



Tecnologias de Educação a Distância e o desenvolvimento de Competência Tecnológica: um estudo de caso em uma Instituição de Ensino Superior

Technologies for Distance Education and the Development of Technological Competence: a Case Study in an Institution of Higher Education

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ABSTRACT

The introduction of new technologies to the educational process, especially virtual learning systems used through the web, is enabling Distance Learning (DL) to become more interactive, bringing a new way of thinking and analyzing and continuously improving the quality of education. This study aims to understand the development of technological competence in DL from the perspective of technology as a practice (ORLIKOWSKI, 2000, 2007) and of competence as a practice (SANDBERG, 2000; ORLIKOWSKI, 2002). It is assumed that the development of technological competence in DL is a recurring and iterative process, in which competence is developed through interaction between agents and artifacts. The analyzed case is a publicly held Brazilian Institution of Higher Education (HEI) with approximately 145,000 students in distance education centers throughout Brazil. Interviews were conducted with DL managers, developers, teachers and tutors to capture their varied views about the process of technology use and the development of technological competence. The research shows that the dynamics of introducing this new type of education has promoted changes in the competence of both the institution and the professors.

KEYWORDS: TECHNOLOGICAL COMPETENCE, DISTANCE EDUCATION, TECHNOLOGY IN PRACTICE, COMPETENCE IN PRACTICE, INSTITUTION OF HIGHER EDUCATION

RESUMO

A introdução de novas tecnologias no processo educacional, notadamente os sistemas virtuais de aprendizagem via web, vem possibilitando que a Educação a Distância (EAD) se torne mais interativa, trazendo uma nova forma de pensar e analisar e de aperfeiçoar continuamente a qualidade do ensino. O presente estudo tem como objetivo compreender o desenvolvimento da competência tecnológica em EAD a partir da perspectiva da tecnologia como prática (ORLIKOWSKI, 2000, 2007) e da competência como prática (SANDBERG, 2000; ORLIKOWSKI, 2002). Parte-se do pressuposto que o desenvolvimento da competência tecnológica em EAD é um processo recorrente e interativo, em que a competência é desenvolvida na prática por meio da interação entre agentes e artefatos. O caso analisado é de uma Instituição de Ensino Superior (IES) brasileira de capital aberto que conta com aproximadamente 145 mil alunos nos polos de EAD em todo o Brasil. Foram realizadas entrevistas com gestores, desenvolvedores, professores e tutores de EAD, de modo a captar diferentes visões acerca do processo de uso da tecnologia e desenvolvimento da competência tecnológica. A pesquisa mostra que a dinâmica de introdução dessa nova modalidade de ensino promoveu mudanças tanto sobre a competência tanto da instituição quanto dos professores.

PALAVRAS-CHAVE: COMPETÊNCIA TECNOLÓGICA, EDUCAÇÃO A DISTÂNCIA, TECNOLOGIA NA PRÁTICA, COMPETÊNCIA NA PRÁTICA, INSTITUIÇÃO DE ENSINO SUPERIOR

1. INTRODUCTION

In the context of increasing globalization and technological advance, provided mainly by communication through the web, Institutions of Higher Education (HEI) are forced to develop new alternatives for distance learning (DL), requiring the highest level of information reliability, to define their strategic positioning (FORTE, SOUZA & OLIVEIRA, 2009; NETO & TAKAOKA, 2009; MOORE & ANDERSON, 2003; TEIXEIRA, MOURA, GONÇALVES & BARBOSA, 1998).

The following research question guides this study: How has the use of distance education technologies promoted the development of technological competence in HEI?

The answer to this question is the main objective of the study. For this purpose, technology is viewed as a practice (ORLIKOWSKI, 2000, 2007), in which technology is created and changed by human action in the exercise of organizational practices (FELDMAN & ORLIKOWSKI, 2011), and competence likewise is viewed as a practice (SANDBERG, 2000; ORLIKOWSKI, 2002). Under this perspective, technological competence is identified in action, from the articulation among artifacts, agents and practice, with the development of competence being a cyclical process because information always moves between human agents and the technology itself.

As specific objectives, this study sought to i) identify the DL technologies used by the Institution of Higher Education; ii) understand the competences of the agents involved in the development and use of DL technology, in terms of knowledge, experience and abilities; iii) examine the DL practice upon the introduction of technology, in terms of training and adapting to changes; and iv) analyze the impact of the use of technology in the development of technological competence in terms of teacher qualification, teaching content and market share.

