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Digital Story Conceptual Change-Oriented (DSCC) to Reduce Student Misconceptions in Physics

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ABSTRACT

The development of digital story conceptual change-oriented (DSCC) has been implemented to reduce the number of students' misconceptions. In this study, DSCC is reviewed based on the story aspect. This experimental design study used a one-group pretest-posttest design. The sampling in this study was taken by a purposive technique involving 114 students from two districts. The diagnostic instrument used was four tier-test and rubrics for assessing the story aspect of DSCC. In determining the decrease of the students' misconceptions, the researchers use the DQM formula. The analysis of DSCC's assessment result was done using a holistic method. The result of the study shows that there was a decrease in the number of students' misconceptions within the high category. The highest number of the student who decreases after the implementation of DSCC was 100% and that statement of misconception was: "every motionless object has no energy". On the other side, the result of the story aspect assessment shows that there was 20% of students gave negative comments for DSCC's sequence/chronology events and 10% of the state that the location/ plotting of places was inappropriate(out of character). It is recommended for further research to consider the learning model to optimize the minimalization of the number of students' misconceptions.

INTRODUCTION

Some of the studies shown that misconceptions still exist although had been revealed overtimes (Halim, Yong, Subahan, & Meerah, 2014; Santyasa, Warpala, & Tegeh, 2018). Some factors could be suspected as the cause of misconception, namely the learning process, curriculum, and teacher's paradigm that learning is the transfer of knowledge (Kurniawan, 2018b; Santyasa et al., 2018; Üce & Ceyhan, 2019).

Learning situations should adapt easily with global changing especially technology. Therefore, students should be facilitated with advanced experiences to enhance their interest in learning (Niemi & Multisilta, 2016). Teachers must be able to apply innovative learning plans by integrating technology into the learning process. The use of technology not only increases motivation, but the effectiveness of teacher teaching also able to develop students' analytical skills independently (Tandon, Singh, & Poojapathak, 2018). Nowadays, mobile phones could be closing the limit of conservative teaching with modern methods with some applications that are applicable in the classroom and they can operate it themselves (Sanabria & Arámburo-Lizárraga, 2017).

Many studies had proven that some physics subjects are difficult because of their abstracts concepts (Kotluk & Kocakaya, 2016). This obstacle causes misconceptions. Various methods were used to correct misconceptions such as analogy (Akcay, 2016), concept cartoon (Atasoy & Ergin, 2017), problem-based

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learning(Tasoglu & Bakac, 2014), and computer assisted-learning (Üce & Ceyhan, 2019; Wartono, Hartoyo, Nilasari, & Batlolona, 2019) including through real and virtual experiments (Halim et al., 2014; Muliyani & Kaniawati, 2015).

Although both real and virtual experiment methods have been applied in the class, the chance of misconception exists remains. If misconceptions remain, it is precisely due to the absence of cognitive conflict, especially in students who lack understanding even after being reinforced by using media or using an experiment because students are only enabled to interpret limited information based on a provided rule (Potvin & Cyr, 2017).

In this study, the researcher offered alternative ways of teaching by using technology-integrated media into a classroom called a digital story. In Indonesia (especially in the physics subject), it has not been applied yet in physics learning. Most of the studies about digital stories concern to the English or linguistic subject(Maddine, 2014; Nassim, 2018; Prins, 2017), students' participation, and students' self-efficacy (Yildiz Durak, 2018).

The other digital stories contain pictures, texts, and audio recorded coherently (Razmi, Pourali, & Nozad, 2014; Thang et al., 2014). The digital story in this study combines all of them in one format (in .mp4). These are the essential differences so the student can observe the DSCC directly on the display by only push the "play" button.

Moreover, a digital story can cover a large area, both in terms of delivery techniques, the deliverer, and flexibility in choosing the content to be involved. This media could create a joyful situation for the student while learning in the class, experiencing extraordinary activities so they could possess multiple skills at the end of class (Nassim, 2018).

A digital story is not only applicable to young learners, but it is also applicable to be used by adult learners. A lot of adults wants to expand their skill and knowledge especially in using technological devices. The making of a digital story could be interesting for adults by using variances of multimode text or semiotic resources (Prins, 2017). The interaction between digital story content and students will increase students' involvement, which in turn, will support the achievement for better learning outcomes (Choi, 2018).

A digital story is considered to be used because it could be applied in the various scientific disciplines and it can improve students' achievement compared to PowerPoint presentations (Özpinar, Gökçe, & Yenmez, 2017). It can train high-level thinking skills, increase motivation, and bring forth competent student performance, writing skills, reading skills, enhance student concentration, and improve pleasant learning situation in writing(Dewi, Savitri, Taufiq, & Khusniati, 2018).

