

Knowledge conversion in VLEs: metrics to detect the SECI process in an e-learning course

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ABSTRACT

The knowledge-creation and knowledge-management literature of the late twentieth century can provide insights also for online learning studies. Indeed, a process of learning is an active process of knowledge construction made by the learners' community, in which each actor gives a specific contribution to knowledge development in the community. The responsibility of the learning process does not rely only on individuals, but on all the members of the community: everyone contributes in making knowledge available to others.

This is true also in virtual learning environments. In these contexts, the teacher gives information and background knowledge on a specific topic. Knowledge is then shared among participants through technical instruments, such as discussion forums, in order for them to create new knowledge.

The aim of this paper is to analyse the SECI process in a Virtual Learning Environment (VLE), to show the stages that provide knowledge conversion, but also knowledge creation and sharing.

To this aim we provide a framework based on SECI and some metrics to identify the SECI phases in a VLE course.

Keywords: Virtual Learning Environment, SECI, Knowledge Conversion

1. INTRODUCTION

Today's competitive scenarios are characterized by an increasing complexity and impose the need to acquire new knowledge quickly: knowledge has become a new strategic lever in any context. To generate a competitive advantage, knowledge must be shared within the organization, through interactions and exchanges of information, experiences and practices among groups with common interests and objectives. Moreover, new knowledge needs to be created through a dynamic process, which involves people, structures, resources and the external environment.

According to [15], new knowledge is created and shared through the continuous interaction between tacit and explicit knowledge, in a process made up by Socialisation, Externalisation, Combination, and Internalisation (SECI). This interaction creates a growing spiral, which begins at the individual level, and then moves to a collective one, in some cases going beyond the organisational boundaries.

One of the main contexts in which knowledge is very important is the learning environment. [25] states that quantitative and qualitative tools and techniques of knowledge creation and sharing can be applied in learning environments. In this paper we show how the SECI process develops in a VLE, providing some metrics to identify its phases in a virtual community.

2. THE SECI MODEL

Knowledge management literature has provided, over time, many definitions of "knowledge", ranging from practical definitions to philosophical up to conceptual ones. In this study we do not focus our attention on "what knowledge is", but rather on what helps learning, as a part of the process of creation and sharing of new knowledge, to occur.

Knowledge has two components. Tacit knowledge is highly personal and hard to formalise, it is an in-head, unspoken background knowledge that can be difficult to transfer [18]. Besides, explicit knowledge is structured and codified knowledge, which can be articulated in formal language and is easily transferred [13], [14].

According to [16], explicit and tacit knowledge are not completely separate entities, but they are mutually complementary.

The well-known SECI model, proposed by the same authors describes how explicit and tacit knowledge is generated, transferred, and recreated in organisations. The basis of this dynamic model of knowledge creation is that human knowledge is created and disseminated through social interactions between explicit and tacit knowledge. More specifically, the SECI model consists of four modes of knowledge conversion: Socialisation (tacit to tacit), Externalisation (tacit to explicit), Combination

(explicit to explicit), and Internalisation (explicit to tacit). Through the conversion process, tacit and explicit knowledge expands in both quality and quantity, making a spiral, rather than a circle. The spiral starts at the individual level and becomes larger and larger in scale, expanding as it moves through communities of interactions, which transcend sectional, departmental, divisional and even organisational boundaries [16].

To understand how to create a knowledge dynamics it is important to underline another element of the SECI process: the *Ba*, i.e. the shared context. Knowledge needs a context to be created: “there is no creation without place” [5]. *Ba* does not necessarily mean a physical place, rather it is a space in which there is “interaction”, so information can become knowledge.

“Knowledge is created through the interactions amongst individuals or between individuals and their environments, rather than by an individual operating alone” [17].

In a VLE it is possible to find all these elements. Indeed, in a VLE individuals with private background knowledge interact on specific topics in a space made up in order to provide a context for shared information. In this way, knowledge can convert in its various components, flowing from an individual level to a group level and creating new knowledge for the whole community.

3. SECI AND ITS RELATIONSHIP WITH E-LEARNING

E-learning is certainly the major innovation in training of the last twenty years. Differently from the previous forms of distance learning, e-learning bases its effectiveness on the extent of the communication at the disposal of participants, thanks to the use of Internet [2].

