PJHRD Philippine Journal of Health Research and Development

RESEARCH ARTICLE

Development and evaluation of H5P Interactive Learning Objects for online learning in pre-clinical medical education

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ABSTRACT

Background: The pandemic forced a shift to online education, which encountered issues such as connectivity issues and lack of interaction. The HTML Package (H5P) is an open source software platform that enables the creation and delivery of asynchronous interactive online learning content with minimal technical and data requirements. There is a need to explore H5P in this context.

Objectives: To describe the development of digital learning objects using H5P integrated into a university learning management system and to evaluate students' perception of this in terms of usefulness, integration, impact on learning, and important attributes of the learning object.

Methodology: H5P interactive content was created and integrated into the UP Manila LMS and used for the OS212 ORL Module. The 179 second year medical students were then invited to answer a survey regarding their perception of H5P's ease of use, impact on learning outcomes, integration, and key attributes of an LO. Data gathered was analyzed using descriptive statistics.

Results: There were 134 respondents and they had a highly positive assessment of the H5P learning objects with regards to all studied parameters. Majority of the students found the H5P content easy to use, appropriate and well integrated, and helpful for learning.

Conclusion: The H5P platform provides the opportunity for the development of online educational content without the need for advanced technical skills. The high level acceptance of LOs using H5P technology underscores its potential to enrich students' educational experience.

Keywords: *online learning, learning objects, H5P, medical education, survey*

Introduction

The COVID-19 pandemic forced Philippine medical schools to undergo a radical shift from the traditional face-to-face learning activities to an online curriculum [1]. Medical school faculty, accustomed to the traditional lecture approach of face-to-face teaching in the classroom were replaced with online, interactive live lectures or seminars, or with pre-recorded lectures or seminars removing the possibility of interaction [2].The effective use of these modalities was hampered by barriers to online learning such as unreliable or slow internet access, and the financial cost of maintaining internet access for the synchronous online activities, as well as the lack of interaction between learners and educators in the asynchronous activities [1]. As such, there is a need to explore alternative online methods that utilize an asynchronous mode of content delivery with minimal technical and data requirements [1] with components that allow a more flexible, student-friendly learning experience, but still involves the active participation of students in experiences that are cognitively engaging.

One such approach is the use of interactive digital learning objects. The Institute of Electrical and Electronics Engineers (IEEE) Standard for Learning Object Metadata has defined a learning object (LO) as any entity, digital or non-digital, that is used for learning, education, or training [3]. This broad definition has been further refined by the New Media Consortium, which defines it as any grouping of materials that is structured in a meaningful way and is tied to

an educational objective. The materials or "blocks" in a learning object can be documents, pictures, simulations, movies, sounds, and so on. Users interact with the materials through an interface, which includes the graphic design, navigational elements, and other controls that the user sees. It specifically characterizes a learning object as being digital in nature. Digital learning objects can present information in several different ways, thus allowing students to explore the subject matter from various perspectives. Their flexibility, cost effectiveness, and customizability are compelling reasons for using digital learning objects [4].

HTML5 Package (H5P) technology is an open-source software platform introduced in 2014 that allows educators to create interactive digital learning objects. It is a self-hosting plugin extension which can be integrated into a university learning management system such as Moodle or Canvas, and which allows faculty with non-expert computer literacy and skills to create mobile-friendly, interactive learning content that promotes self-directed learning. Once installed, educators can embed the learning object into their modules for students to access. These can also be shared with and modified by other educators as open educational resources [5].

Interactive digital learning objects (LO) created using H5P and similar technologies have been integrated into several medically related fields. Sinnayah, *et al.* used H5P in their anatomy and physiology curricula to create "chunked" learning modules which linked instructional material to LOs such as drag-and-drop questions [6]. Using H5P in Moodle, Wehling, *et al.* transformed pre-existing otolaryngology lectures into interactive videos [7]. Further, they created a fast-track approach that enables educators to create these videos quickly. De Goés, *et al.* used Macromedia Authorware® to create interactive presentations and image galleries about neonatal nursing [8]. Bryner, Saddawi-Konefka, and Gest integrated vector-based artwork and animation sequences into a storyboard using Macromedia Flash MX in a course on anatomy and physiology [9]. O'Bryne, Patry, and Carnegie used a similar program (Adobe Flash MX™) to develop interactive anatomy images [10].

