Interdisciplinary Journal of E-Skills and Lifelong Learning

An Official Publication of the Informing Science Institute
InformingScience.org

IJELL.org

Volume 13, 2017

A LEARNING ANALYTICS APPROACH FOR EVALUATING THE IMPACT OF INTERACTIVITY IN ONLINE VIDEO LECTURES ON THE ATTENTION SPAN OF STUDENTS

Nitza Geri *	The Open University of Israel, Raanana, Israel	nitzage@openu.ac.il
Amir Winer	The Open University of Israel, Raanana, Israel	amirwi@openu.ac.il
Beni Zaks	The Open University of Israel, Raanana, Israel	beniza@openu.ac.il

* Corresponding author

ABSTRACT

Aim/Purpose	As online video lectures rapidly gain popularity in formal and informal learning environments, one of their main challenges is student retention. This study investigates the influence of adding interactivity to online video lectures on students' attention span.
Background	Interactivity is perceived as increasing the attention span of learners and improving the quality of learning. However, interactivity may be regarded as an interruption, which distracts students. Furthermore, adding interactive elements to online video lectures requires additional investment of various resources. Therefore, it is important to investigate the impact of adding interactivity to online video lectures on the attention span of learners.
Methodology	This study employed a learning analytics approach, obtained data from Google Analytics, and analyzed data of two Massive Open Online Courses (MOOCs) that were developed by the Open University of Israel in order to make English for academic purposes (EAP) courses freely accessible.
Contribution	The paper provides important insights, based on quantitative empirical research, on the following: integrating interactive elements in online videos; the impact of video length; and differences between two groups of advanced and basic learners. Furthermore, it demonstrates how learning analytics may be used for improving instructional design.

Accepted by Editor Janice Whatley | Received: August 1, 2017 | Revised: September 24, October 10, 2017 | Accepted: October 12, 2017.

Cite as: Geri, N., Winer, A., & Zaks, B. (2017). A learning analytics approach for evaluating the impact of interactivity in online video lectures on the attention span of students. *Interdisciplinary Journal of e-Skills and Lifelong Learning, 13,* 215-228. https://doi.org/10.28945/3875

An earlier, shorter version of this paper was presented at the Chais conference 2017, in Raanana, Israel, and included in Y. Eshet-Alkalai, I. Blau, A. Caspi, N. Geri, Y. Kalman, & V. Silber-Varod (Eds.), *Proceedings of the 12th Chais Conference for the Study of Innovation and Learning Technologies 2017: Learning in the Technological Era.* Raanana: The Open University of Israel.

Findings	The findings suggest that interactivity may increase the attention span of learners, as measured by the average online video lecture viewing completion percentage, before and after the addition of interactivity. The impact is significantly stronger for the more advanced course. However, when the lecture is longer than about 15 minutes, the completion percentages decrease, even after adding interactive elements.
Recommendations for Practitioners	Adding interactivity to online video lectures and controlling their length is expected to increase the attention span of learners.
Recommendation for Researchers	Learning analytics is a powerful quantitative methodology for identifying ways to improve learning processes.
Impact on Society	Providing practical insights on mechanisms for increasing the attention span of learners is expected to improve social inclusion.
Future Research	Discovering further best practices to improve the effectiveness of online video lectures for diverse learners.

Keywords	online video lectures, interactive video, Massive Open Online Courses (MOOCs), distance learning, students' attention span, learning analytics, attention economy

INTRODUCTION

Online video lectures are becoming a main component of online learning within formal courses and informal learning environments, such as Massive Open Online Courses (MOOCs) (Daniel, 2012; Kalman, 2014; Raffaghelli, Cucchiara, & Persico, 2015; Siemens, Gašević, & Dawson, 2015). Online video lectures have been successfully used for supporting face-to-face learning (Boton & Gregory, 2015; Brecht, 2012; Kinash, Knight, & McLean, 2015; Whatley & Ahmad, 2007; Wieling & Hofman, 2010), as well as in-class learning, e.g., when there is a need to show students visual elements (Ostashewski, Reid, & Ostashewski, 2016). However, online video lectures are not a silver bullet solution for solving the challenges of online learning (Geri, 2011; Guri-Rosenblit, 2009; Lee, 2017).

One of the main drawbacks of online video lectures is that their availability may lead to procrastination, which eventually would cause student dropout (Diver & Martinez, 2015; Geri, 2012; Geri, Gafni, & Winer, 2014; You, 2015). Nevertheless, considering student procrastination tendency during the instructional design stage and adding elements such as mandatory viewing of the online videos throughout the semester was found effective in encouraging timely viewing (Costley, Hughes, & Lange, 2017). Another challenge is the short attention span of the viewers. According to a comprehensive study of MOOC learners, which involved analysis of nearly seven million MOOC video viewing episodes, the engagement time in viewing video lectures was six minutes at most (Guo, Kim, & Rubin, 2014; Kim, Guo, Seaton, Mitros, Gajos, & Miller, 2014; Lagerstrom, Johanes, & Ponsukcharoen, 2015).

Interactivity is a crucial element for improving the quality of online learning (Guri-Rosenblit, 2009; Siemens et al., 2015). Furthermore, empirical studies demonstrated the effectiveness of interactivity in extending the attention span of learners and enhancing their achievements (Cherrett, Wills, Price, Maynard, & Dror, 2009; Dror, Schmidt, & O'connor, 2011). Conversely, interactivity may be regarded as an interruption, which distracts students' attention (Davenport & Beck, 2001; Geri & Gefen, 2007; Pearce, Ainley, & Howard, 2005). On top of that, adding interactive elements to online video lectures requires additional investment of various resources, pedagogical, as well as technological. Therefore, it is important to investigate the impact of adding interactivity to online video lectures on the attention span of learners. Moreover, few studies concentrated on technological tools suitable for MOOCs, and there is a need for more research of tools, such as audio and video broadcasting, which are able to support instruction on a large scale (Raffaghelli et al., 2015).

