

Using Patterns to Guide Teachers and Teaching Materials Evolution

George Moroni Teixeira Batista, Mayu Urata, Mamoru Endo and Takami Yasuda
Graduate School of Information Science
Nagoya University
Nagoya, Japan
tenno.kun@gmail.com
mayu@gsid.nagoya-u.ac.jp
endo@is.nagoya-u.ac.jp
yasuda@is.nagoya-u.ac.jp

Katsuhiro Mouri
Astronomy Section
Nagoya City Science Museum
Nagoya, Japan
mouri@nagoya-p.jp

Abstract - Computer-novice teachers can face various problems when using e-Learning systems. Computers and the internet are a vital part of our lives nowadays, and teachers cannot avoid using this kind of technology in reaching their students. The problem became more interesting when we try to find how can the teachers that have little experience with computers be helped to handle this technology? Usually institutions that have e-Learning platforms have separated technical group to operate the technology, however it takes too much time for the contents to be updated, and the students that really needed the updates may never see it. The employment of utilisation patterns can help teachers learn from the teaching experiences of their colleagues that have more experience with computer as they use the system, allowing them to evolve and become better professionals by learning, for example, how their colleagues are overcoming device or system interface barriers. The implementation of a system that allows the teachers themselves create and update content in real-time, allowed the teachers to adjust teaching materials which were out of context for the students, making them easier to understand in time for the students that really needed.

Keywords-e-Learning; teaching; materials; evolution; pattern.

I. INTRODUCTION

This research background began with the ELO (Escola de Línguas Online) project. The project was started in August 2007 by three undergraduate students from the Department of Foreign Languages and Translation of Brasilia University in Brazil. As stated by Boggs and Jones [1], "the Internet is a professional development tool for teachers", and they should take advantage of what this kind of technology has to offer. Following this idea, the objective of the project was to create an online platform for the Japanese language course to allow the students to interact, do activities online and review the content of the face-to-face lessons. After approximately six months the project was accepted by the University and became an official University project with the support of the Department's teachers. Afterwards, the other languages taught in the department were incorporated into the project: a total of seven languages, Japanese, English, Spanish, Portuguese, French, German and Italian. The development

team had eight members, there were twenty-five teachers with the help of two tutors each in a total of fifty-five lectures, and there were more than four thousand users.

Standard CMS (Content Management System) software like Moodle were used at the beginning of the project, but there were several problems, especially with the content editing interface. Another problem faced by teachers was the fact that they could not update or make versions of the teaching materials to make them more suitable for the requirements of their real classes. To solve these problems, an original system was created using the Adobe Flex framework for the content navigation and edition. The system allows the teachers to edit the content in a WYSIWYG (What You See Is What You Get) interface in real-time, create versions, and share and manage teaching materials.

In the current stage of the research, we are also focusing on the possibility of using the system in different fields of study. To achieve this, we began working with the Nagoya City Science Museum in Japan. The Museum produces many kinds of content for visitors, for the Museum website, and for journals and magazines. Because of the great variety of the Museum's public, it also needs a system to create and manage the different versions of the content, as stated by Iwazaki et al [2]; also, having a different theme every month, the Museum needs to create different versions of the contents to match the different themes and guide each type of visitor to the right place. This makes the Museum a good environment in which to test and evaluate the system content management features.

Until now the research focused on the creation of the editing interface and the database to store and manage the versions of the teaching materials. However, since many teachers were using computers for the first time, or had very little experience, those features were not enough to help them learn how to handle the technology. Therefore, to achieve that goal, we are now focusing on the creation of utilisation patterns that the users can use as guidelines to help them to learn about the system features, gain editing skills, and make decisions to solve problems based on the experience of other users, helping them to become better teaching professionals.

This paper is divided in six sections, this section is the Section 1, the introduction. In Section 2, there will be the description of the research objectives. In Section 3, the system concept will be explained. The Section 4 describes examples of teaching materials evolution patterns, and how the users can use them to learn more about the system. The Section 5 is about the evaluation tests and its results. Finally, in the Section 6, the conclusion about the current stage of the research and what is expected to be done from now is discussed.

II. OBJECTIVE

The research objective is to define patterns of utilisation that allows users to improve their abilities by observing other users' experiences; the other users' experiences can be observed through the visualisation of content evolution patterns stored in the system database. As stated by Aral [3], "social influence as part of a dynamic system in which a variety of feedback loops continuously affects behaviour in a constantly evolving fashion". Other users' feedback can allow the users to become better professionals as they apply what they get from that feedback to their work.

