Momentum: Physics Education Journal
7 (2), 2023, 290-298
Available at: ejournal.unikama.ac.id/index.php/momentum
ISSN 2548-9127(print) | 2548-9135 (online)

Optimization of web-based physics learning technology through on-demand microlearning video download facility in an internet accessibility variation case

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Received: 19 May 2023; Revised: 16 June 2023; Accepted: 26 June 2023

Abstract: The research aims to see effectiveness through the perception of optimized physics learning web design through the development of on-demand microlearning video download facilities in diverse areas and access devices. Physics learning through web design, despite success in a variety of online learning methods, has major constraints on personalized learning. Individually, students have a variety of access devices and are in areas with a variable learning environment topology towards internet access. Agile development methods were developed to develop on-demand video download features on the physical learning web, and the development results were tested on MI-Ar Raudhah students based on characteristic compatibility. The development of the on-demand and simplified physical learning video download feature using microlearning is very effective for accessing students with varied Internet access devices and topologies.
Keywords: accessibility; video learning; agile methods

How to Cite: Praherdhiono, H., & Prihatmoko, Y. (2023). Optimization of web-based physics learning technology through on-demand microlearning video download facility in an internet accessibility variation case. *Momentum: Physics Education Journal*, *7*(2), 290-298. https://doi.org/10.21067/mpej.v7i2.8527

Introduction

Teaching celestial objects in learning Natural Sciences to elementary school age students is a strengthening of imaginative scientific knowledge. Content of celestial objects such as the sun, moon, planets, galaxies and their use can help build a foundation of knowledge, interests and scientific thinking in students (Profitiliotis & Theologou, 2023). The learning process of the celestial objects provides an opportunity for them to explore the amazing universe and deepen their understanding of the wider world. Through learning the concepts of these celestial objects, elementary school-age students can also gain a basic understanding of the celestials, develop an interest in astronomy, and associate science with the context of observation and the way they view the sky.

Learning about heavenly objects in elementary school can provide an integrated and cross-disciplinary learning experience. The contents of the celestial objects in Natural Sciences can help students understand and associate concepts in a broader context (Herder & Rau, 2022). Students will gain concrete insight into mathematical symbols related to size, distance, period, scale, comparison, and even time. Students can develop their imagination by drawing, painting, or creating works of art based on images of the universe and celestial objects. In the field of technology, astronomical content can describe the use of technologies such as telescopes, satellites, or spacecraft.

The availability of learning media in physical education requires a proper video learning environment. A video-based physics learning environment is able to visualize concepts through animation, simulation, or practical demonstration, thus facilitating understanding (Abdulrahaman et

DOI: 10.21067/mpej.v7i2.8527

al., 2020; Mulhayatiah et al., 2022). The learning environment through video requires engineering to visualize real-life examples of the application of physics to life and real-world situations. The condition of the student generation strongly requires personalized learning, flexibility, and accessibility in the learning environment. Individual videos are able to keep track of their learning speed. The provision of video media is an attempt to facilitate physical learning.

Learning videos are needed in constructing student learning psychology based on physical learning. Physics learning videos are constructed to be an additional source of fun, thus enriching physical learning material (Saurabh & Gautam, 2019). Students gain learning experience by watching video experiments, demonstrations, or conceptual explanations from different sources at the time of class, thus gaining a broader perspective on physical material. The psychological construction obtained is motivating and enhancing interest. Using video can help boost children's interest in physics. Psychology in learning is crucial in an effort to make learning more interesting and enjoyable.

Although the video learning environment for learning physics in theory and practice has many advantages, it still has many weaknesses. Learning video developers are making an abstract visualization revolution too exaggerated. The video has excessive duration and material. Thus, the purpose of the video is to make the concepts of physics easier to understand, which in fact causes children to lose their understanding of the underlying phenomena in physics. Misinterpretation occurs in an animated video that does not give simplicity to the representation of visualization, so that it is not accurately associated with complex concepts (Bonus & Watts, 2021). The main reason is the lack of interaction in video learning that doesn't pay attention to duration in animated video development. Students are just spectators, and there is no live interaction for too long. Therefore, the video-based learning environment is often claimed to have a weakness in direct interaction that deeply undermines the mastery of physical concepts.