The previously cited literature all highlight the versatility of H5P and similar platforms in creating a variety of interactive educational content. Aside from this, these studies also mentioned several other advantages these technologies have over a traditional lecture-based approach. Firstly, the integration of LOs in modules helped improve student understanding of the subject matter [6,8-10]. Survey data collected by the authors of these papers demonstrated that the use of interactive content and self-testing tools supported self-learning and student engagement with the lesson [6,10]. When tested, the perceived difficulty of questions was lower, and quiz scores improved either slightly or modestly [9,12]. Using LOs also provides a better opportunity for students to practice practical skills such as patient counselling, which a lecture would not be suited for [12].

This is in line with the concept of active learning, where students are involved in activities that require them to do things and think about what they are doing, as opposed to passive learning, where students act as receptacles of knowledge and do not directly participate in the learning process [13]. The promotion of active learning among students was shown to have several major advantages over the passive approach of lecturing. It enables students to better understand complicated topics, encourages higher-order critical thinking, improves the assimilation, application, and retention of learned concepts, and allows them to evaluate and reflect on their own understanding [14,15]. As one expert noted in de Goés' study, "the virtual object pushes the student to go in search of knowledge through curiosity, technological innovation and especially the interaction between theory and clinical practice [8]."

Secondly, interactive content is easy to access and use by students. Student reception of the content is mostly positive, with a majority agreeing that such learning objects are easy to navigate and intuitive to use [11,16]. Very few technical problems were encountered when using these learning objects [16]. In addition, students are afforded greater flexibility in their studies, as they can access these LOs at any time asynchronously and pace themselves based on their preferred learning style [16,17].

Lastly, the use of H5P and similar platforms addresses some of the technological barriers encountered by educators in their transition to online learning. These barriers include: time constraints, poor information technology (IT) skills, and inadequate infrastructure [18-20]. By providing an intuitive interface, H5P simplifies the process of creating and editing LOs, allowing educators to quickly create interactive content for their modules. The issue of poor IT skills is also addressed, as H5P itself offers tutorials on how educators can create and make the most out of their Los. The lack of infrastructure is also less of a problem, as H5P is a free self-hosting plugin extension which is already integrated well into platforms like Moodle and Canvas.

Evidently, the application of H5P and similar technologies to fields related to medicine is well documented. However, there is a scarcity of evidence-based literature on the

effective use of learning objects in medical education [21]. Furthermore, its use in the context of Philippine medical education has not been explored, since the switch to online learning only came recently with the arrival of COVID-19 in the country [22]. Considering this, this study aims to bridge this knowledge gap by [1] describing the development of H5P digital learning objects that is integrated into a university learning management system (LMS) and deployed for use in pre-clinical medical education and [2] evaluate students' perception of the H5P learning objects in terms of access, usefulness, impact, and integration into the online module.

Methodology

The first part of the study is a narrative description of the iterative development of the interactive digital learning objects using H5P that were developed for the OS212 ORL Module (Otorhinolaryngology subject matter) in UPCM Learning Unit IV and subsequently deployed in the LMS of the University of the Philippines Manila (UPMVLE, https://vle.upm.edu.ph) and used starting in AY 2021-2022. The ORL Module is part of a multi-disciplinary course on the pathophysiology, symptomatology, diagnosis, prevention, and principles of treatment of diseases of the musculoskeletal, sensory, and integumentary systems. It has 36 credit hours, running continuously over a span of one week (5 days), and involves 25 faculty members.

We came across the H5P platform while researching on methods to increase the interactivity of online educational resources utilized in the Moodle-based university LMS. In the official website for the H5P platform, https://h5p.org, we read the online tutorial about its uses and features, the various types of interactive content; and we viewed working examples of each type of interactive content. After creating an account in the website, we created several interactive content aided only by the detailed step-by-step tutorials available for each content type. For example, to create an interactive video, we simply had to (1) upload or embed a video, (2) add interactions, and (3) create summary tasks. All interactions (multiple-choice questions, free text entry, fill in the blanks, drag and drop, etc.) were available as toggle buttons on a menu bar. As all test content created on h5p.org are publicly available, we requested for and achieved integration of the H5P plugin into the UPMVLE. This would allow us to create H5P interactive content exclusively available to those with access to the UPMVLE. We then proceeded to create H5P-based learning objects within the LMS that aligned with the learning objectives for our course. Using an iterative design, each learning object was refined by customizing the feedback, behavioral and adaptive settings available for each content type.