In this research, we created a DTMS (Dynamic Teaching Materials System). The system can be used to create teaching materials that can be edited in real-time even during the classes. This allows the users to easily apply the necessary updates to the contents as soon as they receive feedback or realise something from their own experience. All the updates and versions of the contents are stored in the database, as well as the contents' evolution patterns, and they can be accessed and used by other users.

III. SYSTEM CONCEPT

In the beginning of the project, we tried using standard CMS software, like Moodle [4], Joomla [5], eFront [6] and Dokeos [7]. They were good for managing course access and user accounts, but the interface was too complicated for most of the users to create content or even to navigate. Since many of the teachers were using computers for the first time, or had too little experience, this kind of problem was unavoidable. Additionally, it was also observed that, as stated by Jones and Lynch [8], "web-based systems need to be adapted and evolve following an educational context that is continually changing"; teaching materials need to be updated continuously, to prevent them from became outdated for the new students every semester, but this was very difficult as the teachers could not perform the updates by themselves because of the interface; or, as in the case of interactive content, they needed to know some programming language to make the necessary changes.

The teachers needed at least four features: a WYSIWYG interface that could create interactive and multimedia content, real-time editing to allow the updates to reach the students who really needed them, content version management for the different types of classes and students, and all the necessary functions to edit and manage the content in one screen, because teachers do not have time to spend navigating through the platform during class. We

could not find a standard CMS that had all the required features at the same time, and the feature of editing the content in the same screen in which the content is being visualised was not to be found in any of the CMS we tested. Additionally, as stated by Alexander [9], the fact of teachers cannot handle new technologies can become a great barrier in the development of e-Learning projects. Further as stated by Roberts, Romm and Jones [10], nowadays technologies like computers are a basic part of students daily life, and teachers should be able to handle them; however, since it is not their speciality, we had to find a way to help teachers to learn how to handle the technology.

To solve the problems we propose an original system for the content edition and version management, the DTMS. As stated by Gillani [11], since language teachers are not information technology specialists, the editing interface needed to be very simple, allowing the users to do almost everything with just the mouse, or even to create, interactive content without programming languages; the simplicity of the new editing interface allows the users to make updates in real-time, in the same screen they use to show the content to students; no navigation is needed, and all the updates and versions are stored in the database. As stated by Krug [12], "it is really important to make the interface uniform in order that the users do not get lost in some parts of the application due to the different patterns of navigations or the menus". This approach was used to create menus to access contents, which helps stop the users from getting lost in the long link lists and other different navigation patterns in the Moodle interface.

Technologies like Java, PHP, Adobe Flash, and Adobe Flex were tested, and the Adobe Flex framework was the technology that best fitted the requirements of the project; because Flex is free, most web browsers come with the necessary plugin by default, and the users do not need to download, install, or configure anything by themselves. The database was created with MySQL [13] and the connection between the Flex [14] interface and the database is in PHP [15].

A teaching material created using the DTMS is called a dynamic teaching material because it can be easily changed to become more suitable to the learning environment. A teaching material like a book is static: if it needs some kind of update the owner will have to buy another book that is a newer version of the book he/she already has; however the DTMS allows the user to create teaching materials that are dynamic. The teaching material itself can be updated, and more importantly, the teachers using the system can make the necessary updates themselves according to the necessities they have during classes; they do not need to wait for the book editors and publishers to release an updated version that maybe solve the problems they were having. In other words the dynamic teaching materials can evolve to meet the needs of the teachers and their students in real-time, in such a way that the updates will not be too late for the students that really need them.

System features for user feedback tasks, are still being developed. However, the teachers can basically use the

system to create content that looks like slides, as shown in Figure 1. The user can insert text, tables, arrows and other graphic shapes, as well as images and videos from his/her own computer or from the internet using the search feature as shown in Figure 1, which allows the user to search images and videos from inside the system interface.



Figure 1. System's editing interface.

All the elements inserted in the slide can be configured to be interactive, responding to mouse clicks, drag and drop, and can also influence each other. For example, if the user drops a word in to another element, the element that received the drop can change to an image that represents the meaning of the word. The entire configuration is done through the system's GUI (Graphical User Interface), and no programming language is required. After the slides are completed, they can be grouped in folders called "books", and the "books" can also be grouped in folders called "courses". That way the teacher can create the slides as if they are book pages, and group the books he/she wants to use as teaching materials to create a complete course.