The purpose of this study is to investigate the influence of adding interactivity to online video lectures on students' attention span. We employed a learning analytics approach (Long & Siemens,

2011) and analyzed data of two MOOCS of English for Academic Purposes (EAP) courses that were developed by the Open University of Israel. We analyzed over 200,000 episodes of online video lectures viewings and compared the viewing completion percentage, before and after the addition of interactivity. Furthermore, we investigated the impact of the video lecture length, as well as differences between the two groups of advanced and basic learners. This empirical paper contributes to understanding how to effectively integrate interactive elements in online video lectures. It also demonstrates the usefulness of evaluations that are based on learning analytics for improving instructional design.

THEORETICAL BACKGROUND AND THE RESEARCH QUESTIONS

LITERATURE REVIEW

This interdisciplinary study is based on concepts from the domains of: cognitive fit theory (Vessey, 1991), student retention in online learning (Ferguson & Clow, 2015; Geri, 2012; Guo et al., 2014; Kim et al., 2014; Lagerstrom et al, 2015), and attention economy (Davenport & Beck, 2001; Geri & Gefen, 2007), and applies them to student viewing patterns of online video lectures.

According to cognitive fit theory (Vessey, 1991), compatibility between task and information presentation format would improve task performance. There are differences among individual students in their abilities to learn independently. Hence, offering them diverse tools from which they can choose those that fit their learning preferences is expected to increase their academic motivation and performance (Chandler & Teckchandani, 2015; Keller & Karau, 2013). Terras and Ramsay (2015) emphasize the importance of considering the diverse psychosocial and cognitive profiles of learners during the design, development, and delivery of MOOCs. Moreover, different types of video lectures have dissimilar effects on the sustained attention and cognitive load of verbalizers and visualizers (Chen & Wu, 2015).

In the context of viewing online video lectures, adding interactive elements is expected to increase student engagement and performance (Cherrett et al, 2009; Dror et al., 2011). Furthermore, in a survey of 246 Chinese students, interactivity was found as positively influencing students' intention to revisit MOOCs (Huang, Zhang, & Liu, 2017). However, adding interactive elements to a video may interrupt the viewing experience (Pearce et al, 2005), and, as the students stop watching the video, they may be distracted and use the break for checking email, answering messages on social applications, or tending to other external requests for their limited attention resources (Davenport & Beck, 2001; Geri et al., 2014; Ramsay & Terras, 2015).

The study of Geri and Gefen (2007) about MBA students' perceptions of the usefulness of various online tools did not examine online video lectures, but its findings revealed that students appreciated mostly summaries of class meeting and presentations, sample exams, as well as task solutions. Students were less interested in interactivity on discussion boards or collaborative tasks. In the same vein, students may not be interested in completing tasks while watching videos, although it is supposedly helpful.

Another aspect that should be considered is procrastination (Steel, 2007). Students tend to delay their studies until the last minute (Gafni & Geri, 2010). When the video lectures are available online, students may wait until the end of the semester (Geri et al., 2014). At that point of time students may skip the interactive activities, due to their limited time.

Another way to address the attention challenge is to offer students mechanisms that would encourage them to complete viewing the course videos in a timely manner. Wandler and Imbriale (2017) propose that online instructors should promote the use of self-regulated learning strategies by students, including scaffolding time expectations, by dividing large assignments to sub assignments with several due dates. Romero, Cerezo, Espino, and Bermudez (2016) suggest using smartwatches for students to decrease procrastination behaviors in MOOCs. Specifically, Romero et al. (2016) developed an An-

droid wear-based application, which receives notifications from MOOCs and reminds students to complete their missions, in a similar manner to the tactics used for encouraging people to exercise. However, this study focuses on instructional design elements that may increase the attention span of learners who are already watching the online video lectures. Therefore, external mechanisms such as those suggested by Wandler and Imbriale (2017) and Romero et al, (2016), are beyond the scope of the current study.

Research Questions

Several factors may affect the effectiveness of interactivity in online video lectures. This primary study is conducted at the course level and explores whether the knowledge level of the students may affect the way they react to addition of interactive elements to online video lectures. On the one hand, advanced students have been found to gain more benefits from learning technologies (e.g., Warschauer, 2004; Wood, 2015). On the other hand, weaker or beginner students may benefit from the addition of interaction, as it is expected to improve their learning experience (Cherrett et al, 2009; Dror et al., 2011). Thus, it is important to inform diverse students in a manner that effectively conveys the message (Cohen, 2009), and it may imply delivering content in more than one format.

Since MOOCs research is still emerging (Raffaghelli et al., 2015), we shall present research questions, and would not propose specific hypotheses. Our first research question is:

- How does adding interactivity to online video lectures affect the attention span of students?

There are several ways to add interactivity to online video lectures. This study refers to asynchronous viewing of the lectures. The interactive activities involve only the individual student, i.e., there is neither collaboration nor interaction with other students, and no communication with the instructor or teaching assistants. The interaction involves answering short closed questions while viewing the online video lectures. Answering the questions is not compulsory, so the student may skip a question, or all questions, and continue watching the video. The second related research question is:

- Are there differences in the influence of interactivity in online video lectures on learners' attention span, between students who study a higher-level course and students who study the same sort of subject matter at a lower level?

