On Air:
Benefits of weekly Podcasts accompanying Online Courses

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ABSTRACT

Podcasts are a widely-used medium for communication and learning. One advantage of them is the possibility to pursue other activities while listening. Contrasting, Massive Open Online Courses (MOOCs) employ video-based teaching methods. Current research, however, challenges the interactivity and variation of teaching content in established MOOCs. This manuscript presents an experiment conducted with a podcast series deployed alongside a MOOC on cybersecurity. In our *Static-Group Comparison*, we identified a significant increase in learning success in weekly graded exercises (6.3%) and the course's final examination (6.4%) for learners exposing themselves to the podcast. Our first study results are promising in favor of multimedia learning. Hence, we present ideas for additional analysis and briefly outline which aspects of the results should be discussed in more depth.

CCS CONCEPTS

• **Applied computing** → **Distance learning**; **E-learning**; • **Social and professional topics** → *Student assessment*; *Adult education*.

KEYWORDS

podcasts, secondary knowledge, mooc, online education

1 INTRODUCTION

Online education surged during the Covid-19 pandemic when schools and higher education institutions had to develop ad-hoc solutions to enable and favor remote teaching [1, 7, 26]. Lifelong learning adults further use online courses. Accessible education, such as in Massive Open Online Courses (MOOCs), thus fosters adult and professional learning.

Current MOOCs primarily feature videos, texts, and multiple-choice questionnaires as their method for primary education. The lack of content variation and educational best practices in MOOCs

still hinder learner success [12, 19]. Other recent research has identified (lack of) *interactivity* as one of the significant factors for demotivation and dropout from MOOCs [8]. Interactivity between teachers and learners is a significant challenge to the scalability of MOOCs. However, a MOOC can improve the *perceived* interactivity by varying its educational methods [2, 8].

Similarly to MOOCs, podcasts are another pillar of entertainment and education for many adults [9, 14]. Podcasts present similar benefits to online courses, e.g., their openness, content prepared for teaching and different target groups, available online, often free of charge, and many more. However, in their nature, podcasts are limited to audio content and usually do not provide an exchange platform for listeners, such as a forum. To cope with the issue of audio-only, many podcasts use show notes and even entire web pages for (additional) visual content. Despite the similarity between podcasts and other forms of online education, such as MOOCs or video-based courses, we observe a lack of research on combining both forms of education.

Hypothesis: Additional audio-only content can help learners of all skill levels further succeed in a course. Learners of higher skill levels could find interesting secondary information. Similarly, learners of lower skill levels could use the reiteration of content on a different medium to better understand the topics.

In this study, we embed podcasts into the habitat of video-based online courses to enhance research on the media of podcasts themselves. Our study, incorporating additional optional podcasts in the context of a MOOC on cybersecurity, targets the following research questions:

RQ1 How is learning success in a video-based online course impacted by additional, optional podcasts?

RQ2 How do optional podcasts foster learner interaction in a video-based MOOC?

The remainder of this manuscript presents our study methodology and preliminary results answering *RQ1*. We hence pose an initial contribution to the body of research:

C1 Exposure to podcasts increases the average learner's performance in graded exercises by 6.3%. (c.f. Section 4)

2 BACKGROUND AND RELATED WORK

MOOCs aim to provide open and scalable education over the Internet. They often rely on pre-recorded videos for primary educational content to enable these goals. One of the main target groups of MOOCs are lifelong learners who aim to pursue further education aside from their professional jobs [18, 22].

Audio-based education and learning content transmission originated in the past century when the radio was first established as a

communication medium. Concretely, Neil Butcher stated in 2003 "Radio has been used in education ever since it became available" [4]. Various researchers testified over the past century to the importance of radio-based education mechanisms. This is mainly due to (1) the ease of creation and (2) the ease of access, particularly, e.g., for rural countries and communities [10, 13, 20].

The surge in podcasting, which started with the introduction of the first iPods®, can be explained by the fact that now everyone could easily create and share their radio program, a podcast, through the internet [3]. During the COVID-19 pandemic, many teachers, educators, and institutions turned to podcasts to continue their education, as it was a more effortless medium compared to video lectures. In secondary and higher education, researchers, hence, already reported various successes with podcasts [9, 11, 14, 25].

Investigating current large-scale MOOC platforms and considering top-rated podcasts shows that both types of media, *Audio* and *Video*, no longer exist independently. More and more MOOCs offer audio files as downloads. Many podcasts offer show notes or even full videos of the podcasts for those interested in visual content. However, to the best of our knowledge, the appropriate combination of both methods remains mainly unstudied in the context of MOOCs. The question remains: Which impact is generated by a dedicated podcast running alongside a MOOC?

