

# Evaluation of Virtual Learning Environments for Higher Education from a General System Theory Viewpoint

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## Abstract

*From this study the author was able to review what it considers being the main elements related to the Virtual Learning Environments Systems especially focusing on higher education in the UK, from a General System Theory view.*

*It began with a review about E-learning before presenting a review about Virtual Learning Environments, following which it presented a review about how higher education institutions had incorporated these systems as part of their class.*

*In this document the author managed to identify the relevant elements of the VLE's systems and how this system is behaving in their institution environment.*

*The author conducted a series of methodology procedures in order to present a VLE Acquisition model as a result of the author's research.*

Index Terms – Virtual Learning Environments, E-Learning, Education, General System Theory, Information Systems.

### 1. Introduction and Background

The new reality in which our society lives and the changes that it faces day after day must be taken into consideration by governmental organisations and by educational institutions, entrusted to form individuals. The educational strategy that every institution adopts depends on the structure of its programs, the pedagogic models and the form of interaction among the different actors within an institution.

The virtual education comes about in present times as an important tool in the support of several educational and learning experiences in which the use of different information technologies have taken residence inside classrooms without being triggered by any strategic plan or policy, but instead their own reality amongst students and teachers. We can see in classrooms nowadays how teachers are increasingly beginning to put their notes on the internet and they communicate with students via e-mail and web forums. Course outlines are commonly published on departmental web-sites. Conferencing software is used in some institutions to create on-line discussion groups amongst students. Also, most University libraries have web-interfaces for searching, checking availability and reserving books.

Virtual Learning Environment or (VLE) define systems comprising of a range of e-learning characteristics and features creating interaction between teacher/tutors and students, including communication and incidental exchange of information by several communication channels together with online publications, management of documents and other information.<sup>1</sup>

This IT phenomenon that is taking place has caught the attention of different institutions needing to search the market and look at how different organizations have explored ways of further impulse technology in an educational context.

When adopting new communication technologies with the purpose of modifying the educational process that it has been developing inside a classroom, it is relevant to establish a clear concept of the purpose of this modification and what the desired results are for that institution.. The success or failure of this learning experience will depend on the behaviour of a series of elements and how they interact as a total system, elements such as educational institutions, teachers, students and all other factors that might affect the virtual educational process.

The market offers a series of standard VLE solutions, which in spite of answering to a similar need, possess differences in their structure, functionality and enclosed price, which forces any institution of high education to think over and justify the decision of purchasing this software.

It is for the previous statements that the author considers using a systemic approach that will allow facilitation of the educational institutions to realize the pertinent analysis before deciding whether or not to incorporate a VLE system and suitable selection criteria to achieve the desired requirements from the diverse range that is on offer between these systems.

### 2. Education and E-Learning

E-Learning means "electronic learning" — it refers to a wide range of applications and processes designed to deliver instruction through electronic means. Usually this means Web-based, however it also can include CD-ROM or video-conferencing through satellite transmission. The definition of E-learning is broader than, but includes, "online learning," "Web-based training," and "computer-based training." Most importantly, it signals the paradigm shift in education and training that is in progress.

At the moment of directing the attention on the tools that support education, the information technologies have a key place in the support of the learning process of the student.

These technologies have managed to find an important place between the traditional method of communication amongst teachers and students accustomed only to the printed papers and books, where today they add audio, video, interactive images and a series of tools that appear directly to have improved the quality of the learnability of the student.

Recently, the establishments of higher education have seen how computers have interfered inside the classroom allowing the student to interact with the use of multimedia tools allowing them to learn in a better way by establishing relations between the subject and the environment.

It is becoming more frequently to see realities in which the teacher and the student are not in the same physical place, while the learning process develops. In order to make this possible, it is vital that the educational programs are accessible in a remote way, both to individuals and to groups, either in their class, or in their homes.

E-Learning united different types of learning methods by being a mixture or a "blend" of online activities and face to-face activities offering the best of both worlds. The term Blended learning refers to the "blend" of virtual and physical resources, we can find a class that might have a face-to-face session followed by the use of online material and later will

continue with an online discussion. The learning activity is in itself blended. It can mix location, both physical and virtual.