The research is based on a case study, with the analyzed case being a publicly held Brazilian HEI with approximately 145,000 students in DL centers located throughout Brazil. The primary data were collected from DL experts and developers, users (teachers/tutors) and HEI managers. In addition to the primary data, secondary data from the investors' report published by the institution itself in the last quarter of 2012 were also used.

The article is structured in five sections, the first being this introduction. In section 2, a discussion on technology and technological competence and the theoretical model proposed for the study of technological competence in DL is presented. In section 3, the methodological procedures are presented. Then, in section 4, the analysis and discussion of the data are presented, and finally, in section 5, the conclusion.

2. TECHNOLOGICAL COMPETENCE IN DISTANCE EDUCATION

Technological competence is composed of tangible and intangible technical resources (production facilities, engineering and knowledge) and procedures for quality control, and once developed, it can be used to provide various services and applied to different markets (DANNEELS, 2007).

For many authors, technological competence is defined as a part of organizational competence. According to Helfat *et al.* (2007), organizational compe-

tence involves a set of differentiated technological competence, complementary assets and organizational routines and capacities that provide the basis for the competitiveness of a company in one or more businesses.

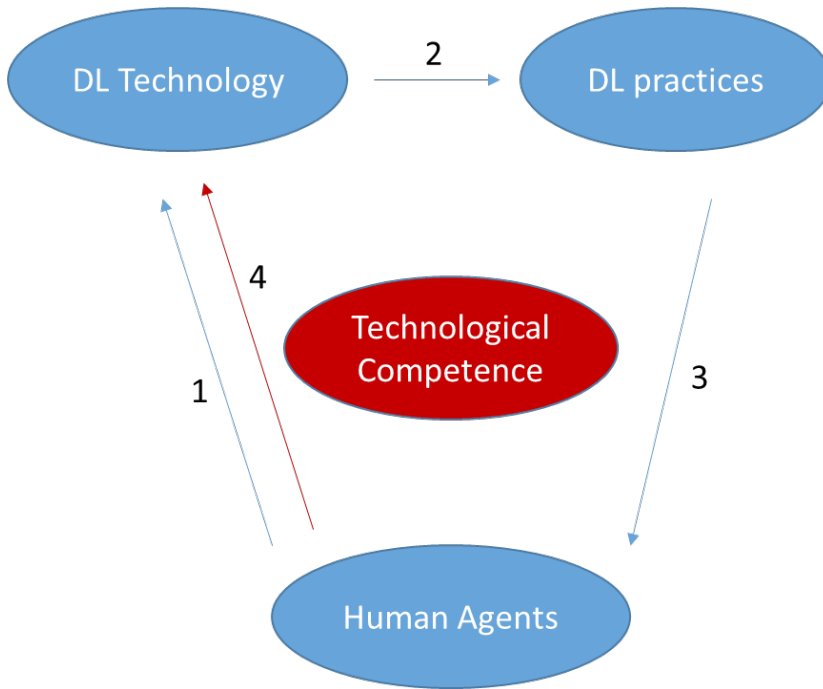
This paper considers technological competence to refer to common pieces of scientific and technological knowledge and related routines (CORIAT & DOSI, 2002) because organizational knowledge is not only embedded in the minds of the members of the organization but also in a) a set of routines, other organizational practices and shared representations and b) a set of material artifacts that shape the intra-organizational relationships and individual behaviors (COHEN, BURKHART, & WINTER, 1996). In this regard, technological knowledge can be organized and explored by various organizational and coordination arrangements.

The view of technology proposed by Orlikowski (1992, 2000, 2007) is considered, in which human agency plays an important role in both technology design and its use. In Orlikowski's view, technology is socially constructed by actors working in a given social context and is developed through the different characteristics and meanings that actors ascribe to it (interpretative flexibility). It is the continuous action of the human being, acting habitually, that objectifies and institutionalizes technology (ORLIKOWSKI, 1992).

Technology is therefore influenced by human action, creating unexpected results in relation to the original purpose (LABATUT, AGGERI & GIRARD, 2012). Therefore, to better understand the dynamics of the development of technological competence, it is necessary to examine the interaction among technology, routines, execution of actions and the way new practices are institutionalized.

