Technology, Knowledge and Learning
https://doi.org/10.1007/s10758-024-09768-9

EDITORIAL

Advances in Video Analytics

Muhittin Şahin[1]

Accepted: 16 July 2024

Abstract
Learners interact with content, assessments, peers, and instructors in digital learning environments. Videos, which are popular due to internet technologies, capture learners' attention, boost motivation, and enhance learning. Learning analytics broadly optimize educational environments by analyzing data, with video analytics focusing specifically on video interactions to enhance learning outcomes. Video-player interactions (e.g., play, pause) and video content interactions (e.g., true-false questions) provide insights into learner behaviors. Lack of interaction is a major reason for high dropout rates in video platforms and MOOCs. Video analytics can help address this issue by analyzing and improving engagement with video content. This special issue has a specific focus on video analytics and impact of this field to the learning experience. Four articles were included in this special issue. The findings reveal that I) the type, length, and purpose of the video are important for student engagement, ii) important tips on video-based learning design are presented, iii) when interacting with the video player, pause, play, rewind and fast forward are the most commonly used interaction types., iv) providing more information about video interaction processes with dashboards would provide much more insight, and v) dividing the videos into more than one section both creates the perception of better structuring of the process and the segmentation of the videos contributes more to learning.

Keywords Video analytics · Learning analytics · Learning experience · Video player interaction · Video interaction

1 Introduction

Learners can interact with content, assessment, peers, and instructors in the digital learning environments. In terms of content, learners interact with content such as videos, textual content, infographics, presentations, drag and drop materials. Videos are the primary con-

✉ Muhittin Şahin
sahinmuhittin@gmail.com

[1] University of Mannheim, Mannheim, Germany

Published online: 05 August 2024

tent type that use by the instructors in the digital learning environments (Seo et al., 2021). On the one hand, it is seen that internet technologies facilitate and popularize the use of video (Ronchetti, 2013; McCarthy, 2010), on the other hand, videos attract the attention of learners, increase their motivation and improve their learning (Yoon et al., 2021; Lemay & Doleck, 2020; Mbouzao et al., 2020; Yousef et al., 2014; Kay & Kletskin, 2012; Cruse, 2006; Zhang et al., 2006). In addition to these studies, there are also studies in which video preferences according to their gender (Sahin & Ifenthaler, 2021; Ching & Hsu, 2015) and learning control of videos (system-paced or learner paced) (Schroeder et al., 2020; Schroeder & Adesope, 2015). In this context, determining the learning patterns in the videos provide important clues on how to increase students' success, engagement, motivation, and satisfaction. At this point, video analytics, which is a sub-concept of learning analytics and focuses on latent patterns and data in video interactions, provides important insights.

Learning analytics is defined as the analysis and assessment of data from digital learning environments in order to optimize learning environments and processes and make educational decisions (Ifenthaler, 2015). Learning analytics is considered as an umbrella concept and can be named differently depending on the source from which the data is collected. For example, if the educational data is obtained from assessment processes and includes the optimization of these processes, it is referred to as assessment analytics (Sahin & Ifenthaler, 2024), and if it is obtained from video processes and includes the optimization of these processes, it is referred to as video analytics. Video analytics aim to optimize both videos and learning processes with the data obtained from interaction with video. The important point here is the source from which the metrics in the educational processes are obtained. Learning analytics include improving learning outcomes, success, providing support, designing customizable learning processes, supporting decision-making, providing real-time feedback, and visualization (Sousa et al., 2021; Ifenthaler & Yau, 2020). Within the scope of these purposes, video analytics enable the development of learning processes based on video interactions.

