Infographic Instructional Media as a Solution and Innovation in Physics Learning for Senior High School Students in Indonesia

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***Abstract*—This research is aimed to find out the usability of infographic as an instructional media in Physics learning among high school students. This research is the third phase (evaluation phase) of the Design and Development Research Approach introduced by Richey and Klein. Chai & Chen Evaluation Model was used in order to evaluate the usability of infographic. There are six students were selected for the research using purposive sampling. The data are obtained by in-depth interview method in the form of semi-structured interviews and analyzed by Miles and Huberman Qualitative Data Analysis Model. This research used open code to simplify the process of data analysis. The findings show that the use of infographic is very helpful and useful for students to understand the Physics concept of rectilinear motions kinematics. Finally, from the perspective of students as infographic instructional media users, it can be concluded that the infographic is an effective solution to Physics learning due to it is more flexible, stimulates learning, and students can develop their own concepts that solve Physics learning problems. In addition, the infographic is an innovation in practicing Physics, as it is a new media in education especially in Physics learning.**

***Index Terms*—Usability of infographic instructional media, a solution and innovation in physics learning, perspective of senior high school students.**

I. Introduction

Nowadays, despite the increasing use of technology in education, there is still a shortage of educators [1] and students [2] who use computer facilities as a medium of education. Such as, the use of smartphones and computer labs in schools. Teachers report that they need more training in teaching and learning [3]. Therefore, skills are needed to implement effective teaching and learning, especially in the development of technology-learning media. There are differences in roles and knowledge between teachers and computer experts. Teachers who master the lesson theory are less able to convey the teaching in the form of media. While computer experts who are capable of making learning media using computers usually do not master the theory of the lesson.

In Physics teaching and learning, students are required to understand the concepts that are appropriate in the existing curriculum. Instead of promoting student enthusiasm and referring to the current curriculum in Indonesia, Curriculum-2013, it requires teacher creativity in designing teaching and design strategies to enhance students' creative, working and scientific thinking skills. There are important aspects for students to learn and experience the phenomena in the environment. Teaching strategies are the teaching activities that teachers and students need in order to achieve the goals of teaching effectively [4].

From the data of previous research, there are problems in the teaching and learning of Physics. It showed that most students still have trouble understanding the concepts of Physics [5]-[7]. This can cause students have misconception of Physics concepts. There are experts like [8] who explain that misunderstandings exist in all areas of Physics. This causes for most students, Physics is the most difficult subject [9] and [10]. This also happened in Indonesia where [11] found 1340 student respondents from all over Indonesia who also stated that Physics was a subject they did not like. This is also supported by a study conducted by [12] and [13] that could result in low numbers of students choosing Physics subjects in Senior High School (pre-university) and causing educational and economic distress [14].

Infographic is a visual media that is considered as an effective communication media [15]-[17]. Many studies have used infographics for educational purposes [18]-[32]. Infographic is expected to visualize concepts for learning faster by using less text in it [33]. Infographic terms that can be utilized in education according to [34] are that infographic represent visual information that has less text and serves as a visual summary of contextual concepts so that it is easier to understand meaning graphically.

There are three basic things known as the education triangle, what is taught (curriculum and content), how to teach (teaching methods), and how to measure student learning outcomes (assessment) [35] and [36]. In addition, [37] states that a teacher must be able to assess what students must learn to reflect what is really happening in class. This assessment is used to gather information about students. Also it is used as one aspect to consider student achievement scores using the assessment process [38]. After all processes are completed, what thing that cannot be ignored is a matter of implementation and evaluation. No matter how good the development of the media, if not implemented, the development process will be in vain [39]. According to [40],

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trying out user-developed materials and improvements will make a significant difference. Rather than these reviews, it is clear that the process of evaluating learning media is very important.

Although research has been found involving concepts, teaching, and technology (media) problems for Physics subjects. However, there is very little research on the use of infographic media in Physics lessons at the Middle School level, especially in Indonesia. The use of infographic media has not been widely practiced, including scientific studies about it. In addition, local research focuses more on survey methods and only a few studies use development methods for science subjects [41], [42], and [43] such as Research and Development (R&D). So this research is unique and have a clearly gap because it uses a different method, namely, Design and Development Research (DDR) by [44].