The higher education institutions have to be prepared for this transformation phase that education is experiencing and transform their educational structure and strategies to incorporate these new technologies.

### 3. Educational Technology

For years, it has strongly been witnessed how the virtual platforms have fervently broken into the education field. This answers to a set of needs and global aims, which are related to the academic, economic, governmental and political - social world they have stimulated, embraced by organizations such as the European Union, from even before the year 2000.

Is it evident that the majority of higher education institutions are aware that it is absolutely necessary to integrate the resources that are offered by Information Technology and Communication tools in support of education, particularly with the continued rise of virtual education amongst higher educational institutions.

The market has generated a group of tools to respond to the demand of virtual environment, these VLE's systems have the function to connect and interact with the teacher and the student incorporating a wide aspect of the teaching and learning process.

Comparing the tools that information technology offers, Web tools would appear simple to use and less expensive in comparison with software development tools such as programming in languages like C, Java or Visual Basic, enabling the users to use these applications in a familiar manner akin to browsing the internet like most of them frequently do. In order to incorporate this technology into education, years have been spent expanding the integrated platforms for the elaboration of courses for the Web, known also as: virtual environments.

This tool allows a standardization of virtual environments and they possess a series of tools that can be employed at this site as well as being able to modify it without possessing high knowledge of programming, so allowing teachers of different specialities to carry out administration tasks and work at this site in order to customize it according to the needs that their class would have..

At this moment there exists a great offer of standard products on the Market, where we can distinguish those such commercial products as Blackboard, First Class, Angel, etc. and those that are open source, in which beside being free, the user, which in the majority are organized in communities, can take part in the modification and improvement of this platform. Inside these systems we find VLE's systems like Atutor, Bazaar, Bodington, Claroline and Moodle.

### 4. Major Functions of Virtual Learning Environments

Among the functions that the VLE's systems offer, there are three fundamental areas. The first one is Online Course Administration allowing the creation of system areas, which are created in the majority by the Manager and can consist of

an entire degree, a specific course or just a class. This creation, whilst in the majority of the systems must be built by the manager automatic or manually.<sup>ii</sup>

The second area is Content Management, where the teachers have the facility under the role of "Course Manager" to upload files to the server, to modify them or delete them.

Some VLE systems provide different levels of content management upload features such as Basic document upload, where Course Managers can upload different types of files, so the student can download it later, other features allow the Course Manager to control files on the server in a way that he could control the date and time where it can be available to download or to stop displaying the user access.

Also, is it possible to upload files for sequential viewing in a defined order and to organize the files into a hierarchical structure using folders, similar to how Windows Explorer works.

The third key area of VLE systems is the Communication Tools, which allows interaction between the teachers and the students. Usually the teachers will fulfil the role of moderator and control of the used tools within a discussion context. (i.e. Discussion boards, E-Mail, Chat, Whiteboard, etc.)

### 5. General Theory System Approach

When studying any issue, one of the first approximations is to divide the object studied into parts and each of these parts is then studied independently. A principal theory that supports this idea is the reductionism theory. An alternative theory is the General Systems Theory (GST), an idea that was published in 1945 in Germany under the title name of "An Outline of the General Systems Theory", focused principally on the area of biology by Von Bertalanffy, with the goal of being able to study at the same time the entirety and the parts

The General Systems Theory (GST) passes across different fields of human knowledge with the aim of explaining the conduct of reality. This theory allows defining the model to be studied as a set of entities which possess certain attributes, which support relations between them and which exist in a certain environment to a certain objective. (Johansen, B, 1997) These entities plus their attributes are interacting between them across the relations established inside a specified environment. The systems relate their subsystems amongst the internal environment with the intention of achieving a specific aim in terms of effectiveness and of efficiency.

The GST establishes that the total system is a whole consisting of interrelated parts. A system is a set of two or more inter-related elements (parts) in which each element has an impact on the others. Parts or subsets of a system cannot act independently; their actions always have an impact upon the other parts and subsets, and consequently the whole system. A system has emergent properties that are not apparent in an analysis of its parts. "The whole is more than the sum of the parts." [Aristotle].

