

Design of Digital Literacy Environments Based-On Interactive Learning Services

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Abstract. The differences in terms of access and ICT skills between different groups in society have created a problem of digital divide. To overcome this problem, informal learning models and strategies are required to achieve a greater impact on the population and that population can develop skills that enhance inclusion in the society knowledge. This work proposes the design of a digital literacy informal environment that aims to set a new educational paradigm approach to encourage different learning communities to uses new ICT that allows them to be more competitive in today's world and thus shorten the digital divide. Finally, a case study is presented. The case study was implemented in the Aguascalientes State, Mexico, in a learning community composed by librarians.

Keywords: Digital literacy · Informal learning · Learning environments · Learning services · Interactive systems

1 Introduction

The influence of ICT in the knowledge society has changed economic, political, cultural and social concepts allowing access to other levels of welfare and progress. To develop a knowledge society, it is necessary to define new approaches and models of knowledge acquisition. The inclusion in the knowledge society will enable individuals to access other levels of welfare and progress (Orrego and Velásquez 2011). However, the 21st century citizen must first acquire new personal, professional and social digital skills that are required by the knowledge society for inclusion in a digital world based-on ICT. The process of acquiring digital skills is known as digital literacy. This term refers to an individual's ability to use technologies appropriately, as well as to understand and be able to express themselves in different languages and digital media, as well as to develop knowledge related to information through ICT, and to develop social and political values and attitudes in relation to technologies.

In this sense, education as an individual process to be inserted into society throughout life is done through public or private institutions and also in the daily coexistence that seeks to integrate the individual in a specific cultural time and context. As Marciales Vivas (2012) and Sánchez (2013) point out, “in the course of our lives we move in three educational spaces: (a) formal, given by the institutions and that obeys to a curriculum certified by public and/or private governmental institutions and whose purpose is to qualify us for work; (b) non-formal, which refers to complementary formations without curricular value, and whose purpose is to keep us updated in our professions or to acquire skills, knowledge, etc., useful for daily life; (c) the informal, which is the education that is received every day in the social ambit and is what gives meaning to our socio-cultural integration in the particular society in which we live”.

Although education is a universal right, there are still social segments throughout the world that by their economic resources, geographical location, gender, age, beliefs, language, race, disability, schooling, etc. (Block 2004), cannot access to an education that is based on a closed system. Formal and non-formal education creates a closed space where only a few have access, creating even a gap in accessibility to education. On the other hand, informal education represents an alternative to break the old educational paradigms and create new educational models that are capable of creating real and virtual environments where citizens of diverse social segments grouped in learning communities can receive digital literacy. Ann et al. (2009) claim that most learning takes place in communities. Formal education cannot prepare people for a world that changes rapidly and continually. So, we need to live in learning communities.

Based on these limitations, in our study, a multicontext-aware resource recommendation model and strategy for service-oriented ubiquitous learning environment is proposed with taking into consideration not only the services and learners’ dynamic context information. Finally, by presenting our prototype system and illuminating a typical scenario, we could show that our proposal can help learners obtain the proper resources to enhance the learning efficiency.

As it is very difficult for learners to find the most proper contents according to their preferences from massive resources in E-learning environment (Luo et al. 2008), the learning services compositions mechanism as a core component must be introduced.

This paper proposes the design of a digital literacy environment based-on interactive learning services that aims to encourage different learning communities into the knowledge society and thus able to decrease the digital divide.

The model is composed by different levels of layers, and its main element is a process of knowledge acquisition for transferring dynamic and gradually the digital skills that allow an individual become into a digital citizen certificated. Finally, a case study is presented.

The case study was implemented in the Aguascalientes State, Mexico, in a learning community composed by librarians.

1.1 Digital Literacy

In the twenty-first century, the progress and development of a country no depends solely on its material resources or on the investment of capital, but increasingly, it is

necessary to have human resources (citizens) qualified or literate in the use of ICT (Area Moreira 2002), in such a way that through these human resources innovation and development can be fostered, thus advancing towards a knowledge society. Therefore, to overcome the obstacles to closing the digital divide, it is necessary to provide the population with a series of digital skills. These digital skills are known as “Digital Literacy”.

The term digital literacy refers to the ability of an individual to properly use the technologies, as well as to understand and be able to express themselves with different languages and digital media. In addition, being digitally literate involves developing knowledge and skills in relation to information through ICT, as well as developing values and attitudes of a social and political nature in relation to technologies. Digital literacy is a learning process that involves providing people with concepts and methods, as well as practices that allow them to appropriate of the ICT.

