

# Development of a Kanji Reference Tool and its Moodle Integration EduKanji 2.0: Design, Development and Implementation

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**Abstract** Due to the COVID-19 emergency, Ca' Foscari University of Venice has reorganized a large part of its courses for on-line delivery through the LMS Moodle. Unfortunately, this platform, besides having a particularly complex interface to use, does not have modules dedicated to the teaching of Japanese. Addressing this issue, this paper proposes the design of a module for kanji teaching integrated with the Moodle workflow, to produce complete and printable kanji sheets with all the necessary information, thus reducing teacher workload. The methodology used derives from an Instructional System Design development model (SAM, Successive, Approximation Model) that allows continuous feedback from the teacher, so as to adapt the developed prototype to his/her teaching needs.

**Keywords** Digital Humanities. E-learning. Instructional Design. Japanese Language. Language Teaching. User Experience.

**Summary** 1 Introduction. – 2 Moodle. – 3 Anxiety and Comfort Zone. – 4 Prototyping a Moodle-Integrated Tool for Delivery of Kanji Learning Sheets. – 5 EduKanji 2.0. – 6 Database and System Structure. – 7 Development and Feedback Cycle. – 8 EduKanji 2.0 in Teaching Sessions and Further Developments. – 9 Conclusions.



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## 1 Introduction

In the present paper I would like to investigate one possible way to help the teachers of the Japanese language courses of the Department of Asian and African Studies (DSAAM) at Ca' Foscari University of Venice in the creation of online materials, which are highly requested especially in this particular moment in history, since, beginning from March 4, 2020, the Italian government ordered the closure of all schools and Universities due to the COVID-19 emergency.

The solution proposed in this article - namely, a web application currently under development - is the result of the analysis of the official reference platform for the production of online courses in Ca' Foscari - the LMS<sup>1</sup> Moodle - and its lack of specific modules for the delivery of Japanese learning materials, which inevitably forces the majority of teachers to produce materials from scratch in the form of PDF and PowerPoint files. Although the application is not fully implemented yet, it has begun to be used for Japanese Mod.1 (second language) courses (Bachelor's degree program) in the 2020/21 Academic year, with encouraging results in terms of integration in Moodle and speed of creation of materials.

## 2 Moodle

Due to the COVID-19 emergency in Italy, which began in February 2020, Ca' Foscari University of Venice reorganized a large part of its courses for on-line delivery, and thus teachers had to use exclusively online tools to prepare their lessons. In particular, the LMS Moodle, the official Ca' Foscari LMS platform for blended and online courses, became widely used. Even before the COVID-19 emergency, Moodle was already being used as a system for delivering assignments to students and uploading exercises or integrative materials; however, due to the impossibility of teaching in classrooms as before, teachers had to think of new ways to prepare and deliver their lessons, and Moodle became the natural choice, thanks in no small part to the dedicated desk support service offered by the University. In the Department of Asian and African Studies, where I am presently researching as a post-doctoral fellow in Japanese language education, Moodle has proved the most natural option even for teachers who were hitherto more reluctant to rely on digital platforms.

However, as Moodle is a very large community-based project based on small-scale funding, a User Experience approach in the develop-

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<sup>1</sup> Acronym of Learning Management System. For details on Moodle, refer to the official documentation: <https://docs.moodle.org/38/en/Features>.

ment of the User Interface does not seem to be a priority.<sup>2</sup> Almost all the interface activities require a reload of the whole Moodle page in order to update the information on the screen (instead of the website dynamically updating the area of interest), thus increasing the waiting time and user frustration. Moreover, the interface itself is complex and seems to ignore most of the best practices of Interaction and Web Design of the last 20 years, as for example Krug's (2014) guidelines to minimize the time spent by the User to navigate a page and 'scan' its contents; these guidelines, at example, suggest to use a self-explanatory navigation pattern, to put in the main menu only the important information and to avoid too many nested submenus if not strictly indispensable. As Moodle has been designed not only to build courses but also to manage student registration, scores, feedback, quizzes, and surveys, the interface is very complex. The administrator can hide functionalities, such as theme configurations, third-party modules uploading and system settings, but this does not simplify the complicated interface navigation system.

The complexity and User-unfriendliness of Moodle is often reported as a problem. Sathian, for example, reports the frustration of users that have to deal with this program and stresses the need for a well-redesigned Theme that addresses issues related to Usability.<sup>3</sup> However, especially when there are many users on the platform at once, as in the case of Ca' Foscari University in Venice, it is not possible, for security reasons, for teachers to change the installed theme.

As user needs may vary, depending on what each uses Moodle for, I delivered a survey (March 15th, 2020) to the teachers of Japanese of the DSAAM, to gather their opinions about the usage of the platform. The survey was answered by 13 teachers.

**Table 1** Survey on Moodle usage by DSAAM Japanese teachers (Mantelli 2020)

	Question	Type	Options
1	Is Moodle easy to use for your activities?	Single selection	Easy, Average, Hard
2	How long do you take to prepare a lesson of 30 minutes?	Single selection or open answer	Less than 1 hour 1 to 2 hours 2 to 3 hours More than 4 hours

<sup>2</sup> The problem of the usability in Moodle has been discussed in this thread where users and Moodle developers argue about complexity and User Interfaces: <https://moodle.org/mod/forum/discuss.php?d=239414>.

<sup>3</sup> R. Sathian, "The Problem with Moodle UI". *Edwiser*, July 13, 2016, <https://edwiser.org/blog/problem-moodle-ui/>.

