Didactic innovative proposal for mathematic learning at the university by the blended model

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Abstract

This work presents a didactic innovative proposal to teach mathematics in the university by means of the Blended Model. The proposal has been developed from a previous study of the limitations identified in the materials existing for this learning modality. It includes the structures as well as didactic characteristics of its elements. The model elements are a Calendar Planning that contains the sequence of the activities, student’s and teacher’s Guides, Classroom Activities (CA) and Non-Classroom Activities (NCA), including the independent work orientations, book use patterns and the use of Moodle platform. The proposal has been applied in some courses in university technical degrees in Latin America. As an example of the didactic model application developed, we present the results found by applying it to the Differential Equations topic. The results are based on a students’ questionnaire answers and the control-activity marks of the topic inside the subject. The results show an improvement in the learning process, and evidence that the students have reached the self-management of the contents supported by the orientations contained in the didactic proposal. Moreover, the proposal has been validated by an international expert panel. The results of this evaluation are good and confirm the learning improvement that the proposal represents.

Keywords: innovation in university teaching, mathematics, independent work, blended learning, class attendance and distance learning.

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1. Introduction

The application of a didactic innovative proposal requires a solid theoretical foundation, especially if it is developed as a Blended Model. This also implies major changes in its practical development. In theory, there is a risk to consider this type of learning as a combination between classroom modality and e-learning models, without including changes in the didactic proposal.

At a high educational level, blended learning should include a set of pedagogical demands to promote the development of the students’ knowledge independence, this being a key goal. This entails the modification of material as well as human and time resources, optimising the training-quality levels.

The innovative aspect of our proposal is firstly that it arises from research on the theory approach operated as a foundation system. At the same time, the material resources have been prepared by a research process. They have been designed specifically for the field of mathematics, in which there was no previous deep approach to the needs and requirements of the teaching resources in the university education in a blended modality.

The research, which focuses on the mathematics for technical degrees, proposes:

- The design of a complete proposal, with a theoretic basis and assembling objectives with individually made resources that deal with optimisation requirements of the blended model.
- The application of the proposal to the subject in several degrees.
- The validation process at an international level by an expert consultancy.
- The preparation and application of a competences assessment consistent with the didactic proposal developed.

2. Theoretical fundamentals

We consider that “the blended learning implies a qualitative improvement with respect to e-learning models and classroom learning, if the best of both models are taken and they are assembled properly” (Llorente and Cabero, 2008). We support the idea that this blended modality represents a good opportunity to integrate the technological advances with the participation and interaction of traditional classroom teaching.

From a pedagogical perspective the blended model is defined as “a strategy that combines the classroom teaching with the students’ autonomous work outside the classroom. This means that the pedagogic and didactic aids must be considered as well as the learning objectives and the students’ particularities” (Aspden and Helm, 2004).

According to Hourrutinier (2006), the blended modality combines the classroom meetings with the media ones, where student independence and the self-preparation are relevant. This researcher considers the blended modality to be a learning system that allows the formation of research spaces and knowledge exchange that generates knowledge management between the students.

In the conceptualization of this didactic modality, we identify as essential characteristics of the teaching-learning model: “flexible, structured, focus on the student, with a classroom activity system that allows the lecturers to guide, support and accompany the students in the way that they do not feel alones” (Vega, 2005; Vega, 2012).

For the blended modality that is adopted in this didactic proposal, it is very important to achieve the knowledge independence of the student during the teaching-learning process. The main concept that supports this approach is the students’ independent or autonomous work.

The Learning Tasks System is one of the ways to do the autonomous work and focuses on the development of the students’ knowledge independence. They are supported by the Study Guides.

We also begin with a didactic approach consistent with the Blended modality as a foundation of the Tasks System: “a developer learning that represents the way to learn and dedication to one’s own learning that guarantees the change in learning control from the teacher to the process control for the learners” (Castellanos, Reinoso, Garcia, 2000).

With respect to the teacher, this modality requires a change of role. The teacher must be a mediator-facilitator in the pedagogical process, capable of properly applying the model to encourage the students to self-manage their learning, by proposing tasks especially with technologies of the information and communication (TIC) support.

The teacher’s role as a guide and facilitator to promote scientific creativity in the students has been analysed and characterized in depth by Oliveras et al. (2011), Rodriguez et al., (2012) and Oliveras et al. (2012) and is taken into
account in the theorizing and implementation of the proposal, as the base to develop the knowledge self-management, which is a key factor of this blended didactic model.

3. Method

The teaching proposal was designed for application in Mathematics subjects of university technical degrees. This was implemented in two subjects of the second year of computer engineering and mechanical engineering of the University of Technical Degrees (CUJAE) of La Habana, Cuba.

The model elements are:
• A Calendar planning that contains the sequence of the activities
• Student’s and teacher’s guides with:
  • Classroom activities (CR) and Non-classroom activities (NCR)
  • Independent work orientation
  • Book use patterns
  • Use of Moodle platform.