Moreover, the application of technology in learning can be a solution for independent learning problems with diverse levels of cognitive ability of students (Hussain & Shiratuddin, 2016).

In this study, the researchers tried to design a digital story-oriented conceptual change (DSCC) with the form of video animation so that it differs from digital story designs in general. Also, this digital story is used as an instrument to help diagnose students' misconceptions.

Thus, this study aims to describe the effect of digital stories in decreasing the number of students' misconceptions.

METHODS

This study is a pre-experimental study using a one-group pretest-posttest research design. This study process is shown in Figure 1.

Also, the subjects involved in responding to DSCC were middle school students who had learned the concept of energy, specifically 114 students from two sub-districts.

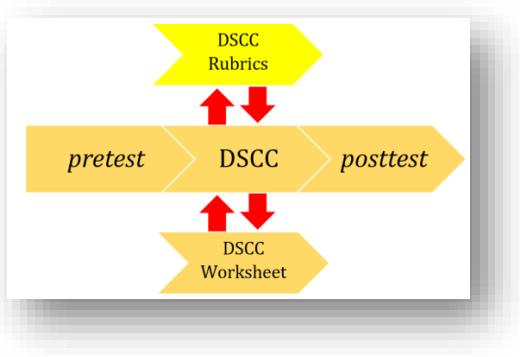


Figure 1. Research Process Chart

The instrument used to measure digital stories is the observation rubric. To measure the extent to which the reduction in the number of misconceptions, an instrument in the form of a four-tier test (FTT) was used. To determine the students' misconceptions, the researcher refers to the scoring proposed in the previous version designed by Muliyani & Kaniawati (2015) with modification from three-tiers to four-tiers questions. By referring to this decision, the results of the analysis of student answers will be matched to the content of table 1. The calculation to know the extent of the reduction in students' misconceptions refer to equation (1). In the analysis process, the researchers adopted an argument that a student is categorized to have misconceptions if they give the wrong answer either on tier-1 and/or on tier-3 (Muliyani, 2018). The incorrect conceptions or partial/incomplete conception before getting scientific information that the definition is contradictory to the scientists' definition belongs as a misconception. Most of the term in daily life is not the same as the term in the scientific field. The subject matter in class is not enough to represent their beliefs on surrounding events (Aydın, 2017).

Table 1. DQM category

Tier-1	Tier-2	Tier-3	Tier-4	Decision
R	C	R	C	Scientific conception
R	UC	R	UC	Lucky guess
W	UC	R	UC	Guess
R	UC	W	UC	Guess
W	UC	R	C	Guess
R	C	R	UC	Lack of Knowledge
R	UC	R	C	Lack of Knowledge
R	C	W	UC	Lack of Knowledge
W	UC	W	UC	Unknown Concept
W	C	R	C	Misconception
W	C	R	UC	Misconception
W	C	W	C	Misconception
W	C	W	UC	Misconception
W	UC	W	C	Misconception
R	C	W	C	Misconception
R	UC	W	C	Misconception

Explanation:
R: right
W: wrong
UC: uncertain
C: certain

The results of FTT answer analysis were calculated by adopting the DQM equation by Kurniawan et al., (2016) and the results were immediately categorized according to Table 2.

$$DQM = \frac{\%\,pretest - \%\,posttest}{\%\,pretest - \%ideal} \times 100\% \qquad (1)$$

(Kurniawan et al., 2016)

DQM = the percentage of students' misconceptions decreases.
% ideal = 0 (percentages of the number of students' misconception).

Tabel 2.DQM Category

Categories	Interval of DQM
Low	$0 < DQM \leq 30$
Medium	$30 < DQM \leq 70$
High	$70 < DQM \leq 100$

(Kurniawan et al., 2016)

The researchers summarized some research related to the concept of physics

that is a misconception. For this study, the physics subject tested was the concept of energy with the distribution of misconceptions as shown in table 3.

Table 3. Distribution of Misconception

Misconception	Operational definition
Mis-1	If the speed of a moving object is doubled, then its kinetic energy is also doubled
Mis-2	Gravitational potential energy only depends on the height of the object.
Mis-3	Every motionless object has no energy
Mis-4	the only form of potential energy is gravity

To measure the digital story in this study, an instrument was designed in the form of a rubric to measure the Story Aspect (SA) with indicators according to Table 4.These indicators are designed and adjusted based on the needs of physics lessons.

Tabel 4. Indicator of Story Aspect (SA)

Story Aspect	Operational definition
Chronology of events	The relevance of the sequence of events
Location of events	The selection of the store location

The assessment of each SA indicator is in the form of scale that comprised of 1 (Less), 2 (Enough), and 3 (Excellent) of the holistic approach proposed by (Troitschanskaia et al., 2019). This assessment divides some criteria to sub-criteria that integrated each other (Zlatkin-Troitschanskaia, Shavelson, Schmidt, & Beck, 2019). Holistic assessment concern with some criteria that each item has a minimum and maximum score (Metruk, 2018). All of the results were analyzed and converted into percentages.