The need for interaction in online learning activities seemed to be a weakness of the physical learning video medium. However, learning is an attempt at cognitive confirmation in students. It should be noted that animated videos may not always be able to provide adequate context or a direct correlation with real life. This is due to video learning is not developed based on microlearning potential. As a result, the length and simplicity of the video actually weakened the context of learning. But the right context must be able to confirm the student's cognitive abilities so that it can help the student understand the relevance of physics in real-world situations (Zendle et al., 2018). If animated video does not pay attention to microlearning, then the context relevant to student cognitive enhancement only stops at the provision of purely scientific entertainment. Naturally, interaction occurs when students and teachers are in the learning process. So video learning technology is considered unable to provide direct and individual feedback that is specific to each student, as usual in learning. In the video, the physics learning that happens is a cognitive confirmation interaction. The cognitive development of students is heavily dependent on the fulfillment of the needs of different levels of student understanding. So the weakness of video learning physics is not being able to directly adapt learning to the individual needs of students, not because of the lack of interactiveness in video.

Web-based media has the potential to be a learning environment for physical learning. The ease of video storage is the main reason. For example, social media enables a learning video storage platform in a very simple way. Uploaded learning videos can be accessed at any time by students or other users. Web-based learning media such as video storage allow easy access and flexibility in organizing, managing, and sharing learning materials (Alonzo & Kim, 2018). The potential is not beyond the broadcasting capabilities or the distribution of learning videos to a wider audience. Through the sharing or repost feature, learning videos can be easily distributed to other users through a web-based learning media platform. The main obstacle is that physical learning videos placed on social media require high-bandwidth internet access. Slowing or stumbling over the screen will interfere with the students' cognitive confirmation.

The potential of web-based learning media is multiplatform accessibility. Web technology has the potential to be accessible through a variety of devices (Neelakandan et al., 2020; Suwadi & Lam, 2020). Thus, the learning device configuration can be adapted to the user's ownership of a computer, smartphone, or tablet. Web-based learning media facilitates the accessibility of learning videos for students or other users at various places and times. The use of multiplatforms allows students to learn through video learning in the most comfortable environment and according to their preferences.

Physics learning videos on web-based media are an attempt to shift student dependency on learning technology preparation. Preparation of student learning environments through interactive video in an attempt to get students into learning (Yoon et al., 2021). The use of animated video in physics learning has always focused only on providing adequate technological devices, such as computers, tablets, or projectors (Saputra & Kuswanto, 2019; Syefrinando et al., 2022). Thus, learning developers are strengthening their reliance on the use of technology. Dependency on the provision of technology is a new barrier if not all students have the ability to access learning devices. So physical learning videos on social media are needed as physical learning technologies to reduce dependence on learning devices.

MI Ar-Raudhah is a school with characteristics of mountainous and marginal areas. Marginal schools generally have varying economic conditions, resulting in proper ownership of learning equipment varying considerably in terms of quality. This condition contributes to the use of highly varied access devices. Besides, mountain topology is one of the barriers to internet access (Canfield et al., 2019). MI Ar-Raudhah students are scattered in the mountainous areas, causing internet access conditions to vary significantly. The topology of areas with mountain contours causes Internet access services not to be evenly distributed.

Several studies have found that including video and audio on the web makes the learning environment more integrated. The emphasis of the research studies is on increasing user interaction with video media through simple navigation (Wong & Reimann, 2009). Web-based interactive asynchronous video learning is employed as the platform. Web-based video research was also conducted to assist meaningful learning, such as practical accessibility, information flexibility, and integrating asynchronous on-demand learning videos into interactive resources (Admiraal, 2013). The value of cognitive confirmation interactions was demonstrated in research on the usage of web-based video learning environments. Over the last five years, research into the use of video as learning content in a web-based learning environment has had an impact on how students perceive interactions and experiences in video learning (Pimentel et al., 2019). Asynchronous on-demand learning films that are personalized to students' requirements and circumstances will enhance the student experience and access efficiency. According to research results, strengthening students through the use of video media in learning environments can lower cognitive load scores and lead to more predictable progress.