1.2 Informal Learning

Generally the basic learning in life is learned informally. Education, as an individual process to be inserted into society throughout life, is carried out through public or private institutions and also in the daily coexistence that seeks to integrate the individual in a specific time and cultural context. Marciales Vivas (2012) and Sánchez (2013) claim “*in the course of our lives we move into three educational spaces: (A) formal, given by institutions and following a curriculum certified by public and/or private governmental institutions and which is intended to qualify for work; (B) non-formal, which refers to complementary formations with no curricular value, and whose purpose is to keep us updated in our professions or to acquire skills, knowledge, etc., useful for everyday life; (C) the informal, which is the education that is received every day in the social field and is what gives meaning to our socio-cultural integration in the particular society in which we live*”.

2 Related Works

In Pinto and Sales (2007) work the public libraries represent the vehicle of knowledge, they are an essential support for lifelong education, the cultural progress of an individual and the social groups that make up a given environment. They argue that public libraries face the new challenges of the digital divide that the information society and knowledge provoke in today’s society. Public libraries, in their proactive role, can play a decisive role in integrating minority groups into society through the promotion of cultural exchange and training programs in information literacy. Thus, public libraries can serve as forums for informal learning for all groups in society.

Villa Orrego and Moncada Velásquez (2011) implemented a government program oriented at digital literacy in a rural community. The research aimed to identify and analyze the communication processes derived from the participation of a rural community in the Medellín Digital project. It was evidenced that the participation of people in this process of digital literacy promotes the renewal of some communicative

practices, the configuration of new roles within the family, and the social appropriation of the project. This particular experience to approach Information and Communication Technologies (ICT) modified the lifestyle of participants, their beliefs and future education expectations, their self-esteem and their social cohesion level.

3 Digital Literacy Environments Based-On Interactive Learning Services

The new knowledge society has transformed the way we work, live and learn. This situation implies the development of new skills for the management and usage of emerging technologies that facilitate adaptation to the new economic, political, social, lifestyle, and lifelong training requirements. Online learning environments have contributed to the transformation of teaching methods, giving priority to the creation of communities with common learning objectives.

The online learning environments are designed based on the needs of the users, the learning objectives as well as the technology available. Online learning environments can be used to complement the learning process in formal and non-formal education systems, through the exchange of experiences and knowledge, collaboration and creation of working groups, interaction with other community members and the possibilities of self-evaluation. In this context, learning communities find support services oriented to their learning needs, their competencies and their collective behavior (Sloep and Berlanga 2011).

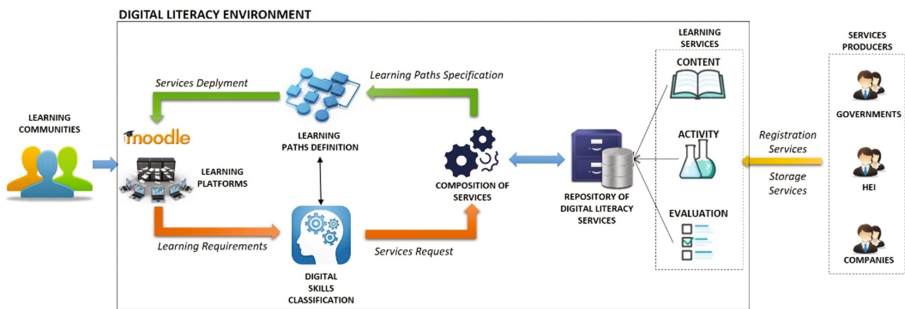


Fig. 1. Design of digital literacy environments based-on interactive learning services.

Each segment of the population perceives in different ways the use of ICT according to their cultural characteristics (Kyriakidou et al. 2011). Under this premise, a digital literacy environment should be designed based on cultural, geographic, political, economic, and even age and gender characteristics of a particular learning community. In this sense, if we consider these characteristics for the design of digital literacy environments, a population of individuals can be segmented into several more homogeneous communities, and thus learning services can be more efficient to attend the digital literacy needs of each learning community. In the following subsections, the main elements of Fig. 1 are described.

