Supporting Multi-Device E-Learning Patterns with Second Screen Mobile Applications

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ABSTRACT

Many providers of Massive Open Online Course (MOOC) platforms released mobile applications in the recent years to enable learning offline and on the go, for a more ubiquitous learning experience. However, mainly the MOOC content was optimized for small screens, but mobile devices provide the opportunity to enrich the MOOC experience even further by enabling new forms of learning. Based on a previous learning patterns evaluation and a user survey, this paper presents a second screen prototype for the MOOC platform of the Hasso Plattner Institute, whereby the mobile application can be used as a learning companion while using the web platform on a computer. Four different actions were implemented which can be done next to watching a video lecture. The evaluation showed that the prototype was helpful and made learning more efficient, as reported by users, and also ideas for further improvements were proposed.

CCS CONCEPTS

• **Human-centered computing → Ubiquitous and mobile computing**; *Mobile devices*; • **Applied computing → E-learning**; Interactive learning environments; Distance learning;

KEYWORDS

MOOC, E-Learning, Mobile Learning, Multi-Device, Second Screen

ACM Reference format:
Tobias Rohloff, Jan Renz, Max Bothe, and Christoph Meinel. 2017. Supporting Multi-Device E-Learning Patterns with Second Screen Mobile Applications. In *Proceedings of mLearn 2017, Larnaca, Cyprus, October 30-November 1, 2017,* 8 pages.
https://doi.org/10.1145/3136907.3136931

1 INTRODUCTION

With the advent and maturity of Massive Open Online Courses (MOOCs) in the recent years, platforms have evolved and mobile applications were published to support high scalable e-learning at any location [8]. Some of them even provided offline functionality to offer a more ubiquitous learning experience but the MOOC concept remained the same – mainly the content was optimized for small screens. However, only few research is available how the mobile context and the pervasive presence of mobile devices can improve and enrich the MOOC experience by enabling new forms of learning. Sharples et al. [10] showed that mobile technologies can provide context-sensitive, geo-located and crowed-learning since mobile devices offer a ubiquitous access to learning material, carry sensors for real world data and provide worldwide connectivity. Additionally, de Waard et al. [4] investigated how the MOOC format fits as a pedagogical approach for mobile learning. They illustrated that both formats support knowledge creation over time independently from space and context, as well as collaboration.

Also, some first investigations regarding the mobile learning behavior were conducted on openHPI, the MOOC platform developed by the Hasso Plattner Institute. Based on Learning Analytics (LA) data, the learner's device usage and its influence on the learning experience and outcome was examined [9]. Tendencies have been revealed, where users who learn with the mobile and web application together show a high platform activity and a high learning outcome, whereas users who only learn with mobile application performed as one of the weakest user groups. Thus, different strategies were proposed to attract the learning with multiple devices and to better support mobile-only learners. This paper focuses on the former with a prototype for a stronger interlinking between the web and native mobile client of openHPI to support the combined usage of multiple devices while learning online. It is realized as a second screen prototype, whereby the mobile device can be used as a companion while using the web client on a computer.

Related research about second screen studies is presented in Section 2. Afterwards, the prototype concept is discussed in Section 3, followed by an implementation overview (Section 4). Finally, the prototype is evaluated and the results are assessed in Section 5. Section 6 concludes the paper and discusses possible improvements.

mLearn 2017, October 30-November 1, 2017, Larnaca, Cyprus

ACM ISBN 978-1-4503-5255-0/17/10…$15.00
https://doi.org/10.1145/3136907.3136931

2 RELATED WORK

The term second screen is mostly used to describe mobile applications that enhance the TV experience by providing additional content or interactions. Nevertheless, insights from corresponding research can also be used to improve the concept for the openHPI second screen prototype which links the web client with the mobile application. Courtois and D'heer [3] investigated how tablet users incorporate second screen applications in their television viewing experience. They found three different usage groups: one that only focuses on television, one that combined television with other screen media and one that combined it with various media, including print and screen media. The tablet devices were mainly used to search for information or for social media but mostly established channels like Facebook were used for it. Therefore, they claim that the potential for other second screen applications beyond social features is higher. However, a large user group is not aware of the existence of such applications. They recommend that the primary screen notifies and remembers about the second screen option and clearly communications the benefit and added value. Also, they highlighted that especially the younger user group showed a larger interest for second screen applications.

Geerts et al. [5] presented insights from the perspective of the viewers and producers of second screen applications, evaluated by interviews, observations and data analysis. For viewers, the ease of use and usability are an important concern. Also a low threshold for accessing the application is desired without additional downloads or installations. Again, the awareness of users has to be increased by announcements of the primary screen that there is a second screen application. But the most crucial part of providing such an application is finding the right balance between engagement and distraction. For example, videos on the second screen are not useful since the user cannot follow both videos simultaneously. While a mobile device offers a lot of distraction by itself, the companion application should synchronize its updates and state with the main content. Also, users appreciate extra content on the second screen much more than just repeating what happens on the main screen.

