Benefits of interactive H5P learning applications for implementing an activity-based learning approach for printing engineers

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Abstract

The development and implementation of innovative teaching and training concepts in the engineering sciences in general and printing technology in particular often includes e-learning applications. While this seems to be appropriate for standard knowledge transfer scenarios, the promotion of in-depth understanding and application knowledge is usually more challenging. This paper offers some suggestions as to how the open-source content cross-platform framework H5P can be used to develop interactive, activity-based e-learning content for printing engineers and which potentials and limitations of this technology can be derived from that.

Keywords

e-learning, activity based learning, printing engineers, H5P

1 Introduction

At least since the COVID-19 pandemic severely disrupted tried and tested teaching processes, e-learning in higher education is back in the focus of interest. As an extensive bibliographic survey in (Aristovnik, Karampelas, Umek, & Ravšelj, 2023) has shown, engineering education was (along with health education) one of the most-discussed topics. The quality of online learning mechanisms and active learning activities were among the hotspots of online learning research (l.c.).

Topics like these were dealt with in the surfaceCOLLEGE project, aimed at the creation of innovative digital learning content to be embedded in a blended learning concept for printing engineers (GRAVOmer, 2024). This content is aimed at the DQR Level 5 of the German Qualifications Framework / Deutscher Qualifikationsrahmen (Federal Ministry of Education and Research, 2024), intended to bridge the gap between German vocational training (DQR Level 4) and academic education, which is a bachelor's degree (DQR Level 6) or higher. Future learners in this course are likely to have very different levels of subject-specific knowledge, know-how in dealing with online media and varying amounts of professional experience. Therefore, a learning method had to be found that supports e-learning-based, self-determined learning and allows for multiple repetitions. Following a market analysis, H5P (an abbreviation for *HTML 5 package*), was identified as a suitable technology for this purpose, supporting the creation and sharing of digital learning content, the application of distributed, asynchronous and location-independent learning, and configurable feedback.

H5P is an open-source content collaboration framework intended to make it easy to create, share and reuse interactive e-learning content (H5P Group, 2024a). Thereby, it touches on a topic that has been studied intensively as early as the 1990s, when *Multimedia Authoring Systems* were developed with the intention to provide easy-to use tools for instructional designers, educators and teachers to develop interactive multimedia and hypermedia learning environments (cf. (Cutler & Candan, 1996), (Dabbagh, 2001) or (Rutledge & Hardman, 2001)). Authoring tools like *Authorware*, *Asymmetrix Toolbook* or *Macromedia Director* were intended for authors with a didactic background, but little or no programming experience (Dabbagh, 2001). They used different *organizing metaphors* (or *authoring paradigms*) to structure

instructional materials and learning activities. Authorware, for instance, used a *flow control paradigm*, organizing the educational content in a decision-tree-like structure. Toolbook used the metaphor of an *interactive book*, and Director used a *movie metaphor*, in which multimedia elements are arranged on a timeline, comparable to a storyboard in film (Cutler & Candan, 1996). Although these authoring tools were quite popular in the day, mutual incompatibilities, limited reusability and proprietary standards were a recurring issue. Besides, the different authoring paradigms were often well suited for a certain type of e-learning application, but less so for another. The decision tree-approach of Authorware, for instance, was very well suited for complex question-and-answer-scenarios, but less adapted to the implementation of complex animations.

With the advent of the internet, *Web Based Training (WBT)* became more important, although it lacked the sophisticated interaction or animation capabilities that desktop-based authoring systems already possessed at that time. However, content delivery and accessibility due to online connectivity, and thus, the delivery and management of instructional content and the organizational aspects of online learning became a core topic of scientific discussion (Watson & Watson, 2007, p. 28). This led to the development of Learn Management Systems (LMS) such as Moodle, ILIAS or OLAT, mainly focused on the organization of the learning process and course administration (l. c.). Because these were based on standard web technologies like HTML, CSS and JavaScript, they were platform-independent, (at least in theory) open-source, and easily accessible.