In this study, technological competence is identified in terms of action, and its development is cyclical because information always passes through human agents and technology itself, resulting in a recurring process of development of technological competence. In the proposed model (Figure 1), technological competence in DL consists of three pillars: artifacts (DL platform), human agents (developers, managers and users) and practices involving the use of the technology. The cycle begins (phase 1) with the design of technology by managers and developers. Then (phase 2), the technology is employed by users (professors/tutors) in DL practices. The practices experienced by the group (developers, managers and users) will be integrated into the set of competences of the group itself (phase 3) and will also influence the development of the technology itself, iteratively changing the original project (phase 4). This recurring interaction among technology, human agents and practices influences the development of the technological competence of the organization, which is therefore the result of this cyclical process.

FIGURE 1. MODEL OF THE DEVELOPMENT OF TECHNOLOGICAL
COMPETENCE



The focus of this study is the technological skills linked to the use of distance learning technologies (DL). DL is a form of organized learning and requires special techniques for course creation and instruction. Its communication occurs through various technologies, in addition to a special organizational and administrative arrangement (MOORE & KEARSLEY, 2011).

The beginning of a DL project implies the choice of the Virtual Learning Environment (VLE) or LMS (Learning Management System) (FERNANDES *ET AL.*, 2010). It is also known as distance learning platform, a web space related to the organization of courses and disciplines, content management and monitoring of students (BEHAR *et al.*, 2013) based on pedagogical assumptions (MACHADO, LONGHI, & BEHAR, 2013). It aims to amplify the administration of courses and assist students in individual planning of the learning process, and enable the exchange of information and knowledge (MAIA, 2012).

There are several LMS platforms in use. A widely adopted is the Modular Object-Oriented Dynamic Learning Environment (Moodle), which is an

open-source system created in 1999 by the webmaster Martin Dougiamas at Curtin University of Technology in Australia, and its advantages include its availability and adaptability to the needs of the institution (FERNANDES *ET AL.*, 2010; SANTOS, 2012).

According to a recent study by Clarence *et al.* (2013), more than 19 platforms are in use. In Brazil, the most widely used platform is Moodle. Generally the courses available in Moodle belong to closed communities and are associated with the qualification program.

Today there are new virtual learning environments as the Massive Open Online Course (MOOC). Mooc can be defined as a model that integrates three elements: connectivity of social networks, the knowledge of an expert in a particular area and the collection of open online resources (MATTA & FIGUEIREDO, 2013). One of the teaching resources used are the videos, with duration of 20 minutes. These video lessons show the slides with the dialogues and teacher explanations, always instructed in English, with subtitles in English (MATTA & FIGUEIREDO, 2013).

In addition to the VLE, it highlights the use of learning objects, defined as any digital material (video, sounds, animations, etc.) that have educational purpose, i.e. a pedagogical basis, divided into 3 categories (MACHADO *et al.*, 2013):

- Simple: little user interaction with the object (i.e. text).
- Intermediate: limited interaction, a source of information (i.e. video).
- Complex: provides an interaction and greater user interactivity with the object (i.e. portals).

The choice of learning objects is made by the trainer and the manager who should choose one that will bring more meaning to student learning (MACHADO *et al.*, 2013).

One way to have a more interactive class is the satellite that has the service capacity of thousands of students simultaneously in different regions, with the possibility of reaching municipalities that did not have traditional educational institutions. In this model, classes are live, with the presence of present tutor, which performs complementary activities in the classroom, and tutor the distance, connected via the Internet, with students present in several classrooms, separated by panels of up to 50 students.

Transmission is via satellite, from a generation or studio room, with the possibility of communication through image, video, audio and data. The author states that this method facilitates synchronous interaction through the posting of questions and participation via chat or voice, ensuring interactivity between students and teachers and brought important development and expansion of the supply of

distance learning courses, especially higher education.

In short, there are three main technologies that support distance learning: virtual learning platforms, learning objects and the support infrastructure to DL, such as recording studios and satellite transmission, storage and clouds in data processing, etc.

Last but not least, whatever the technology used (educational TV, video conferencing, teleconferencing, audio conferencing, video - class, computer, computer networks and others) and the media used in a distance education program (software, printed materials, radio, TV, Internet, CD-Rom.), it requires a special attention to the pedagogical model adopted, which should be made explicit in the planning of DL program and strategies of didactic action employed.