As to the short attention span of MOOCs learners (Guo et al., 2014; Kim et al., 2014; Lagerstrom et al., 2015), we propose that the general reported findings of maximal six minutes of engagement time in viewing video lectures may not be applicable to MOOCs from the sort examined in this study, or other forms of online video lectures, which are part of formal courses. MOOCs learners have different motivations for learning, which affect their perseverance. When viewing an online video lecture as part of a formal course, especially if the viewing is compulsory, it is expected that learners would be more inclined to perform the task. Likewise, if viewing the videos would increase the chance to obtain a formal benefit, such as helping the students pass an exemption test, their inclination to watch the videos would be higher (Geri, Winer, & Zaks, 2017). While interactivity may expand the attention span of learners, as the videos become longer the chances of attrition increase. Sometimes short videos of about five minutes, or less, are not applicable, the third research question that we examine is:

- What is the practical appropriate maximal length of an online video lecture that would still be short enough to retain learners?

Methodology

This study adopts a learning analytics approach (Long & Siemens, 2011) that is a common methodology is the study of MOOCs (Raffaghelli et al., 2015). Learning analytics evolved from the general trend of data analytics research and practical applications (LaValle, Lesser, Shockley, Hopkins,

& Kruschwitz, 2011) particularly its use in learning environments (e.g., Hershkovitz & Nachmias, 2009; Levy & Ramim, 2012; Romero & Ventura, 2013; Romero, Ventura, & Garcia, 2008).

We investigated how adding interactivity to online video lectures affects students' attention span by analyzing usage data of two MOOCs, which were developed by the Open University of Israel (OUI) in order to make English for Academic Purposes courses freely available. All undergraduate Israeli students must take a series of exams in EAP until they reach an exemption level. The initial EAP level is determined by a national exam. Typically, the academic institution offers a series of courses to prepare the students for the following internal exams and charges additional tuition fees for each course.

The Israeli Council for Higher Education asked the OUI, in 2015, to develop four MOOCs, two pre-basic EAP courses, a basic level course, and an advanced one. The most advanced level of EAP course was not included in the project. During the first stage of the project (from January 1, 2016 until August 6, 2016), the MOOCs were based on online video lectures and basic exercises. On the second stage of the project, which started on August 7, 2016, the online video lectures provided interactive assessment and feedback via advanced technological tools. The two phases of the project created a natural "before and after intervention" testing environment.

Before the intervention, the videos included 'rhetorical' questions, which the instructor answered. Hence, the viewers may have thought about the answer, but did not do anything. The interactive elements that were added to the videos included short "closed" questions, such as multiple choice questions, pairing items from two lists, and ordering items. The students could select whether to pause viewing the video and answer the question online or ignore it and continue viewing. It was not mandatory to answer the questions at any time. Those who chose to answer a specific question received an immediate feedback, as well as an opportunity to correct their answer if they were wrong. The short videos included sporadic interventions, as deemed appropriate by the pedagogical staff who prepared the contents of the courses. As this was a new paradigm, the instructional design team did not suggest any guidelines regarding the sort of questions or the intervals between the interactions. The videos usually included one to three interactions, with an interval of a few minutes between them. The lengths of the videos also varied, as further detailed in the results section.

In order to examine the effect of interactivity on the attention span of learners, as measured by their viewing completion percentage, we analyzed aggregate viewing data of the online video lectures that were the main instructional method of these MOOCs. The actual aggregate viewing data of each one of the online video lectures was obtained via Google Analytics (GA) (Clifton, 2012; Geri et al., 2014, 2017).

The two higher levels of EAP MOOCs, the basic and the advanced courses, were selected for this study in order to decrease a possible influence of dropout due to students' inability to cope with academic requirements. The sample included 67 video lectures, which comprised all the online video lectures of both courses.

The analyzed data comprised all the actual viewing data of the 67 video lectures during the examined period, as recorded by GA. During the first examined period, the access to the videos did not require registration. Therefore, there are no further details on the students who watched the videos. The rationale of the decision was to make the courses highly accessible and remove any constraints, even the nuisance of registration, in order to increase the motivation to try the new medium. During the second stage (beginning on August 7, 2016), users were required to register, but their details were not verified (i.e., the registration was on an individual basis and did not require affiliation or verification by a college or a university that the user was indeed a student). Since the purpose of the study was to identify ways to increase the attention span of learners, regardless of their background, no attempts were made to obtain more information about the demographics of the students.

During the initial analysis, which was performed shortly after the intervention and referred to a shorter period (51 days), few outlier videos were excluded because their aggregate viewing patterns suggested that they included a relatively high proportion of viewers who only sampled the videos, but were not engaged in learning (Ferguson & Clow, 2015). The excluded lectures were mainly the first videos of each study unit within the two MOOCs. Moreover, due to the novelty of the EAP courses, both average and median results were calculated. The medians were calculated in order to avoid a possible bias due to atypical behavior of some users of these MOOCs. There might have been instructors who would like to explore the videos, and their viewing patterns were different from those of learners. Furthermore, the intervention occurred before the beginning of the academic year, and the period afterwards was relatively short, hence the viewing patterns might not be have been representative. However, our analysis showed that the average and median results were similar. Moreover, the data analyzed in the current study referred to a longer "after" period (270 days). Therefore, the analyses reported in this study related only to the average results.

RESULTS

Table 1 illustrates a descriptive comparison of the two MOOCs before and after the addition of interactive questions to the videos (i.e., the intervention). The same videos were used in the English for Academic Purposes basic and advanced courses before and after the intervention. Since the videos varied in their length, the relevant measurement that was used for evaluating the change was the average completion percentage.