Question	Type	Options
3 Did you experienced difficulties in creating materials?	Single selection	No Yes, a little Yes, a lot
4 If you wish, describe your difficulties in using Moodle	Open answer not mandatory	

**Table 2** Results of the survey on Moodle usage (Mantelli 2020)

Question	Option	Number of answers	Percentage
1. Is Moodle easy to use for your activities	Easy	1	7%
	Average	9	70%
	Hard	3	23%
2. How long do you take to prepare a lesson of 30 minutes?	Less than 1 hour	2	15%
	2 to 3 hours	2	15%
	3 to 4 hours	0	0%
	More than 4 hours	7	55%
3. Did you experienced difficulties in creating materials?	No	2	15%
Question	Answers		
4. If you wish, describe your difficulties in using Moodle	<ul style="list-style-type: none"> <li>- Uploading files is too difficult. Files need to be reduced in size to be uploaded.</li> <li>- The process of receiving and correcting assignments from the students through Moodle is complicated.</li> <li>- I'm not able to produce quizzes for the students through Moodle functionalities.</li> <li>- Creating quizzes for students is not impossible, but is very complicated.</li> <li>- Producing materials to be uploaded to Moodle is hard.</li> </ul>		

Looking at these answers, it is possible to deduce that even if only 23% of those interviewed think that Moodle is really hard to use, 55% spend quite a large amount of time preparing their lessons on it (more than 4 hours), and 46% of the interviewers think that the usage of digital tools to prepare the materials for the lessons is very hard. The result of the survey confirms the difficulties in using Moodle interface and in following its workflow. By looking at the answers to question 4, it appears that two problems are broached: 1) uploading external files to Moodle and 2) using internal Moodle functionalities (Quizzes) to produce content. These problems represent the duality

of the Moodle platform, which is used both as a multimedia container and for its core functionalities.

The course-building logic of Moodle is, in fact, based on the usage of modules to create deliverable contents through the platform. Modules are mainly divided in two groups: “Activities” and “Resources”.

“Activities” represent modules that allows users to build practice elements for the students like Quiz (exercises), Assignments creation, Feedback collection, Lesson creation, Wiki creation and management. These modules allow the students to interact with Moodle itself. “Resources”, on the other hand, are modules used to support the upload of files or links of external pages.<sup>4</sup>

I have analysed the types of content of all the Moodle courses produced by the respondents, with the result that 80% of the modules created are related to the category “Resources”. More specifically: Links to external material such as YouTube video created *ad hoc* or external pages (35%), downloadable contents such as PowerPoint presentations, video lessons in MP4, grammar and *kanji* exercises in PDF, textbook related material in PDF (55%), In-Moodle images and text contents (10%). 20% of the “Activities” are mainly represented by the module Assignment (20%), used to receive students assignments, Choice (20%) used by the students to book meetings with teachers, [Forum] (30%) to create discussion groups, Feedback (10%), Quizzes (5%), and External Tools (5%) used to embed the pages of different sites and web applications in Moodle.

From this analysis it can be assumed that Moodle has been used primarily as a sort of container for contents generated with the most common and traditional digital tools available to the teacher, in particular the Microsoft Office package. Indeed, even YouTube videos have been created with the ‘create video’ option present in PowerPoint. Very few contents have been created with the core functionalities of Moodle, like Quiz for the exercises. In fact, in some cases, exercises that could have been created with the Quiz module, were actually produced in the form of a downloadable PDF. This can be partially explained by the fact that particular exercises must be filled out by hand, but it might also be connected with the intrinsic complexity of creating exercises with the Quiz module - as is revealed also by the answers in the survey.

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<sup>4</sup> docs.moodle.org/38/en/Resources.

### 3 Anxiety and Comfort Zone

With the COVID-19 emergency underway, even teachers comfortable with technology started using Moodle to deliver remote courses and materials, along with other technologies such as Zoom or Google Meet for real-time online lessons.<sup>5</sup>

This event is very significant; several studies (Howard 2011; Howard 2013; Setyarini 2018) have pointed out that with the enormous impact of technologies in language education, teachers that are suddenly required to be proficient in computer technology might experience computer anxiety, which can hinder them from achieving the requisite proficiency level. Indeed, teachers inclination or disinclination toward technology may vary according to gender, age, and individual factors such as self-efficacy, open-mindedness, anxiety level, user experience, emotional state, etc. (Nestik et al. 2018), and that is why it normally requires a long time for the traditional option practices of a heterogeneous group of teachers to be impacted. This process received a boost because of the new teaching necessities due to the emergency situation. Still, the analysis of Moodle usage reveals that a lot of contents are built as external material and then uploaded to the platform; however, adapting to the new platform and overriding the anxiety of entering into new territory requires an effort, which may differ in its degree on the basis of teacher motivation, previous experience, age and gender. For teachers who are not used to digital tools in particular, anxiety at not being able to adapt in a short time may frequently arise.

This need to adapt to new circumstances and to partially leave behind old teaching habits represents for many their departure from their personal comfort zone,<sup>6</sup> and their entry into new teaching frontiers. The process will certainly take time, but I feel the need to encourage and support the embrace of new teaching possibilities. From these considerations arose the idea to develop a prototype of an integrated tool in Moodle to support Japanese teachers of DSSAM.

### 4 Prototyping a Moodle-Integrated Tool for Delivery of Kanji Learning Sheets

From the analysis of all the materials created and uploaded by the teachers, I found that one process that can be improved by enhancing the integration into Moodle concerns the teaching of kanji char-

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<sup>5</sup> <https://zoom.us>; <http://meet.google.com>.