3. METHODOLOGICAL PROCEDURES

This study adopted a qualitative research approach (NOGUEIRA-MARTINS & BÓGUS, 2004) of exploratory and descriptive character (DIEHL & TAHTIM, 2004). The strategy chosen for this work is a single case study.

The analyzed case is one of the largest publicly held HEI of Latin America and the world in terms of the volume of students. In 2012, the institution had approximately 145,000 students throughout its DL centers. There are several teaching units, located in all Brazilian states and the Federal District.

Distance education courses, both undergraduate and postgraduate (specialization programs and courses designated as MBA - *Master in Business Administration*, usually lasting 12 months), include the areas of management, law, health and education.

The data collection in this study was done through the year of 2012 based on the analysis of documents and interviews. The document analysis was based on information available on the University website and the investors' report of the 4th quarter of 2012, which is available on the Internet, as the HEI is a publicly held company.

The interviews were based on a semi-structured questionnaire covering the following aspects: i) technology used for the provision of DL; ii) competences necessary for the development and use of the new technology (developers, professors and tutors); iii) changes in the teaching practices; and vi) impacts on the technological competence of the HEI.

Eight interviews were conducted in total, as follows: 01 interview to validate the semi-structured questionnaire with a specialist in DL management in HEI; 02 interviews with experts in the DL market in HEI (01 expert in DL

team management in HEI and a member of a DL association; 01 specialist in DL environment development in HEI); and 05 interviews in the surveyed HEI (01 Coordinator of a center; 01 General Coordinator with experience as a DL professor and content development professor; 01 Developer of Virtual Learning Environment; 02 Classroom Tutors).

The data analysis procedures followed the model of textual analysis proposed by Flores (1994), considering the theoretical framework and the information gathered in the interviews with members of the DL staff of the institution.

4. ANALYSIS AND DISCUSSION OF DATA

The data analysis presented below is based on the research objectives, which are based on a conceptual model in which the interaction among technology, human agents and practices influences the development of the technological competence of the organization, which is therefore the result of this cyclical process. First, the technology used and the competences of the agents involved in the development and use of DL, in terms of knowledge, experience and competences, are presented. Then, the practices developed upon the introduction of DL in terms of training and adaptation to change are analyzed. Finally, the impact of the use of technology on the development of the technological competence of the institution in terms of professor qualifications, taught content and market share is analyzed.

4.1 TECHNOLOGY IN DISTANCE EDUCATION

The Brazilian Association for Distance Education (Associação Brasileira de Ensino a Distância - ABED) states that though there are many possible definitions, there is a minimum consensus around the idea that DE is a mode of education in which the teaching-learning activities are developed mainly or exclusively without students and teachers being in the same place at the same time (ABED 2012).

In addition to content exposition, digital technologies have provided interactivity, collaboration and cooperation, requiring from managers and users (professors, tutors, students) a set of competences related to the use of technological resources (MACHADO *et al.*, 2013).

It is emphasized that designing a DL model must be executed with great

care, as it involves assorted concerns that must be considered from the start so that the service can be provided with quality and effectively contribute to the outcome of the HEI and so that the investment is made correctly because the costs for the entire DL structure are both high and constant. The analysis of the HEI should consider the following:

1. The acquisition, or not, of centers;
2. The costs of the whole studio apparatus and other technologies;
3. The availability of a web or satellite transmission system.

In the case studied here, the technology adopted for DL is an open platform (Moodle), which requires greater involvement of agents to customize it. However, it was observed that the technology of distance learning is not restricted to the virtual platform but includes other means of communication and storage of information, such as CDs, DVDs and printed material. As observed in Table 1 below, in addition to Moodle, the HEI has also invested in a broad structure of physical hardware and software for implementing DL, such as Internet and satellite transmission infrastructure, recording studios, physical spaces in regional centers and datacenters. In terms of people, the institution involved a large multidisciplinary group of professionals in the design and implementation of the DL draft, including the Information Technology, Management and Pedagogical areas. These professionals all have different competence profiles, as shown below.