At last, Mu et al. [6] implemented and tested a second screen application, that provided remote control, subtitles, chapter navigation and quizzes for the current television content. The functionality was evaluated including a usability test and an interview with participants. The majority of participants expressed an interest in using the second screen. The chapter navigation was the most popular function. The subtitles attracted a smaller interest for the participants because the focus was continual shifting between the primary and second screen. But they mentioned it could be used to store a local transcript of a primary screen's audio for example. With 58.3%, the majority of participants found the quizzing functionality desirable and they mentioned it can increase audience engagement. For all functions, it was important for them to keep it optional as an addition.

3 CONCEPTION OF THE SECOND SCREEN PROTOTYPE AND EXPERIMENT

The initial idea for the second screen prototype was partly derived from a learning patterns evaluation on the openHPI platform. It demonstrated that users who learn with a mixed usage of the mobile and web application show a high platform activity and a high learning outcome. Based on these insights, it was recommended to support and also to attract more users to adopt this learning pattern to increase their learning engagement and success. A suggested approach to achieve that was to provide a stronger interlinking between the web and native mobile clients [9].

Additionally, a survey[1] showed that a large amount of users watches video lectures and performs another learning activity simultaneously. Up to 37.7% are reading the slides next to the video and almost half of the users are taking notes (36.2% digital and 13.7% with pen and paper). Additionally, 9.5% are browsing the discussion forum and answer, read or ask questions. Also, 7.6% solving the quizzes of the video lecture at the same time.

Based on these insights, the different actions for the second screen mode are conceived and introduced in Section 3.1. Afterwards, the approach for the communication between the web client, mobile client and backend is discussed in Section 3.2. To attract this new functionality to the users, Section 3.3 presents concepts to create awareness for it. At last, the evaluation methodology is explained in Section 3.4.

3.1 Second Screen Actions

Condensing the survey results and the available platform content that is related to a video lecture, four different second screen actions were conceived. These actions were promoted by a central introduction view, that explains the new functionality to the user and presents the currently played video lecture. The second screen actions are defined as followed:

Synchronized Slides Reader Enables the user to browse the lecture's PDF slides, with an optional synchronization of the current slide page of the video. For example, this can be used together with a notes application side by side in a split-screen mode or the device can be placed next to the user's notepad to better follow the content while taking notes.

Interactive Transcript The platform offers subtitles which can also be read as a whole transcript. This action allows the user to browse the transcript and also highlights and optionally synchronizes the current subtitle from the played video. For some courses the transcript is prepared in multiple languages, so this action can also support users speaking different languages.

Lecture Quiz Most video lectures are followed by a short self-test, to verify and consolidate the user's learning progress. Thus, this action is a shortcut to the follow-up quiz, if the user wants to save time and solve it simultaneously to the video.

Questions and Discussion The forum allows to start discussions and ask questions about any course-related topic. This actions opens the forum with a filter set for the current video lecture, so that the user can browse through the discussions in parallel.

3.2 Cross-Client Communication

To synchronize the video state between the web and mobile client, a proper communication architecture was required. Until then, the clients only communicated through the HTTP protocol with the

[1] Conducted on openHPI in 2016 with 840 participants.

backend in a usual request/response manner. Nevertheless, a proper push communication was needed to realize the prototype, which requires to send the state from one client to another. Here, HTTP does not provided a favorable solution, even if it could have be achieved with workarounds like long-polling which only emulates the push mechanism.

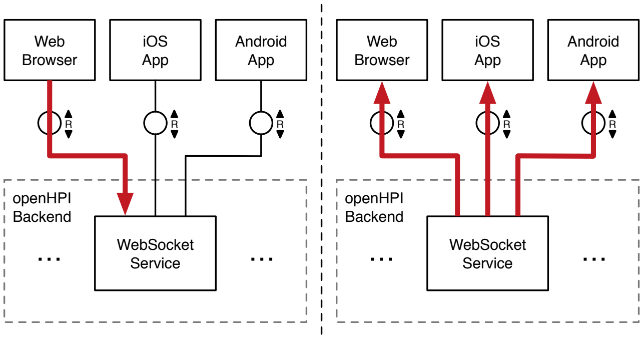


Figure 1: WebSocket-based Client-Server Communication

Therefore, a bidirectional socket-based communication was preferred. In order to support the web client, a modern browser had to back this solution. Hence, the WebSocket standard was used. The WebSocket server was provided as a separate service in openHPI's Service Oriented Architecture (SOA) [11]. When a client is initiating a connection, the service uses the platform's default authorization mechanisms to only forward messages to clients of the same user. If a client sends a message to the WebSocket service, it is able to broadcast the message to all registered clients of this user (see Figure 1).