<sup>6</sup> Psychological state where there is the perception to be in control of own environment in an anxiety-neutral position (Bardwick 1995).

acters. Presently, materials for kanji characters are uploaded by the teacher as PDF files into the Moodle platform. These materials are exercises, quizzes and kanji sheets with information about the characters. Consider the kanji sheet, for example, from a teacher's perspective: it is necessary to create one PDF with information on the characters and the proper order of their relative strokes, kanji readings in Japanese and word examples. Students download the PDF, open it and scroll the document down to the character sheet to learn. When using a mobile device, such as a smartphone, the operation may not be so easy. In a smartphone, PDF files are not always supported by default; they may require the installation of additional software to be displayed and they are not formatted to be easily viewed on a small screen. Moreover, uploading files instead of creating single Moodle sheets disrupts the Moodle workflow, and it is not possible in this way to keep track of whether the students have studied all the characters assigned. However there is presently no integrated Moodle functionality to create Kanji Sheets; but, following what is expressed in paragraph 3, it is important to allow teachers to continue to use Moodle whenever possible. The students of DSAAM also know Moodle well, as they are required to follow the courses and interact with the teachers through it.

For the reasons mentioned above, the most viable solution, at present, may be the creation of a kanji extension for Moodle that allows teachers to produce, on the fly, a full kanji sheet for their students. There are other solutions already available on the Web for the study of the kanji characters and compounds, such as the *Kanji Jiten Online* site in Japanese with full access to all the kanji forms and compounds,<sup>7</sup> the *Goo Kanji Dictionary* site in Japanese,<sup>8</sup> part of the Goo dictionary, and the *Tangorin* site in English with kanji details and compounds.<sup>9</sup> However, these sites, being mainly in English, do not target native Italian speakers, and, as the interface is organized like a normal search engine, with the search bar, login buttons, other links, commercial banner etc., they are not meant to be integrated into Moodle as a module. Creating an extension for Moodle instead makes it possible to create a simple but dedicated interface and to develop functionalities in accordance with the needs of the teacher.

The main way to produce Moodle extensions is by creating a plugin that can be uploaded in the platform, thus extending its functionalities.<sup>10</sup> Moodle plugins can be developed by using the same language

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<sup>7</sup> <https://kanji.jitenon.jp/>.

<sup>8</sup> <https://dictionary.goo.ne.jp/kanji>.

<sup>9</sup> <https://tangorin.com/kanji>.

<sup>10</sup> For details on plugins and their usage refer to the official documentation: [https://docs.moodle.org/38/en/Installing\\_plugins](https://docs.moodle.org/38/en/Installing_plugins).

es that the Moodle platform itself uses: HTML, JavaScript and PHP.<sup>11</sup> By following the official developer documentation,<sup>12</sup> it should be possible to create plugins that meet a wide range of needs.

However, as the official e-learning platform of Ca' Foscari University, the uploading of new plugins is disabled by default and can only be performed by the platform administrator after a careful analysis demonstrating the security and stability of these plugins. This process is clearly time-consuming, and does not necessarily guarantee that the plugin will be accepted. Moreover, even if it were, any changes would have to go through the same process. Therefore the path of creating plugins is not sustainable.

Another possible way to meet these needs may be the creation of a SCORM or H5p<sup>13</sup> package, whose plugins are already available in the Moodle platform of Ca' Foscari University. SCORM and H5p packages are based respectively on the Sharable Content Object Reference Model (Lundy 2003) and on an open-source collaboration framework to develop HTML5 contents. However, while it is possible to build a SCORM package, this requires complex settings both in the developer's code and in the Moodle module section, and it is meant to be used by course creators, not by teachers. H5p on the contrary is a technology that allows the building of small exercises or course presentations, but it is not intended to be used to build full web applications.

The prototype presented in this paper, on the other hand, is a web application which aims at ease of maintenance and expansion, and which can be integrated inside Moodle through the default 'Moodle URL module' - which is itself easy and fast to configure. The module embeds external web pages through the HTML IFrame<sup>14</sup> tag that receives the URL of the site to link to as its main parameter. Thus, to provide all the possible kanji sheets just by using this URL, the application will use a dynamic address such as "https://application-domain/kanji/[kanjitodisplay]". The prototype aims to encourage, not to disrupt, Moodle workflow; at the present moment, it is therefore possible to define only one kanji per sheet. However, each sheet can be organized in folders with their relative Moodle module.

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**11** HTML is a markup language executed in a browser that allow to display text and visual blocks through the usage of character strings called tags. JavaScript is a language executed in a browser that allow to modify existing HTML pages, react to events like mouse clicks, keyboards, create new HTML elements on-the-fly. PHP refers to a language executed in a server that can connect to a database, retrieve and save data and create HTML code.

**12** [https://docs.moodle.org/dev/Main\\_Page](https://docs.moodle.org/dev/Main_Page).

**13** SCORM is a collection of standards that allow LMS like Moodle to work with external web based applications. H5p, similarly provide standards to build external libraries integrable in Moodle.

**14** Iframe tags allow to embed external web resources in a HTML page.



As is shown in the following image, it is sufficient for the teacher to create a new URL Module by setting three parameters: an identifying name for the sheet, the URL that points to the prototype and the Display format, and [Embed], in this case to embed the page in an Iframe.