For example, the scoring summary of the SA indicators can be seen in table 5. This scoring method is effortless, quick, and accurate to assess the DSCC.

Tabel 5. Scoring Guidelines for Story Aspects

Story Aspects	1	2	3
Chronology of events	The flow of events is not logical and or not related	The flow of events is logical but not related.	The flow of events is logical and has a close relationship
Location of events	The location is incorrect and does not add information	The location is right but doesn't add information	The location is correct and added information

RESULTS AND DISCUSSION

The data collection process was begun by giving students a pre-test before the DSCC implementation. While DSCC was being shown in front of the class, the students had written their opinion on the provided assessment sheet. After this sheet was collected by the teacher, the student finished this stage with a posttest. The DSCC in this study included the learning process at the time of treatment because of its nature as a learning media so that the implementation is flexible. Based on the results of data analysis by using equation (1), it can determine the number of students who have misconceptions both before learning and after learning. The results are shown in Figure 2.

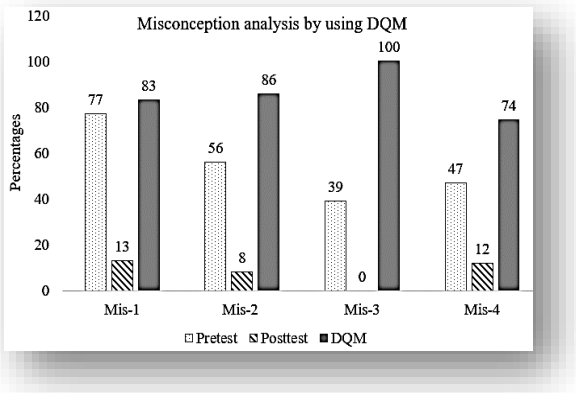


Figure 2. Misconception Analysis by Using DQM Equation.

Figure 2 shows that the implementation of DSCC reduces all of the misconceptions. Refers to table 2, all of the misconceptions decreased in the high category (> 70%). The largest decrease is in the Mis-3 which achieves an ideal condition (0% of students' misconceptions). The processes repairing the misconception by using a sample of DSCC are shown in Figure 3 and Figure 4.

Figure 3. The DSCC Implementation Scene 1-2 (Indonesian version)

Figure 4. The DSCC Implementation Scene 3-7 (Indonesian version)

Furthermore, the results of the assessment of DSCC were assessed based on the story aspect (SA) indicators by adjusting the three categories, such as: excellent (3), good (2), and bad (1). Each value must refer to table 4. Only the DSCC that meets all the requirements of SA could have maximum scores.

Figure 5 shows that chronological events were is dominant at a good category and the location of events is at the excellent category. This is linear with the results of the FTT which still leaves few students with misconceptions. There were 30% of the total students stated that both the chronological events (20%) and location of the event (10%) were difficult to understand. The hardest part of the Digital story was recording/identifying the information based

on the displayed story. This result is supported by Yildiz Durak (2018), who states that the most disliked part is capturing stories/ messages from the digital stories. In other words, the difficulties in finding the concept/information are linear with student confusion by assessing/observing the DSCC presentations (in this case, chronological and location). Therefore, the students' needs are a priority in learning using the concept of technology integration design. Another factor that indicates relevant to this limitation is the display duration. Some DSCCs need a duration of about 1 minute – 2 minutes. It could affect the respondent that almost of them in the age range of 13-15 years old, thus, their readiness ability may differ between one another (Balaman, 2017).

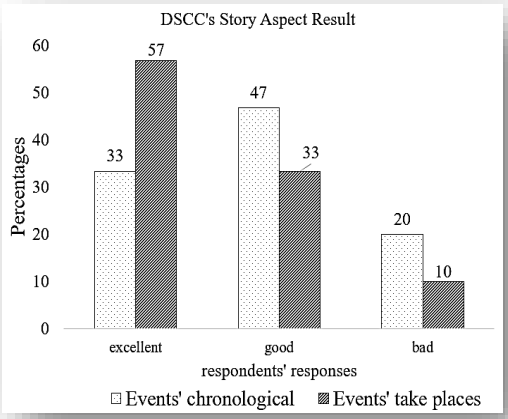


Figure 5. Story Aspect of DSCC

The decrease in students' misconceptions has been predicted because DSCC is designed to break students' beliefs. Psomos & Kordaki (2015) state that the storytelling technique could be learning media to solve misconceptions.

This result implies that digital story content is very innovative, the learning goal is clearly illustrated, the media very easy to operate, can support learning because it increases students' interest, increases students' activity, and increases students' skills(Batsila & Tsihouridis, 2016).