3.3 Creating Awareness

In general, when testing a prototype that introduces a new usage pattern, one of the most crucial challenges is to reach a valuable amount of users. The multi-device setup of the second screen mode is such a new usage pattern. On the one hand, its benefits and added values should be communicated through platform announcements and its social media channels, as well as by the mobile application itself. On the other hand, the primary and secondary screen should notify and remember the user about the new functionality to create awareness when the application is already used. Therefore, the web client provided a notification next to the video player to draw the attention of mobile users. Also, if the mobile application is informed that a video is currently played by the web client, it also notifies the user and encourage her or him to start and try the second screen mode.

3.4 Evaluation Methodology

The prototype's user experience and satisfaction was tested with a mixed method approach for a quantitative and qualitative investigation. For the qualitative analysis, a survey was conducted. It determined the helpfulness, efficiency and satisfaction of the different actions and the overall second screen mode with various metrics. Also, the user was able to submit ideas for other second screen actions that she or he might wish. A link to the survey was provided directly by the mobile application after using the second screen mode. Therefore, the survey was optimized for mobile screens in order to be properly feasible on mobile devices. Also, it was advertised by platform announcements and social media articles about the prototype to reach a larger audience. For the quantitative evaluation the Learning Analytics capabilities of the openHPI platform were used [7]. Based on the tracking of user interaction events it was possible to measure how often and how long certain second screen actions were used in order to obtain valuable usage statistics. This can provide information about which actions are favored by users.

4 IMPLEMENTATION OF THE SECOND SCREEN PROTOTYPE

This section provides an overview about the implementation of the second screen prototype. Since covering all details of the implementation would go beyond the scope of this paper, this section focuses on the most interesting aspects. At first, the WebSocket communication is explained in Section 4.1. Then, details about the content required by the second screen actions are discussed in Section 4.2. At last, the architecture and user interface of the mobile client are shown (Section 4.3).

4.1 WebSocket Communication

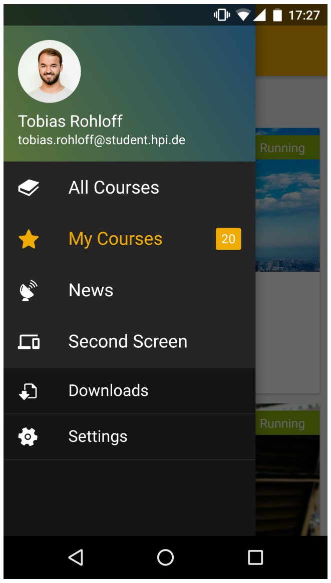
Since the WebSocket standard was especially designed to work with modern browsers, the majority of them supports this specification out of the box. To encapsulate the WebSocket functionality from the rest of the web client and isolate the additional networking and possible errors, a solution was preferred to run the WebSocket concurrently. The multi-threading capabilities of browser are limited, but it can be achieved with the Web Worker API [12]. This API allows to create dedicated worker objects, that run a separate script on a different thread. Furthermore, it provides the SharedWorker interface, whereby these workers are even shared by different tabs or windows of the same origin. This is beneficial especially when maintaining a WebSocket connection to use a single connection for all opened tabs and also persist the connection between page loads, instead of creating and opening a new connection each time. Therefore, this approach was chosen.

On the server-side the WebSocket service was realized as a Python program based on the `aiohttp` package[2] and the mobile client for Android uses the WebSocket implementation of `Java-WebSocket`[3]. The messages broadcasted by the WebSocket server are formatted as JSON strings.

4.2 Supplying the Content

To synchronize the state of the web video player to the native mobile application, the video player can publish its state by sending messages to the WebSocket which then gets transferred to the server and broadcasted to all active clients. Thus, a couple of messages are posted, for example if a video `play`, `pause`, `seek`, `stop` or `close` is triggered. Additionally, if the video is currently playing, a `running` message is published every second to continuously update the clients.

[2] https://pypi.python.org/pypi/aiohttp
[3] https://github.com/TooTallNate/Java-WebSocket



17:27

Tobias Rohloff
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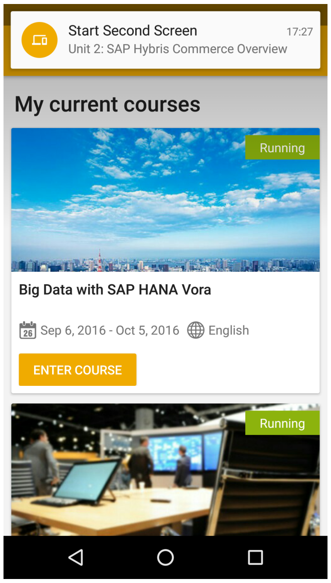
All Courses
My Courses 20
News
Second Screen
Downloads
Settings