However, Learning Management Systems require adaptable, scalable and reusable e-learning modules; so-called *learning objects* (l. c., p 30). H5P is an innovative solution to develop this kind of learning content, which remedies several disadvantages that older desktop-based authoring systems had: It is web based, free to use, open-source, non-proprietary and compatible to multiple LMS (Rekhari & Sinnayah, 2018, p. 192). Besides, H5P also implements multiple authoring paradigms, named *content types* (H5P Group, 2024b): The H5P content type *branching scenario*, for instance, is very similar to the decision-tree metaphor of Authorware, *H5P course presentation* closely resembles the interactive book paradigm of Toolbook, and *H5P interactive video* uses the movie metaphor of Director. Thus, multiple paradigms that formerly only existed in mutually incompatible, proprietary implementations, are now integrated in one unifying concept.

Interesting as this idea might be from a scientific standpoint, it is, of course, important to evaluate H5P under practical learning conditions. Therefore, the surfaceCOLLEGE project tried to test several content types to create custom learning environments for printing engineers. For each content type evaluated, a real-life learning scenario was chosen, sample didactic content was created and the results were evaluated. The primary results will be discussed below.

2 Methods

The evaluation of the H5P technology for the education of printing engineers began with an identification of the DQR level 5 target group, an assessment of their learning needs and a mapping of these needs to a corresponding learning matrix. In line with this concept, sample topics suitable for interactive online learning were identified and matched to corresponding H5P content types. After that, sample topics were selected for a prototyping implementation. To cover a broad spectrum of options, four comparably complex scenarios were chosen, each of them using one of the H5P "meta" content types that allow for the integration of other content types (cf. (Gierth-Scheer, 2023, S. 22)): a material detection course using a flow control paradigm, an interactive book on color theory, an interactive video on paper manufacturing and a 360° 3D scenario intended for situated learning in a virtual printing room.

All prototypes were developed with the free to use version of H5P. There is also a commercial version available on h5p.com, which provides additional functionality for collaboration, the management of user rights and more (for an overview of all the differences please cf. (H5P Group, 2024c)). To integrate the sample content in a LMS, the H5P WordPress plugin was used.

3 Results

The *H5P interactive book* has a rather traditional authoring approach that is also used in presentation tools such as PowerPoint or Keynote. It can display images, texts and audio as well as more complex interactive content (H5P Group, 2024d). Complex interactions can, for instance, be achieved by integrating other H5P content types such as *Agamotto* (interactive sliders, cf. Figure 1, above right) or *Image Hotspots* (cf. Figure 1, below left). The content can be divided over several pages; the document structure can be accessed via a vertical scrollbar on the left, allowing for a user-controlled, non-linear navigation. Progress indicators and a summary page can be included as well (Bauer, 2023).

