Overcoming Senior High School Students’ Misconceptions on Newton’s Laws: A DSLM with Inquiry Learning based Computer Simulations

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Abstract. Now a day, several problems regarding the misconceptions still occurred in the physics learning, especially in mechanical concept, such as Newton’s Laws. The aim of this research is to overcome students’ misconceptions on Newton’s Laws through combining Dual-Situated Learning Model (DSLM) and inquiry learning based computer simulations. The research has been utilized the ADDIE model, stands for Analyzing, Designing, Developing, Implementing and Evaluating. The subjects who involved in the research are 20 senior high school students (10 boys and 10 girls, their ages were an average of 16 years-old). The instrument used in this research is eight question of Four-Tier Newtonian Test (FTNT). At the developing phase, we have been developing the Dual-Situated Learning Model (DSLM) which is combined with inquiry learning based computer simulations. At the evaluating phase, we obtained the data about students’ misconceptions of forces concepts are decreased sharply. To sum up, the combining DSLM and inquiry learning based computer simulations are effective to overcome the misconceptions of senior high school students on Newton’s Laws.

1. Introduction
In attendance is a prevalent arrangement that science knowledge continuously constructs upon students’ prevailing concepts [1, 2]. Students repeatedly incline to procedure their particular concepts for the reason that they absorb nearly the world about them concluded school instruction or their routine familiarities [3, 4]. But occasionally the concepts that students absorb are dissimilar as of scientific concepts, which have been known as misconceptions. Study additional confirmations that students’ misconceptions can be tough and demanding to truthful [5, 6, 7]. At the present time misconceptions have been any of substantial province investigation in physics education [8, 9], supplementary detailed at Newton’s Laws. Students’ misconceptions on Newton’s Laws concepts are befalling since they actually do not comprehend roughly the interpretations the third of Newton’s Laws [10], they are:

Newton’s First Law: \( \sum \vec{F} = 0 \) (1)

Newton’s Second Law: \( \sum \vec{F} = m\vec{a} \) (2)

Newton’s Third Law: \( \vec{F}_{\text{action}} = -\vec{F}_{\text{reaction}} \) (3)
Students’ misconceptions on Newton’s Laws can be changing through conceptual change learning model. Conceptual change model offered through Posner et al [11] and there are four situations that essential to be encountered formerly conceptual change expected ensues: (1) students need converted disgruntled by their prevailing concept(s), (2) the fresh conception(s) must be comprehensible, (3) the fresh conception(s) must be believable, and (4) the fresh conception(s) must be abundant. One of the conceptual change models was proposed by She [12, 13] that is Dual-Situated Learning Model (DSLM). She & Liao [14] further research shows that DSLM was effectively aimed at enabling students’ conceptual changes. The DSLM can be approved through rough flair of tutoring exploit, for example analogy, demonstrating and inquiry events [14]. At the practice in this research, we used the DSLM combining through inquiry learning to optimize the use of the conceptual change model. The DSLM with inquiry has to impend on the improvement of students’ conception of science learning [15]. Moreover, the physics’ phenomena can be illustrated by computer simulations. Computer simulated imaginings are talented to sanction students to observe and comprehend abstract concepts, which is improved the student achievement evocatively [16, 17, 18]. Therefore, DSLM with inquiry learning based computer simulations expected to overcome students’ misconceptions and change it to scientific concepts.

2. Methods
The ADDIE model (Analyzing, Designing, Developing, Implementing and Evaluating) are used as research methods [16]. The ADDIE model has been employed to develop a DSLM with inquiry learning and practice to the 20 senior high school students (10 boys and 10 girls, their ages were an average of 16 years-old). The Four-Tier Newtonian Test (FTNT) was used to identification of students’ misconceptions on pre-test and post-test. The FTNT was developed as of previous research on Fratiwi [10].

3. Result and Discussions
The improvement of DSLM with inquiry learning based computer simulations on Newton’s Laws concepts was more importance on the conceptual line of attack to overcoming senior high school students’ misconceptions. The ADDIE models have been comprised advance phases: Analyzing, Designing, Developing, Implementing and Evaluating as deliberated as follows.

3.1. Analyzing
On the analyzing phase, we classify the complications of the research and to accomplish assignments’ analyze. The productivity of analyzed route was used Dual-Situated Learning Model (DSLM) with inquiry learning based computer simulations. Based on previous analysis, DSLM has six stages in the learning process and not practice to use in the classroom. Therefore, we used inquiry learning to optimize the use of DSLM. Before the learning process with an inquiry, the four stages of DSLM was used to analyzing and grouping the students’ conceptions based on Four-Tier Newtonian Test (FTNT). Analyses were beside accompanied on “RPP” or learning design. The “RPP” have been established grounded on a conceptual method through a DSLM with inquiry learning based computer simulations. The analyzing of DSLM with inquiry learning based computer simulations shows in Table 1.

| Stage 1: Investigative attributes of the science concept | Inquiry Learning | Computer Simulations |
|---------------------------------------------------------|-----------------|---------------------|
| Stage 2: Analytical students’ misconceptions             |                 | This stages are doing out of the classroom |
| Stage 3: Defining which mental sets students              |                 |                     |
| Stage 4: Planning dual situated learning events          |                 |                     |

Table 1. The analyzing of DSLM with inquiry learning based computer simulations
### Stage 1: Orientation
Students and teacher use computer simulations for demonstration or doing experiment for construct students’ conceptions.

### Stage 2: Exploration
Students and teacher use computer simulations for demonstration or doing experiment for construct students’ conceptions.

### Stage 3: Conceptual formation
Students and teacher use computer simulations for demonstration or doing experiment for construct students’ conceptions.

### Stage 4: Application
Students and teacher use computer simulations for application of the concepts in real phenomena.