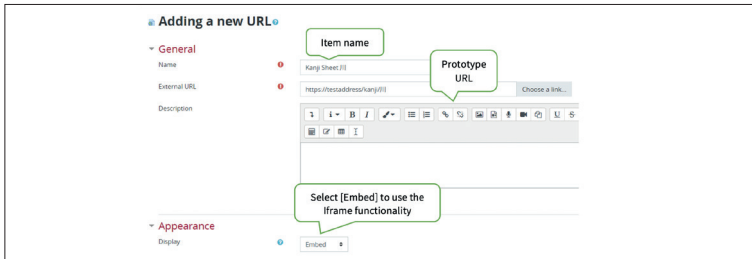


Figure 1 Configuration window of the Moodle 'new URL' module

After saving the configuration, the entry will display a Moodle element as shown in the screenshot below.

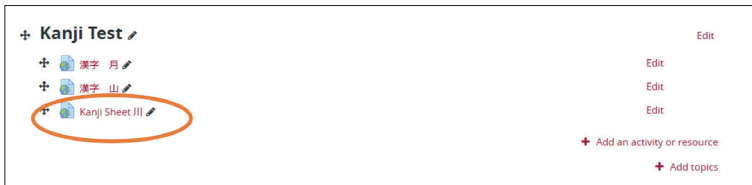


Figure 2 List of embedded pages in Moodle

In the next section, I will describe how the prototype works.

## 5 EduKanji 2.0

Although this prototype has been created from scratch, the idea of providing kanji tools for the teacher takes its inspiration from a department project from 2011 called EduKanji. I consider this present prototype to be an evolution of the previous project, and thus the prototype will be named EduKanji 2.0. This new project, besides trying a new approach in Moodle integration, has been developed as a responsive application to be easily displayed and used in several devices like smartphones and tablets. It automatically connects to several sources (as further explained below) in order to acquire more details on the kanji shapes stored within it and, on the basis of the results of

a survey on the EduKanji usage (Bettin 2017) of 75 students, implements some suggestions as printable customized kanji sheets, references to JLPT (Japanese language proficiency test) levels<sup>15</sup> and a kanji reference table according to the textbooks in use in the DSAAM. The overall User Experience is granted not only by the easy-to-use responsive interface, but also by the design of the system architecture and of the database. Several studies have linked the success of a full User Experience of the digital artifacts to the careful design of all its layers (Cooper et al. 2007; Garrett 2011; Triberti, Brivio 2016). In the hierarchical structure of the Garrett conceptual model to project User Experience (Garrett 2011), for example, the system design is represented by the ‘functional specifications’, a low-level plane on which interface, interaction, content design are located. In other words, a bad system design has a bad impact on the whole program. Database design for language-learning applications is an important aspect to consider, too. Its importance has been stressed by studies on Connectivism (Siemens 2005) and structured data (Pozzi 2011). Pozzi holds that to support the main paradigm of Connectivism (given the fact that “knowledge exists by itself. Individuals mustn’t build it but they are supposed to realize that knowledge by connecting the nodes where it’s located” (Fumero 2006, 301), it is necessary to carefully structure the database that is the source of this knowledge. The strength of Connectivism is that it considers in full all the technological and cognitive aspects of social and mental activities of present times, by seeing the entire human being as an entity connected, together with other human beings, to a neural network wherein they can communicate, collaborate and share information. This is why the lowest level of Connectivism itself represented by the data and the system’s design has to be carefully considered.

For all the above reasons, I will dedicate the next section to describing the approach to the system and database design. In this section, on the other hand, I will describe how EduKanji works.

After having configured the Moodle module as described in the previous paragraph [fig. 1], a full kanji sheet will be displayed inside an iFrame in the Moodle page, as in the example in figure 3.

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**15** The JLPT has five levels: N1, N2, N3, N4, N5. The easiest level is N5 and the most difficult level is N1. The average number of kanji to know for each levels is as follow. N5: 300 kanji, N4: 300 kanji, N3: 600 kanji, N2: 1,000 kanji, N1: 2,000 kanji. Each level target a specific set of kanji. Data gather from: *Nihongo sentaa* (Japanese Language Center): <https://www.nihongo-c.jp/topics/jlpt0817.html>.

**Kanji Sheet 川**

漢字 edukanji FOGLIO RIPASSO

Italiano: Fiume  
 画数: 3 JLPT: 4  
 オン読み: ゼン  
 <ん読み: かわ  
 部首: 川 (やまへん) つくり: 川  
 STAMPA

**Etimologia / Derivazione** Da Wikimedia  
 Carattere derivato da pittogramma, originariamente rappresentante un fiume che scorre. Il pittogramma si ritrova già nelle iscrizioni su ossa oracolari risalenti all'età del bronzo, e successivamente sulle incisioni bronzee di epoca Zhong; le immagini sottostanti ne illustrano l'evoluzione grafica fino alla forma attuale come kanji, derivato dai corrispondenti hanzi cinesi

iscrizione sulle ossa oracolari dell'età del bronzo | iscrizione bronzea dell'epoca Zhong (XII secolo a.C.) | stile calligrafico sigillare dell'epoca Qin (II secolo a.C.) | carattere attuale

**Kanji presente in:**  
 新ずらすら2 32 子供のころ、川で遊んだり、木に登ったりしました。エジプト文明は、ナイル川の近くで生まれた。

**Esempi di termini** (Da A4edu (a4edu.com))

川沿い	かわぞい	lungo la riva (di un fiume)
川	がわ	fiume , corso d'acqua
川	かわ	fiume , corso d'acqua
川沿	かわざし	argine del fiume , lungofiume
川上	かわかみ	a monte (di un fiume)

Figure 3 Example of EduKanji sheet embedded in Moodle

The upper section of the screen [fig. 3] contains the vectoral image of the kanji, on the left, and information about readings, JLPT level, radical and approximate Italian translation. At the present moment, since the target for teachers and students is the DSSAM, the contents and examples are in Italian, but translations into English and other European Languages are planned for the future. While the original kanji source implemented in EduKanji may already have an English translation, this may not be the case for other European Languages, and thus it would be necessary to produce new translations in the target language. By pressing the play icon [>] under the image, the animation kanji strokes will be played in the correct order. It is possible to pause and stop the animation with the pause [||] and stop [x] icons.