Table 1. Descriptive comparison of video lecture viewing (n=67)

	Before (no interaction)	**After (interaction)**
Period	Jan. 1, 2016 - Aug. 6, 2016	Aug. 7, 2016 – May 3, 2017
Days	218	270
Total views	112,846	115,087
Total time viewed	616,122 minutes	835,695 minutes
Average views per calendar day	565	426
Average video view duration (standard deviation)	6.85 minutes (2.86)	8.49 minutes (3.36)
Average completion percentage; (standard deviation)	61.10% (7.63)	77.08% (9.14)

Table 2 and Figure 1 present online video lecture viewing completion percentage by course level with and without interaction. The intervention significantly increased the average completion percentage of video lecture viewing for both courses: by 22.91% for the basic course (from 59.07% to 72.60%), and by 28.76% for the advanced course (from 62.86% to 80.94%). The paired samples two-tailed t-test results for the basic course were t=-17.43, 30 degrees of freedom (df), p<.0001, and for the advanced course t= -22.44, 35 df, p<.0001.

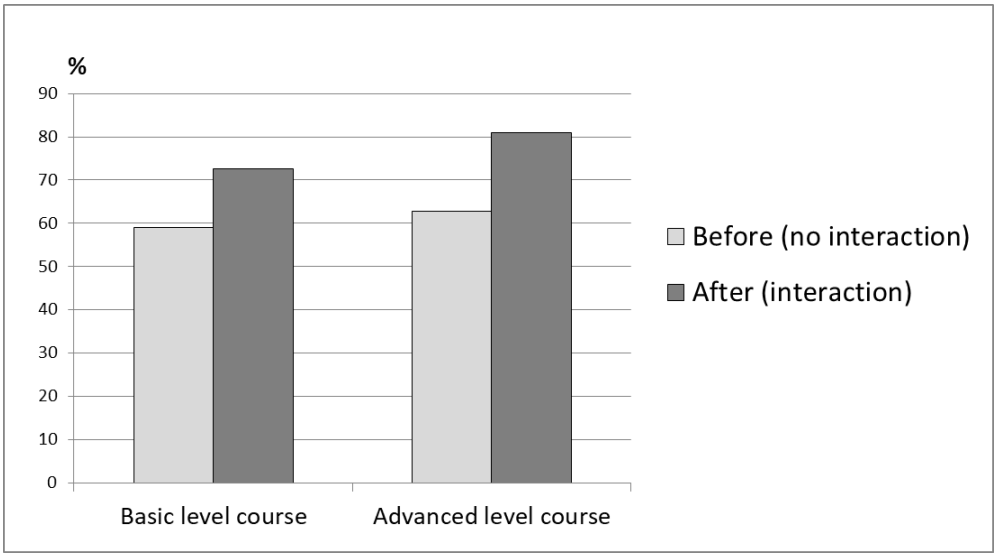

Figure 1. Average completion percentage of online video lecture viewing by course level with (after) and without interaction (before)

Table 2. Descriptive comparison of video lecture viewing by course level with (after) and without interaction (before)

Course Level	**Basic**		**Advanced**	
Number of videos (n)	**31**		**36**	
Total video length (for the whole course)	440 minutes*		331 minutes*	
Average video length (standard deviation)	14.18 minutes* (5.46)		9.19 minutes* (4.53)	
Interactivity	**Before (no interaction)**	**After (interaction)**	**Before (no interaction)**	**After (interaction)**
Period (duration)	Jan. 1, 2016 – Aug. 6, 2016 (218 days)	Aug. 7, 2016 – May 3, 2017 (270 days)	Jan. 1, 2016 – Aug. 6, 2016 (218 days)	Aug. 7, 2016 – May 3, 2017 (270 days)
Total views	49,965	51,648	62,881	63,439
Total time viewed	355,797 minutes	450,907 minutes	260,325 minutes	384,788 minutes
Average views per calendar day	229	191	288	235
Average video length* (standard deviation)	14.18 minutes (5.46)	14.01 minutes (5.18)	9.19 minutes (4.53)	9.18 minutes (4.49)
Average video view duration (standard deviation)	8.04 minutes (2.43)	9.73 minutes (2.80)	5.83 minutes (2.84)	7.42 minutes (3.47)
Average completion percentage (standard deviation)	59.07% (8.81)	72.60% (10.47)	62.86% (6.05)	80.94% (5.51)

* The same videos were used before and after the intervention. However, minor changes were made in the lengths of four video lectures.

Regarding differences between the two courses, before the intervention, there was a significant difference with a medium effect size between the completion percentage of the basic (59.07%) and the advanced (62.86%) courses (t=-2.073, p=.042, 65 df, equal variances assumed, Levene's test for equality of variances: F=3.174, p=.079, Cohen's d=-0.502). After the intervention, the differences between the courses increased (72.60% for the basic and 80.94% for the advanced) and were significant with a large effect size (t=-3.986<.0001, 43.911 df, equal variances not assumed, Levene's test for equality of variances: F=5.536, p=.022, Cohen's d=-0.997).

In order to examine the third research question, regarding the practical appropriate maximal length of an online video lecture that would still be short enough to retain learners, we split the sample of 67 videos to quartiles. Table 3 includes the completion percentage and other descriptive information of the four quartiles. We conducted an analysis of variance (ANOVA) of the completion percentage before and after the intervention, as well as Scheffe tests to identify the quartiles that significantly differ in their completion percentage. Both before and after the intervention, the ANOVA tests were significant (before: F=5.594, p=.001; after: F=15.033, p<.0001), with the fourth quartile significantly different from the first and second quartiles before the intervention, and from the other three quartiles after the intervention, according to the Scheffe tests.

