MODELING, DEVELOPMENT AND DIFFUSION OF HYPERMEDIA-INTERNET APPLICATIONS FOR THE BRAZILIAN RURAL SECTOR*

André Luiz Zambalde
Federal University of Lavras – CAPES BEX 5529/09-3
Caixa Postal 3037, 37200-000 Lavras Minas Gerais Brasil
zamba@dcc.ufla.br

Miguel de Castro Neto
ISEGI, Universidade Nova de Lisboa
Sala 17, Piso 2, Campus de Campolide, 1070-312 Lisboa Portugal
mneto@isegi.unl.pt

Paulo Henrique de Souza Bermejo
Federal University of Lavras – UFLA
Caixa Postal 3037, 37200-000 Lavras Minas Gerais Brasil
bermejo@dcc.ufla.br

Ricardo Luiz Araújo Drummond
Estudar Consulting of Belo Horizonte
Avenida dos Bandeirantes, 330 Bairro Sion, 30315-000 Belo
Horizonte Minas Gerais Brasil
ricardo@estudar.com.br

Giselle Vanessa Benzaquen D'Assumpção
Estudar Consulting of Belo Horizonte
Avenida dos Bandeirantes, 330 Bairro Sion, 30315-000 Belo
Horizonte Minas Gerais Brasil
giselle.benzaquen@estudar.com.br

ABSTRACT

Brazil is a developing country in the midst of major social, economic, technological, cultural, and educational change. In the areas of technology and education, the transfer of information and knowledge, with the support of hypermedia applications, Internet, and distance learning have been a major concern of public and private entities, especially in regards to agriculture and animal production. In a country with approximately 195 million inhabitants and 8.5 million square kilometers, where the rural sector

accounts for 25% of gross domestic product, 30.3% of exports, and 37% of jobs[1], the use of information and communication technologies in education and inclusion is fundamental to promoting developmental strategies and citizenship. In this study, we sought to describe the process of modeling, development and dissemination of hypermedia applications for the Brazilian rural sector, taking as a case unit, the "Digital Citizen" Internet portal. A qualitative research, with exploratory-descriptive goals, and a case study based on documentary and observation is presented. In the current research and beyond, the practices related to modeling, development, and dissemination of hypermedia applications via distance learning (Moodle® and Flash®), as well as investigations and discussions involving government processes and practices related to digital inclusion and social development of rural citizen Brazil are specified. We conclude that Brazil is tackling the challenge of digital and social inclusion, based on a project whose main components included (a) deploying an infrastructure for telephone and broadband across the rural areas, (b) offering free internet in public schools and rural communities, (c) promoting projects and companies that work with hypermedia applications, and (d) supporting initiatives that involve the development and provision of services at a distance. The rural citizen has been able to maintain his residence in their midst with quality of life.

Keywords: E-learning, Hypermedia, Agriculture, Animal Production

---

1. INTRODUCTION

With a population of approximately 195 million people, Brazil is the world's tenth largest economy. Of continental dimensions, its 8.5 million square kilometers (fifth largest in the world) includes an agricultural complex based first in high technology and productivity and, secondly, in a wide network of family-based agriculture. Agribusiness is responsible for 25% of gross domestic product (GDP), 30.3% of exports, and 37% of jobs in Brazil. Additionally, the network of family-based agricultural production and related supply chains accounts for 9% of national GDP and includes millions of Brazilians – an area that generates jobs and incomes in small towns, where its role is crucial in economics and strategic terms to maintain the population in these localities, thus, preventing migration to urban centers[1].

With respect to information and communication technology, Brazil has 50 million installed computers and 40 million Internet users. It is the largest number of Internet users in Latin America and 11th in the world. It is also the 6th world market for cell phones, with more than 150 million subscribers and 41 million fixed telephones[1].

Considering this scenario and analyzing technological, spatial, and political-institutional variables of the rural Brazilian family segment, Zambalde and Neto[2], citing Portugal[3], called attention to two key factors for its development: a) the need to access adequate, organized, and specialized information using computers, software and Internet, mainly targeting education, interaction, and knowledge and b) improving the organizational capacity of producers to gain the scale necessary to seek niche markets, add value to production, and generate innovation.

With regard to access to both adequate and specialized information, particularly when referring to Internet usage, information and knowledge dissemination, and learning processes, there are many challenges faced by the rural sector; specifically, for those related to infrastructure and access technologies[4], educational issues and systems or specific software, such as the development of hypermedia, distance education, and digital repositories[4, 5, 6, 7].

In this study, we sought to address the development and diffusion of hypermedia-Internet applications, particularly those involved in educational settings, distance learning, and those aimed at social and digital inclusion. The main objective was to describe and analyze the processes of modeling, development, and dissemination of hypermedia applications for the rural sector in Brazil, taking "Portal of the Digital Citizen" as study unit. The portal operates in distance education and social and digital inclusion by providing free distance courses, with the support of governmental and nongovernmental organizations. Moreover, also present is an overview of the current Brazilian government's actions involving rural digital and social inclusion.