The relationship between the different subsets or parts does not have scale differences between them, the collective membership of a system governs the whole, and this concept

is known as synergy. The main idea is that each subset might be specialized in a particular task or area, but the contribution of each, plus how they benefit from each other, would give the real value to the system.

### 6. Construction of a VLE system model

Analyzing the VLE systems in relation to GST, we must first identify which are their principal entities or subsets. To begin this identification, we should start with the users. We will divide the users first into subsets that represent the three different roles in which the user is registered in the system; i.e. "Administrator", "Course Manager" and "Student". Furthermore, in a graph together with these subsets, we group the different features of the VLE's systems.

Despite this being the first approximation, it already allows us to identify those who are the first subset that are directly focused on the use of the VLE system, in other words, this system gathers only those subsystems that are simply seen in the interaction of the VLE system and the direct users who were entering to the system under one of these three roles.

It is then necessary to start adding all those other subsets that relate to this system and that become an important part of the VLE system.

The Administrator would have to answer technical queries related to the hardware and assist in any technical difficulties that the users may have. User's activities within the VLE would also have to be assisted.

An important actor in this system is the Organization itself, particularly those in the area that have the role of making decisions depending on goals and restrictions previously imposed. These decisions may occur at the level of head of the institution or by the head of a department, despite in some cases the direct need to use this program by them is very low. Instead, they are tertiary users who will be affected by the pros and cons of the system and the degree of satisfaction that the selected solution provides.

From the side of the software we find the "Developers", which in this particular case will be represented by those that symbolize the different entities that offer these types of solutions such as commercial providers or as open source.

The VLE system would be integrated in several institutions with other corporate systems, which could be related to a bigger MLE (Managed Learning Environment) system or just Student Record System. For several institutions to be able to accomplish this, integration would play a key part in their final decision and in the future changes.

It is necessary to mention the Learning Communities that despite not being part of the system's environment interacts with it and can manage to affect it considerably either positively or negatively, especially if the selected option is an open source system. In the same way, the system might be affected by outside changes like the development in the same VLE industry or changes in the Educational or Technological trends.

Finally, the system must be aware of Legislative issues connected to education, usability and other issues related to VLE system.

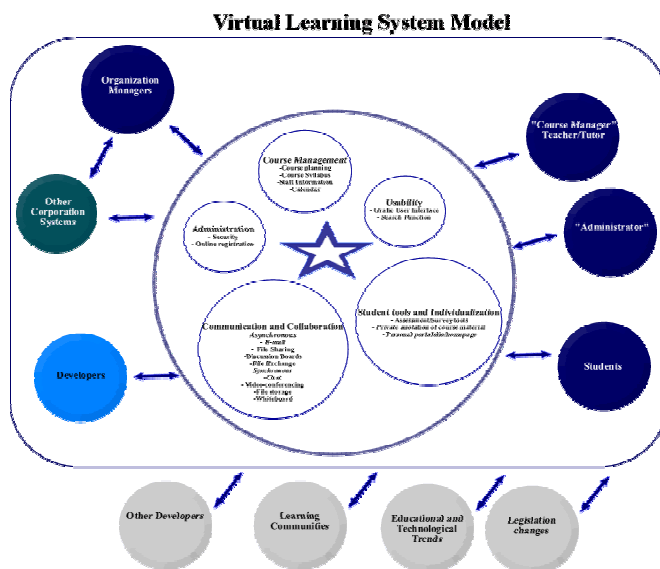


Figure 1: Virtual Learning System Model according to the General System Theory.

### 7. Acquisition of A VLE System

Before it is established how an organizations should approach acquiring a VLE, one of the first steps is to understand that the VLE systems are not just a software but can be classified as an Information System.

This answers our approach that the VLE system analysis must be seen from a systemic point of view where the VLE system is a part of the organization as an entirety.

In order to begin their analysis to determine the proper Information System for them, a higher educational institution would have to follow a structure in order to establish what is their actual situation and what are going to be their needs for this technological acquisition, otherwise they would risk investing an important amount of money in a standard application that later they may realize was just not what they needed.