Table 3. Online video lecture viewing completion percentage by quartiles with (after) and without interaction (before)

Quartile	N	Mean	Standard Deviation	Minimum	Maximum
			Video length (minutes)		
First	17	5.13	2.60	1.04	8.44
Second	17	9.62	0.46	8.59	10.25
Third	16	12.18	1.10	10.49	14.19
Fourth	17	19.09	3.19	14.26	25.04
Total	67	11.50	5.54	1.04	25.04
			Before: Average Completion Percentage (%)		
First	17	64.34	5.68	54.56	71.75
Second	17	63.63	6.21	55.26	74.83
Third	16	61.10	7.29	44.10	70.94
Fourth	17	55.35	8.16	30.42	63.50
Total	67	61.10	7.63	30.42	74.83
			After: Average Completion Percentage (%)		
First	17	83.80	6.38	72.38	96.79
Second	17	79.01	3.67	70.32	84.81
Third	16	77.74	5.61	62.97	83.24
Fourth	17	67.81	10.82	32.68	79.74
Total	67	77.08	9.14	32.68	96.79

The results presented in Table 3 are demonstrated in Figure 2, which shows that as the video length becomes longer, the average viewing completion percentages gradually decreases, both before and after adding interactivity. However, the differences between the first, second, and third quartiles are small (and mostly not significant, as reported above). Contrarily, the completion rate of the videos in the fourth quartiles, with average length of 19.09 minutes and 3.09 minutes standard deviation (SD), is significantly lower, even after adding interactive elements. Hence, with regard to the third research question about the practical appropriate maximal length of an online video lecture that would still be short enough to retain learners, our findings suggest that the range of the third quartile, 11-14 minutes may be the maximal effective video length range. However, this range may be affected by other factors, and should be corroborated by further research.

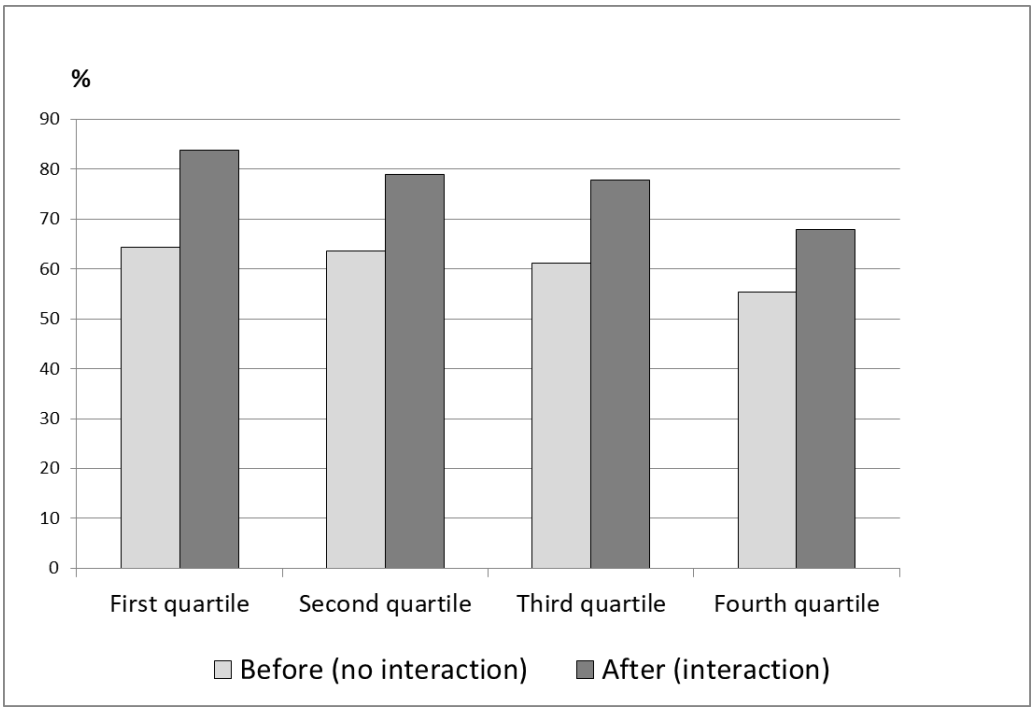

Figure 2. Average completion percentage of online video lecture viewing by quartiles of length with (after) and without interaction (before)

DISCUSSION

THEORETICAL IMPLICATIONS

Our findings suggest that interactivity may increase the attention span of learners, as measured by the average online video lecture viewing completion percentage, before and after the addition of interactivity, for both the basic and advanced English for Academic Purposes courses. The impact is significantly stronger for the more advanced course. However, when the lecture is longer than about 15 minutes (i.e., the fourth quartile in the analysis presented in Table 3), the completion percentages decrease relatively to the completion percentage of shorter videos, even after adding interactive elements.

The positive impact of interactivity on the average online video lecture viewing completion percentage is in line with the findings of Cherrett et al. (2009) and Dror et al. (2011). However, even after adding interactivity to the shorter videos (The first quartile, average video duration 5.19 minutes, SD=2.6, range 1.04-8.44 minutes) the completion percentage rate did not achieve 100%. This finding demonstrates the challenge of retaining attention (Davenport & Beck, 2001).

Thus, this research contributes to theory by both examining the impact of the interaction between video length and interactivity on the attention span of learners, and by providing a tool for quantifying the effective length of online video lectures.

Limitations

Nevertheless, further study is required for substantiating the findings. The MOOCs examined in this paper were intended to prepare the students for formal exemption tests and to save them tuition fee on a face-to-face course. Therefore, the students had a strong extrinsic motivation to complete them. The findings may not be applicable to other sorts of MOOCs, or to other types of learners.