3.1 Learning Communities

A population of individuals can be segmented into learning communities, grouped according to the similarity of their characteristics as age, gender, economic, social, geographical, political or cultural circumstances, thus, it is possible to define more homogenous learning communities. The formation of Learning Communities -as homogeneous as possible- allows obtaining more detailed specification requirements for the development of digital literacy services. The step of obtaining the requirements specification based on the context of the learning community allows defining the classification of digital skills that must be acquired by that community (Fig. 2).

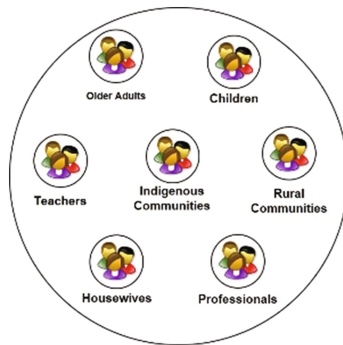


Fig. 2. Example of learning communities classification

Through the services approach, different learning scenarios can be created for the different profiles of learning communities.

3.2 Service Producers

It is ambitious to bring digital literacy to a large number of learning communities and that they can move to the knowledge society. However, it is not impossible if we consider actors that can create collaborative ecosystems that allow us to take advantage of the use of installed infrastructure, technological, human and economic resources and social interaction.

Taking advantage of this collaboration, it is possible to design collaborative strategies that are transformed into processes of knowledge transfer and appropriation of ICT in each of the different learning communities. After the study and analysis of different models of digital literacy, it was possible to identify and classify the main actors that can be the producers of services.

Governments: Through their digital agendas integrate public policies necessary to boost the innovation and competitiveness of their nations. This implies to offer better services in infrastructure and accessibility, and to ensure equal access by promoting rights and obligations for digital citizenship, as well as being the main promoter of digital inclusion campaigns.

Higher Education Institutions (HEI): The development of a knowledge society is a complex and multivariate challenge, which requires a multidisciplinary vision for its decrease. The HEI can offer this panoramic vision, as well as contributing with pedagogical and knowledge transfer models, with digital contents, educational platforms, etc., in such a way that they are relevant mediators to achieve the digital inclusion in the citizenship.

Companies: The companies are an important factor as agents promoting innovation and competitiveness. Thus, they promote the development of the most competitive human capital. They also have the function of generating digital services according to the demands and needs of citizens.

3.3 Digital Skills Classification

Digital Skills refer to good understanding and broad knowledge about the nature, function and opportunities of ICT in everyday situations of private, social and professional life. Also, people must understand the possibilities offered by ICT as tools to support creativity and innovation (Reuelta-Domínguez 2011).

If a citizen wants to get in the knowledge society, first, it is necessary to acquire a series of digital competences classified at basic, intermediate and advanced levels. These digital competencies can be acquired through formal, non-formal and informal educational processes (Fig. 3). In such a way, when the individual appropriates ICT, he or she becomes a digital individual, and thus, he or she can into a certification process that accredits his or her digital skills, so, become a digital citizen.



Fig. 3. Transition from Individual to digital citizen (Muñoz Arteaga et al. 2015)

The longer an individual spends more time using ICT, is gaining more experience and digital skills that allow him to move to higher levels, which involves performing more complex tasks with the use of ICT, to achieve inclusion in the knowledge economy.

As already mentioned, ICTs have a sense of utility for a learning community, when they are used to solve problems of daily life and work. Based on this idea, a classification of digital skills defined for a learning community is not necessarily useful for another learning community. Therefore, each learning community has associated a classification of digital skills that are useful for its context.

3.4 Learning Paths

Learning paths in education have emerged as an important advantage in planning, organizing, and controlling learning processes. The adaptability of learning paths includes changes to the user interfaces that are used to control the learning process. According to Yang et al. (2014) a learning path defines the steps that should guide a student in effectively building of their knowledge and skills.

Learning paths add a logical approach to model the task for a user interface, necessary to provide a cognitive function for the adaptation of the context, in this case, the context is represented by each learning community. Therefore, a learning path defines the interactive processes for the learning of the digital skills based-on the learning services.

3.5 Repository of Digital Literacy Services

The repositories are used by the institutions as a place for the organization, access, preservation and diffusion of digital objects in a specific subject, or digital files of different topologies (Texier et al. s/f; Álvarez Terrazas et al. 2011). The learning services repository is the space where service producers can publish, classify, disseminate and improve learning services.

Accessibility is the main feature of the learning services repository. Open access to learning services helps design learning environments to serve a wide variety of learning communities. A service producer can also evaluate other services created by other producers, with the aim of improving them if necessary, so that, they can adapt them to other learning communities.

