The development of Newton’s law encyclopedia based on advance organizer

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Abstract. This research aims to develop Newton’s Law encyclopedias based on Advance Organizer, that is suitable for use as a source of learning. The method used in this research is Research and Development (R&D) using ADDIE model. The steps of ADDIE model are analyze, develop, implement, and evaluate. The research instrument was obtained from interviews, observation, and questionnaires. The encyclopedia cover is designed to illustrate the content of the material on this product. The title of each content is arranged alphabetically in Bahasa. The content of the encyclopedia consists of (1) dinamometer, (2) force, (3) weight, (4) frictional force, (5) normal force, (6) centripetal force, (7) tension force, (8) Newton’s First Law, (9) Newton’s Second Law, (10) Newton’s Third Law, (11) gravitational force, (12) Kepler’s Law, (13) gravity acceleration. Finally, the structure of this encyclopedia is structured based on steps in Advance Organizer model, there are presentation of Advance Organizer, presentation of learning task, and strengthening cognitive organization. This encyclopedia expected to be feasible of use as a learning resource for textbook companion in senior high school based on validated by experts.

1. Introduction

Learning resources have roles in an effective and efficient instruction and learning process. This was confirmed by Department of National Education (2008) that defined learning resources as all things or potency that could be utilized by teachers, either separately or in a combined form, in a teaching-learning process with the purpose of improving effectiveness and efficiency of instructional goals.

Preliminary studies using questionnaire conducted in four schools, i.e. SMA Labschool Jakarta, SMAN 21 Jakarta, SMAN 50 Jakarta, and SMA Islam PB Soedirman Jakarta, showed that 51% students used textbooks, 28% students used printed modules, and 11% students used student worksheets. 66.4% of students who used textbooks claimed that textbooks were less helpful in understanding material of physics. This was due to incomplete material, ineffective language, less connection presented between two subjects, etc.

One of learning resources is in the form of printed instructional media [1] The encyclopedia is the quintessential reference tool, a source that seems to cover any topic imaginable and the one many people remember learning to use at an early age [2]. An encyclopedia is a systematic summary of all significant knowledge or a summary of the knowledge on one subject. Encyclopedias are the most
frequently consulted reference tools. The primary use is to search for specific facts; i.e., to answer who, what, where, when and how. They are often the first step toward a more extended search [3].

Studies conducted by Nurhatmi, Rusdi, and Kamid (2015) [4], Nurafifah, Budi, & Siahaan (2017) [5], and Ari Prasetya Widiana and Daimul Hasanah [6] stated that encyclopedia could be used as a supporting learning resource to complete information about physics. However, utilization of encyclopedia as a learning resource was still very limited, i.e. 6% of 110 students used encyclopedia to support physics learning. Whereas encyclopedia can be used as a reference that provides complete fundamental information about various subjects in any field or branch of science. Besides, there are encyclopedias that includes only one branch of science [7].

A study conducted by Saepuzman, Samsudin, Sutrisno, Kaniawati, and Yusnim (2015) showed that 50% of 38 students had difficulty to draw diagram of forces acting upon an object [8]. Alias and Ibrahim (2016) also confirmed that students had difficulty to draw diagram of forces acting upon an object and some students did not know how to solve component x and component y [9]. An encyclopedia has detailed description about forces acting upon an object that can help to solve the problem.

Learning model used in a learning process affects student concept mastery. Advance Organizer has been considered to has an ability to improve student comprehension skill. This was confirmed by a study conducted by Amelia, Mansyur, dan Kade (2016) that claimed that Advance Organizer model could improve student concept comprehension skill [10]. Advance Organizer provides a framework to enable students to learn new ideas or information by meaningfully linking these ideas to the existing knowledge [11].

