Use of virtual learning environment for teaching experimentation

Pablo Alejandro Lonngi Villanueva, María de los Dolores Ayala Velázquez
Departamento de Física, División de Ciencias Básicas e Ingeniería, Universidad Autónoma Metropolitana, Unidad Iztapalapa, San Rafael Atlixco 186, Col. Vicentina, 09340, México, D. F.

E-mail: plov@xanum.uam.mx

(Received 27 July 2011; accepted 20 June 2012)

Abstract
We present how particular objectives, readings, questionnaires and enquiries in a virtual learning environment such as the Moodle platform, can be used as innovative elements for teaching experimentation in the first year at the university. Examples are given of how this promotes students' awareness of the importance of the course contents for their professional formation, their active participation in the activities and motivation to work in their own thinking and metacognitive processes, promoting their significant learning.

Keywords: Research in physics education, Teaching methods and strategies, Curricula and Evaluation, Use of communication and information technologies.

Resumen
Presentamos cómo los objetivos particulares, las lecturas, cuestionarios y encuestas de un ambiente virtual de aprendizaje como la plataforma Moodle, pueden usarse como elementos innovadores para la enseñanza experimental en el primer año de la universidad- Se muestran ejemplos de cómo estos elementos promueven el reconocimiento de los alumnos de la importancia en su formación profesional de los contenidos del curso, su participación en las actividades y les motiva a trabajar en sus propios procesos metacognitivos y de pensamiento, promoviendo su aprendizaje significativo.

Palabras clave: Investigación sobre Formación en Física, Enseñanza de métodos y estrategias, Curricula y Evaluación, Uso de la Tecnología de la Información y Comunicación

PACS: PACS: 01.40.Fk, 01.40.Ha, 01.40.gb, 01.40.J. **ISSN 1870-9095**

I. ANTECEDENTS

Courses of Experimental Method have an extended metrologic content with specialized terms quite unfamiliar in everyday language. They are offered in the 2nd and 3rd trimesters of the Basic Core (Tronco General) of the Basic Sciences and Engineering Division BSE (Ciencias Básicas e Ingeniería, CBI) at Universidad Autónoma Metropolitana, Unidad Iztapalapa (UAMI).

Pupils enrolled in BSE come from an educative environment where their only contact with experimental activities and use of measuring instruments has been through "experiments" consisting in obtaining some value(s) following the professor instructions, with no development of experimental skills, rigor and experimental scientific creativity.

Disconnection between observation of phenomena around them and reflection about the related scientific concepts and laws does not permit them to build a frame of cause-effect relations; lack of knowledge about how measuring instruments work and their characteristics, even the simplest, such as the granatary scale and the vernier caliper, makes their correct use difficult. The students' attitude, generally passive with respect to observation, thought, reflection and action in the lab or classroom, together with lack of attention, listening, concentration and deficient class note-taking, make their active and continuous participation in the laboratory difficult. This describes the situation of pupils whom we expect to graduate in 4 years and to become in 5 years excellent professionals in their field of interest.

II. PROBLEM DEALT WITH IN A VIRTUAL ENVIRONMENT

How can the BSE pupils be helped through the Experimental Method courses to become prominent professionals able to succeed in their work and society?

Aware of the complexity of the problem, we looked for ways of dealing with it in an environment appropriate to the pupils' needs and demands and we decided to take advantage of the Information and Communication Technology (ICT), which offer resources which favor and facilitate this complex task.

We chose the Moodle platform due to our knowledge of it, the fact that it offers various resources such as wikis, forums, web pages, questionnaires, polls, etc., besides facilitating file edition and upload, work control with beginning and reception closing dates, which help pupils to organize themselves and to make better use of time. Other very useful features of this type of platforms is that one can place in them various materials, enquiries, tasks and exercises, combined with other resources of the ICT that render it very versatile and adaptable to the pupils' different types of intelligence.

III. CONCEPTUAL FRAME

According to cognitive learning theory [1], learning is based on six basic principles:

- Learning and development depend on the apprentices' experiences.
- Apprentices build their knowledge in an effort to give meaning to their experiences.
- The formation of apprentices who understand depends on what they already know.
- Understanding formation is facilitated by social interaction.
- Apprentices learn to do well what they practice.
- Concrete learning experiences linked to the real world result in a deeper understanding than abstract and unconnected ones.

