Assessing two-dimensional collisions second-years students using PhET simulations on momentum and impulse concept

R Adimayuda¹,², L Sari¹, A Ismail¹, I F Amalia¹, S Gumilar¹ and A Samsudin²

¹Departemen Pendidikan Fisika, Institut Pendidikan Indonesia, Jl. Terusan Pahlawan No.83, Sukagalih, Kec. Tarogong Kidul, Kabupaten Garut, Jawa Barat 44151, Indonesia
²Departemen Pendidikan Fisika, Universitas Pendidikan Indonesia, Jl. Dr. Setiabudi No. 229, Bandung 40154, Indonesia

*rizal.adimayuda@gmail.com

Abstract. Assessment is an important component in education that always needed. To improve the quality of education can be done by improving assessment learning quality and system. This study aims to determine the performance of students of grade X SMA N in Bandung West Java Indonesia school with 34 participants on a two-dimensional collision concept. This research is descriptive research which is conducted to examine the condition and situation that is happening, so that gives a fact-based description found in the school in other to find information factually. Problem studies that analyzed are the student's performance after using PhET simulations on two-dimensional collision concept. The instrument utilized in this study is a written test in the form of students’ worksheets of momentum and impulse. Student worksheets test shows the average percentage on student performance in understandings concept of two-dimensional collision concept is 67.14%. These data indicated that student learning performance in good category. Learning by using virtual laboratory can provide more meaningful learning especially in physics concept that cannot be presented and observed directly in daily life.

1. Introduction

Assessment is one of an instrument in learning. A good learning system will produce good quality learning. This quality of learning can be seen by the assessment result of student performance. The important role of assessment is to determine students learning outcomes. Aiming for that reason, Wiggins revealed that assessment should consider by teachers as they design and what they need [1]. Students not only able to understand the concept in learning but also students must be able to understand, analyze and creative. According to these reasons, the teacher's assessment must include the three aspect domains (cognitive, affective and psychomotor) that have to be applied maximally. Basically, a general assessment conducted by the teacher is more focused on the affective aspects and cognitive students using the lecture method.

Using lecture methods (teaching-centered learning) will tend to limit the development of student activities in exploring their knowledge. As a result of this, students become less motivated in participating in learning, as well as the ability to understand students in momentum and impulse concept has not got to expected results. An effective learning innovation is needed to anticipated this situation. Learning with virtual experimental methods is a method that can increase the motivation and activity of
students in learning. Moreover, many researchers concluded that computer simulation is one of good alternative learning for an abstract concept, which heightened student understanding [2-5]. With using Physics Education Technology (PhET) simulations, students can directly interact (virtually) with the concepts they learn.

The virtual laboratory for two-dimensional momentum and impulse concept in Physics Education Technology (PhET) simulation which utilized is to clearly explain information and conditions before and after collision happen. Prihatiningsih et al. [6] concluded that learning by using PhET and KIT simulations can improve student motivation and activity. This is correlated to Siahaan et al. [7], Gunawan et al. [8], and Samsudin et al. [9]. The ultimate aims of this research were to find out how the profile of student performance in two-dimensional collision material with the use of PhET Simulation.

2. Methods

The research method used in this research was an embedded case study with a single-case design. Similar to a case study, case studies require the integration of data and knowledge from various sources to improve action and make better decisions [10]. The population in this study were students of class XI Science SMA N in one of school at Bandung, West Java. Determination of the sample in this study using a purposive sampling technique. The sample was chosen deliberately with a specific purpose. The subject in this study was class XI IPA 3, which amounted to 34 students (18 male students and 16 female students).

PhET simulations are utilized to visualize concepts that are hard to imagine such as momentum and impulses. The use of PhET simulation is only supporting the student to perform better. Data assembly techniques used in this study were instruments in the form of LKS (student worksheets). Furthermore, the collected data will be processed with a percentage of interpretation of data techniques. The score obtained is calculated using a formula and converted on a percentage scale (0% -100%). The formula is as follows:

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Percentage = \frac{\sum \text{Score Obtained}}{\sum \text{Maximum Score}} \times 100\
\]

These percentage value that obtained will be adjusted to the following table:

| Percentage (%) | Explanation |
|----------------|-------------|
| 75 ≤ S < 100   | Very good   |
| 50 ≤ S < 75    | Good        |
| 25 ≤ S < 50    | Enough      |
| 0 ≤ S < 25     | Less        |

3. Results and discussion

Learning designed in this study utilizes a scientific approach learning with media used, namely PhET simulation and powerpoint. Clark [11] showed that some elements of media such as animated motion or animated zoom could serve as good enough conditions to facilitate the learning of students who insufficiency the skilled. The implementation of learning with the use of PhET simulation is intended so that students can clearly observe the picture of the elements before and after the collision, as well as the components that work on two-dimensional collisions. Student performance is measured through nine items on student worksheets. The researcher focused on the assessment of two items that were considered to be aspects that could be represented core on learning in a two-dimensional collision concept. From the results of processing 34 student worksheets, the following data are obtained:
Table 2. Average score of students’ conceptual understanding.