Based on the reviews that have been described, infographic media assessment in Physics learning for students at the Senior High School level must be evaluated in the learning process. Infographic used in this study is a instructional media that is used with smartphones and can be accessed by Facebook groups. In this study, researchers used Bloom's Taxonomy as a basis or reference to analyze the usability of infographics in understanding the concept of rectilinier motion kinematics. Assessments made in the cognitive domain of Bloom's Taxonomy are remembering (C1) and understanding (C2) or commonly known as Lower Order Thinking Skills [45].

II. Methodology

This study uses a method in research, that is DDR [44]. DDR consists of three phases, namely phase 1 is the need analysis phase, phase 2 is the design and development phase, and phase 3 is the assessment phase. This research is an assessment phase of DDR. The assessment carried out is the use of infographic media according to the perspective of students (infographic users) by using a usability assessment model developed by [46].

A. Sample of Research

The sample of this research was grade X students from one of the senior high schools located in Semparuk sub-district, Sambas Regency in 2016/2017, with a total of 6 students. In this study, sampling was conducted purposively, which means that the researcher deliberately chose individuals and locations to conduct studies or understand a phenomenon with specific objectives [47] and [48]. Sampling in this study was based on the frequency of students using their infographics and activeness on the facebook group. There were 4 students chosen due to they were active in the Facebook group. Meanwhile, 2 students were chosen because they have never accessed infographics through the Facebook group. Facebook groups in this study has functions as a medium for sharing infographics and as a medium of communication between students and researchers during the research process.

B. Instruments and Procedures

Data collection procedures in this research using interview techniques with guideline interview as the instrument. The usability of infographic media analyzed according to students' perspective and carried out by semi-structured interview method. Before the usability assessment is carried out on the research subject, the researchers checks the smartphone's student ownership. This is done to make students easier to access infographics through social media (Facebook). For this reason, researchers have created groups on Facebook for related class. Furthermore, learning done by students with infographics is learning outside the classroom (not during school hours). Media infographics are downloaded and studied by students for a certain period of time, through the Facebook group. The example of infographic that used in this research can be clearly seen in Fig. 1.

Fig. 1. Example of the infographic in this research.

This study was conducted in September 2017. Independent learning was given for 2 weeks for students to learn the concept of kinematic motion independently. This learning takes place outside of school time. During self-study, researchers regularly monitor student activity on facebook group with screenshots everynight in the same time is 10 P.M. in Western Indonesia Time. After this stage, the researchers will conduct interviews with six students (PS1-PS6). This is done to determine their evaluation of the usability of the media infographic they have used.

C. Data Analysis

Interview data in this study were analyzed using [49] Qualitative Data Analysis Model. Data is analyzed thematically and then transcribed with Microsoft Word. Justification for choosing Microsoft Word because it can make it easier for researchers to load files in which Microsoft Word is also used to manage interview data with the aim of identifying the topic at the center of the phenomenon [50] and [51].

In data reduction, researchers create code to facilitate the process of data analysis, namely open code. It is used by researchers to encode interview data because researchers code based on words in interview transcripts after reading and understanding the meaning intended by respondents [52]. The following are example of codes that researchers have used such as Table I.

TABLE I: CODE EXAMPLE IN INTERVIEW DATA ANALYSIS

Coding	Code	Description
A1-P1L1	A1	Refers to the code of the person being interviewed
	P1L1	Refer to the page and line of questions and answers from the interview

Much research is involved in the display of data and analysis that were previously collected, because many researchers compile only narrative texts. However, what makes this study different from other studies is that the data analysis is done by emphasizing thematic information. This is obtained through a process of analysis by starting to encode each category in the interview transcripts, then grouping them into sub-themes, and then similar sub-themes will be grouped into themes.

In addition, researchers also try to arrange relevant data so that information can be concluded and has a certain meaning. This process can be done by presenting data, making connections between phenomenas to interpret what actually happened, and what needs to be followed to achieve the research objectives. Presentation of data like this is an important step in achieving valid and reliable data analysis.

The next step is to draw conclusions based on the findings and validate the data. If the conclusions submitted at this stage are supported by strong evidence or in other words, they are consistent with the conditions found when the researcher returns to the field. It is means, the conclusion drawn is reasonable.