The service repository is classified into three types of learning services:

- *Learning services* are organized and structured as a set of knowledge and skills.
- *Content services* are all those actions and tasks performed by an individual to strengthen skills and knowledge.
- *Evaluation services* that are used as instruments to measure the level of domain of the skills and knowledge of an individual, as well as to detect their failures and to make the necessary adjustments within the learning paths.

4 Case Study: Learning Community of Librarians

The following case study presents the design and implementation of a digital literacy environment for a community of librarians in the state of Aguascalientes, Mexico.

4.1 Context of Public Libraries in Aguascalientes State, México

The Government of Aguascalientes State, within its sexennial plan 2010–2016, considers as one of the main activities to close the digital divide for the improvement of the quality of life in Aguascalientes. Based on this need, the Fomix Aguascalientes

2011-01 project was created as an intervention strategy that contributes to the social appropriation of ICT in an effective and efficient way in urban and rural areas mainly.

In January 2012, the Government of Aguascalientes State announced that it would be the first entity in the Mexican Republic and Latin America to be connected by a digital network called: State Network of Education, Health, Government and Security (in Spanish Red Estatal de Educación, Salud, Gobierno y Seguridad: REESGS) (Prensa 2012). The purpose of REESGS is to encourage the exchange of information between the departments that provide services to their community, in this way, and with a project of such magnitude, the called “digital divide” would be shortened, and thus, the society of Aguascalientes would have significant resources to acquire digital citizenship.

The impact of this news involved the Cultural Institute of Aguascalientes (in Spanish Instituto Cultural de Aguascalientes: ICA), which is the agency responsible for administering 66 public libraries that are distributed in each of the 11 municipalities of the state of Aguascalientes (Fig. 4).

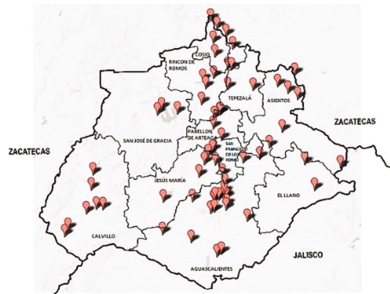


Fig. 4. Geographical distribution of 66 public libraries in the state of Aguascalientes.

Table 1 presents the relationship between the number of libraries and the number of inhabitants of each municipality.

Table 1. Total of libraries distributed in each Municipality and population that it attends

Municipality	No. of libraries	Population served
Aguascalientes	21	797,010
Asientos	6	45,492
Calvillo	7	54,136
Cosío	5	15,042
El Llano	2	18,828
JesúsMaría	5	99,590
Pabellón de Arteaga	4	41,862
Rincón de Romos	6	49,156
San Francisco de los Romos	4	35,769
San José de Gracia	3	8,443
Tepezalá	3	19,668
Total general	66	1,184 996

Thus, through the Public Libraries of the Aguascalientes State seeks to implement an informal learning model aimed at the entire population with the purpose that they can acquire the skills and competences that allow them to use computers and any kind of electronic devices that through which they can connect to the digital network and they can access to the information that is of priority for their daily needs.

4.2 Problematic

A diagnosis applied in the librarians of the state of Aguascalientes allowed to identify the level of digital competences that they possess. Most librarians have a basic level of digital skills. In order to be able to successfully implement the informal digital literacy model through public libraries, first, it is necessary that librarians can achieve higher levels of digital skills so that they will later be responsible for bringing digital literacy services into the population of Aguascalientes.

4.3 Digital Literacy Informal Environment

To strengthen basic and intermediate digital skills in the learning community of librarians in the Aguascalientes State, an informal learning environment based-on digital literacy services was designed and implemented.

Learning Community and Digital Skills Profile

The case study was carried out in a learning community composed of 47 librarians in the Aguascalientes State, Mexico.

In order to know the profile of librarians that working in the library system, a diagnostic tool was designed and divided into five blocks. In each block, the experience gained, the competences assimilated, the search skills, as well as their didactic-pedagogical skills, and their training needs were investigated.

From the obtained results, it was possible to identify two important aspects:

- (1) The current level of digital skills that the librarians possess corresponds to a basic level, which allowed to establish an initial parameter and thus to be able to establish the digital literacy environment for that learning community.
- (2) A librarian profile that associates the digital skills and the tasks that it performs in a public library (Fig. 5).