| Groups   | Score 1st question | Score 2nd question | Averages |
|----------|--------------------|--------------------|----------|
| Groups 1 | 100                | 90                 | 95       |
| Groups 2 | 60                 | 40                 | 50       |
| Groups 3 | 30                 | 80                 | 55       |
| Groups 4 | 30                 | 10                 | 20       |
| Groups 5 | 100                | 100                | 100      |
| Groups 6 | 10                 | 95                 | 52.5     |
| Groups 7 | 100                | 95                 | 97.5     |
| Total    | 430                | 510                | 470      |

\[
\frac{430}{7} = 61.43 \quad \frac{510}{7} = 72.86 \quad \frac{470}{7} = 67.14
\]

From data on Table 2 above shows the average score obtained by all groups, which is 470 for first and second questions, then this result is divided by the number of groups afterward presented. Based on the results of research, processing, and data analysis that has been done shows the performance achievement of 34 students in the two-dimensional collision concept through the use of PhET simulations in a good category with a percentage of 67.14%. This percentage was obtained from the average student understanding in explaining the momentum vector component in the cartesian coordinates of 61.43% and student understanding in explaining the momentum conservation law and energy conservation that apply to the two-dimensional collision case with an average of 72.86%. This achievement is judged to be influenced by the performance of students who have been taught by the scientific approach that follows steps in the scientific method to understand two-dimensional collisions concepts.

For more detail about students’ conceptual understanding, it can be obtained from average students’ performance in each group. The comparison of this score can be shown in Figure 1 as follows:

![Average score each Group](image)

Figure 1 shows the percentage of students’ performance from highest to lowest. Group 5 has the highest percentage while group 4 has the lowest percentage. This means that group 4 has a better ability to learning conceptual understanding than other groups. Their performance shows the quality of learning they experienced and the ability to understand the concepts that have been taught. The use of PhET simulations can assist students to analyze a case that is difficult to present directly in learning, as does a two-dimensional collision case. With the use of this PhET simulation, students can clearly see the
information and description in a case before and after the collision on the momentum concept. In addition, students can also vary the components that work on two-dimensional collisions, so they can know the outcome of conditions before and after the collision. In line with this, Fithriani et al. [12] said that learning by using PhET simulations can motivate students to understand physics concepts and can create an interesting learning atmosphere, in other to help improve students’ critical thinking skills.

4. Conclusion

Based on the results of the research obtained it can be concluded that the use of PhET simulation with a scientific approach can foster student performance in analyzing two-dimensional collisions on momentum and impulse concept. Student performance in describing the momentum vector component in the cartesian coordinates and student understanding in explaining the momentum conservation law and energy conservation that apply to the two-dimensional collision case is in a good category with a percentage of 67.14%. Suggestions that can be given by the researcher are the instructors should be able to carry out the assessment of student learning achievement in the cognitive, affective and psychomotor domains proportionally. So that efforts to improve the quality of education can provide results as expected.

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References

[1] Wiggins G 1998 Educative Assessment. Designing Assessments To Inform and Improve Student Performance (San Francisco: Jossey-Bass Publishers, 350 Sansome Street, CA 94104)

[2] Kaniawati I, Samsudin A, Hasopa Y, Sutrisno A D and Suhendi E 2016 The Influence of Using Momentum and Impulse Computer Simulation to Senior High School Students’ Concept Mastery In Journal of Physics: Conference Series 739 012060

[3] Gunawan G, Harjono A, Sahidu H and Herayanti L 2017 Virtual laboratory to improve students’ problem-solving skills on electricity concept Jurnal Pendidikan IPA Indonesia 6 257-264

[4] Chen Y L, Pan P R, Sung Y T and Chang K E 2013 Correcting misconceptions on electronics: Effects of a simulation-based learning environment backed by a conceptual change model Journal of Educational Technology & Society 16 212-227

[5] Bayrak C 2008 Effects of Computer Simulations Programs on University Students’ Achievements in Physics Turkish online journal of distance education 9 53-62

[6] Prihatiningtyas S, Prastowo T and Jamtiko B 2013 Imlementasi Simulasi PhET dan Kit Sederhana untuk Mengajarkan Keterampilan Psikomotor Siswa pada Pokok Bahasan Alat Optik Jurnal Pendidikan IPA Indonesia 2

[7] Siahaan P, Suryani A, Kaniawati I, Suhendi E and Samsudin A 2017 Improving students’ science process skills through simple computer simulations on linear motion conceptions In Journal of Physics: Conference Series 812 012017

[8] Gunawan G, Harjono A, Sahidu H and Herayanti L 2017 Virtual laboratory to improve students’ problem-solving skills on electricity concept Jurnal Pendidikan IPA Indonesia 6 257-264

[9] Samsudin A, Suhandi A, Rusdiana D and Kaniawati I 2016 Preliminary Design of ICI-based Multimedia for Reconceptualizing Electric Conceptions at Universitas Pendidikan Indonesia. In Journal of Physics: Conference Series 739 012006

[10] Scholz R W and Tietje O 2002 Embedded case study methods: Integrating quantitative and qualitative knowledge (Sage)

[11] Clark R E 1983 Reconsidering research on learning from media Review of educational research
[12] Fithriani S L, Halim A and Khaldun I 2016 Penggunaan Media Simulasi Phet Dengan Pendekatan Inkuiri Terbimbing Untuk Meningkatkan Keterampilan Berpikir Kritis Siswa Pada Pokok Bahasan Kalor Di Sma Negeri 12 Banda Aceh Jurnal Pendidikan Sains Indonesia 4 45-52