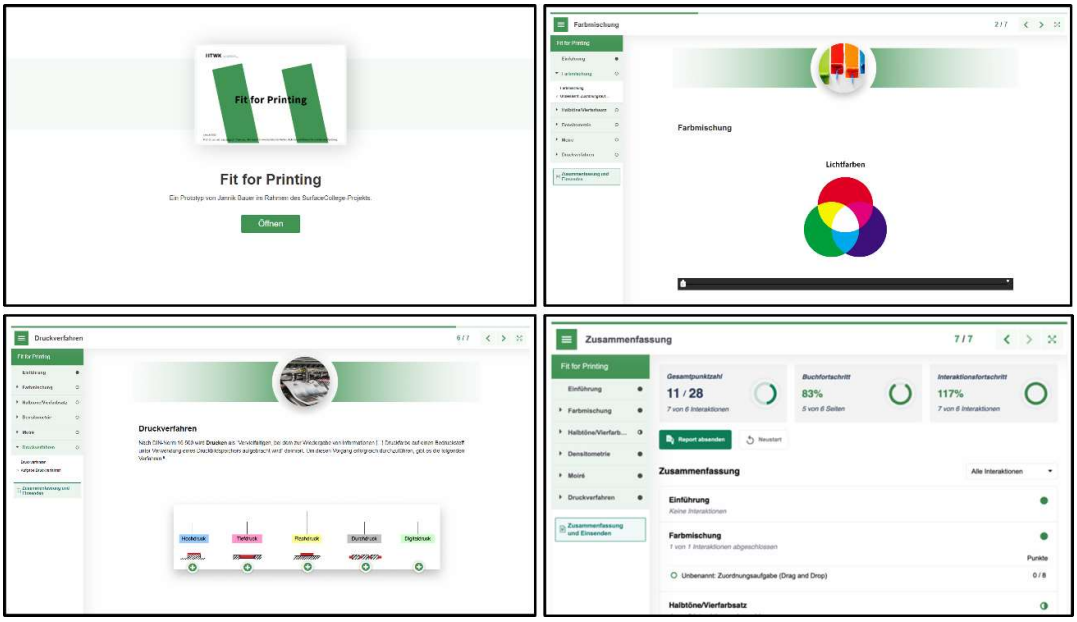

Figure 1: Cover, samples of interactive pages and a feedback page for self-assessment from a H5P interactive book. The table of contents is visible on the left-hand side of each screen (Bauer, 2023)

The *H5P Branching Scenario* enables authors to arrange content in a decision tree with multiple branches (H5P Group, 2024e). Emulating a lab-course on material detection and identification, this interactive prototype presents the learning content (explanation of different identification methods) in a demand-oriented way (cf. Figure 2, above left). Thus, experienced users can, for instance, skip the introduction, while less experienced users repeat difficult sections multiple times. After choosing a certain method for a given identification problem, different test outcomes can be simulated by showing different decision paths (cf. Figure 2, right). Thus, different identification methods can be tried out until the optimal solution is found (Felka, 2023).

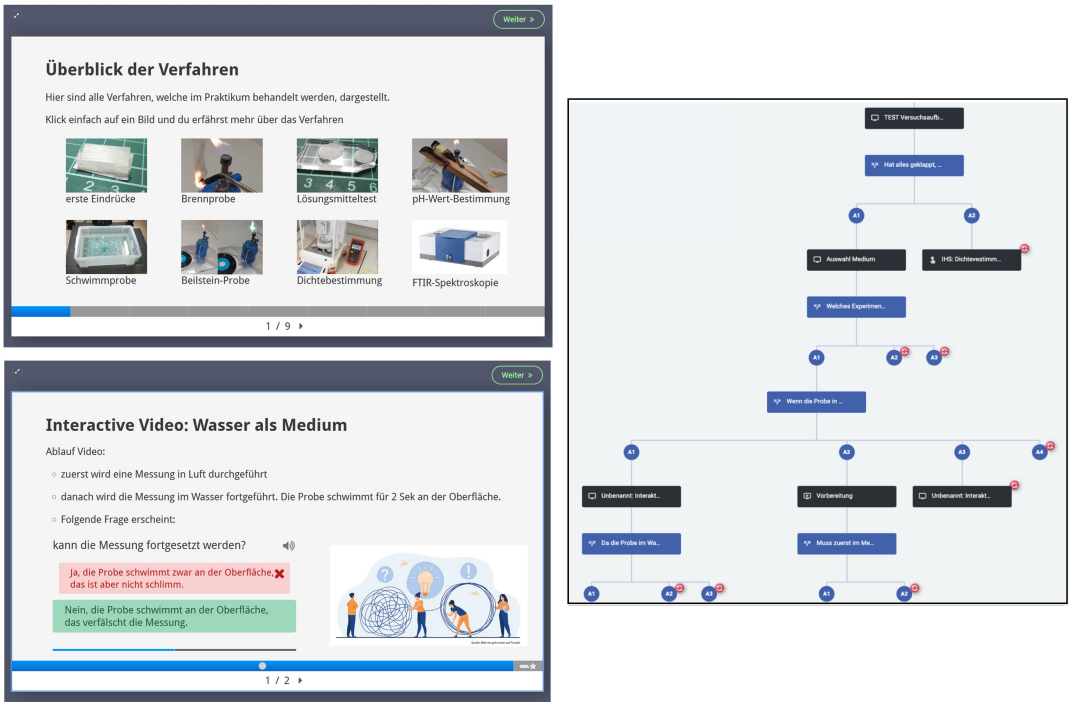

Figure 2: Teaching density measurement methods using the H5P branching scenario. Several detection methods are presented (above left) and can be explored while navigating through a decision tree (right). Real-life decisions can be simulated, and feedback is given (below left) if mistakes occur (Felka, 2023)