The system utilisation process can basically be divided into three phases: the creation phase, the sharing phase and the teaching phase, as shown in Figure 2.

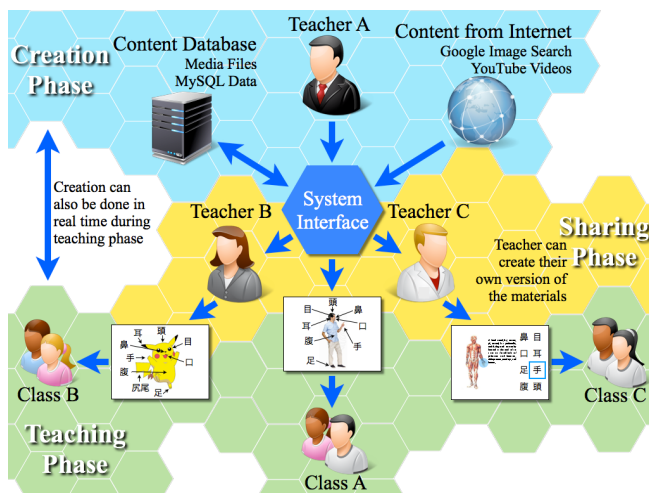


Figure 2. Dynamic Teaching Materials System.

The three phases are connected, creating a utilisation cycle that restarts after the third phase. In the case of a teacher, for example, the three phases cover the user activity from the preparation of the teaching materials to the utilisation of the teaching materials in the classes and getting feedback.

In the creation phase, the user can create a new original teaching material, or choose one that another user has already created, and edit it if necessary. The user can create or choose the teaching material version that is most appropriate for his/her teaching skills, the kind of lesson he/she pretend to do, and the kind of students who are going to participate. When creating teaching materials the users can make a variety of multimedia and interactive content, or something simpler like just text and images; it depends on his/her editing skills and what he/she thinks that is more appropriate. Even if the system has many editing features and an easy to use interface, the teaching materials instructional design is up to the user; the system cannot help with this part since the system cannot predict the kind of situation in which the content will be used. However, before creating something new, the user can use the search feature to see if someone has already created the kind of content he/she needs, and use it as a template to help get some design ideas.

After finishing the content creation or editing, the users can tag the contents when saving it in the database. Tags are used for search, and also to help other users understand the scope of the teaching material; for example, the topic of the teaching material, the language, whether it is interactive, and the target students. Since each update and version of the content can have individual tags it helps the user searching for the content to choose the right version of the right content.

The second phase, the sharing phase, starts once the teaching material is saved in the database. As soon as the content is in the database it is being shared and can be accessed by anyone in the system. Users can access any content in the system database to study, use as a teaching material in the classroom, use as a template to create a new teaching material and so on. All the content created and stored in the system's database fall under the creative commons licence "Attribution-NonCommercial-ShareAlike 4.0 International"; everything can be shared and adapted, and the system keeps track of the authors of every version of all content automatically. In the database table, the content has columns to store the author's ID, the ID of the original content if the content is a version, and for updates it stores the ID of the first release of the content, and a date for every entry in the database. With this data the system can show who created the content, when the content was created, list all the updates, when the updates occurred, show all the different versions of the content, and who created the versions and when. This gives a complete view of what has happened to the content from its first release to the current time.

The teaching phase is the moment when the users actually use the content created using the DTMS to teach in a

face-to-face class or online. In this phase the user can check if the teaching material is really suitable for his/her class style and target students. During the class the teacher can still make changes in real-time if there is some problem found, creating a live update that will be available to the other users as soon as it is saved, like any other content in the system. During or after the class, the user can get feedback from other users and students about the content and the way it was used; this feedback can be comments during the class, emails sent to the user, or even comments in the comment space inside the DTMS interface. The user can make improvements in the content based on that feedback, allowing the content to evolve as it is used by him/her or by other users. When making improvements to the content the user starts to edit the content again, and that restarts the cycle from the creation phase again.

Inside the system interface, feedback occurs as in an online social networking system, where users can comment on the contents, mark what they liked, mark their favourite contents; and the system also stores the number of times each content was accessed. Combining this data with the historic view of the content updates, the system can show the users the pattern of the content's evolution, where they can see which version of the content was more popular, more accessed, the way it was used, if the user feedback, especially comments, had some influence in the subsequent updates or creation of new versions, and so on, showing how the content started, changed over time, what caused those changes, and what the public response was.