Almost all of the learning process in the use of digital stories is fun and entertaining except in finding the main information/concepts presented in the story (Yildiz Durak, 2018). Moreover, activities in DSCC allow the students to analyze the phenomenon at the time, investigate digital sources, and able to make a decision and solve problems collaboratively in class (Vivitsou, Niemi, & Kallunki, 2017).

The highest misconception (13%) is at the Mis-1 with the statement"if the speed of a moving object is made double, then the kinetic energy also increases twice". This is due to students' thinking that tends to believe without further understanding the statement that moving objects must have kinetic energy (Kurniawan, 2018b). Also, students often analogize everyday phenomena in an event but, the case is not the same (Kurniawan, 2018a).

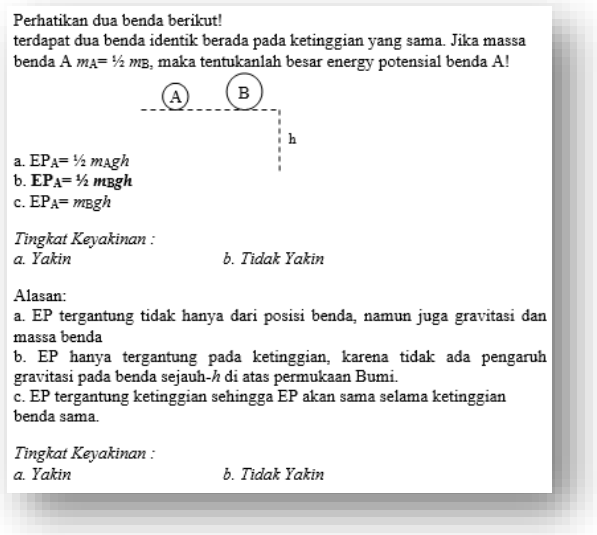
In terms of DSCC, the integration of DSCC into a particular learning model can also lead to not achieving ideal conditions (0% misconception). Although the whole process of the digital story is planned carefully, the selection of learning model references should be considered for the achievement of optimal results (Hussain & Shiratuddin, 2016). As stated as at the beginning of this article, the digital story in the prior studies was not focused on the physics subject, but it focused on the English subject, literacy, English language art (Maddine, 2014; Nassim, 2018; Prins, 2017) especially in misconception topics. Thus, this result could be basis data for the improvement of DSCC in another physics subject. The result of this study belongs to the outstanding category (Hussain & Shiratuddin, 2016) because these digital stories (DSSC) implement the scenario of learning models. The achievement of DQM's category is in the high category.

The finding in Figure 5 also shows that the location aspect is the aspect of the negative vote. After further identification, it is known that the majority of respondents wanted an explanation that is displayed clinically, for example in the form of a free diagram that reinforces the explanation of

the information contained in Figure 2. Technical-related materials certainly inhibit students because the information displayed is not fully understood by students. This technical issue also becomes an obstacle because the process of using digital stories is very closely related to the absorption of information. (Nassim, 2018).

The sample of the instrument used to diagnose misconceptions is shown in Figure 6.

Misconception:
The potential energy depends on the object's height only.
Item indicator:
Determine the net potential energy with a different mass on the same height level.


Perhatikan dua benda berikut!
terdapat dua benda identik berada pada ketinggian yang sama. Jika massa benda A $m_A = ½\ m_B$, maka tentukanlah besar energy potensial benda A!

A B h

a. $EP_A = ½\ m_A gh$
b. $EP_A = ½\ m_B gh$
c. $EP_A = m_B gh$

Tingkat Keyakinan :
a. Yakin *b. Tidak Yakin*

Alasan:
a. EP tergantung tidak hanya dari posisi benda, namun juga gravitasi dan massa benda
b. EP hanya tergantung pada ketinggian, karena tidak ada pengaruh gravitasi pada benda sejauh-*h* di atas permukaan Bumi.
c. EP tergantung ketinggian sehingga EP akan sama selama ketinggian benda sama.

Tingkat Keyakinan :
a. Yakin *b. Tidak Yakin*

Figure6. Example of Diagnostic Test (Indonesian Version)

CONCLUSION AND SUGGESTION

Based on the results and discussion, it can be concluded that the DSCC as a learning media has successfully reduced misconceptions within the high category, more than 70%.

In further research, it is recommended to consider the development of DSCC that is adapted to the learning model that will be used so that students who are still misconceptions become zero. The DSCC presentation should display physical elements such as the systematic solution of physics problems through the representation of force diagram drawings or the like.

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AUTHOR CONTRIBUTIONS

YK conceptualizes ideas and designs research designs. RM makes media and research instruments. YK and SN analyzed the data and performed calculations. SN records the results and writes the discussion.

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