Service Producers

The problem of the digital divide extends to an entire society, and even can affect organizations of all sizes, including governments. The digital divide is a multivariate challenge, so an interdisciplinary and interinstitutional group is needed that can provide an extended perspective to generate integral strategies to reduce it. Table 2 describes the service producers who through their collaboration it was possible to design the digital literacy environment as an integrated intervention solution that covered mainly the points of installed infrastructure, connectivity, digital literacy, certification and learning services.

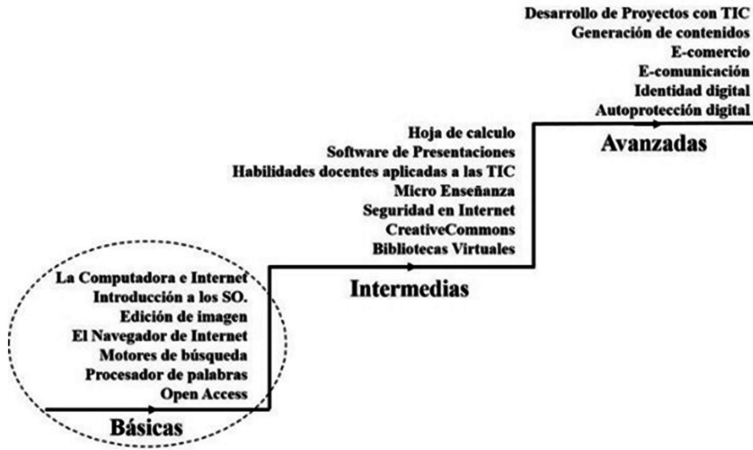


Fig. 5. Profile of librarian associated to the classification of digital skills.

Table 2. Description of service producers

Producer	Kind	Actors
UAA (Autonomous University of Aguascalientes)	Higher education institutions	<ul style="list-style-type: none"> • Researchers • Students • Librarians experts staff
ICA (Cultural Institute of Aguascalientes)	Government	<ul style="list-style-type: none"> • Staff • Coordinator
IDSCEA (Institute for the Development of the knowledge society of the Aguascalientes State)	Government/company	<ul style="list-style-type: none"> • Authorities

Design and Implementation

The design of the digital literacy environment for the case of the learning community of Aguascalientes librarians can be observed in Fig. 6. For digital literacy, two courses were defined that covered the digital skills in basic and intermediate level. Each course was structured by a series of modules, where each module corresponds to a digital competence. This way of structuring the courses by modules facilitated the decomposition of the digital competence, in sub-skills associated to a series of topics. With the decomposition of sub-skills it was possible to define more specific and precise learning paths that were the guides for the development of the user interfaces of the learning services.

After defining the logical model of the informal learning environment, the activities corresponding to the curricular design were performed, as described in Fig. 7. The classification of the digital skills was defined by the experts staff of the UAA library and the Coordinator of the ICA. The ICA staff was in charge of designing the study

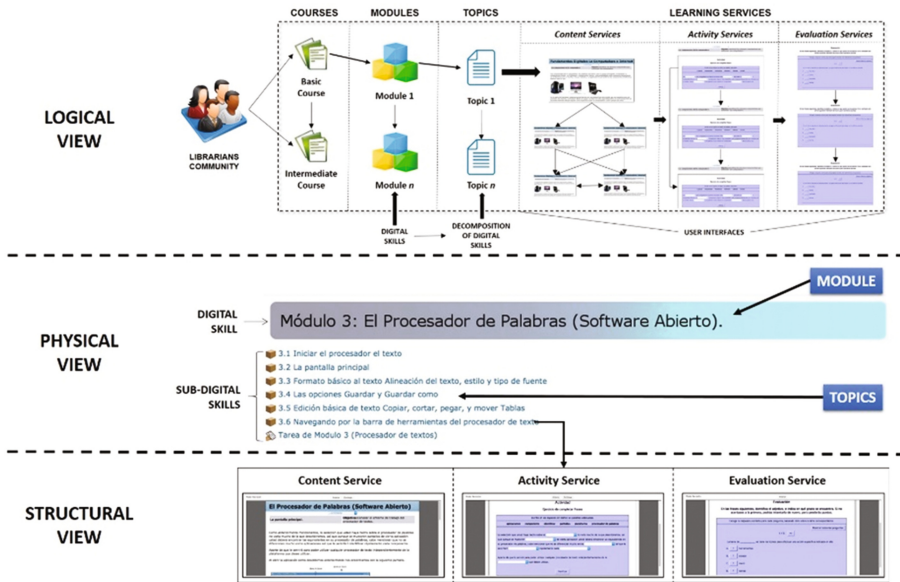


Fig. 6. Design of digital literacy environment for librarians of Aguascalientes State based-on learning services.