IV. EVOLUTION PATTERNS

The DTMS already allows the teaching materials to evolve by being adapted to the learning environment as necessary for the users. Now, we are trying to find a way to use the content evolution pattern to help the users evolve, learning more editing skills and content utilisation techniques by observing other users experience. This can allow the users to create better content and also update the old content to make them better using new acquired skills, making the contents evolve as well. As stated by Jones, Sharonn, and Power [16], the utilisation of patterns emphasises the experience and reuses it to help the users and the development team to learn from what happened in the past and be more prepared for possible problems, allowing them to evolve.

The teaching material evolution pattern is basically how the content is changed over time to try to solve the problems faced by the users using it. Since the same content can be used in different situations, it can face different problems and it can result in the creation of different versions, one for each problem solution. The teaching material can also be used by different teachers, and even if they face the same problem, the way they will try to solve the problem may vary, also resulting in different versions, one for each solution. This information is what compounds the teaching material evolution pattern. In other words, the teaching material evolution pattern shows the problems faced by each version

or update of the teaching material and how it changed to try to solve the problems being faced.

The evolution pattern visualisation and some feedback features are still in development; however it is possible to exemplify the dynamic teaching materials evolution pattern and how the users can use it to learn more, by observing what has already happened naturally to some contents, Figure 3 demonstrates the evolution pattern of the content shown in Figure 1.

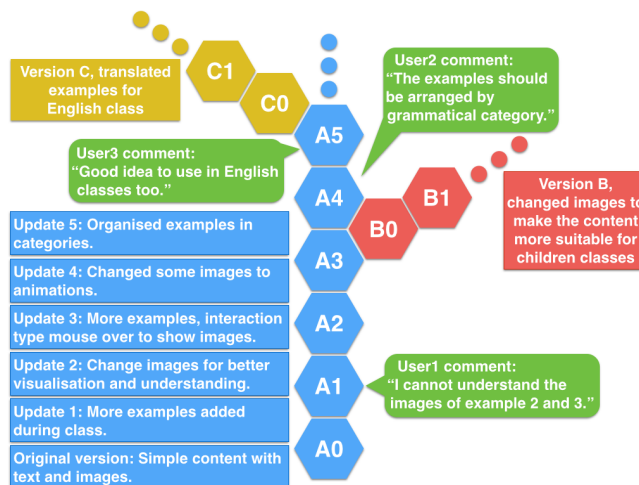


Figure 3. Content evolution pattern with users' comments.

The content "A0" starts as a simple content with sentences using the new vocabulary students are learning in a Japanese class; the content also has images to illustrate the meaning of the sentence or its main word. When using the content in the class, the teachers had to add more examples to help with the explanation, and it generated the content's first update, "A1". After some time, the "user1" made a comment saying that some of the images used in the content were not clear, and to solve that problem the teacher changed the images to ones that were more easy to understand, generation the second update. After that the teacher decided to add more examples with text and images, but there were too many examples with images to show them all at the same time, so the teacher decided to put only the text and use the mouse-over interaction feature to show only the image of the sentence being read, thus saving space on the screen to contain all the examples at the same time.

After the third update, a different teacher liked the content "A3" and wanted to use it in his classes for children; however he thought that he needed more images for the children, so the he used the content "A3" as a template to create the content "B0", a version with the same texts but different images to make the content more suitable for children. The fourth update was made by changing some of the images to animations, for the best understanding of words like action verbs. After the fourth update, the "user2" made a comment stating that the examples should be arranged by categories; to solve that the teacher simply changed the positions of the examples on the screen to put the examples of the same category together, generating the

fifth update. After that, “user3”, an English teacher, made a comment saying that the content could be good for English classes as well, and then he created an English version of the content translating the example sentences but keeping the images.

In this evolution pattern sample, we can see how the content changed over time and why the updates happened, when the content was updated in real-time to meet necessities during classes as in update 1, or updates because of user feedback like update 2, or updates because the author himself/herself detected a problem like in update 3. We can also see how the content was adapted to be used in different situations with different target students by other users.

Another example of a content evolution pattern can be seen in the context of the Nagoya City Science Museum, where the next evaluation tests are going to be held. In the case of the Museum there will be, for example, content to explain about the observation of stars (see Figure 4). The Museum curator needs to use the sky simulator function to generate the starry sky image and then apply filters to show only the necessary stars in the right size, form constellations connecting stars, and input some text labels for more detailed explanations about the stars movement or visible time periods, for example.