Even at the worldwide level, few studies have related these topics in rural areas. Typically, there have been isolated approaches, such as studies on the adoption and use of internet and digital inclusion[4, 8, 9, 10]; repositories and hypermedia applications[5, 7, 11]; and e-learning or distance education[12, 13, 14, 15]. In this sense, the main contribution of this work concerns the description and discussion of "integrated practices" for the development and dissemination of hypermedia applications in the rural sector. To achieve this, we present the following: (i) in Section 2, a theoretical framework of the issues addressed in this study, (ii) in Section 3, methodological procedures, (iii) in section 4, the results of the Brazilian case study, and finally, (iv) the conclusions and references.

2. THEORECTICAL FRAMEWORK

2.1 Hypermedia Systems – Concepts, Modeling and Development

The term, hypermedia was coined by Nelson[16], and means the type of application or information system that combines different media (information nodes) such as text, images, sounds, and videos to anchor structures (elements of the activation of links) and navigation components (links) in order to provide users with the most diverse possibilities of interaction. The internet applications, implemented on the World Wilde Web (WWW) incorporate the concept of hypermedia, CDs, and educational games.

According to Ghiorzi[17], some hypermedia applications are extremely complex and the traditional methods of systems development are not sufficient to adequately model its navigation elements, especially when the number of nodes that the user interacts and navigates is large. These methods (conventional) also do not address all aspects related to navigation and generally do not dissociate navigation from user interfaces. Thus, there are specific methods for modeling that are directed at the development of hypermedia applications. These methods are called Web Engineering and are based on the principle hypermedia applications, especially Web applications[18].

The main methods[19] aimed to model and development hypermedia applications and include Object-Oriented Hypermedia Design Model (OOHDM); WebML and UML-Web Engineering[20, 21, 22, 23]. In this work we used OOHDM, a method developed in Brazil that enhances abstraction and reuse. It is, therefore, a method independent of the choice of language and programming environment. The OOHDM considers that the development of hypermedia applications should be divided into four steps: 1. Conceptual modeling, 2. Navigational design, 3. Abstract interface design and 4. Implementation. Figure 1 illustrates the four steps of the agricultural area called "Culturas" (Cultures, crop or cultivation). Note that, in the beginning, crop (e.g., rice, beans, soybean, etc.) is not defined. This is one of the abstraction and reuse characteristics of OOHDM.

2.2 Exclusion, Inclusion and Distance Learning

According to Mingione[25] the term social exclusion has a variety of meanings and origins; however is commonly used as a set of factors that combine to skirt the individual from collective processes and social, economic, and technological benefits. Generally, when these benefits relate

to access and use of information technologies, particularly the Internet, it is called the Digital Divide[26]. According to Warren (p. 385)[27],"social exclusion leads to digital exclusion, which in turn leads to deeper inequalities, new social exclusion—the vicious digital cycle. This is a general phenomenon—it operates at various geographical levels: global, regional, local. It applies in both urban and rural areas, but there are factors which have particular resonance in the countryside, and because rural dwellers have apparently more to gain from the 'death of distance' than urban dwellers, the costs of exclusion are likely to be higher."
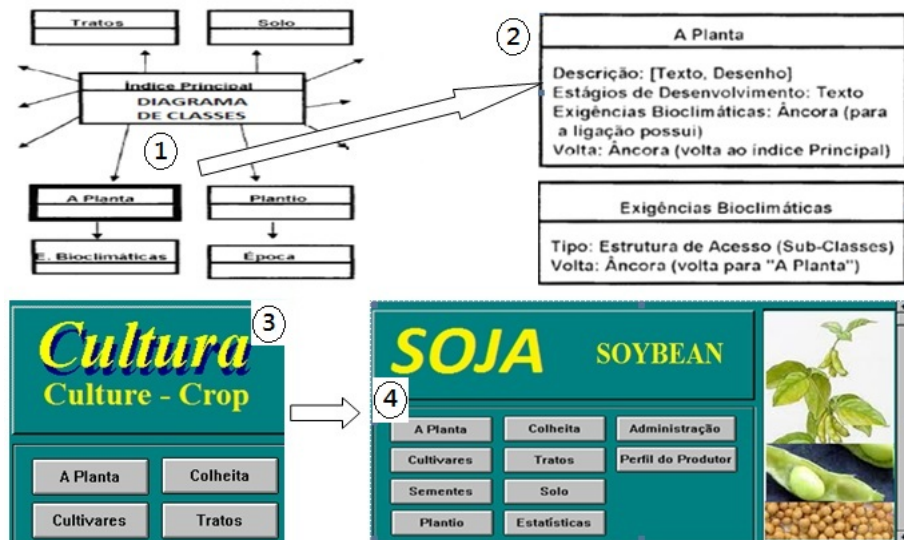

Figure 1. The hypermedia OOHDM Method: four steps[24]

The digital divide raises serious ethical, social, and policy-related issues that concern information and knowledge management in rural areas[28] and imply a need for specific responses[8], particularly in countries with large geographical areas and many small farms that are economically active, as is the case in Brazil. In this sense, the Brazilian government has worked at strategic points, among which we can mention: a) the deployment of telecommunication infrastructures – Internet access in rural areas; b) shares of inclusion/digital learning and rural education, the development and dissemination of educational hypermedia applications are aimed at digital inclusion (basic computer Šskills), the rural sector (administration and agriculture) and the installation of kiosks in rural areas; and c) information and knowledge dissemination projects, repositories of information on agribusiness, agriculture, and livestock[29].