The purpose of this research is to determine the effectiveness of physical learning content incorporated on a website using the micro-learning approach of download facilitation on video on demand. The website has download options to accommodate differences between devices and locations. It is raising awareness of the value of using the internet to learn physics.

Method

The video learning development method used in this study is agile methodology as a standard for developing a new learning environment. Agile development methods are adapted to the need for new technology development to open up new possibilities (Otero et al., 2020). The development aimed at building easier access to information. Agile development methods aim to find new ways to help learners through the learning journey while improving their motivation. Methods prioritize the quality of the output, the readiness of the product, and the speed of development (P. Abrahamsson et al., n.d.). Agile development methods focus on surveys to validate and enrich development results (B. Hobbs & Yvan Petit, n.d.). Figure 1 depicts the procedures taken in generating the complete substance of physical revelation (video).

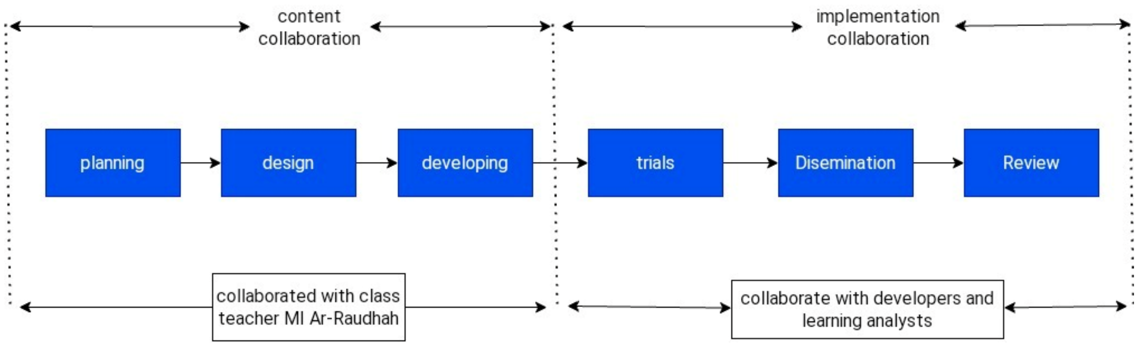

Figure 1. Development stages of interactive video learning

The first stage was planning. The planning phase involved an analysis of needs, objectives, and a clear understanding of the learning video to be developed. The video development team collaborated with the Natural Science teacher on the physics theme at MI Ar-Raudhah Lawang to delve into the content to be taught and set specific learning goals. In addition, at this stage, it is also necessary to determine the format, duration, style, and approach to be used in the video.

The second stage was designing. After planning through collaboration with the class teacher at MI Ar-Raudhah, the design stage was carried out to design the structure, format, and learning video content. This design plan included the sequence of content, visual settings, narratives, and interaction scenarios that would be used in the video. Design also involved the selection of visual elements, animations, graphics, or other interactive instruments that would be used to clarify and facilitate students' understanding of physical concepts.

The third stage was developing learning environment. Once the design was approved by the MI Ar-Raudhah class teacher, the development phase began. Development involved creating visual content, recording narratives, adding animations, and editing videos according to a design plan that has been set. The development team was working to produce a learning video that matches the learning objectives and follows the established quality standards.

The fourth stage was product testing. After the learning video was developed, the validity test phase was carried out to check the quality, validity, and effectiveness of the video. To test the focus of the video development research, aspects such as student understanding, clarity of content, student involvement, and matches with learning objectives were taken into account. Tests involved students or test groups representing the target audience. Based on the test results, the video can be fixed and adjusted if necessary.

The fifth stage was disseminating the product. After passing the test and improvement phase, the learning video was ready for dissemination. The dissemination phase involved the delivery of video to the target audience. Videos could be distributed through online learning platforms, social media, websites, or other relevant distribution channels. It is important to ensure video accessibility and provide clear instructions to students about the use of video in physics learning.

The sixth stage was reviewing the results. The review stage was carried out after the learning video was used by the students or users. The development team would collect feedback and evaluations from students, teachers, or other related parties about their experiences using the learning video. This information was used to review the video, identify improvement areas, and make adjustments if necessary.