The second part of the study utilized both a quantitative and qualitative survey research design. We adapted two externally validated survey questionnaires used to evaluate reusable learning objects, the RLO CETL Learning Object Questionnaire and the Learning Object Evaluation Scale for Students (LOES-S) [23,24]. The RLO-CETL Learning Object Questionnaire was validated in a study by Lamphon [25] on learning objects used in nursing education. Construct validity utilizing principal component analysis (PCA) revealed high internal consistency with regards to students' views on the educational value of learning objects, their utility and usability, and the impact of the learning objects' attributes. The LOES-S was validated by Kay and Knaack in a study on learning objects used in a population of over 1100 middle and secondary school students [24]. Based on the constructs of learning, quality or instructional design, and engagement, this instrument showed acceptable internal reliability and construct validity. These questionnaires have been utilized in similar researches on learning objects that have been published in international peer-reviewed journals [16,26-28]. The adapted survey questionnaire consisted of 33 items, a mixture of summated rating scale (Likert-type) response options, 'yes' or 'no' questions, and open-ended questions. The questionnaire evaluated the ease of use, impact on learning, integration, and important attributes of a learning object. The adapted tool was pretested on a population of second-year medical students of the University of the Philippines College of Medicine AY 2021-2022. Testing of each group of related questions revealed Cronbach alpha coefficients of > 0.8 for each subgroup. For overall reliability, the internal consistency for the questionnaire was α=0.95. These results indicate a satisfactory level of internal consistency of this modified questionnaire.

The study population was limited to the total number of second-year medical students (179 pax) of the University of the Philippines College of Medicine AY 2022-2023 who were enrolled in and completed the online learning module into which the H5P learning objects were incorporated. A sample size of at least 123 pax would provide results with a 95% certainty of what the results would have been if a total population of 180 pax had been surveyed [29] .

The study protocol was submitted to the University of the Philippines Manila Research Ethics Board, which granted a certificate of exemption (UPMREB 2022-0531-EX). Medical students were invited to participate in the study through messages posted in the discussion board of the online module. An informed consent form was incorporated into an accompanying module page.

Data was collected using a survey form created in the questionnaire module of the UPMVLE. Survey forms were completed online, within the password-protected LMS, and were submitted anonymously. No personal information other than the demographic data within the survey was collected or recorded. All data was stored within the LMS, exported in MS Excel format, and was analyzed on the same computer through which the investigators access the UPMVLE.

We analyzed the data using descriptive statistics. The frequency and percentage of responses were computed for the Likert-type data.

Results

We created twenty-three individual H5P interactive digital LOs for the online module, which were devoted to the anatomy and physiology of the sensory organs (hearing, balance, olfaction and taste), the facial nerve, laryngeal anatomy and physiology in relation to hoarseness, and an introduction to the clinical examination and common disorders of these systems. Twenty were Interactive Videos using curated, medically oriented YouTube content embedded into the H5P content type. Interactions included multiple-choice questions, fill in the blank questions, drag and drop text, and elaborating text pop-ups. One was a Course Presentation similar to a PowerPoint presentation, with embedded videos, fill in the blank questions, true or false questions, and elaborating text pop-ups. Two were multiple choice question content types that provided immediate feedback statements depending on the chosen answer. Examples of the learning objects are shown below.

We received 134 responses in the survey, which represents 74% (134/179) of the study population and is a representative sample size. There was a slight predominance of female (56%) over male (44%) respondents in the survey sample. The respondents were 20 to 33 years of age, with the majority between 22 to 24 years of age.