Improving learning by discovering patterns from video behaviors is expressed as video analytics and video analytics is defined as collecting, measuring, and analyzing of video data in order to understand to learners video engages (Mirriahi & Vigentini, 2017). Learning behaviors/patterns of learners in the digital learning environments can be determined and analyzed in order to diagnostic, prediction, treatment and prevention (Yang, 2021). The first step is determining of the learners' behavioral patterns. In this context, video interactions provides important information about learners' behaviors. Video interactions can divide two types such as video-player interaction and video content interaction. Video-player interactions consist of play, pause, backward, forward, skip, close, full screen, subtitle, transcript, etc. Analysis of video-player interaction may provide information about learners' engagement behavior in the video (Seo et al., 2021). On the other hand; true-false questions, interactive elements, content tree, guidance in the videos can be structured as video content interactions (Kleftodimos & Evangelidis, 2016). It is stated that the lack of interaction in video environments is the major reason for the dropout rate on video platforms (Chatti et al., 2016). This high dropout ratio also stands out as the most important problem in MOOC environments (Hidalgo et al., 2020; Jacobsen, 2019; Zapata-Ros, 2014). Video analytics offers researchers a very important opportunity in order to sort this problem out.

This special issue has a specific focus on video analytics. With this special issue, it is planned to present important tips to stakeholders such as researcher, instructor, learner,

administrator, and etc. and to be a guide. The tentative topics for the special issue are as follows:

- Determining learning behavioral patterns according to the video interactions.
- Approaches to identify learners' learning behavioral patterns.
- Learning and instructional design for video analytics.
- Intervention and feedback design for video analytics.
- Visualization and dashboard design for video analytics.
- Challenge and future directions of video analytics.

2 Paper Selection Process

The call was launched through regular channels in December 2021. Until January 15, 2022, nine abstracts were submitted by authors wishing to contribute. After the editorial review, five abstracts were accepted and a call for full texts was sent to the authors on January 31, 2022. Full texts were prepared by the authors until April 30, 20,222 and uploaded to the journal submission system. After this stage, the peer review process started. The reviews were made in two main cycles. After the final reviews, four articles were included in this special issue.

3 Contribution to Special Issue

This special issue starts with a systematic literature review on predictive video analytics by Ozan Rasit Yurum, Tugba Taskaya-Temizel and Soner Yıldırım. In the study, 77 studies conducted with predictive video analytics between 2011 and 2023 were systematically analyzed. After 2016, it was found that there was a significant increase in research and especially reached its maximum in 2020. The most commonly used video metrics are pause, play, backward, forward, and speed change, respectively. The most predicted output variables are performance and dropout. On the other hand, support vector machine, random forest, logistic regression, recurrent neural networks, and k-nearest neighbors are the algorithms used for prediction based on video data.

The second research is the video analytics xAPI for Moodle developed by Sven Judel, Jasper vom Feld and Ulrik Schroeder. The research contains information and findings about the first iteration of the video analytics system called Video Analytics for ModdlE (VA4ME). Video started, video paused, video resumed, video finished, video restarted, seeking, playback rate changed, and vlone changed are logged and used by the system. Based on these metrics, the audience retention, media starts, seek-analysis, and playback rate engines are run and then presented through dashboards. Information about these processes and their dashboard and visualizations are presented in detail within the scope of the study. After the system was developed, it was tested with real users and the preliminary findings are included in the research. It was determined that the usability of the dashboard was at a good level and would provide more insights if the amount of data was increased. Finally, the limitations and future directions of the research are presented.

The third study by Mohammad Khalil, Paraskevi Topali, Alejandro Ortega-Arranz, Erkan Er, Gokhan Akcapinar, and Gleb Belokrys investigated the video behavior of learners in different countries. In the context of SPOC, MOOC, and postgraduate university course, learner behaviors in three different countries and three different platforms were comparatively examined. In the study where 3 different cases were examined, click stream data on all platforms were used as log. When the findings are examined, firstly, it is seen that video behaviors provide meaningful and similar insights. On the other hand, content type, length and purpose of the video are other important findings that have an impact on learner engagement. Basically, it was stated that learning design should be taken into account when designing video analytics and video-related issues should be taken into consideration when designing video-based courses.

