# Is Technology Management Education a Requirement for a Virtual Learning Environment?

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***Abstract*—In this work we present the hypothesis that Education of Technology Management is necessary for the success of a Virtual Learning Environments, not only for Information technology professionals, but as well as for instructors and learners. Assuming its veracity, we compiled a set of skills for Management of Technology to support the elicitation of Interdisciplinary skills for Technology Management Education. Hence, our main result is a framework that intends to support the planning of training of skills of Management of Technology that might improve the efficacy and efficiency of Virtual Learning Environments, but more than this, we hope to arouse the debate.**

***Keywords*-Technology Management Education; Framework; Virtual Learning Environment; Skills**

## I. Introduction

We start with the question: is Technology Management Education (TME) a requirement for the success of Virtual Learning Environment (VLE)? Honestly, this work does not really answer this question, but regarding that success in the context of a VLE is effective and efficient learning, then our hypothesis is: Education of Technology Management is necessary for the success of a Virtual Learning Environment. Despite the fact that it might seem logically straightforward that using TME in managing and utilizing VLE should enhance instructors and learners performance, as far as the authors knows, this question has not been addressed in scientific literature. Hence, a framework to approach the matter may work as a baseline for future studies, and this is the purpose of this work.

For instance, Pusnik *et al.* in [1] in regards to VLE claim that the success of new technologies and services must have a positive impact and be adopted by end users, that is, teachers and learners. A more recent study by Dominguez and Aguilar in [2] review the processes of Information Technology (IT) required for educational organizations, because e-Learning is "deeply affected by the changing environment and technological support", hence they remarked that a satisfactory delivery of service to the user is obtained with intensive monitoring and management of applications and infrastructure. What we may observe from the former two references is an indirect and not clear criterion for VLE's success, and an implicit argument for the requirement of the Management of Technology (MOT) for the VLE, respectively. Clearly, the existence of a correlation between MOT and the success of VLE is established, because without a satisfactory service delivery, the adoption of the VLE by the users is compromised.

Another work highlights the requirement of management regarding VLE in institutions of higher education, by Segooa and Kalema in South Africa [3]. Their emphazis is in developing countries, which is close to our heart because we share similar context, barriers and challenges. Basically, they recommend [3]:

1) To provide enough computers to their students.
2) To ensure network coverage and maintenance that hinder effective use of VLE.
3) To embed VLE programs in the institutional policies and strategy in order to stipulate that both students and lecturers use the tools.
4) To provide continuous training on how VLE can be efficient and beneficial to students and lecturers.
5) To extend the facilities or library hours to allow the student that are underprivileged to access the facilities even after hours like evenings.
6) The encouragement to the newly introduced culture by supporting the program with incentive.

Specifically for educational institutions that normally receive underprivileged students, minorities and native cultures like the *Universidade Federal do Tocantins* (Federal University of Tocantins) and of the authors of [3], items (1), (5) and (6) are very relevant and may seem an unnecessary statement for other institutions. Moreover, items (2), (3) and (4) may seem a solved question for many organizations. However, what matters is that items (2) and (3) show the importance of MOT in VLE, and item (4) remarks the need of training.

As a consequence of the works presented in [1], [2] and [3] that exemplifies the relationship between MOT and VLE, let us first accept that MOT is a requirement for the success of a VLE. Then let us accept item (4) as a requirement, *i.e.*, continuous training of teachers and learners is a necessity because of the constant change in the environment, and the regular emerge and adoption of new technologies.

With regards to all arguments presented so far, TME has not been proven as a requisite to the VLE. However, if we consider that the use of a VLE has three groups involved, instructors, learners, and IT supporting personnel, then we have a reasonable case of the TME for at least the latter group. Herein, we advocate that besides the obvious IT group, the other two groups, instructors and students, will find significant benefits with TME for at least a minimum set of skills that may improve the effectiveness and efficiency of the VLE.

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For the organization of this paper, we chose IMRAD structure [4]: introduction, methodology, results and discussion. The authors believe that the adoption of this structure should facilitate the information storage and retrieval in international databases by search engines for research purposes such as systematic reviews and meta-analysis.

## II. Methodology

For future references, historicity and traceability, we start this work's methodology presentation by reporting its history, which shows that not always a paper results from an intended research or is part of a predicted goal. Then the originality of this work's driving question is verified by means of a literature review performed on internet-based search engines. After that, we mention our research strategy, and we end this section with the basic steps of the project that aroused this work.

### A. History of this Work

The authors collaborate on a project funded by the Brazilian Ministry of Education. This project investigates Educational Technologies for improving the quality of education in the state of Tocantins, Brazil.