The encyclopedia that has been developed by Ari Prasetya Widiana and Daimul Hasanah has not been based on learning models. The encyclopedia that has been developed by Nurhatmi, Rusdi, and Kamid (2015), Nurafifah, Budi, & Siahaan (2017) has not been based on Advance Organizer. The researcher has considered in developing a reference book in the form of advance organizer-based Newton’s Laws encyclopedia that is acceptable as a physics learning resource.

2. Research Methods
This research was included in Research and Development that was designed to develop a product of encyclopedia by means of certain procedure or steps. The research used ADDIE model as a research and development model, that consisted of five steps, i.e. Analysis, Design, Development, Implementation, and Evaluation. Analysis step was done by collecting preliminary information to find out gap between reality and expectation. In the step of design, the researcher made encyclopedia design by collecting things needed. In the step of development, the researcher developed the encyclopedia with the guidance of product design. In the step of implementation, the researcher conducted validation process to media, content, and instructional experts. In the step of evaluation, the researcher conducted improvement on the encyclopedia based on validator’s suggestion. Instruments used in this research are need analysis and questionnaire. The validity of encyclopedia is measured by score gained from validation. The data is analysed by likert scale [12].

3. Result and Discussion

3.1 Development Results
The study by Ari et al. developed the encyclopedia of physics measuring instruments as an independent learning resource for high school students that had advantage of detailed descriptions about physics measuring instruments but was not based on a certain instructional model. The study by Anida et al. developed the encyclopedia of waves based on scientific approach.

The product developed in this research was Advanced Organizer-based printed encyclopedia. The contents presented in the encyclopedia was based on Basic Competency of standard 2013 curriculum content revised edition. The encyclopedia consists of several components, i.e. cover, foreword,
concept map, basic competency of Newton’s Laws of motion and Newton’s law of gravitation, instructions for use, material presentation, glossary, and bibliography.

Encyclopedia or large dictionary containing scientific terminology can be utilized as an important supporting reading material for students [13]. Encyclopedia is a book containing descriptions of various subjects in the field of science in alphabetical or scientific orders [14].

The encyclopedia has three subtitles, i.e. Forces in Newton’s Laws, Newton’s Laws of Motion, and Newton’s Law of Gravitation. Each content in the subtitles was arranged based on alphabetical order. The subtitle of Forces in Newton’s Laws consists of: (1) Dynamometer, (2) Forces, (3) Weight, (4) Frictional Force, (5) Normal Force, (6) Centripetal Force, (7) Tension Force. The subtitle of Newton’s Laws of Motion consists of (9) Newton’s First Law, (10) Newton’s Second Law, (11) Newton’s Third Law. The subtitle of Newton’s Law of Gravitation consists of (11) Gravitational Force between Particles, (12) Kepler’s Law, (13) Gravitational Field and Acceleration.

Material presentation was arranged based on steps of instructional model of Advance Organizer that consisted of (1) Presentation of Organizer that was denoted by AO1 in the encyclopedia; (2) Presentation of Course Content (AO2); (3) Presentation of Cognitive Organization (AO3).

![Figure 1. Cover](image)

Presentation of Organizer consisted of presentation of instructional goals that would be obtained, presentation of organizer in the form of correlated cases or problems between new and prior materials, brief repetition of related material, and encouraging awareness of relevant knowledge.

Presentation of course content consisted of (1) presentation of complete course content; (2) “Physics is fun” was intended to maintain students activity attention by providing simple activity guidance that could be done by students; (3) Explicitly organizing course content could be done by concept map or mind map.

Presentation of Cognitive organization (AO3) consisted of (1) combining new material with student cognitive structure by providing real life examples; (2) improving active learning activity by providing internet link that could be used as an additional reference for enhancing readers knowledge and providing 2 crossword puzzles that could be filled by readers, (3) and improving critical approach toward knowledge by giving questions to students by providing quizzes and the answers. The answers were provided in the reverse form to increase curiosity of students.