Indeed, a process of learning is something more than following a training course: it is a continuous process, which takes place not only in the “consumption” of knowledge, but also in the production of new knowledge [19]. In an e-learning course each learner develops his own interpretation of reality, starting from his own wealth of knowledge and experiences, and from the fruition of the educational contents made up by the instructor [3]. Nevertheless, the highlight in the learning process is given by the comparison, produced by social interactions, among the learners’ meanings, which generates a more shared, rich and realistic interpretation of data [10]. Moreover, students appreciate very much structured online discussions, as they provide opportunities for interactions and socialisation with other students and allow the development of a feeling of inclusiveness in the course [4]. Therefore, e-learning is an active process of knowledge construction made by the learners’ community, rather than a process of instruction directed by the teacher [7].

The development of ICT and of the Internet has fostered the use of e-learning systems. Nonetheless, the great potential of VLEs in education has not been fully exploited yet. This is due to the fact that in most cases the introduction of e-learning systems in education has not been followed by a parallel development and setting of new teaching models, i.e. new ways of organising learning materials, interactions between teachers and students, and so on. Instead, aligning teaching models to the VLE can better support the creation and diffusion of new knowledge in the virtual classroom and, therefore, it can improve educational performance.

In this paper we develop a framework to identify the four SECI phases in VLEs and some metrics to detect them, highlighting some characteristics of the learning process and the specific

contribution brought by each actor to knowledge development in the VLE community.

In order to develop our framework, in particular, we have considered what generally happens in an e-learning course. E-learning courses are provided completely online, using some platforms to share learning objects and to communicate with learners. Generally, the communication network of the course can be analysed taking into consideration the specific technological tools at the disposal of participants, such as chats and videoconferencing. However, these tools can convey synchronous, rather than asynchronous, communication. Asynchronous tools for communication in an e-learning course are forums, that make it possible to track discussions among participants, highlighting:

- the temporal evolution of discussions, thanks to the recording of the timing of each message;
- the dynamics of interactions, thanks to the tracking of the author and responders of each message;
- the content evolution of discussions, thanks to the organization of messages into thread.

According to [13], [14] SECI model, [16] concept of ‘*Ba*’ (as the foundation of knowledge creation), and the learning theory literature [2], the primary requirement for a learning process to develop is establishing a learning environment with a free and voluntary socialisation mechanism, for example through the use of discussion forums. This style of forum management allows the teacher to create an active learning process, involving both learners and himself. Therefore, it would be advisable for that each lesson the teacher opens several threads and encourages learners to participate in them and to add other threads, based on their own interests, experiences, and curiosities on the topics of the course.

4. A FRAMEWORK TO IDENTIFY THE SECI PROCESS IN VLEs

Several studies have investigated the relationship between KM and education [4]; [27]; [22]. In particular, [22] suggested that KM can be used to capture, organise, and deliver knowledge within management systems and can therefore be an effective tool for educational training. However, a concrete way, a framework or some metrics to apply the SECI process in VLEs has not yet been proposed.

To examine knowledge creation process, this study adopts the SECI model for a main reason: the SECI model contains not only knowledge transfer but also knowledge creation. The transfer of existing knowledge and the creation of new knowledge are of major importance in VLEs. Moreover, the SECI model has been widely used in many research areas, such as organisational learning [17].

This paper outlines an approach to determine some metrics to detect the phases of the SECI process in collaborative VLEs.

Our framework is based on the analysis of the processes of knowledge development and social learning.

In our opinion, deep learning originates from within a social context. The first step for deep learning to develop is setting up the proper environment for discussions amongst peers and teachers to take place. In this environment an externalisation of in-head, tacit knowledge can happen, followed by a combination of this now-explicit information with personal background experiences and knowledge (either already existing or promoted by scaffolding mechanisms, such as simulation modelling or experiential learning). Finally, there is an internalisation and deep appreciation of the new information as knowledge [4].

We have named this representation ESECI. It is shown in figure 1. The necessary steps for knowledge creation and sharing are described below.

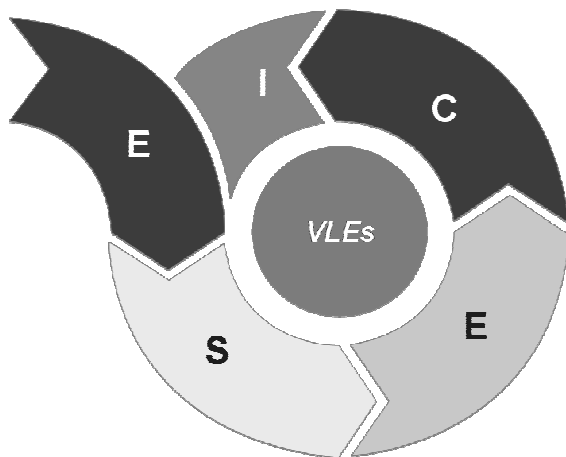


Figure 1 SECI model adapted to the context of e-learning:
ESECI

4.1. Environment

To study the SECI process in a VLE it is very important to build a learning community where individuals are not frightened nor threatened, and where discussions and assessments are moderated by someone who is trusted by the participants. In traditional classrooms, face-to-face contacts among students and between students and the lecturer create a social environment (the Ba) in which information and knowledge can flow. In online education, face-to-face contacts among participants might be infrequent or even totally lacking. Therefore, it is necessary to find other ways to create the proper environment. The software platform at the disposal of teachers and learners is the “physical” space in which participants can meet, but the proper social environment has to be created by using mechanisms that actively encourage online socialisation. In this way deep learning can develop [4], [26], [12].