III. RESULT

From the data was analyzed, it founds nine themes. They are 1) infographic usage guide, 2) infographic content, 3) QR code role, 4) facebook use as shared media, 5) smartphone use as learning aids, 6) the use of infographics as a learning media, 7) the understanding of rectilinear motions kinematics concept, 8) the effects of infographic usability, and 9) subsequent infographics.

The first theme, the infographic usage guide, will be discussed on how to get the infographic usage guide and the benefits of the usage guide. As for how to get instructions for using infographics, students do it on their own via Facebook group. If students cannot access the Internet (facebook), students can get instructions on using the infographic via bluetooth. Then about the benefits of using infographics into several categories from the analysis of interview data, as a guide to learning using infographics, there are stages for learning, students are very easy to learn, students are easy to use, they are learning, and can build their own concepts. The following are opinions that supports students' statements on how to get infographic usage and the benefits of infographic usage.

> *Initially I joined the group on facebook. Then I download the instructions for using infographic media and also download infographic media. I followed the instructions to use the media and started learning for myself.* (PS2-P1L10)
> *How do you get usage instructions and infographic learning media? A: Bluetooth, Madam. From a friend. Once I get PDF files from my friend, I can learn more flexibility anywhere and anytime.* (PS6-P1L18)

The second theme will be about infographic content. According to the students there are two main contents of the infographic, which are contextual images and systematic concepts. Based on the interview data, categories from contextual images are infographic learning media containing contextual examples, examples and contextual benefits, infographic content according to the curriculum-2013, and students can build their own concepts based on the content of the infographic.

> *So, as we have discussed, the basic concepts in infographic media that are in line with the scientific approach to the curriculum-2013 rest on the image of the dots and the distances between the dots. Let's look at the kinematic applications of motion, of rectilinear motions kinematics concept in everyday or contextual life, then make in the media examples of things that are common in the surrounding community, such as using vehicles, so that we can see directly or maybe even try directly on the concept of rectilinear motions kinematics using a vehicle, namely a motor or car, Madam.* (PS2-P2L48)

This third theme discusses the role of QR code found in infographic learning media. The findings from the data analysis of student interviews explain how students respond to QR code, use of QR code, benefit of QR code, reasons to use QR code, reasons rarely to use QR code, and learning without QR code. On QR code, students speak about the meaning of QR code, place QR code on the bottom of infographics, QR code is very helpful and helps conceptualization, QR code is very accessible and saves time in information search, there is concept test in QR code, and QR code is good. The following are opinions that support student's assertion of QR code.

> *By scanning the QR code, I know that there are conceptual tests that must be passed to teachers. QR code is also very useful and helps me deepen and enrich simple kinematic concepts. As an example of concept maps, GLB and GLBB examples and also very important there are conceptual tests that can make me more active in studying Physics because I want to and must solve all the problems that come with it.* (PS1-P6L29)

In the fourth theme, the usability of facebook as a sharing media will discuss the function of facebook group and the use of facebook group. As for the student group facebook function can be categorized as follows: facebook group more flexible, facebook group as sharing media, facebook group as educational media, infographic spread with facebook group can be wider, facebook group is very accurate as discussion forum, facebook group is very just as an infographic learning media dissemination tool, other friends can get the same knowledge and information as people who ask in facebook groups or more precisely in facebook groups, and facebook for social.

What is Madam, besides Madam spreading the infographics and their usage instructions, for discussion too, we can share this infographic with our other friends by making the infographics and usage instructions as our shared status, making the spread even more. (PS1-P8L5)

The fifth theme is the use of smartphones as a learning tool for students in learning of rectilinear motions kinematics concept using infographic learning media. The things that are related to this are about student learning experiences using smartphones, why students learn using smartphones, and students easily understand the kinematic concept of straightforward learning when using a smartphone.

The next theme is the use of infographics as a learning media. About learning by using infographic media in Physics learning, through the following categories, 1) Physics learning using infographic learning media is successful because there are usage indicators, 2) Physics learning using infographic learning media is successful because learning is more flexible, 3) learning is preferred over smartphones because it is more flexible, 4) Physics learning using infographic learning media is more meaningful, 5) students use infographic learning media only, 6) students follow instructions use, 7) infographic learning media becomes the motivation for student learning, 8) learning is carried out with infographic learning media is excellent, 9) infographic learning media makes it easy for students to understand the kinematics of straight motion, 10) students prefer to learn because learning is enjoy and fun, 11) students love learning because it is more flexible and engaging, 12) there is learning stage in infographic learning media, 13) infographic learning media makes students active in Physics, and 14) students do not have problems and are not bored learning with infographic learning media.