The centre and lower sections of the screen contain the result of the connection to different resources to give further information about the kanji shape in question. Depending on the kanji, some information may not be present due to the lack of this information in the resource itself.

The main resources from which EduKanji presently fetches complementary data are:

1. Wikimedia, for the kanji's origin and a brief description thereof, through an API (Application Programming Interface) that scrapes content from the Wikimedia page and returns the needed content;
2. a4edu (Mantelli, Mariotti 2015), a Japanese-Italian dictionary developed for the DSAAM based on the EDRDG<sup>16</sup> JMdicit database that presently counts 43,380 terms translated into Italian out of 180,861 total terms, thanks to the contribution of over 86 collaborators between students and teachers of the DSSAM. The connection to a4edu is made through a dedicated API, developed *ad hoc*.

The data of the kanji reference textbooks in use in the DSSAM are instead registered in the main EduKanji database along with the following data sources:

1. The EDRDG KanjiDic database, containing information for about 13,000 kanji. Each kanji is indexed with the following information: UTF8 code, classical radical code, kanji grade according to the *Gakunenbetsu kanji haitōhyō*,<sup>17</sup> total kanji strokes, JLPT level, various dictionary references (Haig, Nelson 1997)<sup>18</sup> readings in Japanese (*on*, *kun*), Korean and Chinese, meanings in English and other European languages (Italian not included), and readings in Japanese for personal names (*nanori*).
2. The Italian translation of the kanji's meaning taken from the original EduKanji data source.
3. The EDRDG Krad database, containing information about the decomposition of the kanji into radicals or other visual elements.<sup>19</sup>
4. The Kanji Radicals Database. I have created this collection based on the classification in the 18th century Kangxi dictionary, present in the *New Nelson Japanese-English Character Dictionary* (Haig, Nelson 1997). Each entry is formed by the classification number of the Kangxi dictionary, the radical, and the radical reading in Japanese.

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**16** Electronic Dictionary Research and Development Group create by Jim Breen, Monash University in 2000. For details: <http://www.edrdg.org/>.

**17** For details refer to the following Wikipedia page: [https://en.wikipedia.org/wiki/Ky%C5%8Diku\\_kanji](https://en.wikipedia.org/wiki/Ky%C5%8Diku_kanji).

**18** Kanji characters may have multiple readings. *On* readings are based on the pronunciation of the character when was imported from China and interpreted by the Japanese. *Kun* readings, on the contrary, are based of the pronunciation of the native Japanese word that the character represent.

**19** For details refer to the official project page: <http://edrdg.org/krad/kradinf.html>.

All the vectoral shapes of the kanji have instead been saved in the server. These shapes in SVG (Scalable Vector Graphic) format are part of the *KanjiVG* project (Apel 2009) and released under the Creative Commons license.

Another important feature of EduKanji is its printing functionality. By pressing the red button [stamp] 'print' in the upper part of the screen, it is possible to export a PDF file with details on the kanji in question, a step-by-step reference guide on its strokes and a guided and free self-exercise area, as shown in the screenshot below. As each SVG shapes contains the kanji drawing data divided into stroke blocks, to create the step-by-step kanji scheme and to have it automatically fit the paper, the SVG shape has been duplicated as many times as the number of strokes on display. The hidden stroke blocks are displayed progressively, one in each SVG block.

Edukanji

家	オン読み	カ,ケ	画数	10
	くん読み	いえ, や, うち	JLPT	いえ, や, うち
Casa		部首	宀(うかんむり)	

Figure 4 EduKanji, PDF export example

Several studies correlate the ability to write characters to its tracing and copying exercises (Inagaki, Fujita 2003; Onose 1987), and thus through this functionality, students can print the kanji sheets and do writing exercises, so as to train their memory in remembering writing shapes.

## 6 Database and System Structure

As stated in the previous chapter, the system design is an important design phase to provide an optimal User Experience. Using the Garrett model (Garrett 2011) as a reference, a bad system design negatively influences all the upper levels of the application such as the interface and the navigation system by increasing the latency time in navigation and in interface usage. The latency issue is one of the causes of what Winograd and Flores (2008) call “breakdown”, an event that makes the technology manifest and interrupts the unconscious embodiment process of the user with the digital artefact. Moreover, a bad design causes difficulties in maintaining and updating the system, directly affects manpower costs, and may be one of the main causes of project failure and abandonment. A good system design starts by selecting affordable and maintainable database and development technologies. Fortunately there are several free and valid technology options to build Web 2.0 applications.

Web 2.0 refers to websites and applications where multiple users can collaborate to insert and update new contents, “delivering software as a continually-updated service that gets better the more people use it, consuming and remixing data from multiple sources” (O’Reilly 2007, 17). Several studies point out the advantages of using Web 2.0 applications for language learning because they support a constructivist processes of knowledge building and individual creativity (Ullrich 2008) support students’ collaborative processes and monitor collaborators’ work (Mariotti, Mantelli 2012), and allow a better embodiment with the digital interface by improving data retrieval and display time through AJAX<sup>20</sup> (Mantelli 2020). However, Web Applications may be slow if they are built using a traditional approach to data retrieval and display – an approach where each response with new data from the server requires the page to fully reload. This is a common drawback in Moodle interfaces, which are slow and feel hard to use because every operation requires a page reload. A common architecture solution, scarcely used in Moodle, is to asynchronously retrieve data from the server and update just a por-

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**20** Acronym of Asynchronous Javascript And XML, for details on the basic concepts refer to Garrett 2005.

tion of the screen on the fly, without reloading the full page, through a technique called AJAX.