The majority of the respondents rated their internet connection as very good (42.54%). About a quarter rated their connection as good (28.36%), and slightly less rated it as excellent (19.40%). Only a few respondents rated their internet connection as fair (9.70%), and none as poor. In terms of the device used to access the online material, an overwhelming majority used a desktop or laptop computer to view the activities (98.51%). Only two respondents (1.49%) used a tablet to view the activities.

Around two thirds of respondents have not encountered H5P content before (64.93%), while about a third of

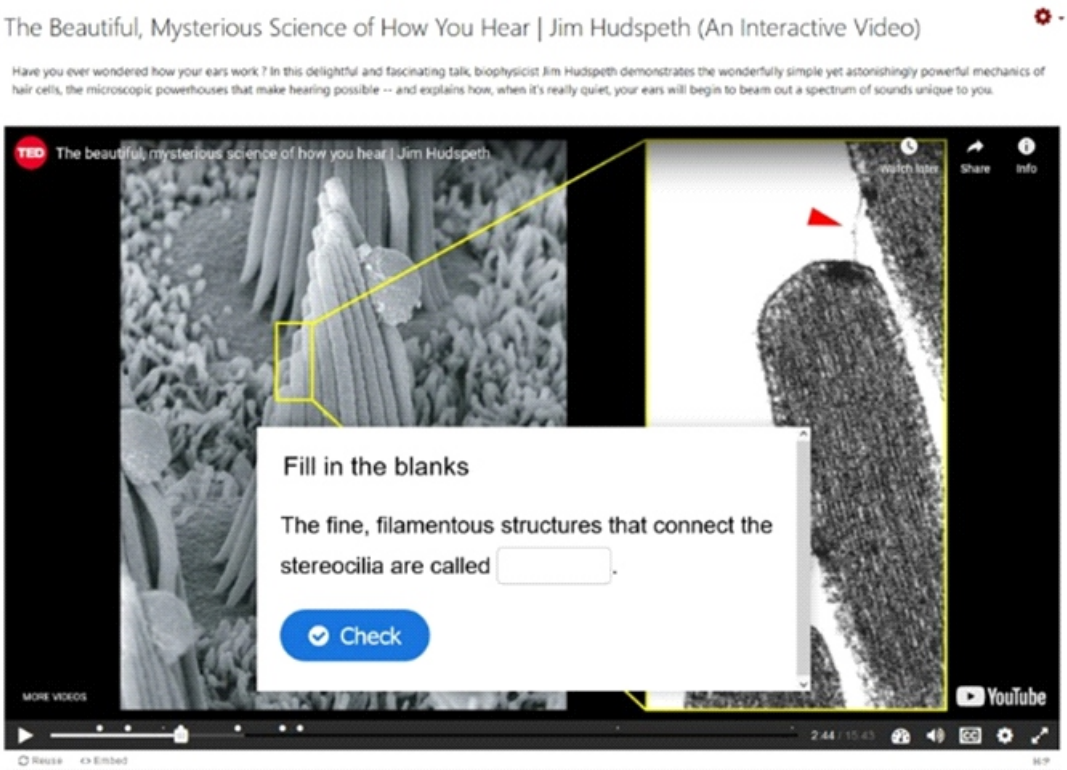

Figure 1. *An interactive video with a pop-up fill-in-the-blank question superimposed on an embedded medical video curated from YouTube.*