### 8. VLE and a Step-by-Step Procedure

The next approach of the model has to deal with having a guideline for the evaluation, in other words, to have a step-by-step structure in order to organize the different elements of the organization and to have the necessary information to select the optimal IT solution.

Over the last few years, several authors have published different software evaluation models that differ greatly from one another, so the guideline the author proposes for this side of the model is a guideline that is based on the ISO/IEC 14102 "Guideline for the evaluation and selection of CASE tools".

For this ISO/IEC standard, the author used a group of features that the four major processes had defined by this standard, those are:

**Initiation process:** It suggests reviewing the organization's current situation from different aspects. The first aspect concerns their own development process and the capability they will have as an organisation to develop a VLE

solution and observe the trends as future reference technology and identify probable impacts on the organization. Finally, it asks to set overall goals and their possible constraints.

**Structuring process:** Establishes to decompose the high level goals into a set of selection criteria to make the (go/no go) selection decision, previously gathering all the information about, in this particular case, the higher educational institution. The information that is required involves several important issues such as whom and how the project will be funded, what is the current hardware scenario at the institution and which are the organization procurement policies.

**Evaluation process:** Establishing a requirement definition that should be organized in a set of previously defined characteristics, after this, the evaluation process suggests gathering general information about the companies that are offering the IT solution, including the gathering of general information such as business history, support, plans & strategy, etc. Also it suggests asking for specific useful information such as the cost of the tool (including considering licence mechanisms such as floating licence, hardware and software requirements, training program, system lifecycle support) and how the system can interact with other systems previously purchased by the institution or probably being acquired in the future. Also it suggests collecting general information about the number of users of the system and to seek any feedback or user's response to the system.

**Evaluation process:** Establish a set of high-priority or critical requirements that the system needs to meet. After that, compare the requirements previously establish with the system.

## 9. The VLE System and Requirements Definition

The Selection process looks to determine how the data generated during the previous process would be combined and used to help clarify which system the institution should acquire.

This process proposes that the characteristics that have been defined before should be given a suitable metric by the institution, in order to be measurable and the totaling of those measures should feed into some specific VLE solution.

It also establishes that no adequate tool exists according to the reality and needs of the institution. In that case, it might be worth considering develop a new tool or to modify an old one, if the institution has the technology tools. Otherwise they would have to abandon the entire evaluation and selection process.

Another approach researched was one related to determining the necessary information system quality that was going to be required by the VLE solution.<sup>iii</sup> There are three parties involved with information systems: Management, Users and IS Personnel.

Based on the above, Eriksson and Törn<sup>iv</sup> defined three IS quality factors as "Business Quality", "IS Use Quality" and "IS Work Quality". The first one involves the senior and departmental management, who will be responsible for the efficient deployment of all types of assets, towards meeting the organization's previously settled information

needs and goals. The IS use Quality factor, is defined by how well the system does what the users want it to do. As users, it refers to the people who directly use the system. The third factor is the IS Work Quality, and is defined by the level of the performance management, development, maintenance and operation of the IS. It is related to being concerned with all aspects that will guarantee how IS serves the user.<sup>v</sup>

The other model that was considered was one related to the characteristics involved in measuring if the product would meet the needs of the user.

In order to accomplish this, it was decided to use a standard definition of characteristics to cover as wide an area as possible of the potential needs that the different users might have.

The tool selected for this, was the ISO/IEC TR 9126-3:2003, "Software engineering -- Product quality -- Part 3: Internal metrics" (<http://www.iso.org>), this document provides internal metrics for measuring attributes of six external quality characteristics and sub-characteristics. The idea is that it would highlight the elements that should be identified as quality requirements in order to define the product quality. The process of determining the quality requirements and their corresponding metric can turn out to be an unwieldy activity and prone to error if a scheme has not been established for this activity.

The six characteristics that the ISO 9126 presents are Functionality, Reliability, Usability, Efficiency, Maintainability and Portability.

## 10. Acquisition Model for VLE systems

A research study was made that included several interviews to experts and a survey directed to VLE users, lead as a result of a model that is the author VLE's systems proposal base acquire, that stand on the ISO/IEC 14102, the IS quality model of Eriksson and Törn and the ISO/IEC 9126.