As referred by Brainin and Bar-Lev[30], the availability of mobile and broadband Internet access in rural areas, particularly in developing countries,

contributes to the construction and preservation of social networks and the participation required in a knowledge society. These technologies allow users to break the barriers of geographic isolation and create new opportunities for education, employment, and access to knowledge[8, 31, 32].

With respect to inclusion and learning, education, information, and knowledge dissemination, some authors have emphasized that access to information and communication technologies at home, school, work, and particularly at kiosks, Internet cafes, and libraries leverage inclusion and teaching-learning[30, 33, 34]. For these sites, mechanisms for distance learning and educational hypermedia systems are important because they facilitate the transfer of information and knowledge, and form and integrate citizens into space[35, 36, 37]. According to a study by Murphy and Terry[38], the main ways to improve education and inclusion in the rural sector include increased availability of educational opportunities, improved information resources, production of teaching materials and more convenient and effective methods of implementation.

In countries such as Brazil and India, and virtually the entire African continent, concerning inclusion, learning, and dissemination, they are in the development and testing phases for free internet access and some involve municipalities, while others broadly restrict the installation of small digital kiosks or telecenters[29, 39, 40].

As referred by Akeroyd[41], in the case of e-education or distance learning, learning management systems (LMS) environments are used and facilitate the entire learning cycle[42, 43].

Manouselis et al. (p. 302)[5], quoting [44] and [15], stated that the resources available in teaching and learning environments and in information repositories leverage the opportunities for agricultural education of youth and adults in rural areas. "With ample lifelong learning opportunities and access to online learning resources, can resist urbanization tendencies, protect the natural and human resources of the countryside, understand the new challenges for rural areas and respond to them with new initiatives, flexibility and adaptability." Specifically, in a country with continental dimensions as Brazil, distance learning is an important channel for generating these opportunities; it is a technology with the potential to support the qualification and training of rural people, job training, and dissemination of information.

From a technical perspective, according to Zambalde[45], the vast majority of educational systems are composed of hypermedia applications developed in Flash[®46] and LMS Moodle[®47] with the support of Scorm[®48].

3. METHODOLOGY

As referred by Jung[49] and Lakatos & Marconi[50] and observing the scientific method, the present research was qualitative, with exploratory-descriptive goals, that used a case study, based on references (books, articles, theses and Internet), documentary (files, reports and promotional materials), and non-participant observations (visits to the company involved in developing and disseminating applications).

This qualitative research had as its main objective, the in-depth study and interpretive process of modeling and development of a hypermedia application directed to the rural sector, as well as research and discussion of its distribution on a website for inclusion and digital, The "Digital Citizen Portal," in the form of a distance course offered using the management system of teaching-learning Moodle® (LMS).

The study has exploratory-descriptive objectives because, based on the case study, it sought to produce an innovative and detailed description of practices that were related to the modeling and development of a hypermedia application involving OOHDM, as well as its diffusion from a distance course on the web that aimed at social and digital inclusion, involving Moodle, Scorm® and Flash®.

In practice, the following occurred: (i) the researchers visited, several times the software development company called "Estudar Consultoria e Empreendimentos Ltda." To investigate the application of hypermedia "Rebanhos" (herds) that was being provided as a course in the modality of distance learning via the "Digital Citizen Portal" (www.cidadaodigital.org); (ii) they investigated all of the processes and procedures that were related to the development and dissemination of this application – from requirements gathering, through modeling and implementation, and pursued to build the course that would be offered to citizens – making notes, discussing and evaluating technologies and practices (qualitative research, exploratory-interpretative based on non-participant observation), and finally; (iii) they synthesized all observations and studies and presented their results and conclusions.

The bibliographic references used were mainly concerned with the modeling and development of hypermedia applications, inclusion and social exclusion, and digital teaching and distance learning.

4. RESULTS AND DISCUSSION

4.1 The Digital Citizen Portal ("Portal Cidadão Digital")

The Digital Citizen Portal webpage has as objective to make available courses via a distance learning mode that are aimed to provide comprehensive training and inclusion of youth and adults from various regions of Brazil (Figure 2).

Figure 2. Digital Citizen Portal webpage (www.cidadaodigital.org)

Individuals express their potential interest in a particular course offered via the portal in order to access it through the "Cartão do Conhecimento" (Knowledge Card – Figure 3). The card is requested via e-mail or in person and collected via digital inclusion points or Internet kiosks that are located in various regions and cities of Brazil. There is a code printed behind the card that is revealed by "scratching" and, with this code, the student registers and is granted courses access, whether at home or at kiosks/telecenters. If a student is already registered for a course, he or she simply enters the username and password.

Figure 3. Knowledge card.   ("Cartão do Conhecimento")

In the portal there are many available courses that are divided by application area: Information technology, First job, Environment, Entrepreneurship, Free Software, Agriculture, Animal Production, and Agribusiness Management. The courses in the Agriculture area include: Organic Farming; Creation and Fattening of Tilapia Fish; and Fruits and Vegetables Processing Technology. The courses in the Animal Production area include: Pasture Management; Beef Cattle; Reproductive Management; and Introduction to Dairy Cattle. The courses in the area of Agribusiness Management include: Marketing Management in Rural Cooperatives; Rural Management; and Introduction to Marketing in Agribusiness.