Moreover, the lecturer must encourage the discussion among students, and he himself has to participate in it in a non-judgemental manner. At the same time the teacher has to moderate the discussion to keep it on track.

The first phase of our framework is to define metrics for VLEs to measure the “quality” of the learning environment.

The communication flows in an e-learning course can be represented through a social network, whose characteristics can be analysed by applying basic techniques of Social Network Analysis (SNA). Several studies have set that a social network is a central element in collaborative learning environments ([9]; [8]). Indeed, the goal of the analysis of social networks is to study the patterns of relationships that connect the actors within social systems, how these models affect the behaviour of the flow of resources conveyed by those connections, and also the manner in which social actors, through these same connections, help to change the overall network structure [21].

There are several measures of SNA that can show the impact of collaboration on learning within the network. Network properties such as centrality and density are employed to explain interactions among group members and the structure of interpersonal communication in the network [6], [28].

Centrality, referring to the connection of one member (vertex) in the network with other members (vertices), can be measured by the number of vertices to which a particular member is adjacent. In online discussions, centrality can be seen as the connections or interactions of one member with others. Often the teacher holds a central position in the network.

Density is a measure of the cohesion of a network and describes the general level of linkage among vertices in a social network. The network density is defined as the number of lines in the network divided by the maximum number of all possible lines [23]. Maximum density is found in a complete simple network (when all vertices are directly connected). The density value of a network varies between 0 and 1. Density provides information on the degree of connection and robustness of the network. The extent of collaboration within a forum is its degree of cohesion, which describes the level of relationships of the actors in the network. As active cooperation among people in the forums increases, the graph representing the social network becomes more cohesive. Moreover, it is important to check if there are some singletons, i.e. some persons who are not reached by any other person in the network. High values of density and centrality and a low number of singletons attest for an environment with high socialisation among students. The possibility to have frequent interactions and a high level of closeness between the parties involved in the process of learning promotes the exchange of knowledge and experiences.

Having outlined an approach to the definition and measurement of the environment characteristics in which the students interact, we propose some indicators for the four phases of SECI in a community of practice. We will start from socialisation.

4.2. Socialisation

Socialisation is the process of converting tacit knowledge into tacit knowledge through interaction and sharing of experiences among individuals. Since tacit knowledge is difficult to formalise it can be acquired by sharing experiences with the source of knowledge. [15] affirmed that “individuals’ tacit knowledge could be acquired and transferred better through observation, imitation, and experience-based practice than formal language-based conversation”.

According to [24], tacit knowledge cannot be measured directly. Indirectly, however, it can be assessed by measuring the socialisation process. The process of knowledge development in a community is strongly influenced by the level of collaboration among its members, which is mainly obtained through their interpersonal communication [26]. The new external meanings and interpersonal processes are appropriated by the individuals concerned, creating deep, internal knowledge acquisition and skills development that are regarded as useful by learners [20].

In a VLE students socialise when they give an answer to some posts or ask a question in forums. Moreover, students socialise through the reading of several discussions, as these are source of information for them. Therefore, the number of posts and readings of a student can be thought of as a proxy for the level of socialisation of the student. The level of socialisation of an individual in the network can be seen as high or low dependently on what is the level of socialisation of the community members. Therefore, we consider as a proxy for a node’s socialisation ability the percentage of formally regulated socialisation activity of that node over the total number of socialisation activities of all students [24].

4.3. Externalisation

Externalisation is the process of articulating tacit knowledge into explicit knowledge. “When tacit knowledge is made explicit, knowledge is crystallised, thus allowing it to be shared by others, and it becomes the basis of new knowledge” [16].

In a VLE we can think about externalisation as a way to develop group knowledge from individual knowledge. The conversion of tacit knowledge into explicit knowledge, therefore, is the key step in the learning process. According to one of the main characteristics of forums in VLEs, each individual contributes in developing the knowledge at the disposal of all participants through an incremental process [11]. To represent communication flows among students and between the students and the teacher we adopt the Incremental Knowledge Network (IKN), which shows also potential knowledge flows amongst participants who posted in the VLE [1]. This representation shows the social context in which new knowledge is added and learning experiences are shared.