Furthermore, since the examined MOOCs are open to all, it is possible that some people watched the videos for other purposes (e.g., to improve their knowledge of English), and their behavior might have been different than that of the students who took these MOOCs in order to prepare for the exemption exam.

Future Research

While MOOCs and other online learning opportunities serve "the needs of the already educationally confident" (Tuckett, 2017), those that do not have the necessary literacy skills require further assistance so they would not be left behind. Future research should seek further best practices to improve the effectiveness of online video lectures for diverse learners, and increase social inclusion.

Other promising research directions for increasing the attention span of learners who watch online video lectures include the use of badges (Gibson, Ostashewski, Flintoff, Grant & Knight, 2015) and elements of gamification (De Castell & Jenson, 2004).

While this study examined a seemingly linear learning, which is supposedly based on serial viewing of online video lectures, nowadays, much learning occurs ad-hoc, as people encounter a problem they want to solve and search for the solution or relevant information online. However, currently searching audio and video content is limited (Silber-Varod, Winer, & Geri, 2017). Nevertheless, if the relevant video lecture is located, and given the high motivation of the viewers, it would be interesting to examine if interactivity would be helpful or destructive in such situations, which are inherent in lifelong learning.

Practical Implications

Adding interactivity to online video lectures and controlling their length is expected to increase the attention span of learners. From a pedagogical point of view, we have shown that the interactive layer, which was added to video lectures, allowed learners to significantly extend their attention span. However, interactivity involves additional costs and adds complexity to the production process. This study demonstrated the potential of learning analytics to identify ways to improve learning processes and to provide important insights to decision makers. The ability to track and analyze behavior of learners who are presented with new features and capabilities is paramount for improving the effectiveness of learning environments, as well as supporting productive allocation of resources.

Conclusions

This study examined several aspects of how adding interactivity to online video lectures affects the attention span of students. Our findings, which are based on sample of 200,000 episodes of online video lectures viewings and are measured by the average online video lecture viewing completion percentage, indicate that interactivity may increase the attention span of learners. The second aspect that was examined concerned the course level. The results showed a significant difference between the basic English for Academic Purposes course and the advanced course, implying that the added interactivity was more helpful for stronger advanced students. Finally, we investigated the practical

appropriate maximal length of an online video lecture that would still be short enough to retain learners. The results revealed that for lectures longer than about 15 minutes, the completion percentages decreased, both before and after the addition of interactive elements.

Providing practical insights on adding interactivity to online video lectures and controlling their length is expected to increase the attention span of learners. As we move forward, we would like to improve the understanding whether interactive online video lectures might narrow the gap between weak and strong learners and allow better social inclusion.

REFERENCES

Boton, E. C., & Gregory, S. (2015). Minimizing attrition in online degree courses. *Journal of Educators Online, 12*(1), 62-90. Retrieved from http://files.eric.ed.gov/fulltext/EJ1051044.pdf

Brecht, H. D. (2012). Learning from online video lectures. *Journal of Information Technology Education: Innovations in Practice, 11*, 227-250. Retrieved from https://www.informingscience.org/Publications/1712

Cherrett, T., Wills, G., Price, J., Maynard, S., & Dror, I. E. (2009). Making training more cognitively effective: Making videos interactive. *British Journal of Educational Technology, 40*(6), 1124–1134. doi: 10.1111/j.1467-8535.2009.00985.x

Clifton, B. (2012). *Advanced web metrics with Google Analytics*. Indianapolis: Wiley Publishing Inc.

Chandler, J. D., & Teckchandani, A. (2015). Using social constructivist pedagogy to implement liberal learning in business education. *Decision Sciences Journal of Innovative Education, 13*(3), 327-348. doi: 10.1111/dsji.12073

Chen, C. M., & Wu, C. H. (2015). Effects of different video lecture types on sustained attention, emotion, cognitive load, and learning performance. *Computers & Education, 80*, 108-121. doi: 10.1016/j.compedu.2014.08.015

Cohen, E. (2009). A philosophy of informing science. *Informing Science: The International Journal of an Emerging Transdiscipline, 12*, 1-15. Retrieved from https://www.informingscience.org/Publications/425

Costley, J., Hughes, C., & Lange, C. (2017). The effects of instructional design on student engagement with video lectures at cyber universities. *Journal of Information Technology Education: Research, 16*, 189-207. Retrieved from http://www.informingscience.org/Publications/3728

Daniel, J. (2012). Making sense of MOOCs: Musings in a maze of myth, paradox and possibility. *Journal of Interactive Media in Education*, 3 (Art. 18). doi: http://doi.org/10.5334/2012-18

Davenport, T. H., & Beck, J. C. (2001). *The attention economy: Understanding the new currency of business*. Boston, MA: Harvard Business School Press.

De Castell, S., & Jenson, J. (2004). Paying attention to attention: New economies for learning. *Educational Theory, 54*(4), 381-397. Retrieved from http://www.sfu.ca/~decaste/techcourse/payingattention.pdf

Diver, P., & Martinez, I. (2015). MOOCs as a massive research laboratory: Opportunities and challenges. *Distance Education, 36*(1), 5-25. doi: 10.1080/01587919.2015.1019968

Dror, I., Schmidt, P., & O'connor, L. (2011). A cognitive perspective on technology enhanced learning in medical training: Great opportunities, pitfalls and challenges. *Medical Teacher, 33*(4), 291-296. doi: 10.3109/0142159X.2011.550970

Ferguson, R., & Clow, D. (2015). Examining engagement: Analysing learner subpopulations in massive open online courses (MOOCs). *Proceedings of the Fifth International Conference on Learning Analytics and Knowledge* (LAK'15), March 16 - 20, 2015, Poughkeepsie, NY, pp. 51-58. ACM. doi: http://dx.doi.org/10.1145/2723576.2723606.