Running
Running

Figure 2: Second Screen - Menu Item



Start Second Screen 17:27
Unit 2: SAP Hybris Commerce Overview

My current courses

Running

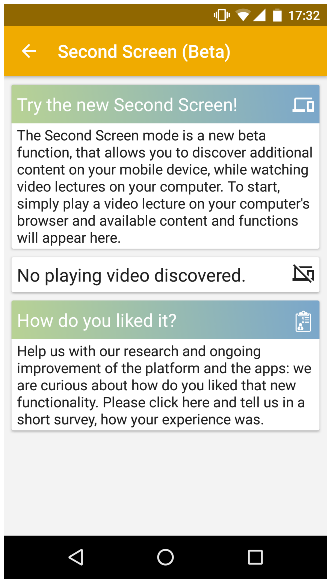
Big Data with SAP HANA Vora

Sep 6, 2016 - Oct 5, 2016 English

ENTER COURSE

Running

Figure 3: Second Screen - Notification



17:32

Second Screen (Beta)

Try the new Second Screen!

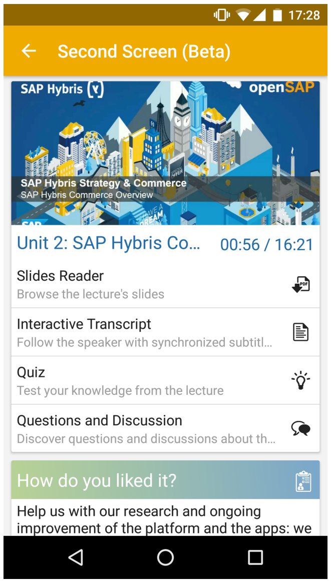
The Second Screen mode is a new beta function, that allows you to discover additional content on your mobile device, while watching video lectures on your computer. To start, simply play a video lecture on your computer's browser and available content and functions will appear here.

No playing video discovered.

How do you liked it?

Help us with our research and ongoing improvement of the platform and the apps: we are curious about how do you liked that new functionality. Please click here and tell us in a short survey, how your experience was.

Figure 4: Second Screen - Introduction and Survey



17:28

Second Screen (Beta)

SAP Hybris openSAP
SAP Hybris Strategy & Commerce
SAP Hybris Commerce Overview

Unit 2: SAP Hybris Co... 00:56 / 16:21

Slides Reader
Browse the lecture's slides

Interactive Transcript
Follow the speaker with synchronized subtitl...

Quiz
Test your knowledge from the lecture

Questions and Discussion
Discover questions and discussions about th...

How do you liked it?

Help us with our research and ongoing improvement of the platform and the apps: we

Figure 5: Second Screen - Detected Video with Actions

Next to synchronizing the video state between the clients, for every action the actual content needs to be provided which is discussed in the following sections.

4.2.1 Synchronized Slides Reader. Next to exposing an URL of the slides' PDF file via an API endpoint, the information is also needed which slide is displayed at which time in order to be able to synchronize the currently discussed slide in the video lecture. Therefore, the openHPI platform uses an automated slide detection. This is done in a three steps process. At first, a slide transition detection and optical character recognition is applied to the video stream of the slides to extract the textual content of each slide [13]. Afterwards, a lecture outline recognition is processed to rebuild a logical system of the text lines within each slide [1, 2]. Now all slides have a title and an up-to-3-level tree-structure outline. At second, a similar process is applied to the slides' PDF file to generate an outline. Here, the textual accuracy is higher but no timing information is available. At the end, the similarity of the outlines from the video stream and file are compared to find matching pairs of slides. Thus, the accurate outlines from the file-based approach are enriched with proper time tags. Now every timestamp of the video can be assigned to an actual slide number.

4.2.2 Interactive Transcript. To provide the interactive transcript, the subtitles for each video needs to be exposed. These are only used by the web client yet, for the video player. Therefore, the transcript data is persisted with the WebVTT[4] standard which specifies a file format for subtitles. This format could be parsed by the client itself but this way it had to be implemented for every client separately that wants to use it. Therefore, the WebVTT files are parsed at the server-side once and exposed via an API route as JSON responses, which all clients are able to understand already.

4.2.3 Lecture Quiz, and Questions and Discussion. The mobile application for Android uses web views for some parts of the platform, that the API does not covers at the moment. Also quizzes and the forum are displayed in that way. Therefore, the quiz and also the questions and discussions actions are simply opened with an URL exposed by an API endpoint.

4.3 Mobile Client

Based on the implemented cross-client communication and provided content, the mobile application is able to offer the proposed second screen actions. Therefore, the architecture of the main components is explained in Section 4.3.1 and afterwards the user interface and navigation flow is presented in Section 4.3.2.

4.3.1 Architecture and Components. In Figure 10 the architecture of the main components to implement the second screen mode is shown. This functionality is embedded in openHPI's Android application. The Android platform was chosen because during the time of this study only an application for Android was released and an iOS application was still work in progress. Thus, the proposed architecture is designed on top of the Android-specific framework, but it could also be used as a starting point to implement a similar functionality for iOS or other mobile platforms.