You mentioned that you can learn to use the infographic media in your smartphone even if it has no intention of learning or in other words just to save time. Can that be meaningful learning? What do you mean if that learning fills your mind? A: Yes, madam. Infographic media is a visual media, so it only affects my sense of sight, so the sound of my friends or vehicles doesn't really matter to me, though I do need to focus and concentrate on understanding the concepts I'm learning. (PS5-P3L9)

This infographic also makes me more active in counting, because in infographics there are examples and problems we need to work on. Not to mention the material and conceptual test questions contained in the QR code made me more active in studying Physics. (PS3-P5L19)

Then for the theme of understanding the kinematic concept of rectilinear motion, it is discussed about students' understanding of the kinematic concept of rectilinear motion. What is part of this theme is how students' understanding of the concept of rectilinear motion kinematics, which consists of the categories students understand with the kinematic concept of rectilinear motion characteristics, students understand with the kinematic concept of rectilinear motion examples, students understand with non- kinematic concept of rectilinear motion examples, and students are very familiar with the kinematic concept of rectilinear motion.

Further on this theme of usability will be discussed about the usability of the use of infographic learning media that students perspectives. All students find infographics very helpful and useful. With infographic learning media students can learn more flexibly, students can learn independently students can build their own concepts, and their Physics learning time has increased since using infographic learning media. The following are perspectives that supports the student's statement of the statement.

Yes, Madam is very easy, anytime and anywhere I can learn using infographic media, both in school, in the classroom, and outside of school, Madam. (PS4-P3L12)

Okay, Madam. Starting with the images and explanations presented in the infographics are contextual images, cars and motorcycles, which means images related to everyday life, which my friends and I can find daily so that we can do it directly. So in terms of material, from basic concepts, such as position, distance, displacement, velocity, and acceleration, which is also explained in this infographic, it was useful for me to analyze the special features of the kinematic concept of rectilinear motion movements in the construction of the concepts. (PS3-P1L25)

The final theme of the next infographic discusses the suggestion and strengthening of students to receive the next infographic learning media. In addition, this theme will also discuss students' needs and interests in infographic learning media for other Physics concepts. The following is an opinion that supports student statements on student suggestions and reinforcement to understand the next medium of infographic learning.

I really like to study independently using infographic. If I was not constrained by the Internet, I thought learning the kinematic concept of rectilinear motion. I was doing could be more meaningful and interesting as it could be a discussion forum within the facebook group. But even then ... with this infographic media, I can easily understand the concept of kinematic motion. Thank you. (PS5-P8L20)

Of course, I'm very interested, and I really need learning media like this infographic for other Physics concepts. Let's be more excited and easy to learn, Madam. (PS1-P8L42)

IV. Discussion

The use of infographic learning media aims to determine the extent to which users (students) can use the product to understand the kinematic concepts of infographic use [53] and [54]. To facilitate researchers in conducting and obtaining interview data for students about the use of infographics, researchers develop interview protocols with the aspects needed to achieve research objectives. There are six aspects that researchers use: 1) learning to use infographic media, 2) QR codes as a medium to access learning, 3) the

use of smartphones in learning, 4) the use of facebook in learning, 5) physical content about the GLB Concept and GLBB, and 6) suggestions and suggestions related to infographic media.

The overall findings from the student interviews show that they are most comfortable with infographics, infographics are very interesting learning media, more flexible in learning and having fun student learning styles, activities, and assessments. This is in accordance with the demands of the curriculum, namely providing opportunities for students to get an education that is appropriate and relevant to the learning styles of students [55], [56], and [57].

In addition, by using infographic learning media, students can develop their own concepts and make their Physics learning time increase. The findings of this study are in line with [58] which states that a person's knowledge can be created or in other words a person can construct his own concept. Students believe that infographic learning media contain systematic contextual images and concepts. The contents and development of this infographic learning media use cognitive content theory with the aim of managing intrinsic cognitive load, reducing foreign cognitive load, and increasing cognitive load closely. This aim is in line with [59] the emphasis on effective learning based on cognitive load theory.