3 METHODOLOGY & EXPERIMENT SETTING

To tackle the previously posed research question of whether podcasts can improve learning success in online courses, we conducted an altered *Static-Group Comparison* study appropriate to Campbell and Stanley [5]. The following sections present the course context of our MOOC (Sec. 3.1), followed by a deep dive into our proposed podcast structure (Sec. 3.2) and research methodology (Section 3.3).

3.1 Course Context

The course alongside which we employ the podcast has been carried out twice in recent years on the education platform openHPI. For the current iteration of the course, we presented the learners with the opportunity to consume additional podcasts on top of the course content to reinforce learning.

The course features six weeks of educational content on cybersecurity, structured to follow six basic topics. In each of the six weeks, learners could consume 10-12 obligatory educational videos of, on average, ~12 minutes in length. A multiple-choice examination concludes each week. Once learners complete all weeks, they conclude the course with an exam covering topics from the entire MOOC. Additionally, learners can watch optional *Deep Dive* videos. Those Deep Dives further explain a specific topic for interested learners.

We kept the topics and most videos identical between recent course iterations (2020 and 2022). Changes we implemented referred to hard-to-understand explanations, which we attempted to improve, and outdated content, which we updated. Further, all seven examinations were revised, introducing new questions to ensure learners could not copy the answers from the previous course.

3.2 Podcast Structure

For our study, we extend the course and its general content, such as videos, quizzes, and texts (c.f. Table 1) by optional podcasts. These

Table 1: Overview of our course structure. Each week consists of multiple mandatory and optional items, as well as a graded exam (EX). The last week (FE) concludes the course with a final examination.

	Mandatory					Optional				EX
W1	🎞	💡	🎞	💡	⋯	🎧	✎	💡	🎞	🎓
W2	🎞	💡	🎞	💡	⋯	🎧	✎	💡	🎞	🎓
⋯			⋯				⋯			⋯
W6	🎞	💡	🎞	💡	⋯	🎧	✎	💡	🎞	🎓
FE										🎓
	Lecture	Quiz	Lecture	Quiz		Podcast	Survey	Quiz	Deep Dive	Graded Exam

can be listened to in addition to the other content, as they feature further secondary knowledge. Our courses already employ similar additions in the form of the Deep Dives available throughout the weeks. Those videos often explore a specific topic in greater depth instead of providing a more interconnected understanding of the course content. This study uses the media *podcast* to research what impact the integration of auxiliary podcasts can have on video-based MOOCs.

We offered one optional podcast per course week to all learners. We recorded all podcasts during course runtime to allow us to react to learners' forum posts. In a previous study, we identified that learners of our learning platform were primarily interested in secondary content to be presented by the podcasts [15]. With the same study, we identified that learners expected podcasts on our platform to be roughly 30 – 45 minutes long. Hence, we approximately structured our podcasts in the following way:

20% Answers to & review of discussions from the course forum
10% Review & overview of topics from the current course week
70% Secondary & additional content building on the current content of the week

Typically, courses on our learning platform are organized, prepared, run, and monitored by a teaching team of experts for the course topic. In most cases, the lecture videos are recorded primarily by one lecturer from the group. However, we chose team members for the podcasts as speakers who did not appear in the videos. This allows the entire team to reflect on the teaching content in the lectures and thereby provide reactionary content [17] inside the course itself. Further, this allowed us to integrate more (different) opinions on specific subjects.

3.3 Research Methodology

In our study, we introduce podcasts into an online course on cybersecurity and observe which impact is achieved. We intended to allow all learners to listen to our podcasts, not just a specific group. Therefore, we could not perform a Randomized Controlled Trial [6, 24]. As this induces potentially invalidating factors, e.g., that only remarkably talented learners are listening to our podcasts (and thus consume the treatment), we plan to enumerate alternative

Table 2: Demography of learners divided by their exposure to the treatment according to our surveys (*N(Total) = 2,167*)

Group	N	Gender Ratio			Response Rate Gender	Age Ratio							Response Rate Age	Previous Podcast Listening Behavior					Response Rate Pod.
		Male	Female	Non-binary		≤ 19	20-29	30-39	40-49	50-59	60-69	≥ 70		None	Very Little	Seldom	Regular	Daily	
Treatment	775	75.5%	23.8%	0.7%	77.5%	4.0%	7.2%	8.2%	16.2%	31.1%	22.0%	4.0%	77.3%	19.0%	29.2%	21.4%	17.2%	13.3%	79.6%
No Treatment	1,390	72.2%	27.0%	0.8%	53.6%	6.7%	12.9%	11.6%	16.2%	28.8%	17.6%	6.3%	54.7%	22.1%	34.0%	20.1%	15.5%	8.3%	56.5%

explanations and threats to validity in our future analysis of this study (c.f. Section 5). With the requirements and dependencies, we performed a *Static-Group Comparison* in our course.