The new EduKanji architecture uses an even more efficient approach that allows overcoming of the problem of the speed of data gathering, which is present in the traditional Moodle client-server architecture. This approach, used by all the modern social networks - Facebook, Twitter, Instagram among others - reduces the amount of data retrieved by the server still more, and thus offers a smooth data access environment, respectful of the user activities by gathering only raw data from the server and completely creating the page in the client (the browser) through use of the Javascript languages. This paradigm change, however, implies the use of different technologies traditionally used in the Moodle environment (PHP as server language and MySQL as a relational database). Indeed, for EduKanji, a language created by Google has been chosen for the server (NodeJs), a JavaScript framework (VueJS) and a non-relational database for data storage (MongoDb).

The choice to use a non-relational database has been made to increase the speed in data querying and to avoid the creation of heavy schema relations typical of the traditional relational databases. Relational Databases are structured in tables each containing  $n$  fields. Even if it is possible to insert multiple data in one field, this may increase database query complexity, and thus it is a common best practice to keep to single data values for each field and to create instead multiple tables joined through key relations. With MongoDB, on the other hand, it is possible to organize data in a way very similar to the source data of KanjiDic. Below is a snippet of this source, freely provided by the EDRDG and fully uploaded in the EduKanji database. This data source has been converted from XML to a JSON<sup>21</sup> format and simplified to allow better readability.

---

**21** JSON (JavaScript Object Notation) is a lightweight data-interchange format, easy for humans to read and write, easy for machines to parse and generate (Crockford 2018).

```

[
  {
    "literal": "家",
    "misc": {"grade": "2", "stroke_count": "10", "freq": "133", "jlpt": "3"},
    "reading_meaning": {
      "rmgroup": {
        "reading": {
          {
            "r_type": "ja_on", "value": "カ"},
            {"r_type": "ja_on", "value": "ケ"},
            {"r_type": "ja_kun", "value": "いえ"}
          },
          "meaning": ["house", "home", "family", "professional", "expert", "performer"]
        },
        "nanori": ["あり", "え", "く", "つか", "べ"]
      },
      "literal": "探",
      "misc": {"grade": "6", "stroke_count": "11", "freq": "930", "jlpt": "2"},
      [-]
    }
  ]

```

Figure 5 Snippet of the original data source of KanjiDic in JSON format

As can be observed from this, data is not grouped in different tables that have to be connected together, but exists in a single document with a parent-child structure. A single piece of data can thus be retrieved by following the vertical organization. For example, to filter data for the kanji reading *ie*, it is sufficient to instruct the database to find the node by writing the following command:

```
reading_meaning.rmgroup.reading.value:"いえ"
```

using the dot "." as a connector of the hierarchical nodes.

MongoDB can also count on numerous Cloud services, i.e. services that enable data to be distributed across different servers, guaranteeing privacy and at the same time allowing data to be always accessible. Services as MongoDB atlas, at example, grant 512 Mb of Storage to be used for free. This point is very significant from a Connectivism perspective, as it allows the persistence of the nodes of information represented by the e-learning data.

EduKanji system design approach allows system-side access to maximize data access by creating all client-side interfaces and using server access only for raw data retrieval. On the other hand, the use of a non-relational database permits to speed up data acquisition and simplify the code for access to this data.

## 7 Development and Feedback Cycle

The prototype introduced in this paper has been designed, developed and systemized through the collection of feedback by applying a development model derived from Instructional System Design (ISD), originally created to define objectives, develop tools and methods,



define content and development time, and verify the correspondence between objective and results in a instructional plan. This is highlighted for instance by Dick who defines ISD as the

systematic method for analyzing, designing, developing, evaluating and managing the instructional process efficiently [...] Sometimes it goes further and covers information technology, human-computer interaction, human performance technology and systematic analysis methods. (Dick et al. 2001, 5)

In this context, the role of models in instructional development “is to provide conceptual [...] and communication tools to [...] manage processes for generating episodes of guided learning” (Gustafson, Branch 1997, 73). However, these systems also have recently begun to provide valuable support to research and development processes, when the outcome is represented by a product for the end user. The ADDIE model of instructional design is probably the most well-known approach for crafting learning solutions. ADDIE stands for ‘Analyze, Design, Development, Implement, and Evaluate’ and it consists of five steps, the last of which involves the collection of feedback from the user or the contractor to start a new phase of Analysis and Design. This model is adequate for teams of three or more members with a well-defined starting plan, but as it spreads out over five phases is not the best choice for the fast development of prototypes and the rapid collection of feedback.

For this project, on the other hand, a design and development model based on SAM (Successive Approximation Model) has been chosen. SAM is a Design and Development process (Allen 2014) which consists in three phases (Preparation, Design, Development).

The Preparation phase is about collecting the information needed to develop e-learning. In this phase, from Moodle’s analysis and the results of the survey, I formulated the idea of developing the prototype described in paragraph 4. I discussed my idea with the teacher (KT) in charge of the kanji course, and, after having ascertained its feasibility, I moved on to the design phase.