But how does the understanding formation process occurs and how is it stored so that it may be retrieved and related with new experiences?

We might talk about a cognitive architecture [2], similar to the architecture of a building that is the structure where its activities occur, so that our information processing system is the frame where we acquire, move and store information. This model has three main elements: information stores, cognitive processes and metacognition.

The information stores are the sensory memory, the (short term) work memory and the long term memory.

Cognitive processes –intellectual actions that transform information and take it from a store to another - include attention, perception, codification and recovery. They are analog to the information processing programs in computers.

Metacognition is the person's awareness and control over his or her cognitive processes [3]; it is the mechanism employed to supervise our learning.

The sensory memory briefly stores information until it is needed [4]. The work memory is the conscious "thinking" part of our cognitive learning system where information is organized and our understanding is built. Work memory limitations [5] cause us to be able to simultaneously elaborate just two or three information items when processing them is required instead of simply storing them [1, p. 252]. This limited capacity of the work memory has important consequences for teaching and learning, for instance, students' writing often improves more quickly if they are first allowed to ignore their handwriting quality, grammar and spelling [6], which may be the reason why pupils starting university studies don't write with good spelling. When the processing ability is well developed, students write better quality essays using word processors. Otherwise, their hand written essays are better [7].

In spite of the research about its inefficacy and the efforts to promote more advanced and effective forms of instruction, lecturing continues to be the most common teaching strategy [8].

Even though the number of elements in the work memory is limited, the elements' size, complexity and subtleness are not [1, p. 256]. This means that every interconnected relation is recorded in the memory as an information point, so that several interconnected individual points occupy just one point of the work memory. The points organized in one unit can be described as a scheme of interrelated information networks built in the work memory and recorded in the long term memory. They represent the way that our understanding is organized and stored in the memory.

Automaticity results from learning a skill to the point that it may be performed with very little conscious effort and may overcome the work memory limitations, reducing the demands made on it. If we professors use advanced forms of instruction with adequate methods, our basic teaching skills, such as discipline in the classroom, question making and clear communication should be automatic leaving enough space in our work memory to operate different models.

Once the understanding is formed and in the work memory, it is recorded in the long term memory, our store of permanent information, where it may last for the whole life [9]. The way in which information is stored in the long term memory determines if we will be able to find it when we need it (recuperation), as well as our ability to apply it in different situations (transfer).

Cognitive processes are the intellectual actions that carry information from one information store to another. They include attention, perception, codification and recovery.

Attention is the basic process of consciously focusing a stimulus. Therefore, it is the starting point of learning. If pupils participate actively in learning activities, they pay more attention than if they are just listening to explanations [10]. We are interested in active and deliberate attention, in which the learning subject concentrates his mind in a given object of knowledge that is motivated by the learning situation organized by the teacher, who can help students to train their attention concentration [11].

Perception is the process that we use to give meaning to stimuli. Pupils' perception of what they see or hear is what enters in their work memory, and if these perceptions are not precise, the information stored in their long term memory will also be imprecise.

Coding is the process of representing information in the long term memory [12] and requires precision because what remains ciphered transforms into what is remembered, for which our goal is that pupils make theirs all the meaning and the significance of the coded information. For meaning and significance one understands the personal ability to relate "something" and in turn a whole with some previous experience or knowledge. The meaning and significance depend on the number of connections or nexuses between an unknown idea with other known ideas in the long term memory [11, p. 188; 12]. We intensify the meaning of the ideas that we teach by helping pupils to connect them with other concepts. For this reason teaching the relations between ideas is convenient and necessary.

Recovery is the process of bringing information from the long term memory to the work memory and it depends on the extent in which information was coded with a meaning. For example, an interesting activity is for pupils to choose their own mnemotechnical rules to help them remember the information that becomes very useful because by concentrating his attention in the acronym, the pupil relaxes and can recover knowledge in a natural way.

Metacognition, which literally means beyond knowledge, is to grow aware and take control of our own cognitive processes. It is known that pupils who identify the form in which they study and learn and consciously work to learn, progress more than those who study passively [12].