4.2 Modeling and Application Development

The application case study presented in this work is called "Rebanhos" (Herds). This was an adaptation of the work by Oliveira et al.[51] to the Internet and distance education, which at the time, was targeted for use in educational hypermedia CDs. Initially, was made an requirement analysis followed by the implementation of steps from the model OOHDM which include: conceptual modeling (application framework); navigation design (nodes, anchors and links); abstract interface design (general interface); and implementation (specific application).

Figure 4 presents the conceptual modeling (class diagram or main index) of the application "Rebanhos" in the original language (Portuguese). Some examples of its content to be processed include: origin ("Origem"), significance ("Importância"), management ("Planejamento"), and diseases ("Doenças").
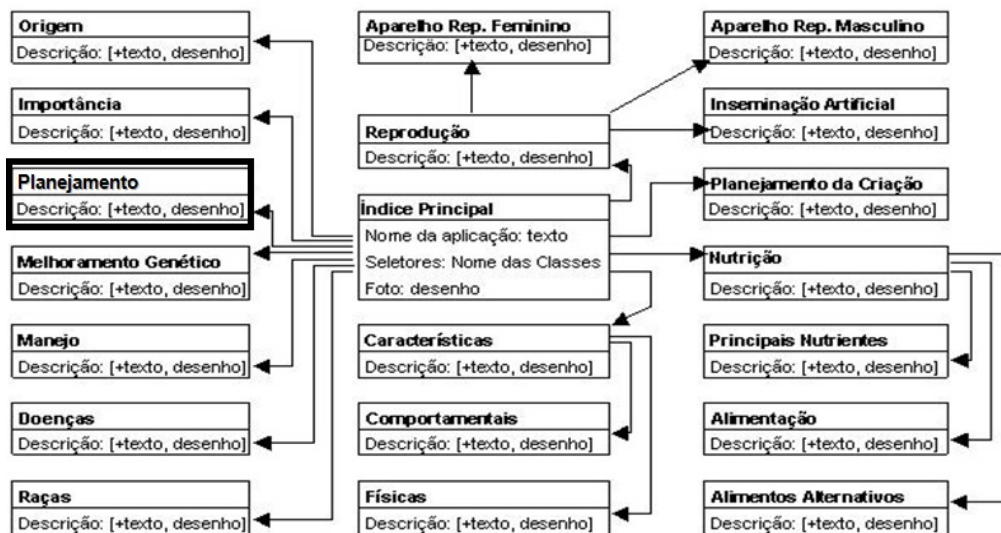

Figure 4. Herds: Conceptual modeling – classes[51]

In the second step, we see the Herds navigation design (Figure 5), where the application navigational classes are specified (access structures, anchors, nodes, and links).

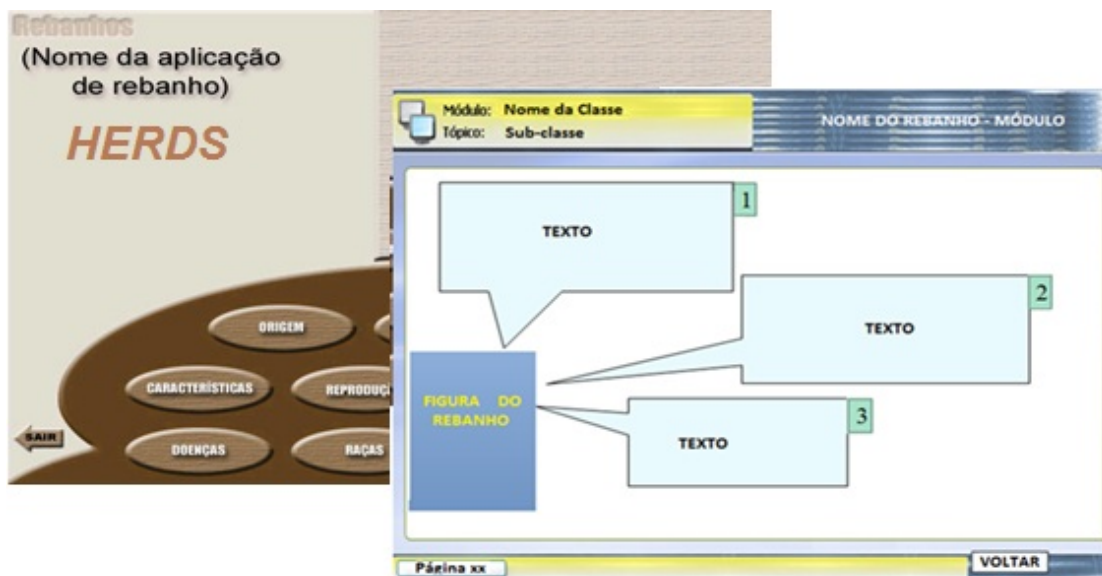**Figure 5.** Herds – "Rebanhos": navigation design[51]

Figure 6. Herds: abstract design[51, 52]

The third step is aimed to specify the application dynamic behavior (i.e., the user interface design elements). This step is defined for each class and subclass and perceptible objects that are available to the user, such as buttons, places for texts and pictures, illustrations, photos and video inclusion, or other interaction elements. Figure 6 shows some possible illustrations for the design of the abstract interface for the application "Rebanhos".

Finally, once reached the "Rebanhos" application implementation stage, in this case, type of livestock (e.g., pigs, cattle, goat, sheep, and horse, among others). In this work, as seen in Figure 7, we attempted to illustrate the application Herds with a focus on the class "Planejamento" (Planning) within the specific context of Beef Cattle.