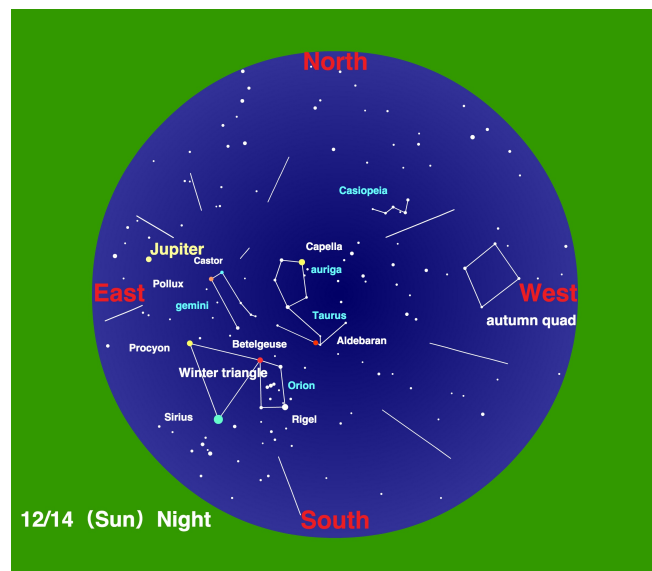


Figure 4. Content naming visible stars in the night sky

Once the content is saved in the database it can be reused as a template to create new content or updated if needed. For example, if the curator needs to show the same constellations but on a different day or time, he does not need to create everything from the scratch, he can just load the content that already has the necessary identifications and explanations, and simply reload the position of the stars for the new day or time, creating a new version of the content for a different date. Most of the content in the Museum is created in Japanese, but since the number of foreign visitors is high, the curators also need to create English and/or Chinese versions of the contents.

In this case, the changes that can happen are not necessarily improvements in the content, but adaptations to make it usable in different situations. The evolution pattern can show, for example, how the labels of the stars needed to be moved when changing the date; thus the curators can try to find better ways to place the labels.

The utilisation patterns being used as user guidelines should have the best practices for the users on two sides: the side of the user who created the content, and the side of the user who is observing the content’s evolution pattern, in a way in which the content’s author can really transmit his/her experience in an intelligible manner, and in which the other users can understand how to access the data stored in the database to actually see the evolution pattern. To help the users to better transmit their experiences and use the evolution patterns to learn and evolve, we suggest a utilisation pattern based on the following points:

- Before creating new content, search the database to see if another user has already created the necessary content; the user can create a version of another user’s content to best fit his/her needs if necessary.
- Every time a user creates or updates a content, he/she should at least use tags that describe the topic of the content, the target students and the content type.
- The author can use individual tags to show the differences between content updates and versions.
- Pay attention to the feedback of other users; they can highlight problems not yet found, or even show better ways to use or edit the content.
- Every time a user makes an update or a version of a content, he/she should write a comment explaining the objective of the update, what kind of problem he/she wanted to solve with the changes, as in the Figure 3 example updates list.
- The user comments are linked to the specific update that was being accessed by the user; it is useful to observe how the comments influenced the subsequent updates and versions.
- Before creating new content, use the search to see how other users are creating the same kind of content; the comments in the previous updates can reveal about possible problems faced by the users, and the updates themselves can show how the author tried to solve the problem. This can help prevent the same kind of problem from happening again.
- Take the time to see versions of your own content created by other users; they might contain hints on how to solve problems, as well as new edition and utilisation techniques.
- Whenever possible, give feedback to the author; it helps him/her to understand the pros and cons of his/her work.

There will be evaluation tests to finish defining the utilisation patterns that can help the users as guidelines for evolution, and also to make adjustments to the interface and check if there are any new functions necessary for the system. Since the beginning of the ELO project the development team was working side-by-side with the users to see exactly

what they needed, and built the system based on the necessities that the users faced in their work. As stated by Vianna, Vianna, Adler, Lucena and Russo [17], having the development team enter the context of the users is very important in allowing the creation of something really original, and in the case of the Nagoya City Science Museum, we expect to keep doing the same kind of collaborative work, checking the real needs the Museum curators have in order to create the necessary contents.