In the context of this study, the findings of the study of the use of infographic learning media on students' understanding of kinematic concepts of motion. These findings support studies [60] and [61] that infographics can enhance visual thinking and academic achievement. This data is also supported by students who pass and exceed the minimum completeness score on the conceptual test contained in the QR code. The findings of this study are also in line with research findings that use infographic learning aids [22], [23], [62], and [33]. Especially in the fields of Physics [34] and [32] similar results were also obtained.

V. Conclusions and Suggestions

A. Conclusions

All information reported in this study aims to assess the use of infographic learning media on the kinematic concept of straight motion. The research findings are aimed at achieving research objectives, namely assessing the use of infographics based on the perspective of students conducted in semi-structured interviews with six students. All students stated that this infographic media is a new media that they use in learning Physics. Although infographics have long been used for example in the development of history and for marketing but it is a new innovation in the world of education, especially in learning Physics (Science).

The guideline for using infographics are very helpful for students as a guide in learning Physics. They also believe that infographic learning media contain systematic contextual images and concepts that enable them to develop their own thoughts on the concepts being studied. More about using infographics as a learning media is very flexible, where they can learn anywhere and anytime including in their favorite places. It also increases their Physics learning time because they enjoy learning Physics by using infographic learning media. From the results of this study it can be concluded that infographic is effective solutions in learning Physics as described in the introduction.

There are challenges for students using smartphones for learning. The challenge is in the form of students not being able to take notes on their smartphone screens. The suggestion for this challenge is to use infographic learning media printed on paper. This is easy to do because the infographic media is in the PDF files form.

Another challenge is when students do not have an internet connection, so students cannot access infographic media. The backup for this challenge is done by students by sharing PDF files of infographic media via Bluetooth. In addition, students who do not have an internet connection cannot discuss in the Facebook group that has been provided. The solution to this challenge is to read and understand instructions for using infographic media properly.

The special characteristic of the infographic used and the thing that makes a huge gap with other research is that the infographic media has a QR code in it. Students who have internet access also often use QR codes available in infographic learning media for the purpose of enriching the concept of kinematic motion. This is an innovation in the world of education, which so far QR code is only used in the economic field.

B. Suggestions

Students recommend that this infographic learning media be implemented and assessed in different ways and in other concepts. This is highly recommended because for them, this infographic is a solution and innovation in the world of education, especially for learning Physics.

This study focuses on the assessment of usability of infographic learning media in Physics learning among senior high school students. Further studies can be extended to different concepts and levels, such as kinematic concepts of straightforward for high school students and fluid concepts for high school students using the same development model.

There are limitations in this study in terms of the number of samples (n = 6). Thus, the researchers suggests that if this research is conducted with a different method and with a different number of samples, even more samples so that this study can be generalized.

Also, the findings of this study indicate that students love learning with their smartphones because they carry their smartphones everywhere, so they can learn anywhere and anytime. The social media of facebook that is used as a medium to share the infographic is rated as easy to access. It is means both of smartphone and facebook has positive impact in education. Researchers recommend for further research be carried out locally or abroad as a comparative study. It is also an effective way to look at demographic differences or another gaps in determining future research findings.

Conflict of Interest

The authors declare no conflict of interest.

Author Contributions

We declare that each author has made a substantial contribution to this article, has approved the submitted

version of this article and hast agreed to be personally accountable for the author's own contributions. In particular, NA as the leading author, has made a major contribution to the conception and design of the research; the data collection, screening of abstracts and full papers, the analysis, synthesis and interpretation of data; RAR provided the theories, model, and method of this research, screening of full papers, the analysis, synthesis and interpretation of data; SSAR has made a major contribution to the data collection, screening of full papers, the analysis, synthesis and interpretation of data; MSNS has made a major contribution to the data collection, screening of abstracts and full papers, the analysis, synthesis and interpretation of data; ZB provided supervision and revision of the research. All authors had approved the final version.

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REFERENCES

[1] P. A. Ertmer, "Teacher pedagogical beliefs: The final frontier in our quest for technology integration?" *Educational Technology Research and Development*, vol. 53, no. 4, pp. 25-39, 2005.

[2] J. Aagaard, "Drawn to distraction: a qualitative study of off-task use of educational technology," *Computers & Education*, vol. 87, pp. 90-97, 2015.

[3] R. J. Stiggins, "Conquering the formative assessment frontier," in *Formative classroom assessment*, J. H. McMillan, Ed. New York, NY: Teachers College, Columbia University, 2010, pp. 8-28.