The incoming WebSocket messages are handled by a central `WebSocketManager` component which runs in the background of the applications. It also takes care of establishing the initial WebSocket connection and provides re-connection mechanisms, for example when the network connection was lost. If a valid message is received, the `WebSocketManager` posts it to an `EventBus`. By running the `WebSocketManager` on a background thread and with the asynchronous message delivery on an `EventBus`, the whole WebSocket processing is handled concurrently next to the

[4] https://w3c.github.io/webvtt/

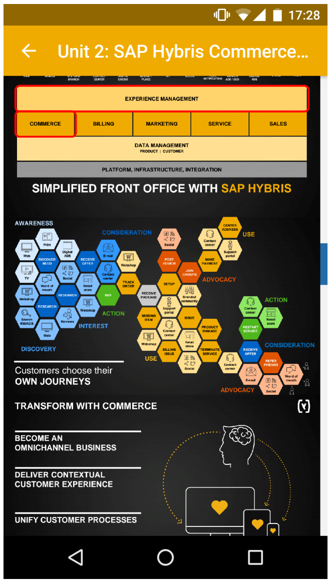
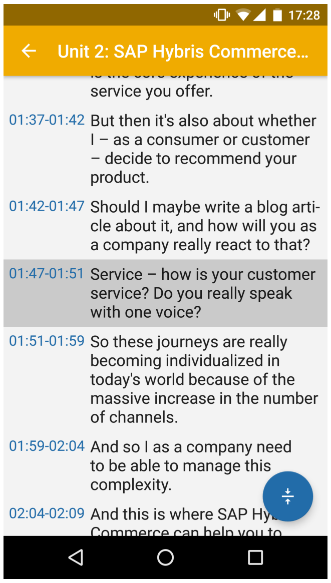

17:28
Unit 2: SAP Hybris Commerce...
EXPERIENCE MANAGEMENT
COMMERCE
BILLING
MARKETING
SERVICE
SALES
DATA MANAGEMENT
PRODUCT | CUSTOMER
PLATFORM, INFRASTRUCTURE, INTEGRATION
SIMPLIFIED FRONT OFFICE WITH SAP HYBRIS
AWARENESS
CONSIDERATION
USE
ADVOCACY
ACTION
INTEREST
DISCOVERY
Customers choose their OWN JOURNEYS
TRANSFORM WITH COMMERCE
BECOME AN OMNICHANNEL BUSINESS
DELIVER CONTEXTUAL CUSTOMER EXPERIENCE
UNIFY CUSTOMER PROCESSES

Figure 6: 2nd Screen Action - Synchronized Slides Reader



service you offer.

01:37-01:42 But then it's also about whether I – as a consumer or customer – decide to recommend your product.

01:42-01:47 Should I maybe write a blog article about it, and how will you as a company really react to that?

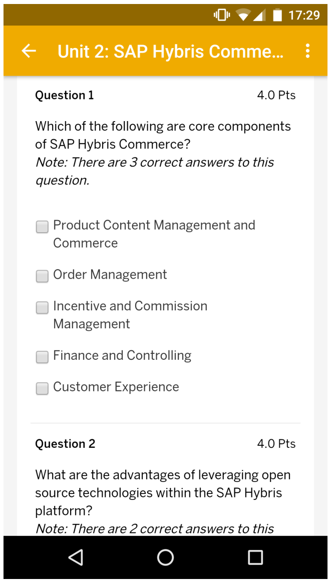
01:47-01:51 Service – how is your customer service? Do you really speak with one voice?

01:51-01:59 So these journeys are really becoming individualized in today's world because of the massive increase in the number of channels.

01:59-02:04 And so I as a company need to be able to manage this complexity.

02:04-02:09 And this is where SAP Hy Commerce can help you to

Figure 7: 2nd Screen Action - Interactive Transcript



Question 1 4.0 Pts

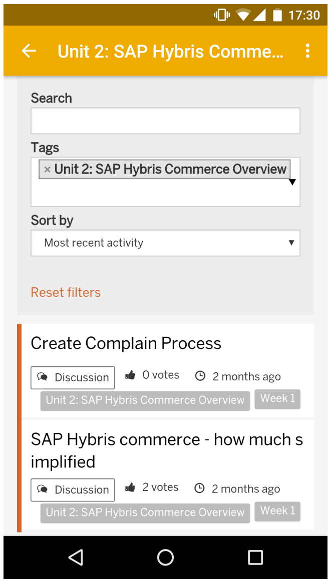
Which of the following are core components of SAP Hybris Commerce?
Note: There are 3 correct answers to this question.