Learning and motivation are so closely related that one cannot thoroughly understand learning without considering motivation [13]. Motivation for learning describes a pupil's disposition to find the academic activities as significant and worthy to undertake and to try to obtain from them the benefits he aspires to [14]. Motivation is a force that stimulates, supports and directs the behavior towards a goal [15]. In addition, great correlation between motivation and accomplishment has been identified [16]. Well motivated students are a source of satisfaction for their teachers because they process information in depth and they stand out in the learning experiences in the classroom, they persist in difficult tasks and they have fewer attention problems with more positive attitudes towards school that they consider satisfactory [17].

Motivation may be extrinsic or intrinsic. Extrinsic motivation is the one leading to devote oneself to an activity as a means towards an end, and intrinsic motivation is the one that moves us to be involved in an activity for the activity itself [18]. Extrinsically motivated students study arduously for an exam, because they believe that their study will be worth high grades; intrinsically motivated students study because they want to understand the content and consider that learning is something worthy by itself. But there isn't a clear separation between these two types of motivation.

The teacher's expectations are inferences about the students' behavior, academic fulfillment or attitudes [19] that strongly influence the educators' conduct and their pupils' motivation and achievements. The effects of these expectations on the way teachers treat their students may be grouped in four areas: emotional support, effort and demand, questions with feedback and evaluation. Positive expectations on the pupils' progress communicate that we believe that they can learn and that we worry about and are occupied in promoting their learning [1, p. 66].

Another important aspect that we should take into account is that the way in which we organize and conduct the learning activities also influences the students' motivation to learn and that success, challenge, concrete and personalized examples, the participation in learning activities, the feedback about the progress in learning, all increase the pupils' motivation to learn.

IV. STRATEGIC AND DIDACTIC TOOLS

The strategy consisted in taking advantage Moodle's resources to make use of them in the virtual classroom that complements in-presence sessions in the lab, where concepts are discussed, training is given in information search and in planning the experimental activities, in using measuring instruments and carrying out complete experimental activities, including the numerical and graphical data analysis, obtaining final results and comparing them with values reported in the literature and writing technical reports.

It is very important to introduce students to the web page, in order to help them to familiarized with its use, so that they can be able to consult its topics according to their particular needs.

The required infrastructure supporting this work scheme requires computer availability for everyone in the lab room, in addition to availability of a computer room for the students to use it off class, help in using Moodle and keeping it on line permanently.

A. Resources of the virtual environment

We are profiting from the following resources of Moodle [20]:

1. **Web sites.**
   The course subjects placed as sites in the virtual classroom are an essential and permanent reference to address the class sessions, their didactic strategies and their conduction dynamics.
   The basic metrological concepts and the impact of their correct usage in society and industry, reflected in ISO standards promote social responsibility in pupils.
   The ability to see in full the course contents through all of the 22 sessions gives flexibility to the class planning because it opens the possibility of choosing different routes according to the group's needs and it allows the aperture of a subject starting from the closure or synthesis of the previous one, without a sacrifice of the materials and thus reinforcing learning.

2. **Lessons.**
   The easiness of relating concepts from a specific subject by means of its partial evaluation, with the

purpose of helping pupils to practice and verify their understanding, is a very useful tool, which also promotes order and discipline for the pupil to do the complete task of reading every subject contained in the lesson, answering a short questionnaire about it and pass to the following one until completing the 4 or 5 subjects forming it. In this course only two lessons are included: one on the International System of Units (SI) and one on measurements, because we wanted to first test their effect on the pupils due to the fact that preparing a lesson is a quite complex task as well as testing its structure and that the points in the questionnaire correctly fulfill their function.

3. **Wikis.**
They are workbooks that can be written as a personal or collective task. We use them to help pupils keep an ordered account of activities, and they promote personal reflection and self-criticism, exchange of ideas, team work and the development of communicative skills.

4. **Questionnaires.**
Different types of questionnaires can be made in Moodle. Their structure, contents and the information they provide about the pupils' advancement, learning and troubles in class and in how they handle information, allow the teacher to accompany pupils in their learning process and to direct the activities in order to solve those identified difficulties. They also ease practicing concepts in problem solving for the pupil to master.

5. **Tasks.**
Different types of tasks are presented in the virtual classroom, some of them directed to information search, others to exercising in order to reinforce and consolidate knowledge and still others to help the development of pupils' thinking skills.