In particular, professors David N. Prata and Patrick Letouze supervise the Master Science Candidate Andre Barcellos at the Graduate Program of Computational Modeling of Systems at UFT. His project regards the development of a VLE for supporting the application of the concept of Nature of Science (NOS) [5] for e-Learning, or henceforth called VLE4NOS (Virtual Learning Environment For Nature OF Science). NOS intends to be a multifaceted science education approach, which includes aspects of history, sociology, and philosophy of science, and has variously been defined as science's epistemology, the characteristics of scientific knowledge, and science as a way of knowing [6]. Basically, his project intends to provide VLE support the approach to NOS proposed by Garcia and Dias presented in [5], where NOS is obtained as an extension of the classroom through reflexive and critical analysis from reading popular media news.

The Graduate Program of Computational Modeling of Systems at UFT has two mandatory disciplines, which are "Scientific Methodology" and "Project Management". Both disciplines have an hands-on approach combined to "Project-Based Learning". In Andre Barcellos' case, it means that in the discipline of "Scientific Methodology" he had to perform a partial systematic review of the scientific literature [7], such strategy is adopted to provide a sound basis for the literature review of the student's dissertation, but the complete review is an option chosen in accordance with the supervisors interest. In the discipline the most important objective is to master the concepts and techniques involved in a systematic review, while inducing the candidate to study thoroughly papers regarding his project. The search for scientific papers was performed in the folowing databases: ACM, Emerald, Eric, IEEE Xplore Digital Library, ISI Web of Science, SciELO, ScienceDirect, Springer, Wiley, and Google Scholar.

During the preparation of the partial systematic review, which was incomplete because only a quarter of the selected papers were evaluated, it was noticeable that MOT was overlooked or barely mentioned. However, simultaneously, Andre Barcellos was a student at the discipline of "Project Management" with professor Patrick Letouze, where he had to prepare his project proposal for qualifying. In this discipline, the project is written in IEEE's template for journals. While preparing the project proposal in details this paper's driving question became clear, though it was not predicted as a relevant issue in the project funded by the Ministry of Education, which is coordinated by professor David N. Prata, with vice-coordination of professor Patrick Letouze.

Hence, planning the VLE development project for NOS induced the elicitation of the requirements for its functioning, and this work reflects our understanding that complexity and interdisciplinary issues present difficulties that may be minimized by a clear and objective use of MOT skills that have to be continuously trained in all three groups: IT personnel, instructors and learners.

It is worth noticing that this subsection also works as a statement of each authors' contribution. Consequently, it is important to declare that professor Gentil V. Barbosa is presently Director of Digital Technologies at UFT, which supports all implementations of digital technologies for e-Learning at UFT; and that he, professor George França and professor Marcelo L. Rocha helped to produce MOT skills elicitation for TME purposes.

### B. Literature Review

The literature review performed in this work was conducted to reveal and identify TME issues regarding the VLE scientific literature. The databases used in the literature review were:

- IEEE Xplore Digital Library (http://ieeexplore.ieee.org);
- Google Scholar (http://scholar.google.com).

In both above cases were applied the same search terms, as shown Table I.

TABLE I
SEARCHED TERMS.

| Id | Search Term |
|---|---|
| #1 | *"technology management education" "virtual learning environment"* |
| #2 | *"technology education management" "virtual learning environment"* |
| #3 | *"education in technology management" "virtual learning environment"* |
| #4 | *"technology management education"* |
| #5 | *"technology education management"* |
| #6 | *"education in technology management"* |

There are two segments of the research terms. The first segment (#1, #2, and #3) has three search expressions that are double terms, which were applied in both databases. The second segment (#4, #5, and #6) has another three expressions that are single terms and were applied only in the IEEE Xplore Digital Library. The fist segment of the search are variations of the term 'technology management education" with "virtual

learning environment". The second segment of the search are the same of the first segment, but without the second part.

First, using the three search terms (#1, #2, and #3) from the first segment of the search, comparing two databases with theirs perspectives importances, it is possible to verify that the obtained quantity of papers is irrelevant, as shown in Table II. Hence, the reason for the second search with only one search expression.

TABLE II
RESULTS OF THE SEARCHED EXPRESSIONS OF THE 1ST SEGMENT AT 01/23/2017.

| Term Id | IEEE Xplore Digital Library | Google Scholar |
|---|---|---|
| #1 | 0 | 2 |
| #2 | 0 | 6 |
| #3 | 0 | 0 |
| **TOTAL** | **0** | **8** |

For our purposes, another search limited to IEEE Xplore Digital Library database was enough. The results obtained with the search of the second segment showed that the total number of papers were 33, as shown in Table III. Consequently, it is still not enough information to perform a systematic literature review of this theme.