$$\begin{array}{ccc} X & & O \\ \hline & & O \end{array}$$

Our *Static-Group Comparison* features two groups of learners who complete an identical examination (O). Traditionally, one of the groups is exposed to a particular treatment (X), and differences in performance for the examination between the two groups are interpreted to be induced by the treatment. Because the groups are not randomized, one cannot be sure that the groups would have been the same without the treatment (as indicated by the dashed line). For our study, learners self-select to consume the treatment. This brings up a potential selection bias, to be discussed in future work upon completion of the analysis. Learners can decide each week whether or not to consume the treatment. We, therefore, consider the learning success in each week relative to the consumption of the respective podcast. We measured the impact three-fold:

(1) The immediate understanding of the podcast's content is measured by an (immediate) follow-up content quiz.
(2) The general learning success of the user can be observed through the weekly examinations.
(3) We provide a survey in which the users can rate the podcast and provide further feedback, e.g., on any activity they performed while listening to it.

Our content quizzes and examinations are multiple-choice tests with multiple questions worth 1 to 3 points. To enable a comparison between the podcasts of this study and our previous podcast-studies [15, 16], we employed both a rating in school grades and a rating for the Net-Promoter-Score (NPS) [21] of our podcasts. The NPS is a tool to derive a comparable rating across different questionnaires. It ranges from -100 to 100.

To consider the learner's exposure to the treatment, we evaluate how much of the podcast they listened to. In their work from the 1970s, Salomon and Clark highlighted the importance of reflecting on self-selected exposure to treatment [23]. In our surveys, we ask the learners to estimate how much of the podcast they listened to.

4 RESULTS AND ANALYSIS

The following sections present the collected data and a first analysis of potential interconnections in the data.

As pointed out earlier, our 2022 course material is derived from the 2020 course. We modified content wherever explanations needed to be updated or could be improved based on user feedback during the previous iteration of the course. Both courses feature optional Deep Dive videos besides the professor's lecture videos. Table 3 shows a comparison between both courses in the two dimensions:

Table 3: Overview of data comparing the 2020 and 2022 iterations of our German MOOC on cybersecurity

|	2020	2022
Enrolled Learners	8,756	6,489
Active Learners	3,394	2,167
Course Completions	2,797	1,668
Course Completion Rate	82.4%	77.0%
Number of Videos (Total)	79	82
Number of Primary Videos	66	68
Number of Deep Dives (Video)	13	14
Number of Deep Dives (Podcasts)	**0**	**6**

(1) Number of enrolled and participating users, and (2) Amount of content elements

To better understand how our learners, who exposed themselves to the treatment, are distributed in terms of demographic criteria, we present Table 2. For each category and each group of learners, we listed the response rates to the surveys or the respective questions inside the surveys in the table. The ratio between the different answers to our survey is calculated relative to the total answers for a category. We observe that the gender of learners shows a relatively similar ratio between the treatment and control groups. Regarding age, people between 50 and 70 are slightly more likely to consume the additional podcasts. We further observed that out of those learners who answered the surveys, the treatment group showed a higher share of participants who previously consumed podcasts.

4.1 Evaluation of the Podcasts

The learners could consume the podcast using any preferred software or method, such as, e.g., web-streaming, download, Spotify, or Apple®Podcasts. In the surveys, learners could rate our podcasts using school grades and the Net Promoter Score (NPS). Further, learners could provide input regarding their podcast consumption. Throughout the six weeks, the average school grade for the podcasts, ranging from *1 – Very Good* to *6 – Insufficient*, was reported as 2.08 (*Standard Deviation*, $\sigma = 0.90$). Figure 1 presents the results of school grades collected via the surveys throughout the weeks.

The different podcasts were evaluated with an average NPS of 6.2, which falls in line with a similar podcast (NPS: 9) we assessed with a MOOC in the summer of 2022 [15]. At the same time, the current podcast is rated better than the NPS of our *Interview Podcasts* (-4) as evaluated during January 2022 [16]. When comparing the different podcasts within our current course, the first and last weeks were
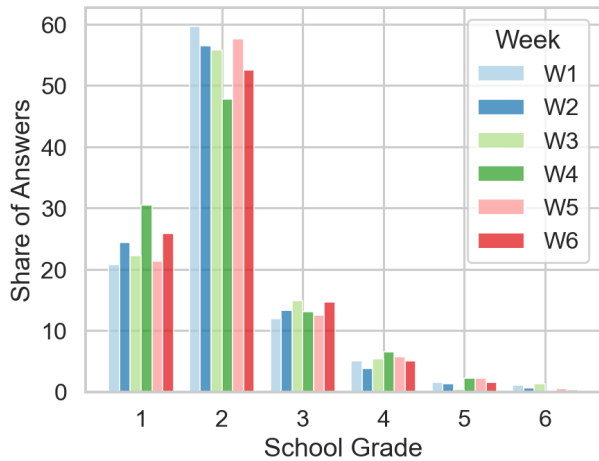
Figure 1: Overview of learner feedback on our podcasts in school grades on a scale from 1 to 6. *N(Total) = 2,818*