In the design Phase the SAM model emphasises the repetition of three small steps (Design, Prototype, Review); at the end of each cycle the feedback collected in the Review step allows the commencement of a new phase. According to the received feedback, the prototype is modified and expanded. In fact, after the release of a first prototype called Alpha, and thanks to frequent interactions with the KT, the decision to implement data source from real reference textbooks used in class as *kanji no mori* and *Shinsurasura* has been taken. A further phase of development and review led to the need to change the Gothic font to a *Kyōkashotai* font, which is similar to the one used in Japanese primary school textbooks; this allows better

identification of the sharp closure (*tome*), the hook-like closure (*hara*), and the fading curved closure (*hane*) of the strokes. Subsequent steps led to further adjustments, such as quoting the authors of the sentences and the sources of the terms, where present.

In the development phase, the SAM model foresees the release of numerous versions, catalogued in macro-groups such as Alpha, Beta and Stable. In the case of this project, the actual use by students and the collection of actual feedback will take place in September 2020, so that, after a first Alpha version, which still included bugs and anomalies, I have managed, for the moment, to release a stable Beta version. This, thanks to a new review phase with the KT, has led to the implementation of a new functionality: a phonetic-semantic kanji database through which it is possible to identify all kanji with a common phonetic component. Recent studies, in fact, indicate that an efficient way to remember the kanji is to develop the learner's "awareness of components in four aspects: positions and combinations, semantic function, phonological function and the limitations of the functions", and that "Understanding the segmental nature of words is especially critical for reading efficiency" (Toyoda 2009, 5). Lack of such awareness, on the contrary, restricts lexical inference and retention (Koda 2002, 227).

Below is a table summarizing all the evolutions of EduKanji in Alpha and Beta release.

**Table 3** EduKanji 2.0 improvements through SAM processes

Version	Improvement
Alpha 1	Implementation of reference textbooks terms and examples
Alpha 2	Identification of a proper font to display Kanji strokes characteristics and layout modification
Alpha 3	In the reference textbook area (Beta 1), added author name.
Beta 1	Phonetic-semantic kanji database implementation

The screenshot displays the EduKanji 2.0 interface. On the left, the kanji '永' (eternity) is shown with stroke order numbers 1 through 4. Below it are playback controls (play, stop, close). A callout box labeled 'Alpha 1,3: Reference textbooks examples' points to a 'Kanji presented' section showing a card for '新すらすら2' (Shin-surasura 2) with the number 36 and a sentence: '二人は永遠に結ばれている。ビートルズの曲は音楽史に永久に残るでしょう。' (Two people are forever united. The Beatles' songs will remain forever in music history.)

On the right, a table lists properties for the kanji '永':

Trad. Appr.	eternity, long, lengthy		
画数	5	JLPT	2
オン読み	エイ		
くん読み	ながい		
部首	水 (さんずい)	ぶんかい	水、
Kanji simili	永 法 詠		

A red 'STAMPA' button is located below the 'Kanji simili' row. A callout box labeled 'Beta 1: Kanji with common shape components and same phonetics (on yomi) are automatically displayed' points to the '永 法 詠' row.

**Figure 6** EduKanji 2.0 improvements through SAM processes

## 8 EduKanji 2.0 in Teaching Sessions and Further Developments

During the first semester of the 2020/21, in addition to obtaining the support of KT for the evolution and debugging of EduKanji 2.0 (which, as indicated paragraph 7, went from an initial Alpha 1 version to a Beta 1 version with the addition of features that KT considered essential for classroom use), I was able to personally experience the use of EduKanji 2.0 whilst teaching Japanese course Mod.1 LM003N (second language).

The course was perfect for experimenting with the use of EduKanji 2.0 since it is intended for beginners just starting to learn Japanese kanji. In addition, since this course does not have the support of native Japanese teachers to teach kanji characters, I was able to personally take advantage of using EduKanji 2.0 integrated into Moodle to provide review material for my lessons.

My use of EduKanji 2.0 as a teacher has been twofold. I have used it 1) to create kanji review sheets embedded in Moodle, and 2) to integrate kanji sheets into my teaching materials through PowerPoint.

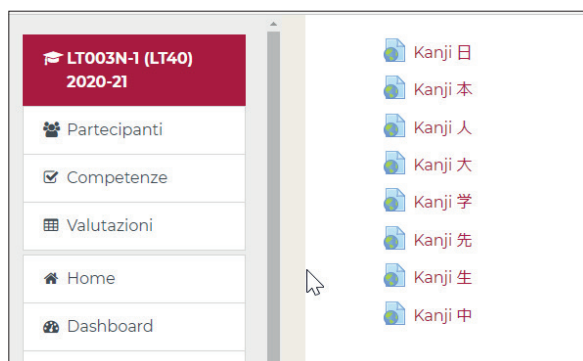


Figure 7 EduKanji 2.0 Kanji Sheets in Moodle for the Japanese Course Mod.1 LM003N

The insert operation in Moodle (point 1) was straightforward and took from five to ten minutes, thus allowing the teacher to prepare several full kanji review sheets (see § 4) in a considerably short time.

The PowerPoint integration (point 2) was a straightforward process as well. PowerPoint has a web viewer feature that can be inserted as an addon<sup>22</sup> that allows web applications to be displayed together with regular slides.

<sup>22</sup> For details on adding a live Webpage to a PowerPoint slide with Web Viewer: <https://freeofficetemplates.com/article/add-a-live-webpage-to-a-powerpoint-slide-with-web-viewer/>.