In this phase of the learning process students focus their attention on how to represent explicitly their personal experiences and what they have learned through the socialisation. We can state that only those nodes who posted have certainly shared their own knowledge with other students. From these considerations we can measure the externalisation level of a student as the number of posts made by that student over the total number of posts in the network (therefore, made by all the students). The value of this indicator gives a rough information about the “quantity” of knowledge externalised by each student, compared to the total “quantity” of knowledge externalised in the network.

4.4. Combination

Combination converts explicit knowledge into more complex and systematic sets of explicit knowledge, called systemic knowledge [16]. In organizational contexts, explicit knowledge is collected from inside or outside the organisation and then combined, edited or processed to form new knowledge. The new explicit knowledge is then disseminated among the members of the organisation [17].

In a VLE there is a combination stage when the information gathered from the specific online discussion (inside) is combined with other information from other online discussions (outside). In particular, by reading other participants’ posts, a student integrates multiple bodies of explicit knowledge and then he adds elements of new knowledge to the network. This knowledge is explicit (expressed by posts), so it is at the disposal of everyone in the forum. For this reason, we propose to measure the level of combination of a student in a forum as the number of posts (new explicit knowledge) he made in that forum over the number of reads made in all forums before writing each post.

The externalised student’s tacit knowledge can be combined with other explicit information, such as articles posted by teacher and online discussions on several topics. In this way, other students can be helped in internalising new knowledge and an environment for deep learning is created [4].

4.5. Internalisation

Internalisation is the process of turning explicit knowledge into tacit knowledge. This phase is characterised by a significant individual deductive effort: indeed, the student has to develop explicit knowledge and adapt it, basing on his experiences, to

the context in which he operates. The output of internalisation is operational knowledge [24]. In internalisation, individuals can acquire and absorb knowledge through demonstration or other means, such as learning by doing and on-the-job training [15].

According to [4], during the internalisation stage in a VLE the participants’ self-awareness and reflection on their learning knowledge is stimulated by feedbacks from the final test and feedbacks from online discussions. These activities allow the participants to gradually internalise their professional knowledge and personal teaching efficacy.

For these reasons we can consider as a proxy for the internalisation of a student his final mark in the course. Through internalisation, knowledge is transformed into learning memory and is actualised in practical operations such as the final exam. Then tacit knowledge becomes the basis for further learning for the student himself and for others through a spiral process.

All the metrics we propose to account for the various phases of ESECI are summed up in table 1.

Environment	SNA indices: Centrality, Density, Number of isolated nodes
Socialisation	$\frac{activities_i}{\sum_{i=1}^n activities_i}$
Externalisation	$\frac{posts_i}{\sum_{i=1}^n posts_i}$
Combination	$\frac{posts_i}{previous_reads_i}$
Internalisation	Final Mark

Table 1 Metrics for ESECI

5. CONCLUSIONS AND FUTURE DEVELOPMENTS

In this paper we have proposed a new framework (ESECI) to detect knowledge acquisition in online learning environments. Our framework is based on Nonaka and Takeuchi’s SECI. The SECI is a good model for teacher’s training [27], but also a good tool for student’s learning.

The primary requirement of our framework is establishing a learning environment in which the students are facilitated in socialisation.

The knowledge-creation process starts with the stage of socialisation, which is acted through discussions in online forums. The socialisation is then followed by the externalisation of tacit knowledge through post writing on the online discussion board. In the third stage (combination), the students combine the various pieces of knowledge acquired from all the participants in the discussion, thus creating new knowledge, which is, finally, internalised. ESECI process of knowledge creation, in this way, describes dynamic interactions between tacit and explicit knowledge in the virtual learning environment. Our framework contributes to theoretical development. Indeed, while the importance of KM in learning contexts has been widely recognized [4], [27], [22], there is not yet a framework to provide guidelines and metrics to detect knowledge paths in a VLE. Therefore, we have proposed some metrics to identify the various phases of a learning process in a VLE. Our framework can be used as a guide to manage educational training. The framework and metrics we provided in this paper can show

some characteristics of the learning process and can highlight the specific contribution brought by each actor to the knowledge development in the VLE community.

This study has several implications for future research. Firstly, the framework we developed should and will be tested with a case study, in order to be validated. Indeed, we are applying the framework and its metrics to a real e-learning course. In particular, we are analysing an e-learning course for managerial education over three years.

Moreover, future studies should investigate the relationships among the various stages of this framework. In particular, it will be very interesting to examine how VLEs could use knowledge creation processes to improve students' learning.

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