Results and Discussion

Development of web-based learning design with micro-learning physics learning video on Figure 2 was based on the results of planning revisions. The development is a revision of the previous development of web-based learning media. However, there is an analysis that needs to be done further. As far as the plan is concerned, it is to facilitate the need for differential internet access. Differences based on topology of mountain contours in students at MI Ar-Raudhah. Specifically, the development is a video study of astronomical physics as shown in Figure 2. The design development area is based on collaborative outcomes referring to learning systems that prioritize storage on student devices. The video features an open content of animated video as its primary content for learning and teaching astronomical physics. Animated videos are segmented into video clips lasting about 5 minutes, in accordance with the sub-topics discussed (Hill et al., 2022). Animated video will have the advantage of flexibility if done through on-demand broadcast techniques in a way downloaded (Pereira & Tam, 2021), as it is versatile for learning and teaching and is almost freely accessible by students anywhere (Lam & Chan, 2021). From other research, one of the main disadvantages of the synchronous mode learning process is that the effectiveness of the delivery of material is heavily dependent on the quality of the internet connection (Azlan et al., 2020; Cao et al., 2020; Odriozola-González et al., 2020). Poor connections can lead to learning disruptions, and this affects the quality of learning.

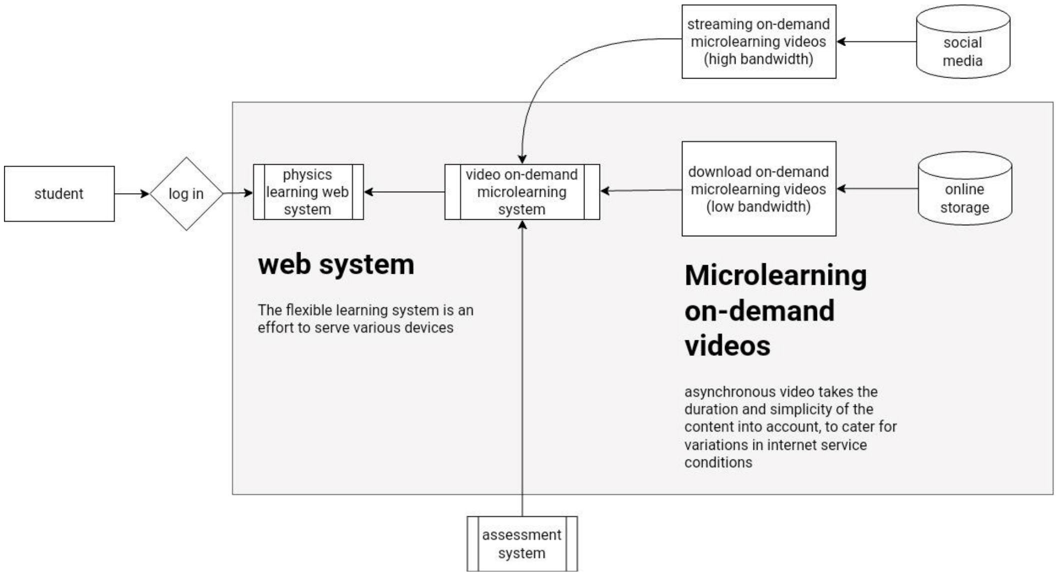

Figure 2. Design of Physics Learning Video

The development using agile method has successfully constructed a physics learning video to be placed on online storage. The video placed in the online storage is the video bumper and the content. Figure 3 is one of the web contents (videos) produced, with solar eclipse material. The video was developed with powerful animated display reinforcement. The interaction was done by putting the narrator's technical exploration. Each video consists of two stages namely the bumper and the content. The results of the video is seen in Figure 3.