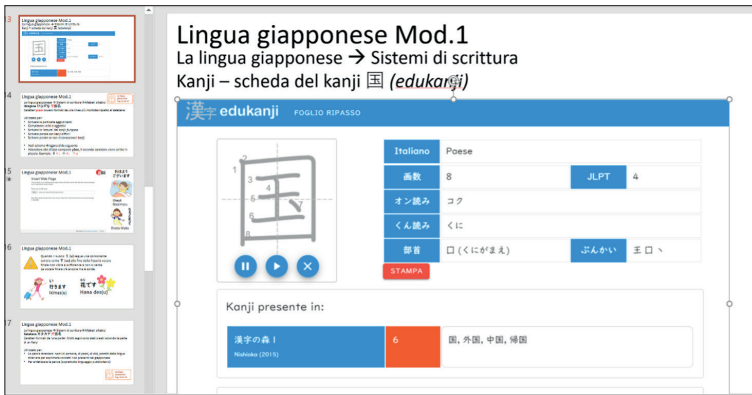


Figure 8 Integration of EduKanji 2.0 in a PowerPoint slide

One has only to insert into the PowerPoint web viewer the address of EduKanji 2.0 with the kanji (e.g.: <https://edukanji.unive.it/kanji/国>) in order to display a full Kanji Sheet, as shown in figure 8).

The advantage of embedding EduKanji 2.0 in PowerPoint slides, lies in the fact that features which are normally impossible to obtain with PowerPoint alone, like kanji animation, can be used. Moreover, with this approach to material creation, it is not necessary to change windows or applications during lessons. Being able to use EduKanji 2.0 features within PowerPoint offers a considerable advantage to the teacher who, especially in the case of distance learning, already has several windows open, such as Zoom, Meet, or the teaching materials slide.

In order to benefit students who are starting to learn Japanese, I also made an extension to EduKanji 2.0 that allows them to visualize hiragana and katakana and to practice writing. This feature was necessary because of the peculiarity of the course, which is mainly attended by students who study Chinese and Korean as their first language, and who do not know the Japanese syllabic alphabets. The feature of animated kana characters is also offered by the DSAAM e-learning system JaLea<sup>23</sup> (Mariotti et. al 2016), but I wanted to provide the student with the possibility of downloading the kanji sheets to practice (see § 4).

<sup>23</sup> JaLea (Your Japanese Learning System) is a e-learning project of the DSAAM founded by Mitsubishi and created in 2016 by Marcella Mariotti as Project Owner, Alessandro Mantelli (developer) and Giovanni Lapis (Contents Editor). For details refer to the home page of the project: <https://jalea.unive.it/jalea>



Figure 9 EduKanji 2.0. Example of Kana exercise sheet

As can be seen from figure 9, it is also possible to view a summary sheet for the selected kana and download it as a PDF.

EduKanji kana slides have been integrated into Moodle by creating two new Moodle pages (one for the hiragana and one for the katakana syllabary). Each page displays all kana characters on the right of the screen. By pressing one character, the correspondent EduKanji page is automatically shown on the right part of the screen [fig. 10].

The screenshot shows the Moodle interface. At the top, there is a red header with the text 'Università Ca' Foscari Venezia'. Below the header, there is a navigation bar with the text 'HOME | I MBI CORSI | LTOENH (LTA0) 2020-21 | HIRAGANA E KATAKANA | HIRAGANA'. The main content area is divided into two columns. The left column is titled 'HIRAGANA' and contains a list of hiragana characters: あ, い, う, え, お, か, き, く, け, こ, さ, し, す, せ, そ, た, ち, つ, て, と, な, に, ぬ, ね, の, は, ひ, ふ, へ, ほ, ま, み, む, め, も, や, り, る, れ, ろ, わ, ん. The right column is titled '漢字 edukanji' and contains a 'FOGLIO RIPASSO' section. It shows a large hiragana character 'あ' (a) with stroke order numbers 1 and 2. Below the character, there is a 'Letture in rōmaji' section with the text 'a'. Below that, there is an 'Esempi' section with a table of examples.

Termine in kana	Termine in kanji	Rōmaji	Traduzione
あなた	貴方	onata	tu
おかあさん	お母さん	okāsan	mamma

Figure 10 EduKanji 2.0. EduKanji Moodle integration for the kana syllabaries

## Access Data

Through Moodle's statistics function, it was possible to verify the frequency of access to the EduKanji 2.0 sheets for both kanji and kana for the LT003N course, which has, according to Moodle data, 250 enrolled students.

Access from September 2020 to March 19th, 2021 is as follows:

**Table 4** Moodle access data of EduKanji sheets

Type Of Sheets (EduKanji)	Total visits	Total number of students
Hiragana	1,022	230
Katakana	624	158

Number of EduKanji kanji Sheets	Average visit per sheet	Average number of students per sheet
36	112	67.41

These data reveal considerable interest in the EduKanji 2.0 sheets, especially for the kana material. This is clearly justified by the fact that the data collected are from a beginner's course.

## 9 Conclusions

As described, following a few design cycles (SAM model), it has been possible to produce a stable Beta version of EduKanji and the first uses of the application in a beginner's Japanese course provided appreciable data in terms of student use. Also, as set forth in paragraph 8, I as a teacher was able to experience the actual benefits of EduKanji 2.0 in the process of integrating kanji boards into Moodle in terms of speed and ease of use. One viable extension of the actual prototype might be the implementation of kanji exercises (cloze, reading-shape association, etc.) and the registration of student results to allow them to keep track of their improvements. The translation of the materials into Italian and into other languages is also being considered for future developments, so that this tool can also be used in other European universities.

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