This model does not try to become an absolutely complete step-by-step procedure in order to acquire a VLE system for a higher educational institution would warrant that the decision would be the optimal in every aspect of the organization. On the contrary, this model looks to be a tool that would help and guide higher educational institutions in the basic but fundamental steps in the process to evaluate the possibility of acquiring a VLE system.

The model consists of three edges, each edge would establish a procedure to follow and each edge is based on another model also.

The first edge is the headers of the model. The headers of the model define the different steps that the organization has to follow until they reach a stage where they would be internally ready to face a difficult software evaluation process in a better way.

The headers can also be viewed as step-by-step headers consisting of four headers: "Current Situation", Overall Goals and Constraints", "Selection Criteria based on Characteristics" and "IS Characteristics Capabilities". These four headers define the fours steps the organization goes through. These steps were built according to the standard

ISO/IEC 14104, related to the guideline for the evaluation and selection of CASE tools.

The Second edge that was introduced into this model was the IS quality model of Eriksson and Törn. This model was taken into consideration because in the GST diagram it was clearly recognized that the VLE interacts with a number of defined subsets inside the organization according to the different roles that the user could have on the system and subsets that were involved with the system but not as a direct user, such as the Organization Managers. In this approach the Eriksson and Törn model and their three IS quality factors as “Business Quality”, “IS Use Quality” and “IS Work Quality” represent the basic three points of view that collect all the entities previously defined in the GST model.

Finally, the third edge has to do with the IS Characteristic Capabilities that group a number of standard features together that were selected on specific standards models as ISO/IEC 9126 and ISO/IEC 14102, because being a result of international standard documents they will give confidence to the users that they are not characteristics created randomly and that they will cover the whole aspect of the system.

#### *The model works in the following way:*

First of all the institution that is evaluating the possibility of acquiring a VLE system, would have to analyze their current situation focusing on those particular three points of view.

After the institution has finished this, they are going to be able to move to the second header, the “Overall Goals and Constraint: where, based on the same three factors, is going to have to define the goals that they wish to address in the future and the constraints they will have to identify and keep in mind.

Until now, no software has been named or characteristics have been mentioned, up until this stage it has to do with the institution and their internal needs.

After finishing this step, they can move to the header “Selection criteria based on these Characteristics (go/no go). In this section, based on the goals and constraints previously elaborated, they will choose a number of characteristics that the VLE system would require in order to support the goals and which ones will not go against the constraints established in the previous step. In this characteristic, it would be identified for every factor the key characteristic that would become a (go/no go) characteristic, in other words, if a VLE solution does not provide this characteristic it might be that the solution cannot be approved.

The last step of the process is the IS Characteristics Capabilities, where the Organization Quality Factor would review the characteristics defined in the previous step and complete them with the characteristics defined in this model based on the ISO/IEC 14102 elements that would cover elements related to “Acquisition Process”, “Organization”, “Support Indicators” and “Evaluation or Certification”. The Use Quality factor would complete their characteristics according to ISO/IEC 9126 characteristics as “Functionality”,

“Reliability” and “Usability”. The reason for using this particular ISO/IEC standard is because it provides generic user quality characteristics, so this would allow more flexibility to the different organizations.

For the third factor of IS Work Quality, it a fusion of characteristic from the ISO/IEC 9126 and evaluation elements from ISO/IEC 14102 as Maintainability and Portability was used.

After the institution has built these characteristics, probably requiring at least between 6 months and a year to conclude, it would be the responsibility of the institution to define which are going to be the metrics that are going to be used to the start evaluating softwares.

The model only leads the institution up to the point that they will be able to construct their own characteristic and metrics, after that the existing variety of needs between educational institution does not suggest to continue further in the model constructing a rigid metric tool but instead leaving that stage for the institution to determine.

## 11. CONCLUSION

E-Learning and Virtual Learning are more than just some tool designed to solve distance learning, these tools are also important elements of the blended learning experience itself and a strategic tool for educational and government organizations. VLE system is not just a software, it is an IS that would require commitment from all of the organization.