V. EVALUATION TESTS AND RESULTS

From the beginning, the system has been developed in collaborative work between the development team and the users; whenever possible there have been interviews and reunions conducted between the users and the development team to discuss the system's performance, what is good, what needs to be fixed and why the changes are needed.

The first test environment can be seen in Table 1; the test was performed at the beginning of the ELO project when all the languages of the Department were being incorporated into the system. The teachers gave their evaluation of the system in interviews after using it in face-to-face classes and in online support activities. The test was focused on new navigation patterns for using the system in the face-to-face classes, what kind of teaching materials the teachers really needed to create or edit, and to evaluate the necessity of tutors in helping teachers prepare and set up the necessary equipment to use the system in the classroom, especially in the case of teachers with little experience with computers.

TABLE I. BRASILIA UNIVERSITY FIRST TEST ENVIRONMENT

Test period	from February 2008 to April 2009.
Development Team	8 members.
Languages	Japanese, Spanish, French, English, Italian, Portuguese and German. Total of 7 languages.
Lectures	55 lectures, graduate and undergraduate level.
Teachers	25 teachers.
Tutors	2 per teacher, total of 50 tutors
students	2907 students
Total of users	2982 users

The new content interface that implemented a new navigation pattern solved the problem the teachers and student were having in navigating the platform to access other contents. Before with the standard Moodle interface, the users could view the courses and the contents inside the courses as lists of links, but sometimes the lists became too long and it was difficult to find the contents, difficult to see which one was used in the class for revision, and also difficult to see which contents were related. The new

interface had all the content in one screen, accessed by menus and submenus, organised by topic, which no need to navigate to different pages or areas of the online platform. The new interface also helped the teachers when using the system in face-to-face classes because the projectors had a screen resolution smaller than the normal displays, usually 800x600 pixels, and the new interface was designed to fit this smaller size; since no navigation was needed after entering the course page, the teachers had all they needed on the screen, saving time when showing the contents.

Even the teachers who had experience with computers stated that the support of the tutors to set up the equipment in the classroom was essential, since in Brasilia University the number of classrooms equipped with computers and other multimedia equipments is very low; almost every time, the teachers had to bring the equipment and set it up in normal classrooms, which is very time-consuming to do alone, and is unfeasible taking into consideration the total time for the class.

Regarding the types of teaching material needed by the teachers, the most required types for the face-to-face classes were text with images to illustrate the meaning of new vocabulary, animations or videos to illustrate action verbs and dialogue examples; for grammatical explanation the most popular contents were interactive contents that, for example, showed how the use of different grammatical forms changed the meaning of the sentence as the user moves the mouse cursor through the available options. The test results were very good for the stage of development that was focused on solving the problems the teachers were having with the Moodle interface.

The second test was conducted with a smaller group, just six Japanese teachers, twelve tutors, and one hundred and forty students in nine lectures. The test was conducted from July 2009 to December 2011, and focused on the real-time content editing interface, the creation of content versions, and how to store the versions on the database. During the period of the first test, the teachers made the instructional design of the contents, but most of the content was developed by tutors that had experience with computer, or were trained by the development team.

The system had good approval from the language teachers; they made comments like "the system was really good because we can do almost everything with just some mouse clicks", "the real-time editing makes the system work like an electronic blackboard" and "the possibility of creating different versions of the teaching materials in real-time solves the problem of teaching materials which are out of context for the students". However we still had some problems because at that time the system did not yet have a content search engine; to use the content, the teachers needed to know the content name or the ID number to load it from the database. It was difficult for the teachers to know which content had versions and which version was the best to be used in their classes since the system did not have an interface to show the relationship between the contents' versions.

After fixing the problems found by the tests, the current development stage is focused on content version management, the interface for showing the relationship between the content versions and the interface for showing the evolution pattern of the content. Future tests of the system will be done in collaboration with the Nagoya City Science Museum. We have already had some meetings with the Museum curators to discuss the necessary new functions and create a database structure that can store the changes and track the different versions of the contents. The next test will focus on the creation of different versions of the content, storing the creation process, and trying to define the best interface to show the evolution patterns of the contents, in a way that the users can see it, understand what has happened to the content and learn from the content authors' experience.