Figure 7. Beef Cattle: implementation[51, 52]

4.3 Information Diffusion: Distance Teaching/Learning

The applications developed are made available to potential users of the portal in the form of courses. Thus, the process of distance teaching and learning is initiated when the user signs up in the Digital Citizen Portal and chooses a course. The course is then made available to the user using the Moodle®, Scorm® and Flash® technology.

Specifically for this study, we will describe the application called Beef Cattle Rearing ("Bovinocultura de corte, cria e recria"). This application is a Herds-specific approach. By clicking Start Course, the hypermedia application developed in Flash® is activated, and begins the actual content of the course Beef cattle rearing. In this context, students must go through every chapter and exercise to reach the final evaluation.

Normally, tools of interaction, relationships of the Moodle® system, information on the courses that a student is registered, and a bulletin board on the student's progress are displayed in Figure 8. For example, in the Participants ("Participantes") option, students can interact with colleagues from their own region or country with users from other regions. Under Contact ("Contato"), the student can communicate directly with the teacher or tutor. In Learning Materials ("Material didático"), the student has the complete text of the course and can print it if he or she is interested. The Library ("Biblioteca") offers reference lists from the Internet, books, and magazines for further reading. Finally, the possibilities of teaching and learning and interaction are enhanced by the tools of the environment and tools for hypermedia Flash® (anchors, animations, sound, video, etc.). At the end of the course, the student completes an assessment and, if he or she obtains at least 50% (fifty percent) or more, he or she will receive a certificate of completion. Since the student can be enrolled in one or more courses on rural subjects or others, this model creates a bundle of opportunities for citizens who live in the countryside and seek to enhance their relationships and knowledge.

A survey by the Digital Citizen project ("Cidadão Digital") on the content offered, areas of interest, and number of students enrolled from 2009-2010 revealed they were offered a total of ten courses defined as applying to rural areas. These courses included Rural Administration, Introduction to Marketing in Agribusiness, Organic Farming, Beef cattle Rearing, Beef Cattle Reproduction, Introduction to Dairy Cattle, Dairy Cattle Milking Management, Creation and Fattening of Tilapia Fish, and Food Processing Technology. Additionally, the courses consisted of hypermedia applications (OOHDM, Flash®) that were associated with the learning management system Moodle® (LMS) and were made available according to the reference model (Scorm®), with approximately 20 to 30 hours and almost exclusively directed to the everyday realities of the Brazilian rural sector. Therefore, this application was a way of working with adults and young people by creating development prospects, especially for family farms and small producers. Further, the course offerings allowed for the training of 970 (nine hundred and seventy) people, with reprove and dropout rates of 15% of all students.

Figure 8. Beef Cattle: teaching-learning, interaction and support[52]

As to the courses here classified as digital inclusion, ten courses were offered and included Interactive keyboarding, Introduction to computer, Internet, Windows®, Linux®, Word®, Power Point®, Excel®, BROffice®, and Web design. These courses were also based in hypermedia and lasting from 15 to 30 hours. The offering of these courses has allowed the training of 10,645 (ten thousand six hundred and forty-five people) involved both rural communities and urban sectors, with reprove and dropout rates of 8% of all students.

4.4 Courses Policies and Actions for Digital and Social Inclusion

There are countless initiatives offering distance learning courses that are geared to the rural sector, which are present in different regions and organizations throughout Brazil.

The National Rural Training Service (SENAR) and the National Confederation for Agriculture and Livestock of Brazil (CNA), for instance, offer an Internet program titled "Internet training program for the school of agriculture, and for farms for their families to develop knowledge, skills, and

attitudes toward cohesive agribusiness in Brazil"[53]. This program includes six courses that include: Supply and Income; Environment; Professional Qualification; Decent Work; Rural Poverty, and Property Law. Moreover, there is a course with a specific approach to rural women, called "Excuse me I'm going to fight" that teaches the concepts of entrepreneurship and business. This program has also introduced courses that involve computer technology, such as: Getting Started in Computer Science; Getting Started with Internet; and Getting Started with E-mail.

The Brazilian universities that specialize in the agricultural sciences are also currently exploring the potential for distance education. Institutions such as the Federal University of Lavras- MG[54] and Federal University of Viçosa – MG[55] offer various post-graduate courses (specialization) at a distance. Among the main courses offered, we can refer: Farming; Dairy Cattle; Management, Marketing and technology; Botany of ornamental plants and landscaping; Pharmacology; Medicinal plants: Management, use and processing; Forms of alternative energy; Animal health protection; Protection of plant varieties; and Plant protection.

On the other hand, several private sector organizations are also beginning to make available, at a low cost, hypermedia applications that are targeted to the rural sector and involve digital inclusion and environments of distance education systems. Some examples include Viçosa - MG Online University[56], and the Education Portal[57].

The way that these courses come to the website of citizenship and, consequently, to the population and contribute to the promotion of social and digital inclusion, follows a set of activities that are originated on auctions, contracts, partnerships, or public acquisitions. That is, governments (municipal, state or federal), via public notices or partnerships, hire companies and institutions (universities, institutes, foundations or similar) to develop and disseminate educational applications to meet the needs of public digital inclusion points (Pids) all over the country.