Gafni, R., & Geri, N. (2010). Time management: Procrastination tendency in individual and collaborative tasks. *Interdisciplinary Journal of Information, Knowledge, and Management, 5*, 115-125. Retrieved from https://www.informingscience.org/Publications/1127

Geri, N. (2011). If we build it, will they come? Adoption of online video-based distance learning. *Interdisciplinary Journal of E-Learning and Learning Objects, 7*, 225-234. Retrieved from https://www.informingscience.org/Publications/1521

Geri, N. (2012). The resonance factor: Probing the impact of video on student retention in distance learning. *Interdisciplinary Journal of E-Learning and Learning Objects, 8*, 1-13. Retrieved from https://www.informingscience.org/Publications/1629

Geri, N., Gafni, R., & Winer, A. (2014). The u-curve of e-learning: Course website and online video use in blended and distance learning. *Interdisciplinary Journal of E-Learning and Learning Objects, 10*, 1-16. Retrieved from https://www.informingscience.org/Publications/1959

Geri, N., & Gefen, D. (2007). Is there a value paradox of e-learning in MBA programs?. *Issues in Informing Science and Information Technology, 4*(1), 163-174. Retrieved from http://proceedings.informingscience.org/InSITE2007/IISITv4p163-174Geri322.pdf

Geri, N., Winer, A., & Zaks, B. (2017). Challenging the six-minute myth of online video lectures: Can interactivity expand the attention span of learners? *Online Journal of Applied Knowledge Management, 5*(1), 101-111. Retrieved from http://www.iiakm.org/ojakm/articles/2017/volume5_1/OJAKM_Volume5_1pp101-111.pdf

Gibson, D., Ostashewski, N., Flintoff, K., Grant, S., & Knight, E. (2015). Digital badges in education. *Education and Information Technologies, 20*(2), 403-410. doi: 10.1007/s10639-013-9291-7

Guo, P. J., Kim, J., & Rubin, R. (2014). How video production affects student engagement: An empirical study of MOOC videos. *Proceedings of the first ACM conference on Learning@ scale conference,* March 04 - 05, 2014, Atlanta, GA, pp 41-50. ACM. doi: http://dx.doi.org/10.1145/2556325.2566239.

Guri-Rosenblit, S. (2009). *Digital technologies in higher education: Sweeping expectations and actual effects*. New York, NY: Nova Science Publishers.

Hershkovitz, A., & Nachmias, R. (2009). Learning about online learning processes and students' motivation through Web usage mining. *Interdisciplinary Journal of E-Learning and Learning Objects, 5*, 197-214. Retrieved from https://www.informingscience.org/Publications/73

Huang, L., Zhang, J., & Liu, Y. (2017). Antecedents of student MOOC revisit intention: Moderation effect of course difficulty. *International Journal of Information Management, 37*(2), 84-91. doi: 10.1016/j.ijinfomgt.2016.12.002

Kalman, Y. M. (2014). A race to the bottom: MOOCs and higher education business models. *Open Learning: The Journal of Open, Distance and e-Learning*, *29*(1), 5-14.

Keller, H., & Karau, S. J. (2013). The importance of personality in students' perceptions of the online learning experience. *Computers in Human Behavior, 29*(6), 2494-2500. doi: 10.1016/j.chb.2013.06.007

Kim, J., Guo, P. J., Seaton, D. T., Mitros, P., Gajos, K. Z., & Miller, R. C. (2014). Understanding in-video dropouts and interaction peaks in online lecture videos. *Proceedings of the first ACM conference on Learning@ scale conference*, March 04 - 05, 2014, Atlanta, GA, pp 31-40. ACM. doi: http://dx.doi.org/10.1145/2556325.2566237

Kinash, S., Knight, D., & McLean, M. (2015). Does digital scholarship through online lectures affect student learning? *Journal of Educational Technology & Society, 18*(2), 129-139. Retrieved from http://epublications.bond.edu.au/cgi/viewcontent.cgi?article=1092&context=tls

LaValle, S., Lesser, E., Shockley, R., Hopkins, M. S., & Kruschwitz, N. (2011) Big data, analytics and the path from insights to value. *MIT Sloan Management Review, 52*(2), 21-32.

Lagerstrom, L., Johanes, P., & Ponsukcharoen, M. U. (2015). The myth of the six-minute rule: Student engagement with online videos. *Proceedings of the American Society for Engineering Education*, June 14-17, 2015, Seattle, WA. Retrieved from https://www.asee.org/public/conferences/56/papers/13527/download

Lee, K. (2017). Rethinking the accessibility of online higher education: A historical review. *The Internet and Higher Education*, *33*, 15-23. doi: 10.1016/j.iheduc.2017.01.001

Levy, Y., & Ramim, M. M. (2012). A study of online exams procrastination using data analytics techniques. *Interdisciplinary Journal of E-Learning and Learning Objects, 8*, 97-113. Retrieved from https://www.informingscience.org/Publications/1730

Long, P. & Siemens, G. (2011). Penetrating the fog: Analytics in learning and education. *EDUCAUSE review*, *46*(5), 30-40. Retrieved from http://er.educause.edu/articles/2011/9/penetrating-the-fog-analytics-in-learning-and-education