[4] Kemp, "Instructional strategy," in *Strategi dan Desain Pengembangan Sistem Pembelajaran*, M. Rohman and S. Amri, Eds. Jakarta: Prestasi Pustakaraya, 1995, p. 24.

[5] E. Hanfort. (2017). Rethinking the way college students are taught. *American RadioWorks*. [Online]. Available: http://americanradioworks.publicradio.org/features/tomorrows-college/lectures/rethinking-teaching.html

[6] E. Mazur, *Peer Instruction: A User's Manual*, New Jersey, NJ: Prentice Hall, 2011.

[7] M. W. Ramsdell, "The design, development, and assessment of advanced modeling based project in introductory physics," Ph.D. dissertation, Clarkson University, 2004.

[8] M. Wandersee and Novak, "Misconception," in *Miskonsepsi dan Perubahan Konsep dalam Pendidikan Fisika*, P. D. Suparno, Ed. Jakarta: Grasindo, 1994.

[9] M. Baran, "An analysis on high school students' perceptions of physics courses in terms of gender (a sample from Turkey)," *Journal of Education and Training Studies*, vol. 4, no. 3, pp. 150-160, 2016.

[10] W. W. Welch and H. J. Walberg, "A national experiment in curriculum evaluation," *American Educational Research Journal*, vol. 9, no. 3, pp. 373-383, 1972.

[11] F. Rofalina. (2015). Infografik: Pelajaran Paling Disukai dan Dibenci Siswa Indonesia. *Zeius Blog*. [Online]. Available: https://www.zenius.net/blog/7657/pelajaran-favorit-dibenci-siswa-indonesia

[12] G. B. Samudra, I W. Suastra, and K. Suma, "Permasalahan-permasalahan yang dihadapi siswa SMA di kota Singaraja dalam mempelajari Fisik," *e-Journal Program Pascasarjana Universitas Pendidikan Ganesha Program Studi IPA*, p. 4, 2014.

[13] K. F. Tsai and G. Fu, "Underachievement in gifted Students: A case study of three college physics students in Taiwan," *Universal Journal of Educational Research*, vol. 4, no. 4, pp. 688-695, 2016.

[14] S. Owen, D. Dickson, M. Stanisstreet, and E. Boyes, "Teaching physics: Students attitudes toward different learning styles," *Clothing and Textiles Reseach Journal*, vol. 5, no. 2, pp. 8-14, 2008.

[15] A. Lazard and L. Atkinson, "Putting environmental infographics center stage: The role of visuals at the elaboration likelihood model's critical point of persuasion," *Science Communication*, vol. 37, no. 1, pp. 6-33, 2015.

[16] M. Smiciklas, *The Power of Infographics: Using Pictures to Communicate and Connect with your Audiences*, Indianapolis: QUE, 2012.

[17] M. R. Umami, S. B. Utomo, and A. Ashadi, "Pengaruh media infografis dan poster pada pembelajaran joyful learning terhadap prestasi belajar siswa ditinjau dari kemampuan logika pada materi pokok kesetimbangan kimia kelas XI IPA semester gasal SMA Negeri Gondangrejo tahun pelajaran 2015/2016," *Jurnal Pendidikan Kimia*, vol. 5, no. 3, pp. 9-17, 2016.

[18] R. N. Winaldy, P. W. Harsanto, and R. M. N. Basuki, "Perancangn media pendukung pembelajaran sejarah dengan infrogafis digital," *Jurnal DKV Adiwarna*, vol. 1, no. 7, 2016.

[19] N. Al-Mohammadi, "Effectiveness of using infographics as an approach for teaching programming fundamentals on developing analytical thinking skills for high school students in the city of Makkah in Saudi Arabia," *Global Journal of Educational Studies*, vol. 3, no. 1, p. 22, 2017.

[20] H. Bicen and M. Beheshti, "The psychological impact of infographics in education," *Broad Research in Artificial Intelligence and Neuroscience*, vol. 8, no. 4, pp. 99-108, 2017.

[21] J. M. F. Brigas and L. F. R. Fernandez, "Infographics as an auxiliary tool for teaching/learning," *Revista de Comunicación de la SEECI*, no. 36, pp. 178-184, 2016.