programs for the basic and intermediate course, according to the classification of digital skills. The ICA coordinator and the UAA Library expert staff validated the final study programs. After defining the study programs, the UAA library experts staff did the process of decomposing the digital skills and then, they designed the learning paths for each sub-skill. At this stage a validation of learning paths was also made. ICA staff along with some students of the UAA were responsible for the development of learning services. Content services were developed using HTML templates, while activity and evaluation services were developed using authoring tools.

The learning services were deployed on a Moodle platform managed by UAA researchers. The composition of the learning services was done manually, because the repository of learning services was not yet available. The implementation of the courses and the follow-up of the learning activities were managed and evaluated by ICA staff and the UAA library experts staff. The implementation of the informal digital literacy environment lasted 12 weeks. Before the implementation, a diagnosis of the available infrastructure of the 66 public libraries was made. It was found that xx public libraries did not have an Internet connection, in addition to having obsolete PCs. For this reason, through the administrative managements of the IDSCEA it was possible to obtain economic resources to equip some of the libraries with wireless internet service, as well as the renovation of computer equipment.

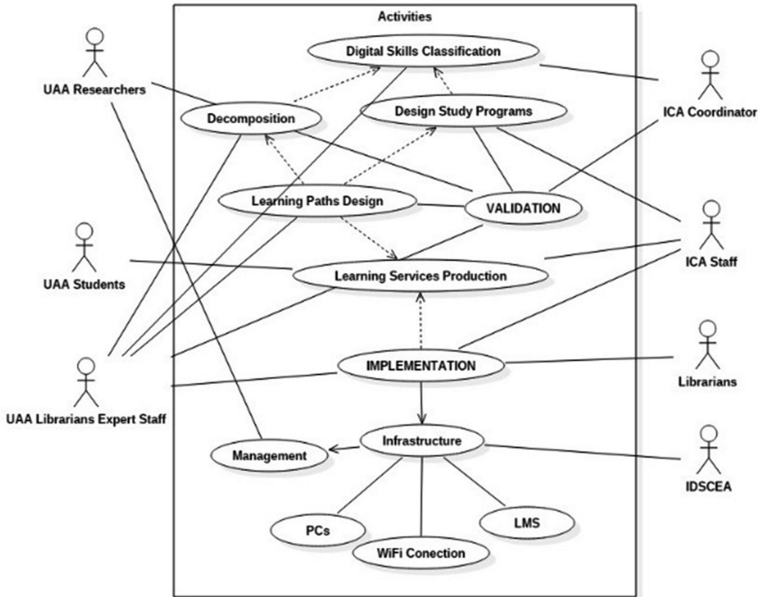


Fig. 7. Use case diagram to describe collaborative activities

Description of Learning Path interacting with Learning Services

Learning paths were specified using flowchart notation. From the specification of the learning paths, the service producers began to development of all digital literacy services to cover each learning path. It should be noted that the repository of services that mechanize the composition of learning services is not yet available (the repository is under construction). For this reason, the services were composed manually and implemented in a Moodle platform.

Next, the implementation of the learning path for the basic competence “Word Processor” is described (Fig. 8). First, the digital skill was decomposed into five word processor skills. After the decomposition of skill, the learning path was composed of five learning activities. Then, each learning activity was associated with a learning service. The resulting learning path is a logical representation that served as a guide for instructional design -in e-learning modalities- for the implementation of digital literacy services within the Moodle platform.

As can be seen at Fig. 8, the learning services have levels of granularity and composition. Granularity is determined based on the range of functions that services need to develop a digital skill, or how services need to be organized into compositions. The service composition refers to the situation in which an individual’s service request is not satisfied by a single pre-existing service but can be satisfied by the appropriate combination of some pre-existing services available.