Ostashewski, N., Reid, D., & Ostashewski, M. (2016). Utilizing multimedia database access: Teaching strategies using the iPad in the dance classroom. *Journal of Dance Education, 16*(4), 122-128. doi: 10.1080/15290824.2015.1091939

Pearce, J. M., Ainley, M., & Howard, S. (2005). The ebb and flow of online learning. *Computers in Human Behavior, 21*(5), 745-771. doi:10.1016/j.chb.2004.02.019

Raffaghelli, J. E., Cucchiara, S., & Persico, D. (2015). Methodological approaches in MOOC research: Retracing the myth of Proteus. *British Journal of Educational Technology, 46*(3), 488-509. Retrieved from https://telearn.archives-ouvertes.fr/hal-01156416/document

Ramsay, J., & Terras, M. M. (2015). The pendulum swing of user instruction and interaction: The resurrection of 'how to use' technology to learn in the 21st century. *E-Learning and Digital Media, 12*(3-4), 372-390. doi: 10.1177/2042753015571827

Romero, C., Cerezo, R., Espino, J. A., & Bermudez, M. (2016). Using Android Wear for avoiding procrastination behaviours in MOOCs. In *Proceedings of the Third (2016) ACM Conference on Learning@ Scale* (pp. 193-196). ACM.

Romero, C., & Ventura, S. (2013). Data mining in education. *Wiley Interdisciplinary Reviews: Data Mining and Knowledge Discovery*, *3*(1), 12-27.

Romero, C., Ventura, S., & García, E. (2008). Data mining in course management systems: Moodle case study and tutorial. *Computers & Education*, *51*(1), 368-384.

Siemens, G., Gašević, D., & Dawson, S. (2015). Preparing for the digital university: A review of the history and current state of distance, blended, and online learning. Retrieved from http://linkresearchlab.org/preparingdigitaluniversity.pdf

Silber-Varod, V., Winer, A., & Geri, N. (2017). Opening the knowledge dam: Speech recognition for video search. *Journal of Computer Information Systems, 57*(2), 106-111. doi:10.1080/08874417.2016.1183423

Steel, P. (2007). The nature of procrastination: A meta-analytic and theoretical review of quintessential self-regulatory failure. *Psychological Bulletin*, *133*(1), 65-94. doi: 10.1037/0033-2909.133.1.65

Terras, M. M., & Ramsay, J. (2015). Massive open online courses (MOOCs): Insights and challenges from a psychological perspective. *British Journal of Educational Technology, 46*(3), 472-487. doi:10.1111/bjet.12274

Tuckett, A. (2017). The rise and fall of life-wide learning for adults in England. *International Journal of Lifelong Education, 36*(1-2), 230-249. doi: 10.1080/02601370.2017.1274546

Vessey, I. (1991). Cognitive fit: A theory-based analysis of the graphs versus tables literature. *Decision Sciences, 22*(2), 219-240.

Wandler, J., & Imbriale, W. (2017). Promoting undergraduate student self-regulation in online learning environments. *Online Learning 21*(2). doi: 10.24059/olj.v21i2.881

Warschauer, M. (2004). *Technology and social inclusion: Rethinking the digital divide*. Cambridge, MA: The MIT Press.

Whatley, J., & Ahmad, A. (2007). Using video to record summary lectures to aid students' revision. *Interdisciplinary Journal of Knowledge and Learning Objects, 3*, 185-196. Retrieved from https://www.informingscience.org/Publications/393

Wieling, M. B., & Hofman, W. H. A. (2010). The impact of online video lecture recordings and automated feedback on student performance. *Computers & Education, 54*(4), 992-998.

Wood, D. (2015). Problematizing the inclusion agenda in higher education: Towards a more inclusive technology enhanced learning model. *First Monday, 20*(9). Retrieved from http://firstmonday.org/ojs/index.php/fm/article/view/6168/4903

You, J. W. (2015). Examining the effect of academic procrastination on achievement using LMS data in e-learning. *Journal of Educational Technology & Society, 18*(3), 64.-74 Retrieved from http://www.ifets.info/download_pdf.php?j_id=68&a_id=1603

BIOGRAPHIES

Nitza Geri is an Associate Professor at the Open University of Israel, Department of Management and Economics, and Head of the Research Center for Innovation in Learning Technologies. She holds a B.A. in Accounting and Economics and a Ph.D. in Technology and Information Systems Management from Tel-Aviv University. Nitza is a CPA (Israel) with over 12 years of business experience. Her research interests focus on the value of information and knowledge: strategic information systems, information economics, attention economy, knowledge management, value creation, Theory of Constraints, and effectiveness of e-learning. Personal site: http://www.openu.ac.il/en/personalsites/NitzaGeri.aspx

Amir Winer Heads the Interactive Courseware unit and the video production studio at the Open University of Israel. He served as a special digitation consultant for Israel's Ministry of Education and led the design of Israel's standard for developing K12 Digital Textbooks. Prior to joining the Open University of Israel, Amir was Head of R&D at the Center for Futurism in Education at Ben Gurion University. Amir is a PhD candidate at Bar Ilan University and holds an MA in Psychology and a BA in Cognitive Science, both from Ben-Gurion University.

Beni Zaks leads the design and development initiatives at the Interactive Courseware unit at the Open University of Israel. He is responsible for maximizing student's learning experience by designing innovative learning courseware, integrating educational technologies and assimilating "Learning Analytics" practices and platforms. Prior to joining the Open University of Israel, Beni led a design studio and was involved in several innovative projects meshing design with new technologies. Beni holds an MA in Digital Art from the Universitat Pompeu Fabra in Barcelona and a B.Sc. in Technological Education and Industrial Design from the Holon Institute of Technology.