TABLE 1. STRUCTURE OF HARDWARE, SOFTWARE AND STAFF IN THE IMPLEMENTATION OF A DL SYSTEM

HARDWARE and SOFTWARE	STAFF
Satellite broadcast system; Internet and optical fiber	- DL professor: gives live classes (via satellite or internet) - Content professor: produces the content of the discipline
Recording and audio and video editing studio	- Editing studio staff (audio and video compilation)

Virtual learning environment (Moodle); Datacenter and information security (antivirus and backup)	<ul style="list-style-type: none"> - IT staff - responsible for the platform - Educators: translation of the pedagogical contribution and the digital environment - Reviewer: adaptation of the language to the digital environment. - Online tutors (student contact through the VLE)
Centers - where students attend classes in semi-presence	<ul style="list-style-type: none"> - Support staff at the centers (office/technical support) - Classroom tutor

4.2 AGENTS

DL technology requires the training of agents, as they need to learn the technology and the educational process, even if at different depths. The advent of the studio requires new competences for the professor who will teach the classes at distance, in addition to the need for a support team at the studio and at the centers.

In the studied case, everyone involved was trained regarding the technology, the educational process and DL legislation. There is a training program for professors and staff using DL tools. The students also receive training because many had no contact with this type of technology before enrolling in the DL course.

The entire learning process contributes to the development of technology because users learn as they use the technology and change the technology through that use, as indicated in the conceptual model. On the other hand, the new technology stimulates the development of new competences for the professionals involved in this process as they adapt to this new scenario.

Table 2 highlights the competences that were developed by the agents due to the introduction of DL technologies in the studied case. For the developers, it is noted that, beyond the initial competences in the area of information technology (dimensioning of the hardware and software structure), there was a development of competences in the educational area (connected to mediation among the professor's didactic production, the web designer and specialized companies). The manager had the new challenge of following, training and interacting with his team members while physically located in different places. The professors, in turn, beyond the minimum training in DL, have developed new teaching competences, such as dialogic writing. Moreover, DL has raised the need for use of interactive tools that were not previously employed, such

as video, images and social networks, which promoted the development of technological competences. This combination of competences has caused the DL professor to develop ways of managing his most complex classes.

TABLE 2. COMPETENCE OF THE AGENTS INVOLVED IN A DL SYSTEM

AGENTS	COMPETENCE	DEVELOPED COMPETENCE
DEVELOPERS	- Have training in Information Technology (IT)	- Improve the concept of the project.
	- Know how to dimension the hardware and software structure considering the volume of users who will use the tool.	- Understand the concept of education, the whole educational process, its importance and specific aspects such as DL legislation.
	- Learn the best way to ensure the safety of the system, ensuring the confidentiality of information.	- Learn to mediate among the professor's didactic production, web designer and specialist companies.
	- Know the server, database, web systems technology and the development of specific systems for the Internet.	
MANAGERS	- Have an entrepreneurial and dynamic profile.	- Have the ability to manage the relationships and interaction between the people involved in the academic tasks, bridging the gap between the educational area and the technical area.
	- Have a multifaceted view: consider the interaction and conflicts of the various areas involved in the learning process.	- Have knowledge of DL technologies

PROFESSORS	- Complete the training course for DL professors.	- Develop writing, which must be dialogical, ensuring the process of communication with the DL student.
	- Have training and mastery in the content of the discipline.	- Learn to use social networks and interactive tools.
	- Achieve a minimum knowledge level of DL technology.	- Learn to give lessons in the studio.
		- Learn to make the link between content and reality, manage the available knowledge in an organized way and encourage collaborative learning.
TUTORS		- Know the DL technology and the various forms of interaction with the student.
		- Have training in the content of the discipline.
		- Know the students' profile.
STUDENTS	- Be organized and disciplined.	- Know how to organize a routine of self-study.
		- Know the DL technology.

4.3 ORGANIZATIONAL PRACTICES AND IMPACTS

The introduction of technology in the education sector has brought changes in teaching practices, changing the role of the professor as he needs to engage with his students without being in the same physical space. Not only the professor but also all users have had their activities changed, in addition to new functions that have arisen with DL, such as tutors and the instructional designer.

Table 3 describes the practices that have arisen with the use of the new technology. Developers began to attend DL communities and events and to use project management tools to monitor the evolution of the platform. In the same vein, the management approach developed practices for interacting with and monitoring the DL team because the team is spread all over the country and because the content must be delivered with the same quality in different locations for students from different backgrounds. From the point of view of

the professor, the new technology has contributed to reflection on the course content and on how to present it, write it and make it more dynamic. At the same time, some of traditional practices for monitoring the students' activities must be performed by the tutors. The students' practices have also changed because they need to learn the routine of self-study and access the information before the classes given by the professors, in contrast to the practice of classroom teaching, in which the students predominantly engage only in the practice of daily attending classes. An environment of active learning is created, where the content is built collaboratively by the interaction between professors, tutors and students.