VI. CONCLUSION AND FUTURE WORK

The development of the system still has a long way to go. With the results of the tests done up to now, it is possible to say that the system has successfully accomplished the interface tasks of an easy to use real-time editing interface, creating an environment that allows teaching materials to evolve, and can also be used in different fields of study. All the problems faced by the teachers at the beginning of the project were solved with the implementation of the new content editing interface. The system allows the users to edit content, update it in real-time and create versions of the content, so that it can be used in different learning situations. However the content management part is still in its initial development, especially the interface.

The content search function that was one of the requests after the first test has also been completed, allowing the users to search for content using keywords, and even allow them to search for the content's previous updates and different versions. This is a useful feature but is not enough to show the evolution pattern of the contents to the users. The system features for user interaction and content feedback are also still in development. As stated by Grant, Facer, Owen and Sayers [18] and by Paiva [19], communication is a very important part of the learning process; hits is not just between teachers and students, but can also be applied to the situation of users learning new techniques from each other to use the system, and is what makes these features key to promoting the evolution of the contents and users.

After the implementation of the feedback features, the system needs to be tested to define the utilisation patterns that allow users to use the evolution patterns of the dynamic teaching materials as a learning tool to improve their abilities to edit and use teaching materials based other users experiences. After the implementation of all the features, the system should allow the users to create and share teaching materials, use those contents to teach, and interact with one another, giving feedback about the content they edit and use. Through these interactions, users can learn from one another's experience and help each other to evolve, becoming better teaching professionals who are more

prepared for the different situations they may face during work.

ACKNOWLEDGMENT

This work was supported by JSPS KAKENHI Grant Numbers 25280131, 24800030, and THE HORI SCIENCES AND ARTS FOUNDATION.

REFERENCES

- [1] E. Boggs and D. Jones, "Lessons learnt in connecting schools to the internet", Australian Educational Computing, Vol. 9, No. 2, pp.29–32, Australian Council for Computers in Education, 1994.
- [2] K. Iwazaki, et al. "Possibility and the Trial based on "connection" between the Science Museum and Universities or Visitors : Development of Exhibitions for the 50th Anniversary Event of the Nagoya City Science Museum", Journal of the Japan Information-culture Society, Vol.20, No. 1, pp.10-17, May 2013.
- [3] S. Aral, "Identifying Social Influence: A Comment on Opinion Leadership and Social Contagion in New Product Diffusion", Marketing Science Articles in Advance, pp. 1-7, 2010.
- [4] <moodle.org/> 2015.02.16.
- [5] <www.joomla.org/> 2015.02.16.
- [6] <www.efrontlearning.net/> 2015.02.16.
- [7] <www.dokeos.com/> 2015.02.16.
- [8] D. Jones and T. Lynch, "A model for the design of web-based systems that supports adoption, appropriation, and evolution", Murugesan, S. and Deshpande, Y. (Eds.): Proceedings of the 1st ICSE Workshop on Web Engineering, 1999, pp.47–56, Los Angeles.
- [9] S. Alexander, "e-Learning developments and experiences" (2001) <web.uct.ac.za/org/fawesa/confpaps/alex.pdf> 2014.06.05.
- [10] T. Roberts, C. Romm, and D. Jones, "Current practice in web-based delivery of IT courses", APWEB 2000, Xi'an, China, 2000, pp.27–29.
- [11] B. Gillani, "Learning Theories and the Design of E-Learning Environments", University Press of America, United States of America, 2003.
- [12] S. Krug, "Don't Make Me Think! A Common Sense Approach to Web Usability", 2nd ed., New Riders, Berkeley, California USA, 2006.
- [13] <www.mysql.com/> 2015.02.16.
- [14] <www.adobe.com/products/flex.html/> 2015.02.16.
- [15] <php.net/> 2015.02.16.
- [16] D. Jones, S. Sharonn, and L. Power, "Patterns: using proven experience to develop online learning", Proceedings of ASCILITE '99, Responding to Diversity, Brisbane: QUT, 1999, pp. 155–162.
- [17] M. Vianna, Y. Vianna, I. Adler, B. Lucena, and B. Russo, "Design thinking Business innovation", 1st ed., MJV Press, Rio de Janeiro Brazil, 2012.
- [18] L. Grant , K. Facer, M. Owen, and S. Sayers, "Opening Education: Social Software and Learning", Futurelab, United Kingdom, 2006.
- [19] V. Paiva, "Letramento digital através de narrativas de aprendizagem de língua inglesa", in English: "Digital literacy through English language learning narratives" CROP, Vol. 12, pp. 1-20, (2007) <www.veramenezes.com/crop.pdf> 2014.07.18.