[22] A. B. Dahmash, A. Al-Hamid, and M. Alrajhi, "Using Infographics in the teaching of linguistics," *Arab World English Journal*, vol. 8, no. 4, 2017.

[23] N. L. Falk, "Infographic development by accelerated bachelor of science in nursing students: An innovative technology-based approach to public health education," *Nursing Education Perspectives*, vol. 37, no. 5, pp. 299-301, 2016.

[24] R. M. Jones, "Teaching scientific communication using infographics," in *Proc. Innovations in Teaching & Learning Conference*, July 2016, p. 2.

[25] J. Jung and Y. Kim, "Effect of infographic instruction to promote elementary students use of scientific model," *Journal of The Korean Association for Science Education*, vol. 36, no. 2, pp. 279-293, 2016.

[26] J. Lievemaa, *Animated Infographics in Digital Educational Publishing: Case Study of Educational Animated Infographics*, 2017.

[27] N. Misuan and A. M. Sula, "Pengaruh pendekatan visualisasi dalam pembelajaran subjek teori: Keberkesanan infografik dalam kursus sejarah seni," in *Proc. iCompEx17 Academic Paper*, 2017.

[28] M. A. M. Noh, M. S. H. M. Fauzi, H. F. Jing, and M. F. Ilias. (2017). *Infographics: Teaching and Learning Tool*. [Online]. Available: http://journal.kuis.edu.my/omje/wp-content/uploads/2017/04/5863_Vol.1_No.1_2017-1.pdf

[29] R. P. Putra, "TA: Pembuatan video seri pendidikan mata pelajaran fisika kelas xi berbasis infographic dengan menggunakan motion tracking studi kasus kinematika gerak lurus," Doctoral dissertation, Institut Bisnis dan Informatika Stikom Surabaya, 2016.

[30] M. Shaltout and H. Fatani. (2017). Impact of two different infographics types" interactive-static" on developing mathematical concepts among female students at second grade intermediate in the Kingdom of Saudi Arabia. [Online]. Available: http://www.bluepenjournals.org/ijrre/pdf/2017/October/ShaltoutandFatani. pdf

[31] S. A. M. Tobing, "Pengembangan media infografis pada materi pemanasan global untuk meningkatkan hasil belajar siswa di SMA Negeri 19 Surabaya," *Inovasi Pendidikan Fisika*, vol. 6, no. 3, 2017.

[32] H. Uzunboylu and E. Kosucu, "Comparison and evaluation of Seels & Glasgow and Addie instructional design model," *Ponte*, vol. 73, no. 6, pp. 98-112, 2017.

[33] R. Krum, "Cool infographics: Effective communication with data visualization and design," *Teacher Librarian*, vol. 41, no. 4, pp. 54-58, 2013.

[34] M. Z. Rizal, "Erancangan buku infografis sejarah dan ornamen simbolik pada masjid kajen," Doctoral dissertation, Institut Seni Indonesia Yogyakarta, 2017.

[35] D. J. Martin, *Elementary Science Method*, 4th ed. Australia: Thompson Wadswoeth, 2006.

[36] S. R. Ariffin, *Teori, Konsep, dan Amalan Dalam Pengukuran dan Penilaian*, Kuala Lumpur: Centerf for Academic Advancement, Universiti Kebangsaan Malaysia, 2003.

[37] N. Idris, *Classroom Assessment in Mathematic Education*, Kuala Lumpur: Graw-Hill, 2007.

[38] N. Idris and S. Osman, *Pengajaran dan Pembelajaran*, Kuala Lumpur: McGraw-Hill, 2009.

[39] N. Apriyanti, S. Umar, and E. Tandililing, "Pengembangan media pembelajaran fisika untuk perolehan belajar konsep kinematika gerak lurus di kelas X SMA," *Jurnal Pendidikan dan Pembelajaran*, vol. 4, no. 3, 2015.

[40] M. Dick, "Interactive infographics and news values," *Digital Journalism*, vol. 2, no. 4, pp. 490-506, 2014.

[41] P. A. Basyari, Sunaryo, and B. H. Iswanto, "Pengembangan media pembelajaran fisika berbasis abobe flash untuk menjelaskan fisika inti dan radioaktivitas untuk SMA kelas XII," *Seminar Nasional Fisika*, 2012.