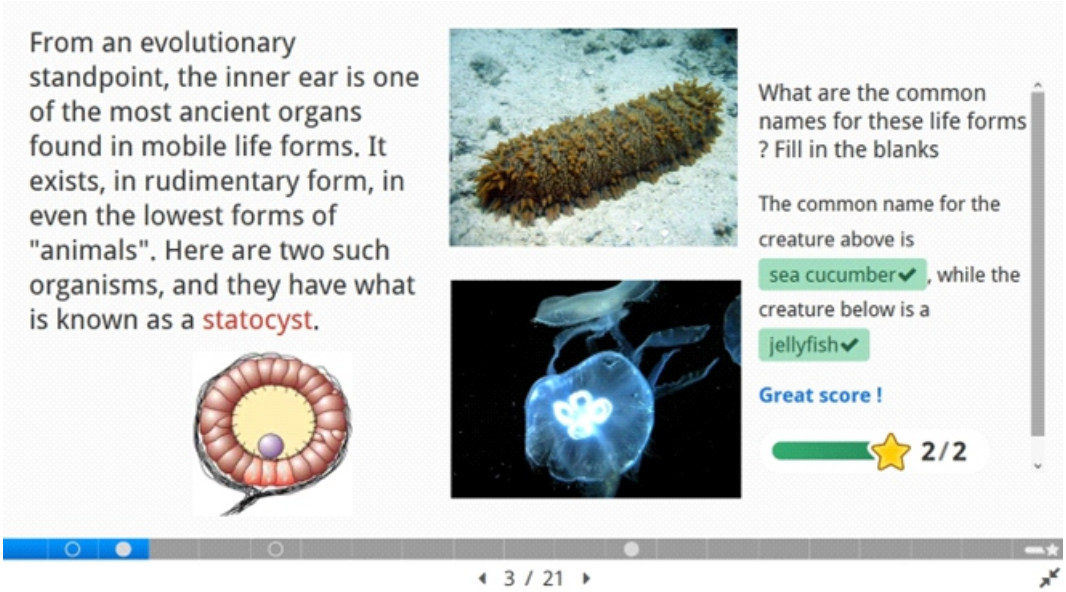

Figure 2. *An interactive slide in a Course Presentation with an integrated fill-in-the-blank question*

respondents (35.07%) have encountered H5P content previously. The vast majority of respondents (85.07%) have not encountered other interactive content on other software platforms similar to the H5P content offered in the online module. For those that had encountered these before, most listed EdPuzzle as the program similar to H5P.

Only nine (6.72%) survey respondents encountered any technical problems while accessing the H5P content, suggesting that this technology is easily accessible to most students in the population studied. The type of technical problem that was identified to be specific to the H5P content and not to the Moodle platform are described as follows :

"...if one answers correctly, you can't look back to the question any more. You must move forward. The only way to see the question again is to finish the whole video then restart..."

"I had to reload some of the interactive videos as it would not load when I first opened it. But, it was easily fixed by refreshing the page."

"Some of the elements don't load automatically even though there's an unfilled circle on the taskbar indicating that there should've been content so I had to reload the page multiple times before it would load."

"It does not work on tables or smartphone devices even if you put the browser option to desktop version. So I could not study the HP5 content if I only had my phone or tablet with me and I was out."

Table 1 shows the results related to "Using the Learning Objects". The majority of respondents rated H5P content's ease of use as excellent (59.70%) and good (39.55%) with only one respondent rating this parameter as "not very good". An overwhelming majority of respondents strongly agree (52.99%) or agree (44.78%) that the H5P content is easy to navigate, with only three respondents disagreeing to this position. Moreover, a total of 97.76% would recommend the H5P content to another person with similar learning needs, and a total of 94.78% would agree to its inclusion in other modules.

Table 1. *On Using the H5P Learning Objects*

Item	Poor	Not Very Good	Good	Excellent
How easy was it to use the H5P content?	0%	0.75%	39.55%	59.70%
	Strongly Disagree	**Disagree**	**Agree**	**Strongly Agree**
The H5P content associated with this module were easy to navigate	0%	2.24%	44.78%	52.99%
I would recommend these H5P content to another person with similar learning needs	0%	2.24%	39.55%	58.21%
I would like more of these H5P content in other modules	0%	5.22%	38.81%	55.97%

Table 2 shows the results related to the "Integration of the Learning Object." An overwhelming majority (99.25%) agree or strongly agree that the H5P content was appropriate for the modules, whereas 97.76% agree or strongly agree that the H5P content was well integrated with the other parts of the module.

Table 3 now shows the results related to the "Impact of H5P content on Learning." As can be observed, the majority of respondents agreed or strongly agreed that the H5P content helped introduce new concepts clearly (95.52%), that the H5P content helped to address specific gaps in their knowledge (96.27%), etc. Furthermore, 99.26% found the H5P content helpful or very helpful for their learning.

Table 4 shows the students' evaluation of the attributes of the H5P content that contributed to learning. It can be seen that the "assessment/self-test exercises" attribute of the LO was quite valuable, as everyone ranked this as important or very important, whereas the "interactivity" and "access anywhere" attribute was just a little less valuable, as 97.76% thought that these were important or very important. This small difference is almost negligible, as most survey participants evaluated all the attributes listed in Table 4 as either important or very important.