For the creation and delivery of videos enriched with interactive content, the *H5P interactive video* is the method of choice. In surfaceCOLLEGE, this content type was used to enhance existing lecture recordings on papermaking (Gierth-Scheer, 2023). Existing video files can be embedded directly into a corresponding H5P container, but referencing YouTube, Vimeo or Panopto files is also possible. To enhance the linear video, accompanying texts, pictures, interactive links and junctions or quizzes can be added (again, other H5P content types can be used for that).

Another interesting feature are the so-called *intersections*. This type of additional content begins with a branching question leading the learners to different jump points depending on their choices. This feature exists in addition to traditional bookmarking, which is used to access chapter beginnings or other markers and is implemented in the H5P interactive video as well. Thus, multiple video access strategies for recall, repetition and in-depth understanding are possible.

In general, the accessibility rules of the *Web Content Accessibility Guideline* (WCAG 2.1 AA) apply to most of the H5P content types, with a few exceptions (H5P Group, 2024f). In the case of videos 'VTT' subtitle files can be added to the H5P module.

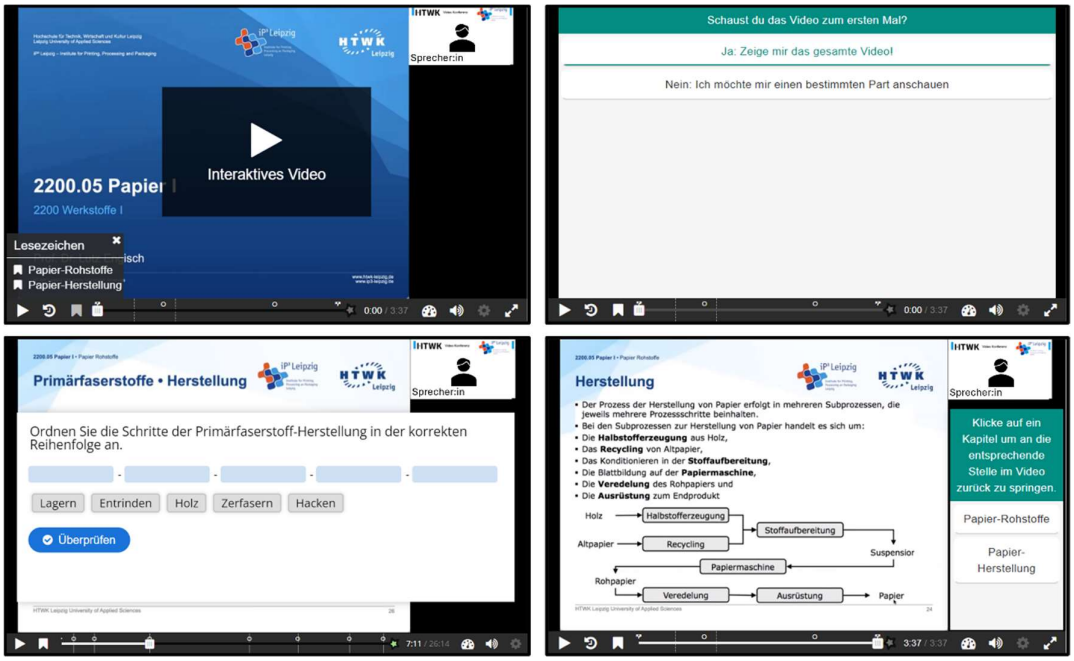

Figure 3: H5P interactive video sample on paper manufacturing. The play bar below the video allows for basic video control (start and stop, skip forward and back, above left). Predefined bookmarks facilitate jumps to specific topics (below right). Knowledge queries (below left) are marked with a circle (○) on the progression bar, intersections (above right) are marked with two arrows pointing in different directions (↖↗). (Gierth-Scheer, 2023)

The H5P content type *Virtual Tour 360°* (H5P Group, 2024g) was used to create a faithful virtual reconstruction of a printing room used for the training of prospective print engineers. Using a SLR camera with fisheye lens, equirectangular pictures were taken from six different positions within the room, which were used to create several 360° panoramic interactive environments (Benter, 2023). Thus, all the machinery within the room can now be viewed from different locations, and the interactive experience is further enriched by adding close-ups, text information or interactive hotspots.