As an example, there is the electronic trading Call No. 004/2010-MC the Ministry of Communications of the Brazilian Government[29] that aimed for "recruiting firms specialized in providing educational services, for offering distance courses via the Internet at the point of digital inclusion ... the tool to access the courses will be through code printed on 'scratch' type card, to attend the Program of Digital Inclusion". In this example, the claims for main courses, or hypermedia applications, were divided into areas that included: (a) vocational preparation (500000 'Scratch' type cards - every card provides access to a course): Preparing for the labor market; Administrative practices; Secretariat; Office Assistant; and Receptionist; (b) Entrepreneurship (400000): Introduction to Entrepreneurship; Leadership; Accounting;

Finance; People Management; Personal and Professional Development; and Oratory; (c) Computer basics (500000): Windows®; Word®; Excel®; PowerPoint®; Outlook®; FrontPage®; and Project®; (d) Information Technology (600000): Introduction to IT; Web Design; Information Security and Digital Certification; (e) Social and Digital Inclusion (300000): Citizenship and management of telecenters; (f) Broadcasting (300000): Management and operation of community radio; Voice over for radio programming and production; Law and ethics; and Brazilian Systems of Digital TV; (g) Free Software (600000): Linux® and BROffice®; (h) Agriculture and livestock (500000): Administration, Beef cattle; Dairy cattle; Pasture management; Organic Farming; and Food processing; and (i) Environment (300000): Environmental management and water resources; Environmental permitting; and ISO 14001.

Therefore, the programs of digital and social inclusion began via the deployment of telecommunications infrastructure and have gone through the hiring of hypermedia applications (modeling and development) to finally reach the tools or websites necessary for distance teaching and learning (broadcast).

One key initiative of the Brazilian government is to promote the social and digital inclusion of communities and rural areas of Brazil via the establishment of Digital Houses in agricultural schools, trade unions, settlements, and communities. The Digital Houses or Digital Country Houses (see Figure 9) are community telecenters that are composed of ten computers, server, printers, Internet (broadband), and furniture.

Figure 9. Social and digital inclusion: Digital telecenters[58]

The public sector is responsible for the training of trainers and users and by content delivery, installation, and equipment maintenance. In the "Casas Digitais" farmers, students, peasants, and settlers can access information on planting, harvesting and management, public policy, developing distance learning courses, integrating virtual social networks, in addition to seeking

new markets for their products. Before the arrival of computers, the only means of communication was the pay phone - one for the whole community. This is just one example, the Digital Inclusion Map (MID) in Brazil points out programs and digital inclusion projects that are associated with social components across the country, and involve diverse sectors of society. Generally, the government classifies these projects on the number of "Deployed digital inclusion points" (PID), which can be translated as computers that are connected to the Internet[29]. Details on virtually all digital inclusion projects in Brazil are available on the Brazilian digital inclusion portal (www.inclusao.ibict.br).

5. CONCLUSIONS

Given the proposed objectives, the present work described the processes and effective practices for modeling, developing, and disseminating hypermedia applications in the rural sector. This was accomplished from a qualitative study that was based on observation and interpretation of the Digital Citizen Portal and associated with a bibliographic research involving hypermedia applications, distance learning, and digital and social inclusion in Brazil.

With respect to the phases of modeling and development of hypermedia applications, it can be said that, in Brazil, these correspond to activities performed almost exclusively by private companies and universities. From a technical standpoint, it can be suggested that, for the modeling and development of these applications, organizations use Web Engineering methods that are based on conceptual diagrams. In the present study, the use of OOHDM was associated with Flash®, Moodle®, and Scorm® technologies. It should be noted, however, that we are referring to a timely and practical study; therefore, is might not be possible to generalize the current findings, especially considering the wide range of available technologies for the development and dissemination of hypermedia applications.

The diffusion of hypermedia applications is almost exclusively made via courses offered in Web portals that are aimed at digital and social inclusion. These portals are managed by private companies but, most often, bear the imprint of public organizations or associations, cooperatives, institutes, or other types. Concerning the present work, we investigated the Digital Citizen Portal and courses targeted for the rural sector cover the areas of management, economics and rural sociology, agriculture - coffee, soybeans, corn, pastures, and livestock - beef and milk, and the environment. These courses are aimed at digital inclusion or in the area of basic computer skills with favored themes such as Windows and Linux; Internet; word processor; spreadsheet; and presentation software.

Finally, in the context of digital and social inclusion, it was observed that, in Brazil, there is an ongoing policy of digital inclusion and social development. Specifically, this policy involves the "National plan for rural telecommunications" and the "Digital territories project" whose objectives include: (a) the deployment of telephone and broadband infrastructures in all rural areas; (b) free Internet access in public schools and rural communities; (c) promoting projects and companies working in the modeling, development, and implementation of hypermedia applications; and (d) support for initiatives of distance learning and services.

6. REFERENCES

[1] Secretaria de Comunicação Social, *Brasil*. Brasília-DF/Brasil: Presidência da República, 2009.

[2] A.L. Zambalde, M.C. Neto, P.H.S. Bermejo, and A.O. Tonelli. Redes sociais da Internet no agronegócio brasileiro: conhecimento, webometria e interação. *Presented at the 6th ISTI – Information Systems and Technology Iberian Conference – 1st Workshop on knowledge management systems and social computing (CISTI 2011)*, Chaves-Portugal, June 15-18, 2010

[3] A.D. Portugal, O desafio da agricultura familiar. *Agroanalysis Journal*, 3(2004), p12-32, 2004.