TABLE III
RESULTS OF THE SEARCHED EXPRESSIONS OF THE 2ND SEGMENT AT 01/23/2017.

| Term Id | IEEE Xplore Digital Library |
|---|---|
| #4 | 32 |
| #5 | 1 |
| #6 | 0 |
| **TOTAL** | **33** |

All these 33 papers were verified for this work, and a small number were used in this text. Therefore, the papers used in this work appears in the reference.

### C. Interdisciplinary Research Project Management

For conducting both projects, the main project funded by the Brazilian Ministry of Education and VLE4NOS project, we use the Interdisciplinary Research Project Management (IRPM) [8] strategy, which is shown in Figure 1. It presents a general methodology for conducting interdisciplinary research with the purpose of maximizing the results from an academic prespective.

### D. Basics of the VLE4NOS Project

Here we present some steps that are necessary for the development of the VLE4NOS Project, which are:

1) Carry out the literature review of "Technology Management Education" with "Virtual Learning Environment";
2) Elicit (acquire), analyze, specify and validate, the necessary and feasible requirements for the full operation of the VLE4NOS;
3) Model the VLE4NOS using the second version of the UML (acronym of Unified Modeling Language);
4) Develop the prototype of the VLE4NOS, containing the scientific news module, teaching module, administration module, security, the relational data model and the simplified layout;
5) Test the VLE4NOS in a school;
6) Register the code of the VLE4NOS.
7) Deploy the VLE4NOS, disseminate its use through other elementary schools and high schools;

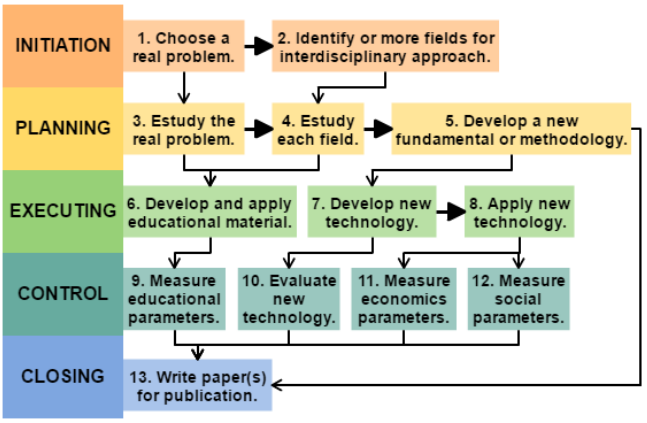


Fig. 1. IRPM Model

## III. RESULTS

### A. Compilation of Skills for Management of Technology

The contextualization of Virtual Learning Environments (VLE) is vital to cognitively support pedagogic knowledge of learning content. This contextualization intrinsically employs interdisciplinary knowledge to the development of VLEs, engendering didactic and pedagogic methods with information technology and communication. The great complexity to implement interdisciplinary knowledge is challenge to meet the needs of educational institutions, rendering ineffectively VLEs for professors do teach and students to learn. The identification of skills to develop Management of Technology (MOT) in the context of VLEs is key towards the development of effective, efficiency and efficacy, VLEs systems. Some essentials knowledge and skills areas of MOT are presented in Figure 2, compiled from Mallick and Chaudhury [9].

### B. Technology Management Education for Interdisciplinary Skills

For VLEs environments, the MOT for Education must contextualize the interdisciplinary knowledge and skills areas of learning sets, Figure 3. The curriculum is the general business function. The goals and objectives of learning must be described in the curriculum. These goals are described in the content knowledge. However, the VLE must consider both the pedagogic and the technology points of view. The technology resources must be exploited towards and in consonance to pedagogic issues. The technology is not the end, but pedagogic. Technology is mean. Maybe, the content could be transmitted to 10.000 students at the same time. Nevertheless, it must be used only if the didactic and pedagogic goals need or support this kind of transmission.

