expose the rationality of science [20]. In line with this conceptualization, Figure 4 has illustrated the quality statement as a process of negotiating the concept (for example: because at first the floating object then the object moves down after being mixed with oil, because oil has a thicker fluid so the pressure on the oil is greater so that it puts pressure downward on an object that initially floats to move down). Disclosure of quality statements as part of the logical thinking process.

The parts of argumentation production (Figures 3 and 4) have been based on an integrated domain evaluating arguments in the context of learning: conceptual structures and cognitive processes using scientific reasoning. Further it can be said that the production of statements has directed students' conceptions of what is meant by the relationship between claim-data. Statements describing the structure of claim-data relationships were able to build knowledge. Therefore the depth of content knowledge (Figures 3 and 4) revealing the relationship (claim-data) has referred to the relevance, specifications and validity of scientific knowledge [21]. Students have understood the phenomena presented until analyzing the root of the problem illustrates that gradually the quality of students' argumentation has developed [22].

## 4. Conclusion

The quality of the production of arguing skills in this study focused on analyzing the process of enriching claim-warrant transformation. The teacher's success in analyzing aspects that have not been met (the feedback process) in producing claims creates a learning process that involves the activeness of student's higher order thinking. In the end students are able to enrich the transformation by focusing on statements resulting from problem solving procedures leading to the accuracy of statements on the quality of evidence and relationships between questions, claims and evidence. But on the other hand, the process of enriching the meaning of transformation as a product of thought requires students' repeated and varied knowledge and experience (referring to the relevance, specifications and validity of scientific knowledge).

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