[42] A. R. Dewi, Widjianto, and D. Haryoto, "Pengembangan modul pembelajaran fisika inti berbasis multimedia dengan Swishmax sebagai media belajar mandiri mahasiswa fisika FMIPA UM," *Jurnal Online Universitas Malang*, vol. 1, no. 1, 2012.

[43] K. R. Pradipta, Widjianto, and P. Suwasini, "Pengembangan media pembelajaran fisika berbasis multimedia dengan Swishmax 4 pada materi kinematika gerak lurus untuk siswa SMA," *Jurnal Online Universitas Malang*, 2013.

[44] R. C. Richey and J. D. Klein, *Design and Development Reseach: Methods, Strategies, and Issues*, London: Lawrence Erlbaum Associates, 2007.

[45] T. K. Tee, J. Yunos, W. Othman, B. Mohamad, M. H. Yee, and M. Mohaffyza. (2011). *Pembangunan Dan Penilaian Kualiti Modul Pembelajaran Kendiri Kemahiran Berfikir Dan Peta Minda*. [Online]. Available: http://eprints.uthm.edu.my/3331/1/5.pdf

[46] C. S. Chai and D. V. Chen, "A review on usability evaluation methods for instructional multimedia: An analytical framework," *International Journal of Instructional Media*, vol. 31, no. 3, p. 229, 2004.

[47] J. W. Creswell, *Researh Design: Qualitative, Quanitative, and Mixed Methods Approaches*, 4rd ed. Los Angeles, CA: Sage Publications, Inc., 2014.

[48] O. C. Ize. (2016). Purposive sampling (deliberate sampling). *Statistic How To*. [Online]. Available: http://www.statisticshowto.com/purposive-sampling/

[49] M. B. Miles and A. M. Huberman, *Qualitative Data Analysis: An Expanded Sourcebook*, Beverly Hills: Sage Publications, 1994.

[50] R. E. Boyatzis, *Transforming Qualitative Information: Thematic Analysis and Code Development*, Beverly Hills: Sage Publications, 1998.

[51] L. L. Watts, E. M. Todd, T. J. Mulhearn, K. E. Medeiros, M. D. Mumford, and S. Connelly, "Qualitative evaluation methods in ethics education: A systematic review and analysis of best practices," *Accountability in Research*, 2016.

[52] S. H. Khandkar, "Open coding," University of Calgary, 2009.

[53] T. Jokela, N. Iivari, J. Matero, and M. Karukka, "The standard of user-centered design and the standard definition of usability: Analyzing ISO 13407 against ISO 9241-11," in *Proc. the Latin American Conference on Human-Computer Interaction*, 2003, pp. 53-60.

[54] J. Nielsen. (2003). Usability 1001: Introduction to usability. [Online]. Available: http://www.useit.com/alertbox/20030825.html

[55] T. Kluwin and D. Moores, "Mathematics achievement of hearing-impaired adolescents in different placements," *Exceptional Children*, vol. 55, no. 4, pp. 327-335, 1989.

[56] M Marschark, H. Lang, and J. Albertini, *Educating Deaf Students: From Research to Practice*, New York, NY: Oxford University Press, 2002.

[57] M. Stinson and T. Kluwin, "Educational consequences of alternative school placement," in *The Oxford Handbook of Deaf Studies, Language, and Education*, vol. 1, M. Marschark and P. E. Spencer, Eds. New York, NY: Oxford University Press, 2011, pp. 47-62.

[58] J. Piaget and B. Inhelder, *The Phycology of the Child*, New York: Basic Books, 1969.

[59] S. Kayulga, *Cognitive Load Theory: Schema Acquesition and Source of Cognitive Load*, Cambridge: Cambridge University Press, 2010.

[60] T. Çifçi, "Effects of infographics on students achievement and attitude towards geography lessons," *Journal of Education and Learning*, vol. 5, no. 1, p. 154, 2016.

[61] S. M. Noh and J. Son, "The effect of physics instruction using infographics based on visual thinking in high school," *Journal of the Korean Association for Science Education*, vol. 35, no. 3, pp. 477-485, 2015.

[62] M. A. M. Noh, M. S. H. M. Fauzi, H. F. Jing, and M. F. Ilias. (2017). *Infographics: Teaching and Learning Tool.* [Online]. Available: http://journal.kuis.edu.my/omje/wp-content/uploads/2017/04/58-63_Vol.1_No.1_2017-1.pdf

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