6. **Polls.**
This type of instrument helps to accompany pupils through their personal reflection about the teaching-learning process of the course, promoting their responsibility, compromise and reflection, which support and reinforce their learning.
In Moodle we used two types of polls. those that the platform offers by default to promote self-knowledge and self-confidence and those specifically designed by the authors to accompany pupils in their process of acquiring and reinforcing capabilities for designing and performing experimental activities, using a methodological guide, metacognitive reflection, report wording, which help us identify their gradual progress in capabilities, attitudes and knowledge, avoiding their feeling bogged down and apathy towards learning.

7. **Forums.**
They promote knowledge through the sharing of ideas, experiences and knowledge, as well as interchange of data and useful hints that may be tested by the other members of the teams in order to verify their application and convenience in concrete situations. They are means to reach an agreement about different subjects that summon them to work as a team and to be more persistent in working in the virtual classroom.
As far as we teachers are concerned, forums help us to accompany our pupils in these processes, to direct them in whatever aspects may be necessary or to call their attention towards an aspect to consider when dialogue appears to have come to a standstill.

B. A few examples

Wiki: Experimental Method. An example from a pupil's diary about the first class:
10/05/11. The course of Experimental Method started today. In this class we made a deep analysis of ourselves in which I realized that I do not know myself 100 percent as I thought. As I progressed in that activity I noticed how difficult it is for me to recognize my virtues and defects, the things I am good or bad at, etc. I also had to visualize how my life would be in 5 years. For that I first had to write what I have to do today to achieve my goals and make that visualization real. This activity seemed very original to me and I believe that it fostered socializing among us and the professors, meaning breaking the ice. I also believe that this course will be fun and very dynamic, which will make it easy to digest and this will have as a consequence a good learning if the participation of the professors and pupils is achieved. In addition, I discovered a lot of things about myself and recalled others that I had forgotten. Finally in class we analyzed the course features and explored the moodle platform where a series of activities will be done that will be useful to reinforce the subjects covered in class. In moodle one can see the synthetic contents of the course, evaluation mode, time schedule for enquiries, relevant dates, etc. Lastly I would like to add that I felt much at ease with my classmates and with the professors.

It is worth mentioning that since then this pupil keeps his diary updated and that it contains important reflections about his learning process and task analysis.

Poll: Weekly progress. With respect to the weekly progress, table 1 shows the answers of 25 pupils in the 4th week about the concept that they considered most useful for the course. Note that even though 25 persons answered the poll, the results compiled in table 1 show that some pupils considered several concepts equally useful whereas for others, the most useful concepts are different.

TABLE I. Concepts and number of pupils who considered them most useful according to the poll of the fourth week.

Concept	Number of pupils
Use of measuring instruments	4
Characteristics of instruments: type, capacity, resolution and sensibility	3
Measurements	1
Compatible measurements	1
Exactitude	1
Uncertainty	5
Propagation of uncertainties	6
Calculation of uncertainty in each measurement	1
Hypothesis	2
Quantify	1
Report contents and writing	2
Report structure	1
Data interpreting	2
Method of the parallelogram	1
Indirect measurements	2
Instrument resolution	3
Absolute, relative and percent uncertainty	3
Measurement errors	4
Knowledge in theory and practice	2
Data analyzing and interpreting	3
Relative uncertainty	1
Cooperation and collaboration	1
Perseverance, discipline and constancy	1
Intuition to formulate and corroborate hypothesis	1
All the concepts covered up to this day	1

Questionnaires: **Assessments on measurements and their uncertainties; significant figures; statistical concepts and propagation of uncertainties**. The virtual classroom for Experimental Method has different types of assessments, among which ten questionnaires on different topics.

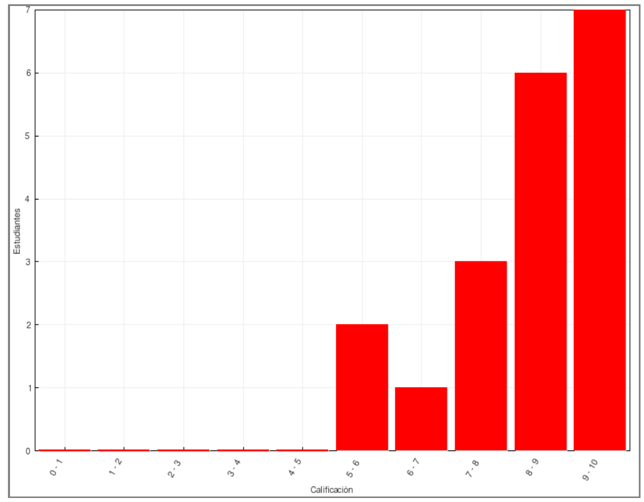

FIGURE 1. Histogram of the number of pupils obtaining the grades shown on the horizontal axis, in the questionnaire about measurements and their uncertainty.