[4] J. James, Mechanisms of access to the Internet in rural areas of developing countries. *Telematics and Informatics*, 27(4), p370-376, 2010.

[5] N. Manouselis, J. Najjar, K. Kastrantas, G. Salokhe, Christian M. Stracke, and E. Duval. Metadata interoperability in agricultural learning repositories: An analysis. *Computers and Electronics in Agriculture*, 70(2), p302-320, 2010.

[6] T. Zschocke, and J. Beniest, Assuring the quality of agricultural learning repositories: issues for the learning object metadata creation process of the CGIAR. *Comunications in Computer and Information Science*, 46(3), p226-238, 2009.

[7] M.J. Carrascal, L.F. Pau, and L. Reiner, Knowledge and information transfer in agriculture using hypermedia. *Computers and Electronics in Agriculture*, 12(2), p83-119, 1995.

[8] A. Salinas, and J. Sánchez, Digital inclusion in Chile: Internet in rural schools. *International Journal of Educational Development*, 29(6), p573-582, 2009.

[9] N. Dlodlo, Access to ICT education for girls and women in rural South Africa: A case study. *Technology in Society*, 31(2), p168-175, 2009.

[10] S.S. Rao, Social development in India communities: adoption of telecenters. *International Journal of Information Management*, 28(6), p474-482, 2008.

[11] L. Nielsen, C. Heffernan, Y. Lin, and J. Yu, The Daktari: An interactive, multi-media tool for knowledge transfer among poor livestock keepers in Kenya. *Computers & Education*, 54(4), p1241-1247, 2010.

[12] Buenafe Rago Abdon, *A critical Evaluation of the Status of eLearning Adoption for Agriculture in Asia*. Tsukuba-Japan: Graduate School of Life and Environmental Sciences - Tsukuba University, 2007.

[13] R. Mason, and F. Rennie, Using Web 2.0 for learning in the community. *The Internet and Higher Education*, 10(3), p196-203. 2007.

[14] E.D. Lake, and A. Pushchak, Better allocating university resources to create on-line learning environments for non-traditional students in underserved rural areas. *Innovative Higher Education*, 31(4), p215-225, 2007.

[15] A. Tzikopoulos, and C. Yialouris, Knowledge repositories for rural communities of learning. *Presented at EC-TEL 2007 – 2nd European Conference on Technology Enhanced Learning*, Crete, Greece, September 17-20, 2007.

[16] T. Nelson, A file structure for the complex, the changing and the indeterminate. *Presented at ACM 20th National Conference*, New York, USA, November 11-13, 1965.

[17] P.G. Ghiorzi, *Extensão do método OOHDM para publicação de aplicações hipermídia em Flex*. Monograph. Florianópolis-SC/Brasil: UFSC, 2008.

[18] J. Fons, V. Pelechano, O. Pastor, P. Valderas, and V. Torres, Applying the OOWS Model-Driven Approach for developing Web applications. In. *Web Engineering: modeling and implementing Web applications*. (Human-computer Interactions Series). London: British, Springer-Verlag, 2008

[19] S.L. Bianchini, *Avaliação de métodos de desenvolvimento de aplicações web*. Master Thesis. São Carlos: ICMC/USP - São Paulo, 2008.

[20] G. Rossi, and D. Schwabe, *Object-oriented Web applications modeling. In. Information modeling in the New Millennium*. USA: IGI Publishing, 2001.

[21] G. Rossi, and D. Schwabe, Modeling and Implementing Web Applications with OOHDM. *Web engineering: modeling and implementing web applications. Human-computer interaction series*. London: Springer-Verlag, 2008.

[22] S. Ceri, P. Fraternali, and M. Matera, Conceptual modeling of data-intensive Web applications. *IEEE Internet Computing*, 6(4), p20-30, 2002.

[23] A. Knapp, N. Kock, G. Zhang, and H.M. Hassler, Modeling business processes in Web applications with ArgoUWE. *Lecture Notes in Computer Science*, 3273, p69-83, 2004.

[24] Victor Lima, *Autoria em Hipermídia: o OOHDM*. Juiz de Fora-MG/Brasil: Instituto de Ciências Exatas da UFJF-MG, 1994.

[25] E. Mingione, Enterprise and exclusion. In I. Christie and H. Perry (Eds.), *The wealth and poverty of networks: Tackling social* (p25-36). London: Demos Collection, 1977.

[26] Manuel Castells, *The Rise of the Network Society*. MA/USA: Blackwell, Oxford/Malden, 2000.

[27] M. Warren, The digital vicious cycle: Links between social disadvantage and digital exclusion in rural areas. *Telecommunications Policy*, 31(6-7), p374-388, 2007.

[28] T.N. Andrew, and D. Petkov, The need for a systems thinking approach to the planning of rural telecommunications infrastructure. *Telecommunications Policy*, 27(1-2), p75-93. 2003.

[29] Ministério das Comunicações. *Inclusão Digital*. Retrieved on June 30, 2010, from http://www.mc.gov.br/inclusao-digital-mc.

[30] E. Brainin, and S. Bar-Lev, The social construction of Internet use among parents and teachers and its relation to teenagers' digital literacy. *Presented at Annual Meeting of The American Sociological Association*, Philadelphia, USA, August 12-13, 2005.