□ Product Content Management and Commerce
□ Order Management
□ Incentive and Commission Management
□ Finance and Controlling
□ Customer Experience

Question 2 4.0 Pts

What are the advantages of leveraging open source technologies within the SAP Hybris platform?
Note: There are 2 correct answers to this

Figure 8: 2nd Screen Action - Lecture Quiz



Search

Tags: × Unit 2: SAP Hybris Commerce Overview

Sort by: Most recent activity

Reset filters

Create Complain Process
Discussion 0 votes 2 months ago
Unit 2: SAP Hybris Commerce Overview Week 1

SAP Hybris commerce - how much s implified
Discussion 2 votes 2 months ago
Unit 2: SAP Hybris Commerce Overview Week 1

Figure 9: 2nd Screen Action - Questions and Discussion

regular application to not disturb the user by taken execution time of the main thread or blocking callbacks when a message is received.

The SecondScreenManager component subscribes to the generic WebSocket messages on the EventBus and checks if a message was send by the web platform and the action is related to the video player. Based on this, it publishes a second screen event to the EventBus. Those events carry the preprocessed video player data from the web and are evaluated by the different view controllers, to show notifications for newly detected videos, to display the video state and to synchronize the second screen actions. The different actions can be started from a central SecondScreenActivity which introduces and presents the second screen mode to the user.

4.3.2 *User Interface and Navigation.*

Within the mobile application, the second screen mode can be reached in two ways. On the one hand, the user can navigate to it by clicking on the corresponding menu item in the main navigation (see Figure 2). On the other hand, a heads-up notification will appear when the user has opened the application and a playing video is detected (see Figure 3). If the user clicks on the notification or the video has stopped or is closed, the notification is removed.

After navigating to the second screen mode, an introduction text will explain the functionality to the user (see Figure 4). Also a linked hint about the survey will appear after the first time a video was detected. The detected video will be displayed with its title, preview image and also its total and current time to clearly show the synchronized state to the user (see Figure 5). Below, the available second screen actions are listed.

In the Figures 6 and 7 the synchronized slides reader and the interactive transcript are shown. The user can freely scroll through the content or synchronize the state by clicking on the action button in the lower right corner. The button appears when the users starts to scroll and disappears when the button was clicked.

In Figure 8 the follow-up quiz is shown, that the user could solve while watching the video lecture on its computer. Besides that, the pre-filtered questions and discussion forum is shown in Figure 9 with threads about the current lecture.

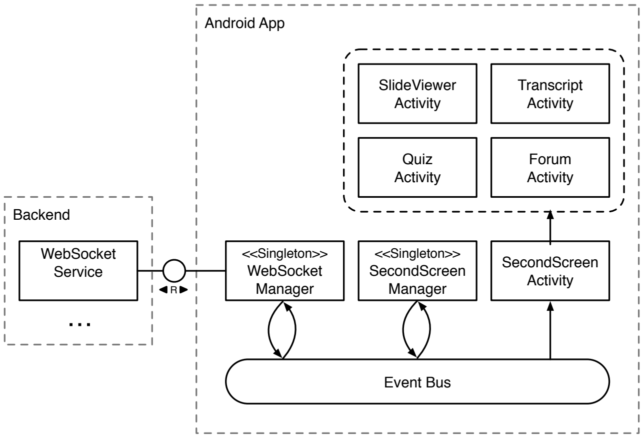


Figure 10: Second Screen Components on Android

5 EVALUATION

After promoting the second screen mode in currently running online courses and releasing the mobile client update, the prototype was examined with a mixed method approach. Therefore, the evaluation is split in a quantitative part in Section 5.1, where the tracked Learning Analytics statistics are presented, and in a qualitative part in Section 5.2, in which the survey results are assessed.

5.1 Usage Data from Learning Analytics

As explained before, user interaction events were tracked for the prototype in order to measure how often and how long a certain second screen action was used. In Table 1, the total amount of all sessions is shown. Additionally, the number of unique users for each action is stated in parentheses after each session count. Since the tracking and timestamps of each start and stop event are produced on the client-side, the session duration calculation is error-prone. Thus, to improve the data quality, we required a session to have a duration between 10 and 3600 seconds. Other sessions are considered as invalid and are not included in this analysis.

In order to provide the second screen prototype to more users, also openSAP, the MOOC platform from SAP based on openHPI's white-label software, was utilized. Therefore, the results were split for both platforms. However, the transcript action is only available on openSAP at the moment because the required subtitle data is not provided on openHPI. Nevertheless, the prototype adapts itself to the available data, so when openHPI will add this data it is automatically available on the second screen mode.

Table 1: Total Number of Sessions (and Unique Users)

Platform	Slides Reader	Transcript	Quiz	Forum
openHPI	787 (272)	-	285 (115)	143 (113)
openSAP	230 (162)	467 (152)	254 (90)	62 (54)

Overall, the second screen mode was used more often on openHPI than on openSAP. The slides reader action was used at most on openHPI, while the transcript action was the most popular action on openSAP. Here the slides reader action was less used. The quiz action was used similarly on both platforms, whereas the forum action was more often used on openHPI.