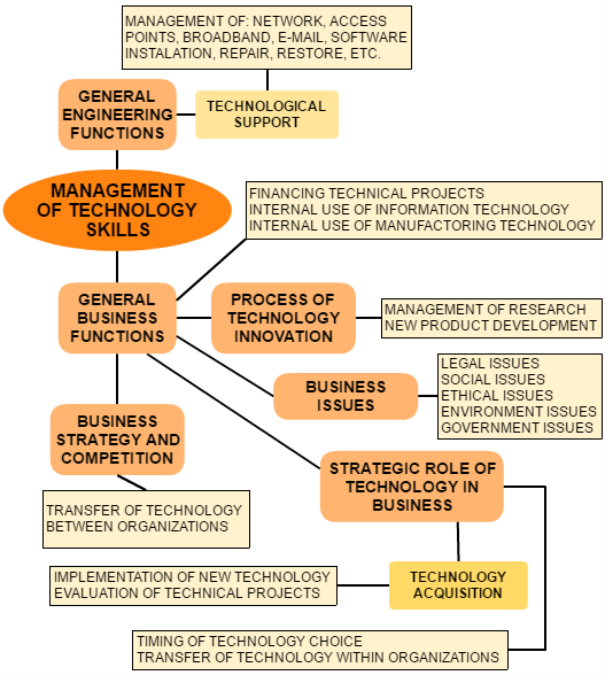


Fig. 2. Compilation of Skills for Management of Technology

An important business strategy is technology partnership. Some educational technology companies have interested in schools/universities to use their learning products. Although partnerships like this are exciting, learning products must be evaluated in many dimensions. For instance, some aspects are: cost, access to technology, special needs, usability, flexibility, learning assessment, time to spend to use the technology, ethics and social issues, quality of learning, collateral skills, maintenance, etc. Another face of business strategy is mentor schools. Schools who already use technology, and want or could share this experience.

The core for strategic role of technology in learning business is the use of technology to create new opportunities to learn, as augment content, animate content, improving time and space to access content, collaboration between students, improving didactic methods, cost savings, and so on.

The timing to technological choice in education environments has some feature patterns with standard divisions for periods of learning. The disciplines could last a semester or be annual. The start and end of a discipline always influence the timing for the technological choice.

The learning technology acquisition must be tested before its implementation. The test could only be implemented in one class or discipline, and then to the outside school. The test could also be implemented at the same time by dividing students in the class into two parts, one use the didactic of the old way and the other use the didactic of the new technology way.

The transfer of technology between organizations must primary consider the pedagogical differences between institutions. Secondly, the technology skills of teachers and students. In addition, the technology conditions of the target institution.

A learning technology coach must implement the transfer of technology within organizations. The coach must contextualize the didactic of the new technology for the new environment, including teacher, students, devices, technology conditions, and so on.

The research development to the process of technological innovation must be done on-site to contextualize results. The management of research must consider the quality of learning, learning effective and collateral development of skills. The new product development must create contextualized pedagogic content. The internal use of information technology must be personalized through general and profound content.

The internal use of manufacturing technology must contextualize usability and provide technical support. The implementation of new technology must train the teacher, and consider the technology knowledge access to the student. The evaluation of technical projects must consider the efficiency and efficacy of the content learning, and the effectiveness of learning to the school/university.

An important legal aspect to learning environments are the underage laws and consequences, including ethical issues like privacy information about the students. An explored social issue for learning is the collaboration, as scientific research results have been proved its efficacy [10]. A flexibility of the learning technology can provide its use in many learning situations of diverse content. At the same time, a specified technology can provide a more efficiency-learning environment. These two aspects should be balanced for use.

The government can influence in learning technology policies by inducing some features of educational technologies favored in grants consumed by schools/universities.

## IV. Discussion

The modeling of computational systems usually involves the union of two or more research areas, one of which is almost always the area of information technology, and the other area brings with it a problem or task to be modeled and improved, and that may generate a new technology. Thus an interdisciplinary approach such as IRPM [8] may be interesting, and for that reason was used it in this work and mentioned in Subsection II-C.

This paper proposes to raise the discussion about education in technology management applied to virtual learning environments. Hence, the driving question is: “Is Technology Management Education a Requirement in Virtual Learning Environment?”. That question is still open, but this possibility should be verified, and the search for an answer may lead to new knowledge regarding the use, operation and maintenance of virtual learning environments. Despite that, we offer an hypothesis, which is “Education of Technology Management is necessary for the success of a Virtual Learning Environment”, and we argue in its favour, in the hope that this research may raise new ideas and to promote the debate on how to improve VLE by building up the concept of technology management.