Table 5 presents the most pertinent answers to the open-ended questions regarding what the students liked and disliked about the H5P content and any other comments that the

Table 2. *On Integration of the Learning Object*

Item	Strongly Disagree	Disagree	Agree	Strongly Agree
The H5P content had content that was appropriate for the module	0.75%	0.00%	38.06%	61.19%
The H5P content was well integrated with the other parts of the module	0.75%	1.49%	45.52%	52.24%

Table 3. *On Impact on Learning*

Item	Strongly Disagree	Disagree	Agree	Strongly Agree
The H5P content helped introduce new concepts clearly	0.75%	3.73%	39.55%	55.97%
The H5P content helped me to address specific gaps in my knowledge	1.49%	2.24%	42.54%	53.73%
The H5P content helped me to retain knowledge in this area	0.75%	4.48%	40.30%	54.48%
Working with the H5P interactive content helped me learn	0.75%	0.75%	44.78%	53.73%
The feedback from the H5P content helped me learn	1.49%	1.49%	41.79%	55.22%
	Unhelpful	**Not helpful**	**Helpful**	**Very helpful**
How helpful was the H5P content for learning in this module?	0%	0.75%	46.27%	52.99%

Table 4. *Importance of Attributes of the Learning Object*

Item	Not at all important	Not very important	Important	Very important
Visual components (e.g. video, animations)	0%	1.49%	37.31%	61.19%
Interactivity	0%	2.24%	34.33%	63.43%
Assessment / self-test exercises	0%	0%	31.34%	68.66%
Access anytime	0%	0.75%	30.60%	68.66%
Access anywhere	0%	2.24%	31.34%	66.42%
Working at my own speed	0%	0.75%	26.12%	73.13%

Table 5. *Summary of Open-Ended Responses*

Positive Attribute Described	
The H5P learning objects aid in the retention of learning	"I found the lecture videos with "Review Questions" very helpful. It was helpful in remembering relevant topics." "I especially liked the H5P content which were like mini quizzes. They helped refresh my knowledge of (past year level) topics as well as helped me understand the current lectures more." "I liked the little pop-ups with the questions that encouraged me to recall previous learnings. I think it was present in all modules. The dry humor of whoever wrote the responses whenever you gave the wrong answer was the highlight of my video watching experience." "(The video) brought back concepts from prior subjects to check on it, as well as maintained engagement by the little quips and fun jokes interspersed within." "(The self-test exercise) helped in the recall and also the notes that helped emphasize the important points" "…the interactive videos containing supplemental info / mini-quizzes. It made me remember things more instead of just watching the video and choosing which ones I should remember." "I really recommend this H5P content because for me, it helped reinforce the info from the lecture and it also served like a knowledge check."
The H5P learning objects improve understanding of the subject matter	"(The video) showed the proper ways of the procedure BUT it also showed the wrong ways which helped me visualize and understand more what should be done." "What I like most about it is I was able to visualize the pharynx and larynx in a real person, and at the same time, I was able to test my own knowledge and skill in identifying structures because of the questions/notes inserted in the video." "Sometimes, videos from the internet are not well explained. But using H5P content, the videos regarding certain topics (especially those which are easily understandable) are reiterated + additional information are emphasized using the pop-up texts." "Having this kind of content for all the topics … would help greatly in retention and understanding topics." "It was also a very good way to integrate everything I read and learned in the articles I read, while also being a good break from all the text."
The H5P learning objects help students maintain concentration / interest	"Interactivity. The feature helps make the topics interesting to learn." "It has helped me focus on watching the videos unlike the ordinary video playback lectures." "… they were all useful in terms of being able to actively recall concepts, and it also aided in making sure we had our full attention to the material being shown, so that we could better understand the topics."
Negative Attribute Described	
Deficiency in incorporated feedback	"I disliked those which required me to input a short answer to an identification question simply because it was difficult for me to get the answer." "I don't like the fill-in-the-blanks type with specific answers because if I don't know the answer I can't figure out where I'll get the answer." "More explanation about why an option is wrong or correct. Hoping also that there are encouraging post-questions commentary, e.g. try again, you can do it." "Please write the explanation even if you get the answers right because sometimes in the multiple choice part I just guess and I don't know why the answer is right"
Technical Issues	"… after answering some questions, I cannot go back to view some of them. It would have been nice to see them again for review.