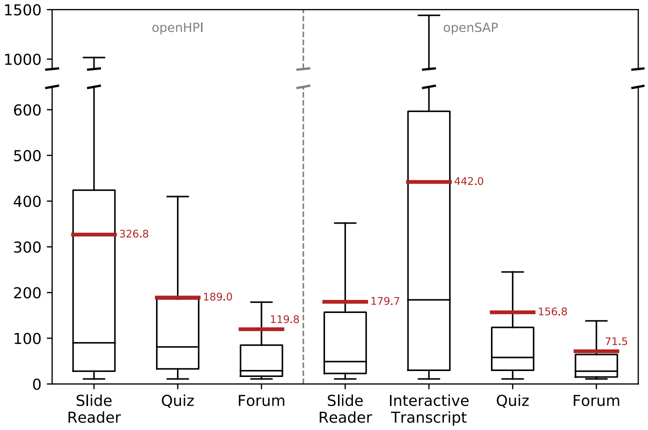


Figure 11: Session Durations of Second Screen Prototype (in Seconds; without Outliners)

In Figure 11 the distribution of the session durations of the different second screen actions in form of a box plot is shown. The median is visualized as a black horizontal bar while the arithmetic mean is displayed as a thicker red bar. To create a better overview, Figure 11 does not display any outliners. The transcript action had the highest average duration with approximately 7.37 minutes on openSAP. The second longest used action on openHPI was the slides reader with around 5.45 minutes, respectively 3 minutes on openSAP. The quiz and forum were again slightly shorter used on both platforms. These usage statistics indicate that learners tend to use passive functionality like the transcript and slides reader more often for the second screen mode, than actions that require more interactions like the forum and quizzes.

5.2 Survey Outcome

To get qualitative feedback about the second screen prototype and its actions, a survey was conducted to which 17 platform users responded. The survey was available for a timeframe of 4 weeks.

Figure 12 visualizes the survey outcome regarding the helpfulness of the second screen prototype. The responses are grouped by the positive feedback (*very helpful* and *helpful*) and negative feedback (*not helpful* and *not at all helpful*). For the sake of completeness, the undecided responses are included as well. These groups are centered around a zero line in order to allow an easy comparison of the different second screen actions. Positive feedback is stacked upwards, whereas negative feedback and abstentions are stacked downwards. Figure 12 displays the overall perception of helpfulness of the second screen prototype, as well as the levels of helpfulness of each action. While the slides reader and the interactive transcript actions received mostly positive feedback (70.6% and 64.7%), the quiz and forum actions received mixed feedback with 58.8% (positive feedback) vs. 23.5% (negative feedback), respectively 47.0% and 23.5%. All in all, the results show that 64.7% of the users have found the overall second screen mode as helpful.

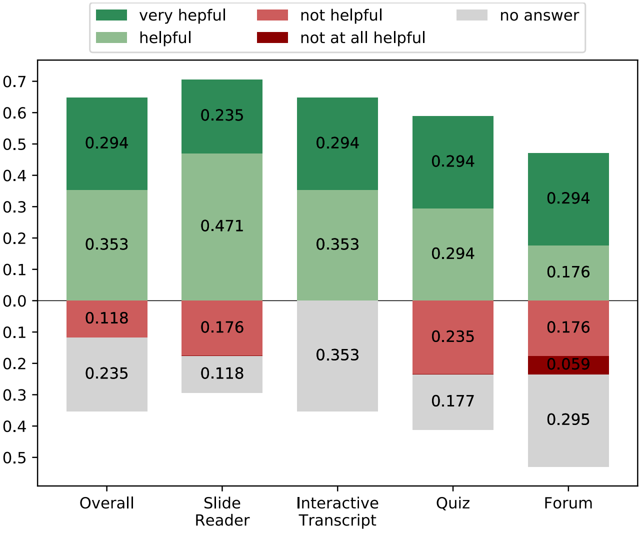


Figure 12: Helpfulness of Second Screen Prototype

Next, the users were questioned about the learning efficiency when utilizing the second screen prototype. This means that users were able to learn faster or more comfortable. 56.2% of the users have reported that the prototype made learning significant more efficient to them. Figure 13 shows the experienced increase in efficiency when using the second screen prototype. This visualization is similar to the one of Figure 12. Positive feedback (*strongly improved*, *moderately improved* and *weakly improved*) is stacked upwards, while negative feedback (*not improved*) and undecided answers are stacked downwards. All of the second screen actions were in total perceived to enhance learning experience with users stating this with 58.9% to 64.7%. Most notably, 35.3% of the users rated the learning process as *strongly improved* when using the quiz action. Thereby, the slides reader and the interactive transcript actions received slightly better feedback than the quiz and forum actions.