Figure 2: Overview of learners' performances in the weekly graded exercises throughout the course. *N(Total) = 10,266*

best rated with an NPS of approx. 12. The podcast offered in the fourth week was rated the least preferred (NPS: -5.5).
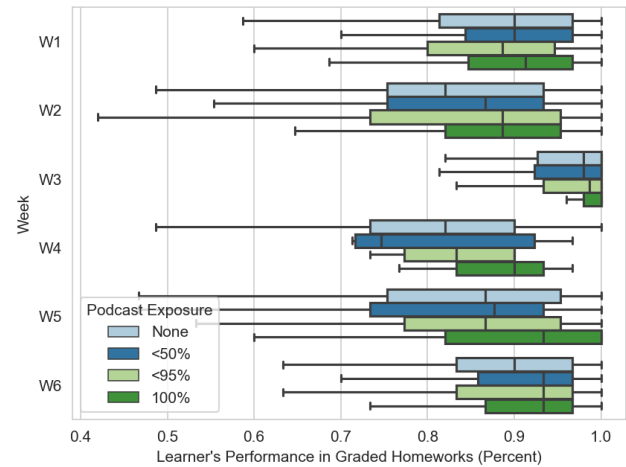
4.2 Weekly Graded Exercises

The weekly assignments cover knowledge presented in the learning videos. We reiterated these weekly topics in the podcasts and further expanded them with additional ideas, opinions, or more detailed explanations. Thereby, the consumption of podcasts is expected to influence learners' examination results throughout the weeks positively.

Figure 2 presents the learners' performance in their weekly assignments divided by their *Exposure* to the podcasts. The exposure is self-supplied and grouped into *None*, < 50%, > 50% and 100 % completion of the podcast. *None* covers all learners that did not supply any survey response. Generally, the learners with higher exposure to podcasts achieve better results in weekly quizzes. The mean performance of learners who consumed less than 50% of the podcasts was 84.2% ($\sigma = 12$). The mean performance of those who completed the podcast was 90.5% ($\sigma = 17$). The learner's independent sample t-test showed that the 6.3% difference was significant ($t(10.266) = 10.7, p < .05$), suggesting a genuine difference in learning outcomes.

5 DISCUSSION AND FUTURE WORK

Initial results from our study make us feel optimistic about the potential impact towards researchers and educators derived by this study. Throughout the six course weeks, we observe significantly increased learning success derived by exposure to the treatment, as seen in Figure 2.

In future work, we aim to analyze *RQ2* on the interaction between course participants as initially posed. Further, we aim to evaluate how and to which extent the weekly consumption of podcasts diffuses into learning success for the final course examination. Upon completed analysis, we plan to discuss our findings for factors such as learners who took part in the 2020 course or the potential selection bias of learners' (previous) knowledge for our podcasts.

As with any new learning item, the factor "new" might contribute to our podcasts' success and results. Finally, we aim to thoroughly reflect on our methodology, particularly the missing pretest and potential implications for the current results and future studies. For this reflection, we plan to discuss threats to internal validity imposed by the methodology [5].

6 CONCLUSION

In this study, we show that optional podcasts alongside a MOOC featuring secondary knowledge can help to increase learner success and interaction throughout the course. We performed a *Static-Group comparison* alongside a six-week MOOC with optional weekly podcasts open to all learners to consume. In the study with approximately 2.2k learners, we observe significant improvements in learning success throughout the six course-weeks for learners consuming the additional podcast.

With the preliminary nature of this work, we refrain from drawing generalizable conclusions but are optimistic about the impact observed so far. A proper discussion of the observed results, particularly covering the methodology and the missing pre-test for the study, is yet to be performed and included in a follow-up publication with further results.

We preliminarily conclude that running an optional podcast alongside a MOOC can be helpful for learners who do choose to listen to it. A podcast with additional speakers can help shine a more diverse light on a topic. As podcasts are considerably easier to create than videos, we want to motivate teachers and educators now to provide this additional learning item as it benefits those interested learners.

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