Using the virtual tour, learners can familiarize themselves beforehand with all the machinery without time limits or supervision. Print related knowledge can be acquired in a realistic application situation, thus enabling situated learning.

Figure 3: Virtual Reality visualization of the university´s printing room. Positions indicated by arrows can be accessed using a map (above, left) or by mouse interaction. Hotspots (⊕) give access to additional information (Benter, 2023)

4 Discussion

The technical analysis of all H5P prototypes led to several conclusions. The development of the *H5P Interactive Book* was more or less straightforward. However, the control over layout and object spacing was somewhat limited and the content type offered no support for a responsive adaptation to different screen sizes or dynamic layouts. Furthermore, the inclusion of the *Agamotto* content type resulted in some problems with the slider control due to the Interactive Book referencing an older malfunctioning version (Bauer, 2023, S. 55). Furthermore, a learning progress of more than 100 % could be achieved on the summary page (cf. Figure 1, below right) caused by a current malfunction through which Agamotto is not considered as an interaction.

The self-directed learning approach of the *H5P branching scenario prototype* received a mostly favorable response in a preliminary expert evaluation, although a breakdown in even smaller sub-units was suggested. From a technical perspective, both an overall progress indicator that maps the learners' progress along the decision tree and a mechanism to store interim results were missed (Felka, 2023). Due to a lack of functionality flaw in decision tree editing, deleting of branching nodes leads to a complete deletion of the sub-tree below, which made subsequent modifications very difficult.

The enrichment of video content with interactive media using the *H5P interactive video* worked more or less as intended. Due to the requirements of the General Data Protection Regulation (GDPR), the inclusion of videos from third-party platforms is currently restricted in the EU or not possible at all. Therefore, the prototype discussed here used a direct embedding. This, however, led to a storage problem that made further editing of H5P files impossible if the video files were larger than about 120MB. Unfortunately, a cropping of video data within the content type is currently not possible (Gierth-Scheer, 2023). However, as of February 2024, the storage problem seems to have been resolved.

The *360° Virtual Tour* of the printing room turned out to be a rather voluminous application, too, containing six different 360 panoramas taken from different viewing angles enriched with about 50 additional scenes. This led to a H5P file of about 153 MB in size, and even this was only attained after the panorama shots were significantly reduced in size, which led to minor graphical distortions. Unfortunately, an automated preloading of information without further interaction is, sadly, currently not available in H5P (Benter,

2023). Likewise, load balancing (the adaption of download speeds to available network capacity) or the inclusion of data streams in different resolutions (high resolution for desktop viewing, low resolution for smartphones) would be welcome additions.

In general, when editing or creating learning content, the options to undo changes and to correct mistakes were often limited for media types other than text. This may lead to a slightly increased effort, especially when rearranging content for didactic reasons.

Apart from these technical limitations, the use of standard web technologies (HTML5, CSS, JavaScript) proved to be a clear advantage of H5P, allowing for an easy access via web browsers, good cross-platform compatibility and a more or less seamless integration in many Learning Management Systems. Due to the inclusion of many different authoring paradigms (book metaphor, flowchart, timeline) and the possibility to interleave specific content types, developers can choose from a wide variety of options to create, share and reuse interactive learning objects.

5 Conclusion

In this paper, a wide variety of H5P content types were tested regarding their potential to implement activity-based learning concepts for printing engineers. H5P turned out to be an open-source, platform-independent, web standard based technology that offers a wide range of organizing metaphors to authors of e-learning applications, which makes it a very powerful and flexible tool. H5P applications tend to be reusable and can be seamlessly integrated in many Learning Management Systems.

The prototypes shown above illustrate how H5P technology is used to create and present scientific content for printing engineers. This was also confirmed in the surveys of future users. One of the identified core potentials lies in supporting needs-oriented learning and easy access through web browsers.

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