This questionnaire was answered by 19 pupils in a total of 27 attempts, which let them achieve the grades shown in Fig. 1.

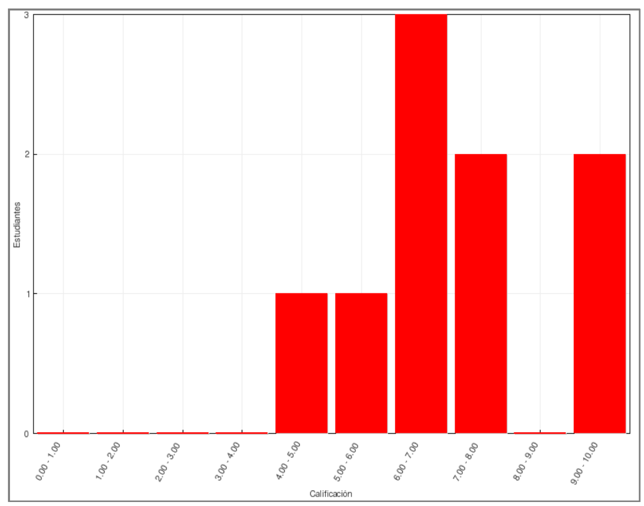

FIGURE 2. Bar graph of the number of students achieving the grade ranges shown on the horizontal axis in the questionnaire about their knowledge and understanding of significant figures.

The assessment on significant figures was answered by seven pupils in 13 attempts and only two had achieved a grade between 9 and 10.

Examples of progress in understanding concepts on statistics and corresponding grades or degree of success are reflected in Fig. 3. One can observe for the first student that in spite of practically no improvement in her first three attempts, reflecting the necessary exploration phase, at the fifth she achieved the highest grade. After that, this student, by the way, had a very noticeable change of attitude showing more self confidence and a more alert participation.

		Nombre / Apellido	Comenzado el	Completado	Tiempo requerido	Calificación/100	#1	#2	#3	#4	#5	#6	Comentario -
☐		**Nelly Martinez**	7 de febrero de 2011, 01:23	7 de febrero de 2011, 02:03	39 minutos 34 segundos	**45**	5/25	10/15	15/20	10/10	0/15	5/15	Vuelve a estudiar el material y haz un resumen
☐			13 de febrero de 2011, 20:10	13 de febrero de 2011, 21:02	52 minutos 14 segundos	**45**	5/25	10/15	15/20	10/10	0/15	5/15	Vuelve a estudiar el material y haz un resumen
☐			16 de febrero de 2011, 17:22	16 de febrero de 2011, 17:56	33 minutos 53 segundos	**50**	10/25	15/15	10/20	10/10	0/15	5/15	Vuelve a estudiar el material y haz un resumen
☐			17 de febrero de 2011, 23:42	18 de febrero de 2011, 00:03	21 minutos 42 segundos	**81**	12.5/25	15/15	15/20	10/10	15/15	13.5/15	Bastante bien
☐			20 de febrero de 2011, 22:40	20 de febrero de 2011, 23:24	44 minutos	**100**	25/25	15/15	20/20	10/10	15/15	15/15	Muy bien
☐		**Antonio Villegas**	15 de febrero de 2011, 00:40	15 de febrero de 2011, 01:35	54 minutos 58 segundos	**40**	15/25	0/15	5/20	10/10	10/15	0/15	Vuelve a estudiar el material y haz un resumen
☐			17 de febrero de 2011, 13:49	17 de febrero de 2011, 14:43	54 minutos 20 segundos	**55**	5/25	10/15	10/20	10/10	10/15	10/15	Vuelve a estudiar el material y haz un resumen

FIGURE 3. Sample of pupils' improvement answering a questionnaire on concepts of statistics.