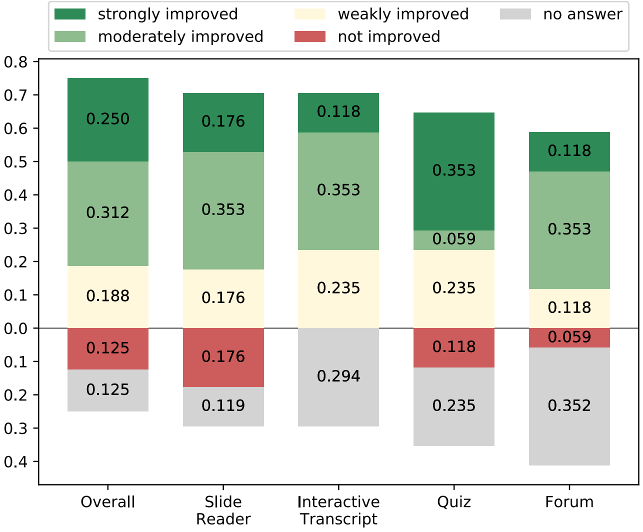


Figure 13: Efficiency of Second Screen Prototype

Furthermore, 65.2% of the users stated that they are going to use the second screen prototype for future learning activities. Figure 14 visualizes all the survey responses for the seconds screen prototype and for all of its actions similar to Figure 13 with *always*, *often*, *not often* as positive feedback and *never* as negative feedback. In total, the users were mostly likely to use the slides reader action (65.2%). This action received no negative feedback. Whereas, the quiz and the forum actions got the best result from users who would like to always use those actions (21.7% and 17.4%). The interactive transcript action is slightly less used according to the users' responses. Notably, the questions about the future usage were less likely to be answered by the survey participants.

Additionally, 47.1% of the users were satisfied with the second screen experience and 23.1% were even very satisfied which is an overall positive feedback. Also the combined usage of a mobile device and computer was rated mainly positive. The majority of users claimed, that they will use the second screen mode in future.

From the individual feedback the prototype was assessed as an "innovative feature" and the "overall good experience and thoughtful effort towards interactive learning experience" were lauded. Also improvements were proposed, like the integration of learning groups, a more focused experience of the slides reader by just showing the current slide and an observed slight lag in the synchronization of the interactive transcript. Most of the participants never used a second screen application before.

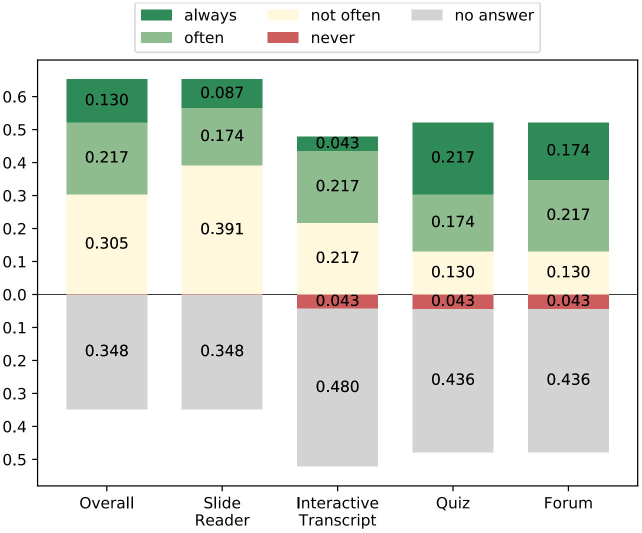


Figure 14: Future Usage of Second Screen Prototype

The generally positive outcome of the survey shows a success of the second screen prototype, which in turn marks a success for the concept and implementation of this study. However, more users have to be attracted in future and improvements were proposed for a next prototype iteration. All in all, the second screen mode is received as a useful addition and learning tool for the feature set of a MOOC platform.

6 CONCLUSION

Mobile devices provide the opportunity to improve and enrich the MOOC experience by enabling new forms of learning. Some first investigations on the openHPI MOOC platform have revealed tendencies, where users who learn with the mobile and web application together show a high platform activity and a high learning outcome. To further support these recognized multi-device learning pattern, a second screen prototype was conceived and implemented. Thereby, the mobile device can be used as a companion while using the web client on a computer and watching video lectures. The mobile application is able to detect the video and offers additional content related to the lecture. Four second screen actions were provided: a synchronized slides reader, an interactive transcript, the follow-up quiz and the filtered questions and discussion forum.

The prototype was released and tested quantitative with usage data from Learning Analytics and qualitative with a user survey. The evaluation gained generally positive feedback, whereby the slides reader and transcript received slightly better results than the quiz and questions and discussion forum feature. The majority of users reported that the second screen mode was helpful and made learning more efficient. Also, most participants want to use it in future. However, improvements were proposed for a next iteration of the prototype and more qualitative feedback from a larger user base would be valuable.

In summary, the generally positive results mark a success for the concept and implementation of this paper. It shows that mobile learning can support scalable e-learning beyond optimizing the content for small screens. The pervasive presence of mobile devices allows us to integrate these resources into the different activities of our daily lives. This enables platform providers to conceive new innovative use cases for mobile learning, whereby this paper is showing one possible approach to achieve that.

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