students made regarding the learning objects. Answers are grouped by the general attribute that was described. The positive qualities about the H5P content that the students described focused on their ability to help in the retention of knowledge, improve understanding of acquired knowledge, and maintain the students' mental concentration and interest in the material being studied. The negative attributes described pertain mostly to a deficiency in appropriate feedback incorporated into the learning object, and technical issues related to behavioral settings for specific interactive content.

Discussion

When Ruiz *et al*. published their review article on learning objects in medical education in 2006 [21], they recognized that digital learning objects could enhance the efficiency of medical education and make it more cost-effective. However, they also recognized the need for technical expertise to produce sophisticated learning objects, and the limited capabilities of most medical educators in this regard. They did foresee that developments in authoring tools and

software enhancements would make the task possible for most educators in the near future. The experience of the authors in creating digital learning objects with H5P technology is an indication that this near future has arrived.

We produced 23 educationally relevant digital learning objects, using only the online tutorials, step-by-step instructions and descriptions that accompanied the H5P plugin, within the Moodle-based learning management system. These were created within a period of three weeks (October 11 – November 2, 2021), and were utilized in the online module for second-year medical students two weeks later. This experience demonstrates the relative ease of authoring interactive digital learning content using this platform. We acknowledge that the author of the digital learning objects considered himself a "digital native" (30), and was highly motivated to create an interactive, online educational experience that did not simply replicate the traditional didactic approach. The author's willingness to immerse himself in the technology by reading the details of each modifiable variable, and dedicating time to experiment with the interface and tweak the settings to achieve the desired output were intangible but important factors in the successful implementation of this project. An attempt to encourage some faculty members also involved in the creation of online modules to produce similar learning objects was met with limited success. It seems that introducing technology to make a task easier does not necessarily lead to its adoption, as the task itself may be unfamiliar. This highlights the need to address barriers to e-learning in health sciences education [31] in order to successfully implement and propagate such creative applications of technology.

Another method of producing a variety of interactive content for use in the learning management system that we looked into were SCORM (Shareable Content Object Reference Model) activities [32]. However, in contrast to the ability to create H5P content within the learning management system, the creation of SCORM activities requires either knowledge of coding in HTML or JavaScript, or the use of third party software authoring tools that are primarily commercial in nature [33]. As such, we considered the need for programming expertise and the financial burden of acquiring software authoring tools as barriers to its adoption.

We also looked into EdPuzzle, whose content was potentially accessible within the university LMS, and was the software platform identified by the survey respondents as providing interactive content most similar to the H5P content. This platform has the capability to create interactive video lessons similar to H5P's Interactive Video content type. However, it is an external tool [34] that requires the instructor or the institution to have an account with a separate educational platform, EdPuzzle.com, where the interactive content is created and stored. Furthermore, it does not have the range of interactive content types that are available in the H5P platform.

The survey results confirm the novelty of the H5P platform and the interactive digital learning objects associated with it in the survey population. The fact that 85% of the respondents have not encountered interactive digital learning content on any online learning platform that was similar to those in the H5P platform is an indication of the lack of experience of both students and faculty in the creation and application of digital learning objects in an online educational environment. This lack of experience is a reflection not only of the situation in the college and university system where the student respondents are enrolled, but also the institutions from where they originally acquired their baccalaureate degree. This mirrors the findings of Baticulon *et al.* [1], which found that traditional classroom-based, teacher-led learning activities continues to be the norm in Philippine medical education; as well as the status of medical education internationally, which is perceived to lag behind current capabilities regarding online learning [2]. It does indicate the considerable opportunities in the application of, and research into, innovative online learning strategies in medical education moving forward.