Pr.#	Texto de la pregunta	Texto de la respuesta	crédito parcial	Nº R.	%R.	% Facil. Correct.	DT	Índice Disc.	Coef. Disc.
(1258)	Relativa x/yz : La incertidumbre relativa de una cantidad en el numerador entre el producto de dos cantidades en el denominador es la	suma de las incertidumbres absolutas de las cantidades entre el producto de las 3 cantidades	(0,00)	6/41	(15%)	40%	0,468	0,31	0,79
		suma de las incertidumbres relativas de todas las cantidades	**(1,00)**	18/41	(44%)				
		relativa del numerador menos la suma de las relativas del denominador	(0,00)	6/41	(15%)				
		absoluta del numerador entre la suma de absolutas del denominador	(0,00)	4/41	(10%)				
		ninguna de las demás	(0,00)	4/41	(10%)				
(1257)	Absoluta producto : La incertidumbre absoluta del producto de dos cantidades es igual a	suma de las incertidumbres absolutas de las cantidades	(0,00)	7/41	(17%)	60%	0,469	-0,02	0,50
		suma de las incertidumbres relativas de las cantidades	(0,00)	5/41	(12%)				
		suma de los productos de una cantidad por la incertidumbre absoluta de la otra	**(1,00)**	25/41	(61%)				
		producto de las incertidumbres absolutas de las cantidades	(0,00)	4/41	(10%)				
(1256)	Identificación de incertidumbres de funciones : Selecciona, para cada función del lado izquierdo, la respuesta correcta de entre las opciones del lado derecho.	**Incertidumbre absoluta de cos (x): sen (x) delta x**	**(1,00)**	16/41	(39%)	31%	0,296	0,13	0,75
		Incertidumbre absoluta de logaritmo natural de x: (delta x)/x	**(1,00)**	18/41	(44%)				

FIGURE 4. Sample items from a questionnaire devised to assess the pupils' proficiency about the propagation of uncertainties.

Figure 4 shows the summary of right and wrong answers in the first few questions of the questionnaire about propagation of uncertainties. The 41 attempts were distributed between 21 students who answered the questionnaire. The availability of the questionnaires for a given period of time gives students the chance to self-evaluate their understanding and progress to obtain better grades and generate attitudinal changes that lead to a deeper involvement in class. Individual student's responses can also be seen in a form similar to Fig. 3 for further analysis.

Lesson: Measurements. This lesson contains the subjects: measuring, estimating values, who measures, comparison an essential element of measuring, measuring units and analysis of units.

Figure 5 shows the initial contents of the first part of the lesson about measurements, while Fig. 6, in the edition mode, shows its structure, making explicit the different topics and different types of each part. Fig. 7 shows the degree of accomplishment of this lesson on a given date of the spring trimester of 2011.

Mediciones

Medir

Es comparar la magnitud de la cantidad desconocida que queremos determinar con una cantidad conocida de la misma magnitud, a través de un patrón definido en una unidad de medida preestablecida y convencional.

Al medir tenemos como referencia dos cosas: la característica del objeto que se quiere medir y una unidad de medida ya establecida. Al resultado de medir lo llamamos **medida**.

El hombre mide y es medido durante toda su vida. Al nacer, se registran el peso, la longitud y la temperatura corporal del bebé y, a partir de ese instante se anota su crecimiento gradual durante sus primeras horas, días, meses y años, para verificar que crece saludable.

Estimamos valores al ver, oír, tocar o cargar algún objeto; estimar la cercanía de los vehículos para ajustar la rapidez de nuestros pasos para cruzar las calles: aumentar la longitud del paso para brincar algún charco; subir o bajar el volumen de la voz para que nos escuchen; percibir un olor e identificar las sustancias que lo producen.

Podemos detectar el tamaño y el peso de los objetos, la dirección de donde proviene un sonido y comparar la distancia entre sonidos que provienen de fuentes diferentes. Distinguimos entre el ruido, la voz y la música, entre tonos graves, medios y agudos, entre un instrumento afinado y uno desafinado, entre una voz entonada y una desentonada o fuera de tiempo y todo esto lo hacemos por comparación. El reflejo o la reacción de nuestro organismo es resultado de una estimación por comparación de alguna dimensión física como la longitud, la temperatura o la intensidad luminosa.