As an initial approach, the model was applied to the learning of the differential equations. The Fig. 3.1 shows the activities sequence proposed to each theme, including classroom and non-classroom activities.

The 30 Classroom (CR) and 25 Non-classroom (NCR) activities proposed resulted in an unequal time distribution, with more time dedicated to NCR activities, according to the theoretical requirements of the Blended Model modality (Fig. 3.2).
The model was validated with the expert consultancy. This consultancy included the following elements:

- Expert Seminar, in which the didactic teaching proposal was explained to the outside experts.
- Model Activities File, which consists of a dossier with the Classroom and Non-classroom activities of the Differential Equations theme, as well as the book chapters that support the activities proposed.
- Expert Model Evaluation Questionnaire, formulated by the authors to validate/reject the proposal with the experts’ opinions.

The model proposed included the students’ evaluation by means of the Competences assessment.

The blended model proposal includes a correspondence between the CR and NCR activities and the competences (specific as well as transversal) to achieve by the students. Each activity was related to several competences to be achieved, and each competence identified was evaluated with several activities (Table 1).

As a result, a complex design model to evaluate the competences was developed.

Table 1. Relation between activities (rows) and competences (columns) of the didactic proposal. CT: transversal competence; CS. Specific competence

<table>
<thead>
<tr>
<th>Competences/Activities</th>
<th>CT 1</th>
<th>CT 2</th>
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4. Results and discussion

Three types of qualitative results emerged from the application of the didactic proposal:

- Expert validation results, with the answers to the questionnaire provided
- Competences achievement results, with the assessment of each competence identified in the proposal
- Students’ opinion of the didactic proposal

The results of the expert validation indicated that they considered the model suitable or very suitable, answering to the 8 questions included in the questionnaire, with these two considerations.

The elements with the best expert opinion were the understandability of the language of the activities and their contents and design that allow to the students learn to solve differential equations. (Table 2)

The elements that experts considered suitable but not very suitable were the adaptability of the activities to the personal progress of each student in the learning and the capacity to generalize the model method of physical system solved with differential equations. (Table 2)
Table 2. Expert consultancy results: VS very suitable, S suitable, NS non suitable, NO: non opinion

<table>
<thead>
<tr>
<th>Question</th>
<th>Answers (value)</th>
<th>Average</th>
<th>Mode</th>
<th>Median</th>
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<tbody>
<tr>
<td>VS (4) S (3) NS (2) NO (1)</td>
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<tr>
<td>Understandable language</td>
<td>5 2 0 0</td>
<td>3.7</td>
<td>4</td>
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<td>Individual advance promotion</td>
<td>2 5 0 0</td>
<td>3.3</td>
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<tr>
<td>Didactically Suitable for the knowledge independence</td>
<td>3 4 0 0</td>
<td>3.4</td>
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<tr>
<td>Allow concept learning</td>
<td>3 4 0 0</td>
<td>3.4</td>
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<tr>
<td>Student learn Differential Equations (DE) with them</td>
<td>4 3 0 0</td>
<td>3.6</td>
<td>4</td>
<td>4</td>
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<tr>
<td>Allow apply DE to solve problems</td>
<td>2 4 0 1</td>
<td>3.0</td>
<td>3</td>
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<tr>
<td>Allow to generalize model methods to systems solved with DE</td>
<td>1 5 0 1</td>
<td>2.9</td>
<td>3</td>
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<tr>
<td>Viable for the autonomous study</td>
<td>1 6 0 0</td>
<td>3.1</td>
<td>3</td>
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</table>

Competences-achievement analysis showed two competences achieved to a high degree. As transversal competence, it was the capacity to use and apply the technologies of the information and communication (TIC). And, as specific competence problem modelling with first-order ordinary differential equations or higher-order and partial derivatives, and interpret the particular solutions of the Ordinary Differential Equations that model problems. The competences achieved to a lower degree were the reflexive appropriation of the mathematical contents and the solving of higher-order differential equations that model problems and interpret these solutions as transversal and specific competences respectively.

The students were asked about different aspects of the proposal: orientations improvement, improved solving and evaluation and feedback. Their opinions were very positive, considering all the aspects to be in the range of suitable or very suitable. The questions asked fell within this range in more than the 90% of the cases.

5. Conclusions

In this work, we present a didactic innovative proposal to teach mathematics at the university by means of the Blended Model. The model has been validated by an expert consultancy. The proposal includes a change into the evaluation method, introducing the Competences Evaluation.

The proposal was evaluated positively by the experts, considering the proposal suitable or very suitable. This allows us to consider the model application to be viable.

Moreover, we conclude that the model was successfully applied, as the students’ opinions were very positive, with a special emphasis on the variables related with improvement in their preparation after the Independent Work and also in the rectification of the errors and resolution of doubts that appeared in the Independent Work by means of the feedback activities.

The competences evaluation system was difficult to implement due to the complexity of the interrelation of the competences identified as well as the contribution to the achievement of each activity of the didactic proposal. Nevertheless, this kind of evaluation is the most consistent with the proposal designed and contributes to the improvement of the professional capacities of the students.

References


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