The last study in the special issue is Niels Seidel's research on advanced video players from youtube. In the study, two main research cases are examined and the processes for these cases are included. In the research, (i) video lengths and segmentation on youtube and (ii) designs were made to structure long videos into segments. The findings revealed that it is a common practice to divide video-based learning resources into multiple segments. On the other hand, segmented videos were found to provide higher learning gains than the unsegmented version of the same video. Participants perceived segmented videos as better structured. Finally, it was found that video length is not very important for learning outcomes as long as videos can be presented in meaningful segments in the video player. Overview of the articles is presented in Table 1.

4 Conclusion

Instructional videos are the most preferred learning material for individuals in digital learning environments. The traces (log data) left by individuals in instructional videos contain important findings for learning and teaching processes. Individuals interact with the video content and the video player in two different ways. This special issue focuses on video analytics that aim to reveal hidden patterns in learning processes and improve processes based on interactions in video and learning processes. In this context, four studies are included in the special issue. The findings of these studies can be summarized as follows:

- The type, length, and purpose of the video are important for student engagement.
- Important tips on video-based learning design are presented.
- When interacting with the video player, pause, play, rewind and fast forward are the most commonly used interaction types.
- Providing more information about video interaction processes with dashboards would provide much more insight.
- Dividing the videos into more than one section both creates the perception of better structuring of the process and the segmentation of the videos contributes more to learning.

In order to take video analytics one step further, the relationship between video analytics and learning theories must first be established. It is necessary to determine the metrics involved in the interaction with both the content and the video player in video processes.

Table 1 Overview of the articles

Author(s)	Keywords	Research Question	Method	Participants	Key Findings
Mohammad Khalil Paraskevi Topali Alejandro Ortega-Arranz Erkan Er Gokhan Akcapinar Gleb Belokrys	Learning analytics Video analytics Video engagement Case study Learning behaviour	University students' video engagement was analyzed in three different countries and digital learning environments.	Case study	Undergraduate students	• The type of content, length, and purpose of the video were found to play an important role in student engagement. • A deeper and more comprehensive understanding of students' interactions with the video was gained, and some of the key issues related to video analytics that need to be considered during the design of video-based learning were shed light on.
Ozan Rasit Yurum Tugba Taskaya-Temizel Soner Yıldırım	Predictive video analytics Online courses Educational data mining Learning analytics Systematic literature review	Examine the use of predictive video analytics in digital learning environments.	Systematic literature review	77 publications	• Pause, play, rewind and fast forward were found to be the most used in-video interactions. • Learner performance and dropout were the most studied variables.
Sven Judel	Moodle xAPI Dashboard Video Analytics	The first iteration of the video analytics system Video Analytics for MoodlE (VA4ME) that enables the logging of video interactions in Moodle without the needs to provide the videos with a separate plugin.	Development research	79 undergraduate students	• A plugin was developed for the Moodle LMS platform. • Insights in the context of video analytics were limited due to low interaction with videos. • The usability level of the dashboard is sufficient. • Providing more data would provide much more insights. • It is recommended to test the developed system with different contexts and working groups.
Niels Seidel	Video Analytics Video Segmentation YouTube Video Player	Examine the video length, segmentation, and design variant for structuring longer videos into segments.	Experimental research	22 individuals	• It is common to segment comprehensive video-based learning resources into multiple sections. • Segmented videos resulted in more learning than unsegmented videos. • Segmented videos were perceived as better structured.

Studies should be conducted on which of these metrics are more important. Conducting these studies cross-culturally will provide much more insights. In addition, investigating whether individuals' video behaviors change according to their individual characteristics and making adaptive designs based on this has the potential to take this research area one

step further. On the other hand, conducting studies on acceptance structures and conducting experimental research on video analytics and presenting evidence will make significant contributions to the development of the video analytics field.

Funding Open Access funding enabled and organized by Projekt DEAL.

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