### Stage 5: Teaching through dual situated learning events

### Stage 6: Teaching by means of a challenging dual situated learning event

### Stage 5: Closure

### 3.2. Designing
This phase was recognized as construction previously it is constructed there should be a plan on the paper primary. In this phase, we designing the computer simulations that focused on Newton’s Laws. This computer simulations design includes physics concepts such as forces, Newton’s First Law, Newton’s Second Law, and Newton’s Third Law. The design example computer simulations design in the form of storyboards shown in Figure 1.

**STORYBOARD**

**NEWTON’S FIRST LAW**

![Figure 1](image-url)

**Figure 1.** The design or storyboard of computer simulation

Figure 1 shows the storyboard of computer simulation. The storyboard was designed by researchers based on student’s misconceptions on Newton’s Laws concepts. At Figure 1, we design the computer simulations for inertia concepts.
3.3. Developing
The developing phase is the procedure of comprehending the design had converted an actuality. These incomes that at this phase all the support of learning procedure should have been thriving equipped. The example of developing the computer simulation shows in Figure 2.

![Figure 2. The example of computer simulation on inertia concept](image)

3.4. Implementing
Implementing is the actual phase to appliance a learning arrangement that is being formed. In this research, the implementing was used for senior high school students on the second semester at X grade. Students used PDEODE*E task to guide demonstrate or experiment process and produce the complete conclusion. This is expected to overcoming students’ misconceptions.

3.5. Evaluating
The evaluating phase is the procedure of learning to comprehension whether the arrangement is being constructed effectively. The effectiveness of learning expending DSLM with inquiry learning based computer simulations was able to be assessed via Four-Tier Newtonian Test (FTNT) as Misconception (MC), Sound Understanding (SU), Partial Understanding (PU), No Understanding (NU) and No Coding (NC) the Newton’s Laws concepts for change the concepts to be further scientific conceptions. The process of conceptual change has shown as Table 2.

**Table 2. Percentage of pre-test and post-test for students’ conceptions**

| No. | MC (%) | SU (%) | PU (%) | NU (%) | NC (%) | MC (%) | SU (%) | PU (%) | NU (%) | NC (%) |
|-----|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|
| 1.  | 22 (66.7) | 3 (9.0) | 3 (9.0) | 1 (3.1) | 0 (0) | 17 (51.5) | 3 (9.0) | 3 (9.0) | 18 (54.7) | 3 (9.0) |
| 2.  | 17 (51.5) | 0 (0) | 3 (9.0) | 3 (9.0) | 18 (54.7) | 3 (9.0) | 3 (9.0) | 18 (54.7) | 3 (9.0) | 1 (3.1) |
| 3.  | 8 (24.2) | 4 (12.0) | 15 (45.5) | 5 (15.2) | 1 (3.1) | 12 (36.4) | 10 (30.3) | 4 (12.0) | 2 (6.1) | 1 (3.1) |
| 4.  | 27 (81.6) | 1 (3.1) | 1 (3.1) | 2 (6.1) | 2 (6.1) | 8 (24.2) | 19 (57.5) | 6 (18.3) | 0 (0) | 0 (0) |
| 5.  | 28 (84.9) | 0 (0) | 3 (9.0) | 12 (36.4) | 0 (0) | 25 (75.9) | 3 (9.0) | 3 (9.0) | 1 (3.1) | 0 (0) |
| 6.  | 6 (18.2) | 19 (57.4) | 5 (15.2) | 2 (6.1) | 1 (3.1) | 22 (66.6) | 6 (18.2) | 15 (45.5) | 0 (0) | 0 (0) |
| 7.  | 10 (28.6) | 8 (20.0) | 13 (39.3) | 2 (6.1) | 1 (3.1) | 16 (48.4) | 16 (48.4) | 15 (45.5) | 0 (0) | 0 (0) |
| 8.  | 25 (70.8) | 0 (0) | 3 (9.0) | 12 (36.4) | 3 (9.0) | 9 (26.5) | 13 (39.4) | 8 (24.2) | 2 (6.1) | 1 (3.1) |

Table 2 shows the percentage of students’ conceptions. For more detail, the change of students’ misconceptions shows in Table 3.
Table 3. Percentage of students’ misconceptions changing

| No. | Pre-test f (%) | Post-test f (%) | Conceptual change (%) | Type of conceptual change |
|-----|----------------|-----------------|-----------------------|--------------------------|
| 1.  | 66.7           | 51.5            | 15.2                  | +                        |
| 2.  | 51.5           | 24.2            | 27.3                  | +                        |
| 3.  | 24.2           | 15.2            | 9.0                   | +                        |
| 4.  | 81.6           | 24.2            | 57.4                  | +                        |
| 5.  | 84.9           | 75.9            | 9.0                   | +                        |
| 6.  | 18.2           | 18.2            | 0                     | 0                        |
| 7.  | 30.4           | 6.1             | 24.3                  | +                        |
| 8.  | 75.9           | 27.2            | 48.7                  | +                        |

Table 3 shows the conceptual change and type of conceptual change for students’ misconceptions on Newton’s Laws. The conceptual change’s type of number 1, 2, 3, 4, 5, 7 and 8 are positive. This is the reserve that students restructured their misconceptions as to scientific concept. At number 6, there are no changes or students still had misconceptions. Many researchers state that conceptual change is time-consuming and problematic to truthful [5, 19, 20, 21, 22, 23].

4. Conclusion
Based on the data analysis, it can be determined that the combining Dual-Situated Learning Model (DSLM) with inquiry learning based computer simulations through ADDIE model (Analyzing, Designing, Developing, Implementing and Evaluating) was talented to efficiently overcoming senior high school students’ misconceptions on Newton’s Laws.

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