[31] M. Warschauer, Whither the digital divide? In D.L. Kleinman, K.A. Cloud- Hansen, C. Matta, and J. Handesman (Eds.), *Controversies in Science & Technology: From Climate to Chromosomes* (p140-151). New York: Liebert, 2008.

[32] M. Arancibia, and Y. Carrasco, Incorporació´n de computadores en escuelas rurales. Estudios descriptivo de cuatro casos del sur de Chile. *Estudios Pedagogicos* 32(2), p7-26, 2006.

[33] S. Cilesiz, Internet cafe´s: bridges of the digital divide. *Proceedings of Society for Information Technology & Teacher Education International Conference* (p806-808). Atlanta: GA-USA, 2004.

[34] J.R. Schement, Measuring what Jefferson knew and de Tocqueville saw: libraries as bridges across the digital divide. *IT & Society*, 1(4), p118-125, 2003.

[35] K.R. Gopakumar, E-governance services through telecenters: the role of human intermediary and issues of trust. *Information Technologies & International Development*, 4 (1), p19-35, 2007.

[36] L.A. Joia, De la inclusión a la ciudadanía digital: El desafio de países en desarrollo. In Jefatura de Gabinete de Ministros de la Nación/Fundação Getúlio Vargas (Eds.), *Diálogo Argentina Brasil sobre Gestión Pública Contemporánea* (p209-215). Buenos Aires: Proyecto de Modernización del Estado, 2007.

[37] H.F.R. Silveira, Internet, government and citizenship. *Ciência da Informação*, 30(2), p80-90, 2001.

[38] T.H. Murphy, and H.R. Terry Jr., Opportunities and obstacles for distance education in agriculture. *Journal of Agricultural Education*, 39(1), p28-37, 1998.

[39] R. Kyama, and N. Mwaura, rural internet kiosks herald last frontier in bridging Africa's digital divide. *E-Learning Africa News Service*, (3), p1-3, 2010.

[40] J. James, Sustainable Internet access for the rural poor? Elements of an emerging Indian model. *Futures*, 35(5), p461-472, 2003.

[41] J. Akeroyd, Information Management and e-Learning: Some perspectives. *Aslib Proceedings*, 57(2), p157-167, 2005.

[42] M.C. Maia, Interpretando Learning Management System (LMS) em Universidades. *Presented at IV Conferência ACORN-REDECOM*. Brasilia-DF, Brasil, May 14-15, 2010.

[43] J. Watson and K.A. Pervaiz. Learning in the age of global information technology: Development of generic architecture for an advanced learning management system. *Campus-Wide Information Systems*, 21(1), p4-21, 2004.

[44] J. Leary, and Z.L. Berge, Trends and challenges of eLearning in national and international agricultural. *International Journal of Education and Development using Information and Communication Technology*, 2(2), p51-59, 2006.

[45] André Luiz Zambalde, *O ensino a distância e o agronegócio na sociedade da informação: diagnóstico e perspectivas (Draft)*. Lavras-MG/Brasil: Agrosoft, 2006.

[46] Flash, *Adobe Flash Professional CS5*. Retrieved on October 25, 2010, from http://www.adobe.com/products/flash.

[47] Moodle, *Moodle – a free, open source course management system for online learning*. Retrieved on July 12, 2010, from http://moodle.org.

[48] Scorm, *Advanced distributed learning*. Retrieved on December 08, 2010, from http://www.adlnet.gov/scorm/index.cfm.

[49] Carlos Fernando Jung, *Metodologia para pesquisa e desenvolvimento: aplicada a novas tecnologias, produtos e processos*. Rio de Janeiro-RJ/Brasil: Axcel Books, 2004.

[50] Eva Maria Lakatos and Marina de Andrade Marconi, *Metodologia científica*. São Paulo-SP/Brasil: Editora Atlas, 2008.

[51] R. Oliveira, A.L. Zambalde, R.M. Alves, S.A.C. Gomes, Uso do modelo OOHDM para a construção de aplicação de ensino para o setor a agropecuária. *Revista brasileira de agroinformática*, 4(1), p47-64, 2002.

[52] Estudar, *Projetos e Cursos de EAD e Cartão do conhecimento*. Retrieved on October 20, 2010, from http://www.estudar.com.br.

[53] Senar, *Serviço Nacional de Aprendizagem Rural*. Retrieved on June 30, 2010, from http://www.canaldoprodutor.com.br.

[54] Ufla-Faepe, *Universidade Federal de Lavras – Fundação de Apoio ao Ensino*. Retrieved on July 3, 2010, from http://www.openufla.com.br.

[55] UFV, *Universidade Federal de Viçosa*. Retrieved on October 22, 2010, from https://www2.cead.ufv.br/cead/scripts/curso.php.

[56] Cpt-Uol, *Centro de Produções Técnicas–Universidade On-line Viçosa*. Retrieved on July 18, 2010, from http://www.cpt.com.br/cursos-online.

[57] Portaleducação, *Portão educação – cursos*. Retrieved on August 22, 2010, from http://www.portaleducacao.com.br.

[58] Agropolos, *Instituto Agropolos do Estado do Ceará – Brasil*. Retrieved on October 30, 2010, from http://www.institutoagropolos.org.br.