3.2 Validation

The encyclopedia that was developed was validated by two content experts, two media experts, and two instructional experts. The validation was intended to provide assessment and evaluation that could be used as analysis material of the encyclopedia so that resulted in a good product. Validation procedure consisted of: a) creating experts assessment instrument based on research objects and methods; b) providing encyclopedia to be assessed by experts; c) revising assessment result and experts’ suggestions.
The assessment of content experts, media experts, and instructional experts in each indicator provided in the table below:

### Table 1. Validation by Material Experts

| No | Indicator                                                                 | Feasibility Test Result (%) |
|----|---------------------------------------------------------------------------|----------------------------|
| 1  | Compatibility between the encyclopedia content and basic competency       | 87.50%                     |
| 2  | Compatibility between content and level of thinking of high school students | 87.50%                     |
| 3  | Material compatibility in the Newton’s Laws encyclopedia                  | 79.17%                     |
| 4  | Writing accuracy                                                          | 87.50%                     |
| 5  | Material advancement in the Newton’s Laws encyclopedia and science         | 87.50%                     |
| 6  | Accuracy of concept presentation order                                     | 87.50%                     |
| 7  | Compatibility between figures and texts                                   | 87.50%                     |
| 8  | Compatibility between concept and fact                                     | 87.50%                     |
| 9  | Compatibility between bibliography and content                            | 87.50%                     |

### Table 2. Validation by Media Experts

| No | Indicator                                                                 | Feasibility Test Result (%) |
|----|---------------------------------------------------------------------------|----------------------------|
| 1  | Compatibility between cover and encyclopedia content                      | 100%                       |
| 2  | Suitability of colors combination and composition                         | 87.50%                     |
| 3  | Size of the encyclopedia                                                   | 87.50%                     |
| 4  | Suitability of font type, size, and color                                 | 84.38%                     |
| 5  | Suitability of figures layout and texts                                   | 94%                        |
| 6  | Line spacing consistency                                                  | 87.50%                     |
| 7  | Simplicity of use                                                          | 87.50%                     |
| 8  | Variety of bibliography                                                   | 87.50%                     |
| 9  | Figures attractiveness                                                    | 83%                        |
| 10 | Font type and size attractiveness                                         | 75.00%                     |
| 11 | Display design attractiveness                                             | 87.50%                     |
| 12 | Layout attractiveness                                                     | 87.50%                     |
| 13 | Compatibility between figures and texts                                   | 75.00%                     |
| 14 | Explicitness of figures sources                                           | 75.00%                     |
| 15 | Writing language appropriacy                                              | 81.25%                     |
| 16 | Serve as an independent learning resource                                  | 75.00%                     |
| 17 | Compatibility between content and encyclopedia components                  | 81.25%                     |

### Table 3. Validation by Instructional Experts

| No | Indicator                                                                 | Feasibility Test Result (%) |
|----|---------------------------------------------------------------------------|----------------------------|
| 1  | Compatibility between content and basic competency                        | 100%                       |
| 2  | Compatibility between content and level of thinking of students            | 100%                       |
| 3  | Writing language appropriacy                                              | 90.63%                     |
| 4  | Figures attractiveness                                                    | 100%                       |
| 5  | Font type and size attractiveness                                         | 100%                       |
| 6  | Display design attractiveness                                             | 87.50%                     |
| 7  | Layout attractiveness                                                     | 87.50%                     |
| 8  | Simplicity of material comprehension for students                         | 100%                       |
| 9  | Accuracy of concept presentation order                                     | 97.50%                     |
| 10 | Compatibility between figures and texts                                   | 87.50%                     |
| 11 | Compatibility between figures and concept                                 | 100%                       |
| 12 | Compatibility between material presentation and **Advance Organizer**     |                             |
|    | presentation step                                                         | 100%                       |
| 13 | Compatibility between material presentation and course content presentation step | 87.50%                     |
| 14 | Compatibility between material presentation and cognitive organization enhancement step | 95.83%                     |
Validation that was done by physics content experts resulted in average score of total aspects of 86.72%. Media experts validation provided the average score of the encyclopedia packaging of 84.09%. While physics instructional experts provided the average score of 94.90%. Based on Likert scale, obtained that the assessment from content experts, media experts, and instructional experts claimed that the encyclopedia quality was “very feasible” to be utilized as a physics learning resource.