The wide variety of VLE software’s available on the market and the level of the decision that has to be made at the moment of choosing one of these systems requires establishment of a strategic plan in charge of a group of professionals from the same organisation, ideally from different areas.

Finally, to keep in mind that the VLE system is an open system (in terms of GST open system definition), this means that the elements that exist outside the system would have an effect on what is happening inside the system, so the institution would have to be aware of the educational, political and technological trends that might happen in the future.

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Figure 2: Virtual Learning System Model according to the General System Theory

	<i>Current Situation</i>	<i>Overall Goals and Constraints</i>	<i>Selection criteria based on Characteristics (go/no go)</i>	<i>IS Characteristics Capabilities</i>
<b>ORGANIZATION QUALITY</b>	<ul style="list-style-type: none"> <li>-Educational Organization structure</li> <li>-Management structure</li> <li>-Organization Impacts</li> <li>-Education Strategy.</li> <li>-Economic Resources</li> <li>-Infrastructure</li> </ul>	<ul style="list-style-type: none"> <li>-Deadlines</li> <li>-Schedules</li> <li>-Budget (Life Cost)</li> <li>-Targets</li> <li>-Strategy</li> </ul>	<p>Organization Quality Characteristics (go/no go)</p>	<ul style="list-style-type: none"> <li>Acquisition Process</li> <li>-Licensing Policies Implementation</li> <li>-Cost Effectiveness</li> <li>-Delivery Constraints (Time) Organization</li> <li>-Infrastructure needs</li> <li>Support Indicators</li> <li>-Supplier Profile</li> <li>-Product Profile</li> <li>-Training Availability</li> <li>Evaluation or Certification</li> <li>-Developer Certification</li> <li>-Product Certification</li> </ul>
<b>IS USE QUALITY</b>	<ul style="list-style-type: none"> <li>-E-Learning platform</li> <li>-Digital resources used.</li> <li>-Educational Quality.</li> <li>-Educational Attainments</li> </ul>	<ul style="list-style-type: none"> <li>-Facilitate Learning</li> <li>-Communication between Students and Teacher/Facilitator</li> <li>- Cooperation Among Students</li> <li>- Active Learning Techniques</li> <li>- Course Feedback</li> <li>-Facilitate Learning</li> </ul>	<p>Use Quality Characteristics (go/no go)</p>	<p><b>Functionality</b></p> <ul style="list-style-type: none"> <li>-Accuracy</li> <li>-Security</li> <li>-Suitability</li> <li>-Interoperability</li> <li>-Functionality Compliance</li> </ul> <p><b>Reliability</b></p> <ul style="list-style-type: none"> <li>-Maturity</li> <li>-Fault Tolerance</li> <li>-Recoverability</li> <li>-Reliability compliance</li> </ul> <p><b>Usability</b></p> <ul style="list-style-type: none"> <li>-Understandability</li> <li>-Learnability</li> <li>-Operability</li> <li>-Attractiveness</li> <li>-Usability Compliance</li> </ul>
<b>IS WORK QUALITY</b>	<ul style="list-style-type: none"> <li>-Capability to generate own software.</li> <li>-Capability to maintain an IS</li> <li>- Capability to operate an IS.</li> <li>- Current Technology (Hardware and Software)</li> </ul>	<ul style="list-style-type: none"> <li>-Enhance technology support and satisfaction</li> <li>-Support technology training</li> <li>-Improve security and disaster awareness.</li> </ul>	<p>Use Quality Characteristics (go/no go)</p>	<p><b>Maintainability</b></p> <ul style="list-style-type: none"> <li>-Analysability</li> <li>-Changeability</li> <li>-Stability</li> <li>-Testability</li> <li>-Vendor Support and services</li> <li>-Updates</li> <li>-Expandability</li> <li>-Training</li> <li>-Documentation</li> </ul> <p><b>Portability</b></p> <ul style="list-style-type: none"> <li>-Portability to Different Hardware Platforms</li> <li>-Ability to Move Data Between Versions of the Tool</li> <li>-Adaptability</li> <li>-Installability</li> <li>-Co-existence</li> <li>-Replaceability</li> <li>-Portability Compliance</li> </ul>