In addition to changes in individual practices, the process of DL implementation in HEI required adapting the entire organization, from the point of view of resources and processes and in relation to its own culture. The creation of a new area within IT (called Web DL) is noteworthy, with its own concepts and techniques and the creation of a formal system of suggestions systematized for monitoring the development of DL. The management becomes centralized, as the professionals who work in DL courses can be located in any region of the country, and the coordination of this structure must be well organized so that the course is uniform and of consistent quality, regardless of the center the student attends.

From a cultural standpoint, despite initial prejudices, it was noted that DL now has as much prestige as classroom learning. As noted in the interviews, the institution has been constantly investing a large amount of resources in DL technology and replacing classroom courses with courses in DL mode.

TABLE 3. DL PRACTICES

AGENTS	PRACTICES	NEW PRACTICES
DEVELOPERS	<ul style="list-style-type: none"> - Provide information on technological interfaces. - Develop software. - Design the hardware structure. 	<ul style="list-style-type: none"> - Present information in a more intuitive way (understandable for users). - Adapt the content created by professors to appropriate language for the Internet. - Attend DL communities and events. - Use a project management tool to monitor the progress of the platform.

MANAGERS	<ul style="list-style-type: none">- Assign professors to subjects/classes.- Monitor the staff, the students and the progress of the course using the available reports on DL technology.- Ensure that technological resources are optimally utilized and that the learning process takes place effectively.- Track the content provided.	<ul style="list-style-type: none">- Promote meetings between the DL and unit coordination to analyze the progress of courses or request new features.- Promote meetings between the DL coordination and the Information Technology Manager to ensure that the requirements of the unit will be handled by the platform.
PROFESSORS	<ul style="list-style-type: none">- Produce content.- Guide the student correctly.- Present classes.	<ul style="list-style-type: none">- Use the mediation resources (replacing information on paper with digital information).- Write in a dialogic form, creating a dialogue between the student and the professor through the didactic material and ensuring the learner's autonomy.- Guide tutors and classroom tutors at a distance, synchronizing goals.- Constantly update their information on the process and the technology itself.- Promote more elaborate and enriched classes, considering students from different regions.- Make the link between content and real life.

TUTORS	<ul style="list-style-type: none"> - Apply the content and contextualize it considering the characteristics of DL students. - Monitor the transmission. - Resolve questions that arise during class or through student contact via VLEs. - Provide technical and pedagogical feedback (describe the impressions on the technology, the professor, and the student) - Monitor student performance and evaluate the content taught. - Implement activities and ensure the achievement of the objectives of the subject, as described by the teachers. - Study the theoretical reading and understand the key concepts before attending class broadcast via satellite.
STUDENTS	<ul style="list-style-type: none"> - Attend daily classes with a fixed schedule.

The changes caused by the DL practices have affected the professor's qualifications and the content taught as well as the market share. As a result, the institution has hired new employees and created new classes to accommodate the increased number of students enrolled.

5. CONCLUSION

The overall objective of this research was to understand the relationship between the use of distance education technologies and the development of the technological competence of the HEI from the interactions among artifacts, agents and practice.

The analysis of the studied case reveals that the modality of distance education has impacted various areas of the institution and contributed to the emergence of new practices and roles for the agents, which directly contribute to the development of the HEI's technological competence.

The various professionals involved have had to change their practices. The professor had to rethink the way he acts and interacts with his students and staff. The managers had to find new ways to coordinate teachers and tutors

located in various regions of the country. The developers had to consider pedagogical aspects in the evolution of software platforms.

The whole process of learning and adaptation improved the technology itself and brought greater dynamism and flexibility to the educational process. The platform created in early 2009 has been entirely changed since; in addition, through contact with the technology, the team's thinking has also changed, and numerous customizations were made to provide a better DL service.

This cyclical process of developing technological competence in DL is constant. Accordingly, future studies are proposed to monitor the unfolding of the combination of agents, artifacts and technology in the development of technological competence of the studied HEI.

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