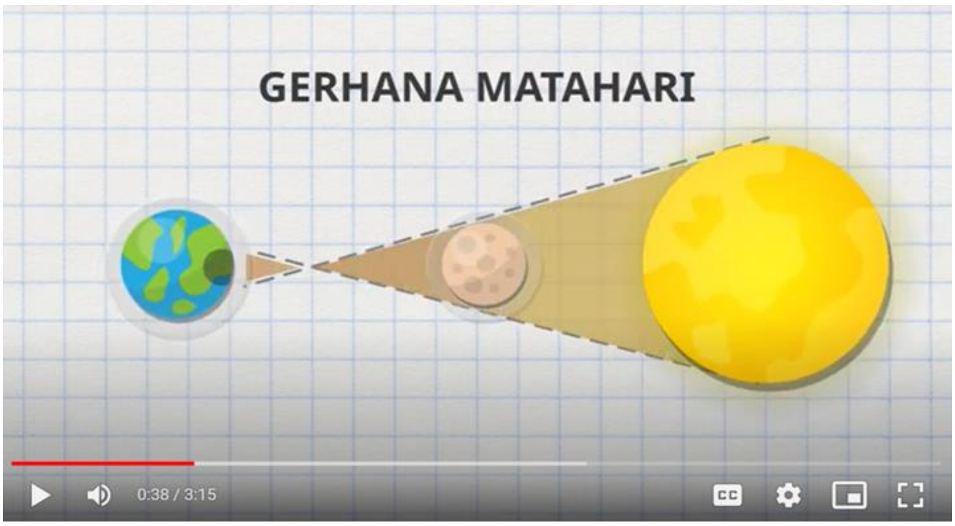

Figure 3. Results of Solar Eclipse Video

Implementation of video learning development Physics nowadays, with its separate concepts, turns out to have some advantages and weaknesses at the time of accession. The advantage of a separate system is that it can overcome accessibility constraints. Not all students at MI Ar-Raudhah have equal access to the devices and internet connections required to access video learning. Even in the same area, it turns out that the infrastructure and technology used to access video have become very varied. This technology is able to overcome the gaps in accessibility and unequal learning opportunities among students. The physics learning media web allows for delivery mechanisms, tracking student activity and evaluation, and providing access to digital resources (Azlan et al., 2020).

The advantage of on-demand video through the download feature is the ability to remove the barriers of technology access capability variation. Although students and parents at MI Ar-Raudhah School are constantly following up on the evolving technology, there is still a possibility of technical problems that may occur during the use of video learning due to the geographical location of the mountains. However, with separate technology, problems such as slow buffering, playback failure, or incompatibility with a particular device that can hinder the student's learning experience can be solved well.

The popularity of video learning with astronomical physics content has high flexibility. Theoretically, video learning can be categorized as 1) video that can be run anywhere without the need for internet, 2) having context suitability, and 3) having the ability to adapt to video devices on mobile. Video development is adapted to m-learning development. M-learning research with video content has the greatest impact on the learning process (Quesada-Pallarès, 2019). Animated videos make physics learning more lively and realistic, making learning interactive, easy, and fast. Animation content development sets out the importance of video-based learning and m-learning in smart learning while discussing the basics of the environment and smart learning requirements. Frameworks and models for intelligent learning are presented. Streaming video adaptation models are also proposed for mobile devices. Based on the model, an interactive video-based smart learning system has been designed that allows live video streaming of lecture sessions as well as recordings that offer interactive learning and teaching experiences. This application supports mobile devices and desktop computers. This model was practically implemented with a group of students, and their feedback showed a high level of acceptance of the system, while a fairly large percentage of them acknowledged that the system improved their learning and teaching processes significantly.