Only nine (6.72%) survey respondents encountered technical problems while engaging with the H5P content, and these were identified in the survey as primarily accessibility issues. The fact that very few encountered these problems despite the universality of access attempts indicates that the issues are most likely related to peculiarities of individual devices. The H5P core team does maintain a list of content types that are accessible, that are being maintained by the core team, and that have any known browser limitations [35]. This knowledge can help guide instructors when creating H5P content, in order to minimize content type accessibility issues. Anecdotally, the authors were able to successfully access and view all of the H5P interactive content in the module using both Windows-based and macOS-based laptop computers, an iPadOS-based tablet, and an Android-based smartphone.

The vast majority of students found the H5P content easy to use (99.25%) and to navigate (97.77%) (Table 1). The fact that the vast majority of students would recommend the H5P

content to other students, and would like to see this type of content in other modules provides empiric evidence and compelling reasons to encourage other faculty members to use interactive digital learning objects to enhance or complement their current armamentarium of educational strategies.

For example, recent studies on online learning in response to the COVID pandemic indicate that the most commonly used educational method used was the lecture, with or without interactive components, delivered either live using a video conferencing platform or in a recorded fashion [2,36]. By using the H5P Interactive Video content type, lectures could be recorded, and any questions that the instructor regularly asks could be added as interactions. In this manner, answers from all students, instead of just one or a few, could be elicited, recorded, and assessed. This could also contribute to a more impactful blended learning approach, where lectures are delivered in an asynchronous but still interactive fashion, and face-to-face sessions are devoted to collaborative educational activities that promote active learning [37].

The high level of integration with, and perception of appropriateness of the H5P learning objects to the module are indications that this type of learning resource, when designed and executed appropriately, can enhance the educational experience. Future studies can be directed towards determining their effectiveness in relation to higher levels of training evaluation.

Although all of the attributes of a learning object identified in the survey instrument (the presence of visual components, anytime/anywhere accessibility, individual control of study pace, and the ability to provide feedback) were deemed important, it appears that the students consider feedback, in the form of an assessment or self-test exercise, as the most important feature (Table 4). This is corroborated by the four negative comments in the open-ended questions (Table 5), that mention a deficiency in the feedback incorporated into some learning objects, and suggested more elaborate feedback. This serves as an emphatic reminder to faculty about the value that students place on receiving appropriate feedback. It is good to note that the ability to incorporate feedback is a key feature of the H5P interactive content types, and that the lack of feedback was a deficiency in design execution that could be easily remedied in future iterations of the learning objects.

Another area for improvement identified through the open-ended questions and discovered early on in the survey instrument were technical issues involving the behavioral settings available for each content type. Issues such as the ability to retry interactions, show solutions, rewind videos, skip forward, and others are all modifiable variables that can be corrected iteratively. This issue does highlight the need to provide avenues for regular feedback, in order to guide the refinement and propagation of learning strategies that work, as well as the revision or removal of those that do not.

Finally, with regards to the impact of the H5P content on learning, the vast majority of respondents agreed that the H5P content helped introduce new concepts clearly and helped to address specific gaps in their knowledge (Table 3). This is further reinforced by the positive comments to the open-ended questions (Table 5). The positive attributes of H5P that the students described were similar to the perceived benefits of H5P learning objects shown in a study by Rossetti Lopez *et al.* [16] and these are the ability of the H5P learning objects to improve understanding of acquired knowledge, help in the retention of knowledge, and maintain the students' mental concentration and interest in the material being studied.

Based on the Kirkpatrick training evaluation model, this study is limited to an evaluation of the reaction level of the students to the educational method. Further research on the level of learning achieved, the application of learning, and its effect on outcome-based education are recommended.

Conclusion

This study documents our very favorable experience in the creation of learning objects using the H5P platform, and the highly positive reception of the pre-clinical medical students to its application in their online education.

Interactive digital learning objects that are appropriate and well integrated into the overall learning experience can be created in the H5P platform even in the absence of advanced programming knowledge or technical skills. The advantages of such technology include their ability to improve understanding of acquired knowledge, to aid in the retention of knowledge, and to maintain the students' interest and concentration on the learning material. Finally, although learning object attributes such as the presence of visual components, anytime/anywhere accessibility and individual control of study pace are important, the ability to provide feedback in the form of assessments and self-text exercises is the key feature sought after by students.

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