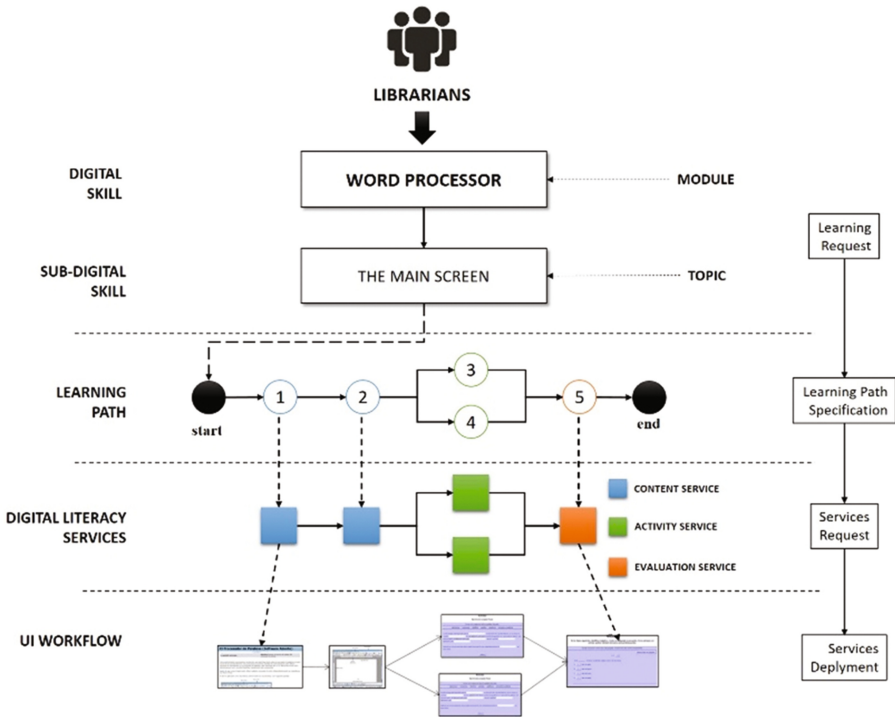


Fig. 8. Architectural view of the interaction between learning and services.

4.4 Results

The implementation of the learning environment was oriented to the training of basic and intermediate levels of digital literacy for the learning community. The 47 librarians acquired knowledge not only in relation to digital skills, but in different areas of the domain of their profession that are related to improving the services offered by public libraries, as follow:

- The librarian understands the cycle of information that includes its generation, treatment, organization and dissemination.
- Ability to manifest and solve an informational need and acquire the skills to transmit it to an automated data system.
- Define strategies for seeking information.
- Define information retrieval strategies in the context of the information being developed.
- Ability to acquire the knowledge that allow the librarian to analyze and evaluate the retrieved information.
- Integrate the information obtained and incorporate it into the knowledge already acquired.

- Develop the capacity to understand the information received and to express it in logical way.
- Knowledge to respect the authorship of the works used by other people and apply the various ways of citing the sources consulted.
- Pedagogical skills that allow you to interact with the community.
- Skills and abilities for the use of computer resources.
- Develop knowledge needed to implement learning and knowledge technologies (LKT).

However, transforming the community of librarians in the state of Aguascalientes into prosumers has been the most important result of the implementation of the informal digital literacy environment. Thus, Aguascalientes librarians, in addition to consuming learning services, have the capacity to create learning services in a creative, critical and responsible way, and adapt them to the specific needs of the end users of public libraries in the state of Aguascalientes.

5 Conclusions

This paper proposes a way of designing learning environments oriented to digital literacy based on learning services. The main objective of the development of learning environments of this type is to be able to bring ad-hoc processes of digital literacy to a diversity of learning communities in a dynamic way so that they can achieve their inclusion in the knowledge society.

In a society, each individual, according to his or her economic, political, geographical and cultural situation, perceives the use of ICT in different ways. Therefore, starting from this premise, transforming a society into a knowledge-based society can be a complex task. On the other hand, the learning community approach allows working with more homogenous groups, and so, it is easier to identify digital literacy needs and establish the digital competences that can be as useful as possible to the context of the learning community.

Currently, there is a wide variety of learning communities (eg, older adults and housewives) who are excluded from formal learning systems, and this situation does not allow them to receive digital literacy. It is therefore necessary to design new informal learning environments where all learning communities can be included in digital literacy processes, and these communities can get into the knowledge society, and thus, improve their quality of life.

On the other hand, the services approach was a key element in getting librarians to acquire digital skills in a gradual and systematic way. The ability to granularity and composition of services helped to create a dynamic and flexible learning environment that adapted to the different learning styles presented by librarians.

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