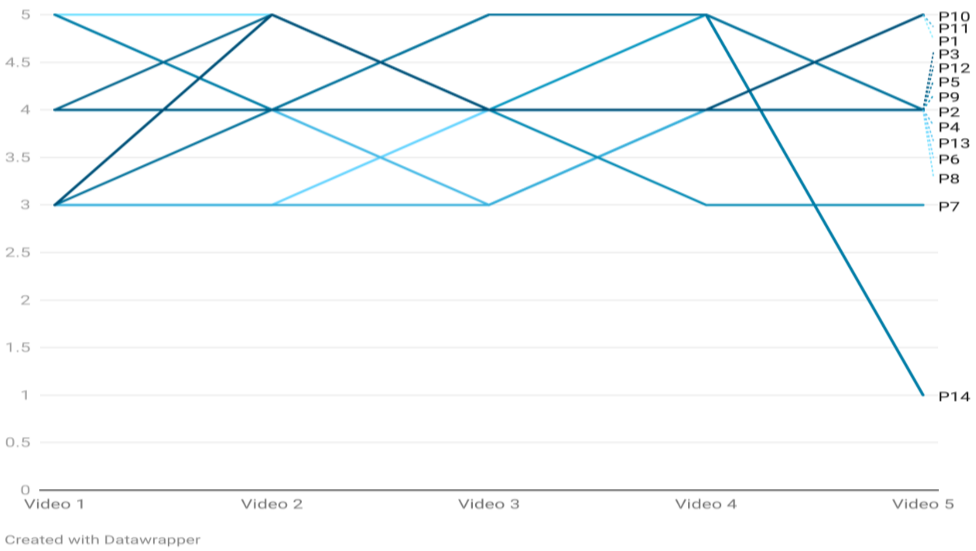

Figure 4. Results of Students Perceptions towards video

Figure 4 shows the results of the treatment-related perception tests. The video perception test was performed by performing perception filling on 14 students at MI Ar-Raudhah. Students who have accessed additional features on the web, like in Figure 2, are given a perception lift on the form. Given that the students are of elementary school age, the perception test was made on a simple scale by giving a perception point of 1 to 5. Point 1 adds useless features, and point 5 adds very useful features. The perception results showed a range of perception values from 3 to 5, and only 1 video by one of the students was perceived as low with a rating of 1. The range describes that the download feature that includes microlearning videos is acceptable, but there are some perceptual variations associated with not only features but also content. The variation in perception of such features, if reflected, is:

1. There is a perception of feature quality that is still related to the varies content. Although there are download features and many learning video resources available, the assessment not only of the feature capabilities but also of the quality of the content may vary. Some videos may be well received by students and meet the desired learning standards. According to the media review results, it may be effective and may only follow the curriculum but not be relevant to the wishes of the student as a whole or be inadequate in explaining the concepts of physics well from the student's perspective. Therefore, it is important for teachers and students to choose and produce videos of good quality.
2. Student perception is still affected by the facility of Direct Interaction performed by teachers during classroom learning. In learning Natural Science related to astronomical physics, direct interaction between teachers and students is still considered important to explain complex concepts or answer students' questions in real-time. Given that the web-based learning facility is still new, despite having been given the download feature, content for video learning is still perceived as not providing the same interactive experience as live interaction in the classroom. Thus, video learning is still seen as a barrier to understanding and actively solving physics problems.
3. Students with low perceptions are still unable to distinguish between features and content. It shows that microlearning physics learning videos with additional navigation download features tend to provide a new learning experience rather than learning methods that involve student active online involvement in general, such as group discussions or practical experiments. This can affect the level of student involvement and their activity in understanding the concepts of physics.
4. Evaluation Challenges: Evaluating and assessing learning are also a challenge in the implementation of video learning. Although the rating is a download feature, the option to ask survey questions is still perceived to be related to content or is sometimes difficult to ensure a comprehensive understanding of students and provide feedback to the system given the age of primary school.

The variation of perception in the learning system of video learning physics is becoming important to note. In-depth research is needed so that developers realize the weaknesses in finding suitable solutions, such as ensuring wider accessibility, improving the quality of content, combining diverse learning methods, and ensuring proper interaction and evaluation.

Conclusion

The development of web-based learning videos is merely a solution to physics learning for device variation cases, but the inclusion of on-demand download features to physical learning videos can aid decrypt access to content. Astronomy and physics learning video footage embedded in a web-based system is very adaptable to a wide range of devices. The on-demand video access process, streaming, is difficult in the mountain topology area since the access position impacts the user's internet connection speed. As a result, the need for interactive video-based physics learning necessitates the inclusion of a download function for on-demand video content. Long download times and big download files are exacerbated by microlearning. Students' perceptions of download features on on-demand video learning physics show improved access. The download capability on the on-demand film, according to the student, is beneficial to astronomical physics learning.

The microlearning on-demand learning content has been built by presenting it as a little piece of physical learning video content that substantially improves student perception. The use of on-demand micro-learning has the potential to create new educational possibilities to enhance learning in a number of scenarios. Furthermore, the video used by the device's student owner enables for the integration of streaming and downloads. The incorporation of video streaming and download is an attempt to increase student involvement and participation in the creation of active learning experiences based on alterations in the topological contours of the learning environment.

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