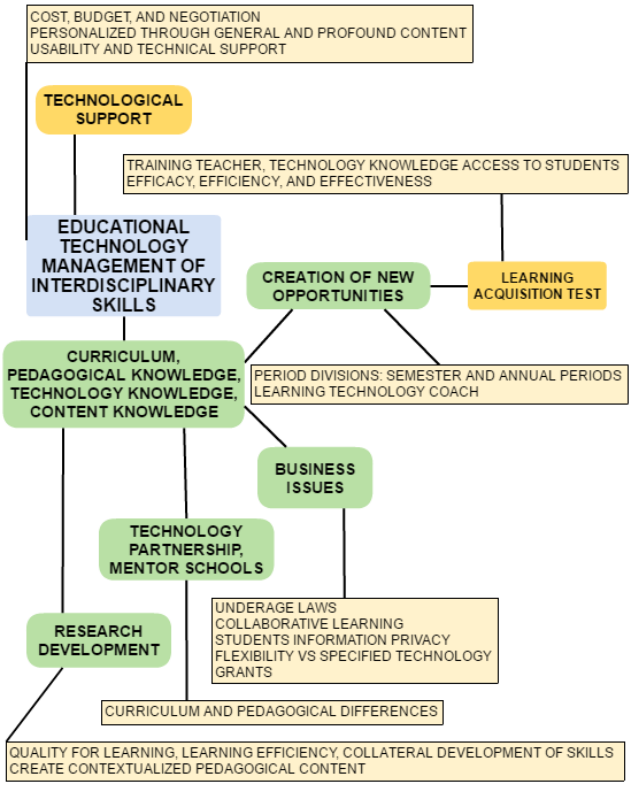


Fig. 3. Technology Management Education for Interdisciplinary Skills

Basically, we highlight that three sets of groups are involved with the VLE: instructors, learners and IT personnel. The importance of Management of Technology for IT personnel is facile to agree on, henceforth it is natural to accept the Technology Management Education for this crowd. For the other two groups that is not simple to sell. However, assuming that it is true, what should be done?

An attempt to answer this last question is the result of this work. First, we proposed a compilation of skills for Management of Technology proposed by Mallick and Chaudhury in [9], in the context of TME in MBA programs, see Figure 2. From that compilation, we obtained our main result: a framework for Technology Management Education that takes into consideration Interdisciplinary Skills, presented in Figure 3.

Clearly, the steps proposed in subsection II-D are potential future works. However, item (1) is sort of accomplished right now in this paper, and item (2) was performed in the context of the project detailed proposal. Therefore, the remaining items from (3) to (7) are future works. Also, to investigate blended learning because of its application to management education [11] might prove interesting in regards to NOS.

Finally, inspired by the work of Badawy in [12], *Technology management simply defined: a tweet plus two characters*, we offer the following definition for Technology Management applied to Virtual Learning Environments: the "process of effective integration and utilization of innovation, strategic, operational, and e-Learning mission of an institution for promoting educational gain". Nevertheless, this time the definition is only a tweet.

## ACKNOWLEDGMENT

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## REFERENCES

[1] M. Punik, B. Łumak, and M. Hericko, "Investigation of virtual learning environment in the context of web 2.0," in *2010 Second International Conference on Mobile, Hybrid, and On-Line Learning*, Feb 2010, pp. 1–6.

[2] A. I. D. Domnguez and M. G. P. Aguilar, "Integrated services management frameworks for online education based on information and communications technology," in *2016 Third International Conference on eDemocracy eGovernment (ICEDEG)*, March 2016, pp. 171–175.

[3] M. A. Segooa and B. M. Kalema, "Virtual learning environments for higher learning institutions in developing countries," in *2015 Fifth International Conference on e-Learning (econf)*, Oct 2015, pp. 353–359.

[4] ICMJ, *Uniform Requirements for Manuscripts.* International Committee of Medical Journals, 2008. [Online]. Available: http://www.icmj.org

[5] A. García-Carmona and J. A. A. Díaz, "Learning about the nature of science using newspaper articles with scientific content: A study in initial primary teacher education," *Science & Education*, pp. 1–24, 2016.

[6] R. L. Bell, "Teaching the nature of science: Three critical questions," *Best Practices in Science Education*, vol. 22, pp. 1–6, 2009.

[7] P. Letouze, J. Junior, and V. Silva, *Um breve guia para revisões sistemáticas: aplicado à ciência da computação*, Palmas TO, 2014.

[8] P. Letouze, "Interdisciplinary research project management," *International Proceedings of Economics Development AND Research*, vol. 14, pp. 338–342, 2011.

[9] D. N. Mallick and A. Chaudhury, "Technology management education in mba programs: a comparative study of knowledge and skill requirements," *Journal of Engineering and Technology Management*, vol. 17, no. 2, pp. 153–173, 2000.

[10] V. Vega and Y. Terada, "Research supports collaborative learning," 2016.

[11] J. Arbaugh, "What might online delivery teach us about blended management education? prior perspectives and future directions," *Journal of Management Education*, vol. 38, no. 6, pp. 784–817, 2014.

[12] A. M. Badawy, "Technology management simply defined: A tweet plus two characters," *Journal of Engineering and Technology Management*, vol. 26, no. 4, pp. 219–224, 2009.