4. Conclusion
Based on problem, research, and discussion provided, it was concluded that Newton’s Laws encyclopedia based on advance organizer was feasible to be used as a physics learning resource.

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References
[1] A. Hidayat, S. Saputro and J. S. Sukardjo, "Pengembangan Media Pembelajaran Ensiklopedia Hukum-Hukum Dasar Kimia untuk Pembelajaran Kimia Kelas X SMAN 1 Boyolali dan SMAN 1 Teras," Jurnal Pendidikan Kimia, pp. 47-56, 2015.
[2] R. E. Bopp and C. L. Smith, Reference and Information Service an Introduction, Santa Barbara, 2011.
[3] C. L. Sitter and M. Gosling, Learn Reference Work, Texas: Totalrecall Publications, 2007.
[4] J. Nurhatmi, M. Rusdi and Kamid, "Pengembangan Ensiklopedia Digital Teknologi Listrik Berbasis Contextual Teaching and Learning (CTL)," Edu-Sains: Jurnal Pendidikan Ilmu Pengetahuan Alam, 2015.
[5] A. Nurafifah, A. S. Budi and B. Z. Siahaan, "Developing Wave Encyclopaedia based on Scientific," International Conference on Mathematics and Science Education (ICMScE), 2017.
[6] A. P. Widiana and D. Hasanah, "Pengembangan Ensiklopedia Alat Ukur Fisika Sebagai Sumber Belajar Mandiri untuk Sma/Ma Kelas X pada Materi Besaran dan Satuan," Jurnal Ilmiah Pendidikan Fisika, Vols. 4, No.2, 2014.
[7] A. R. Saleh and J. G. Sujana, Pengantar Kepustakaan, Jakarta: Sagung Seto, 2009.
[8] D. Saepuzman, A. Samsudin, A. D. Sutrisno, I. Kaniawati and Yusnim, "Diagnosis Kesulitan-kesulitan Siswa dalam Konsep Gerak dan Gaya (Sebuah Penelitian Survey)," in Seminar Kontribusi Fisika, Bandung, 2015.
[9] S. N. Alias and F. Ibrahim, "A Preliminary Study of Students’ Problems on Newton’s Law," International Journal of Business and Social Science, vol. Vol 7. No 4, 2016.
[10] R. Amelia, J. Mansyur and A. Kade, "Pengaruh Model Pembelajaran Advance Organizer Dengan Menggunakan Peta Konsep Terhadap Pemahaman Konsep Siswa Kelas X di SMA Negeri 7 Palu," Jurnal Pendidikan Fisika Tadulako (JPFT), vol. Vol. 4 No 2, 2016.

[11] A. Gidena and D. Gebeyehu, "The effectiveness of advance organiser model on students’ academic achievement in learning work and energy," International Journal of Science Education, 2017.

[12] Riduwan, Metode dan Teknik Menyusun Tesis, Bandung: Alfabeta, 2007.

[13] Daryanto, Media Pembelajaran, Bandung: Yrama Widya, 2015.

[14] A. Prastowo, Panduan Kreatif Membuat Bahan Ajar Inovatif, Yogyakarta: Diva Press, 2013.

[15] R. E. Slavin, Psikologi Pendidikan: Teori dan Praktik Edisi kesembilan jilid 2 terjemahan Marianto Samosir, Jakarta: Permata Puri Media, 2011.

[16] S. Nurazizah, P. Sinaga and A. Jauhari, "Profil Kemampuan Kognitif dan Keterampilan Berpikir Kritis Siswa SMA pada Materi Usaha dan Energi," Jurnal Penelitian dan Pengembangan Pendidikan Fisika, pp. 197-202, 2017.