El mercado y la economía requieren de mediciones en los procesos de intercambio y la ciencia también depende de la medición. Los geólogos miden las ondas de choque originadas por las gigantescas fuerzas que dan lugar a los terremotos; para determinar la edad de las estrellas los astrónomos miden la distancia-luz desde las estrellas distantes, los físicos necesitan realizar mediciones de millonésimas de segundo para estudiar las partículas elementales y confirmar la presencia de una partícula infinitesimal. En consecuencia, se mide una gran variedad de objetos y propiedades y medimos todos, desde el hombre común hasta el científico en un laboratorio con equipo sofisticado de alta precisión.

Al medir debe evitarse alterar el sistema en estudio, procurando no perturbarlo ni modificarlo. La elección de instrumentos adecuados bien calibrados permite realizar las medidas con precisión y reducir las incertidumbres.

Contestar preguntas

FIGURE 5. Beginning of the first part of the lesson about measurements.

Previsualizar | Edición | Informes | Calificar ensayos

Colapsado Expandido

Título de la página	Tipo de página	Saltos	Acciones
Mediciones	Tabla de ramificaciones	Medir	Agregar una página...
Medir	Opción múltiple	Quién mide Quién mide Quién mide Mediciones Mediciones Mediciones Mediciones	Agregar una página...
Quién mide	Tabla de ramificaciones	Siguiente página	Agregar una página...
Sobre medir	Emparejamiento	Sobre quiénes miden Quién mide	Agregar una página...
Sobre quiénes miden	Emparejamiento	Siguiente página Página anterior	Agregar una página...
La comparación, esencial en la medida	Tabla de ramificaciones	Comparar	Agregar una página...
Comparar	Emparejamiento	Siguiente página Esta página	Agregar una página...
Unidades de medida	Tabla de ramificaciones	Siguiente página	Agregar una página...
El concepto de medición	Opción múltiple	Siguiente página Mediciones Mediciones Mediciones	Agregar una página...
Características unidades	Opción múltiple	Siguiente página Unidades de medida Unidades de medida Unidades de medida Unidades de medida	Agregar una página...
Propiedades de las unidades	Emparejamiento	Siguiente página Esta página	Agregar una página...
Análisis de las unidades	Tabla de ramificaciones	Esta página	Agregar una página...
Ejercicios de conversión de unidades	Emparejamiento	Siguiente página Esta página	Agregar una página...
unidades	Opción múltiple	Fin de la lección Unidades de medida Unidades de medida Unidades de medida	Agregar una página...

FIGURE 6. Structure of the lesson on measurements showing the interrelation between its parts and assessments.

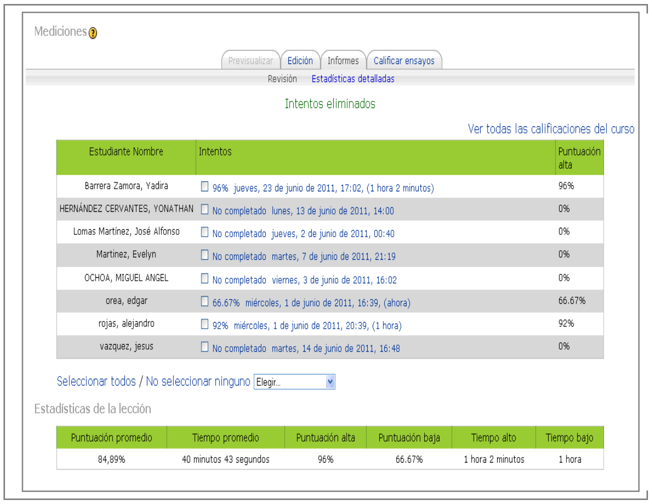

FIGURE 7. Degree of accomplishment of pupils of the spring trimester of 2011.

In Fig. 7 one notices that, out of the eight pupils who had tried to do it, just three had finished it in close to an hour achieving an average grade of 85.

Forums: Is it really very tough to pass Experimental Method? Forums are sure means to enhance ideas sharing and personal reflection through peers. Fig. 8 shows a clear example of the convenience of sharing ideas between different members of the class. The pupil who started this forum comments about how stressful the course appears to him, recognizing that this is mostly due to working in the virtual classroom, an unfamiliar environment.

After reading the opinions of his three classmates seemingly reinforcing the idea that passing the course is difficult, the forum author recovers confidence and invites them to try hard to be updated and avoid flunking the course, which would be even more stressful, and finishes writing: *Let us work hard, we are at middle term and you'll see we can make it.*

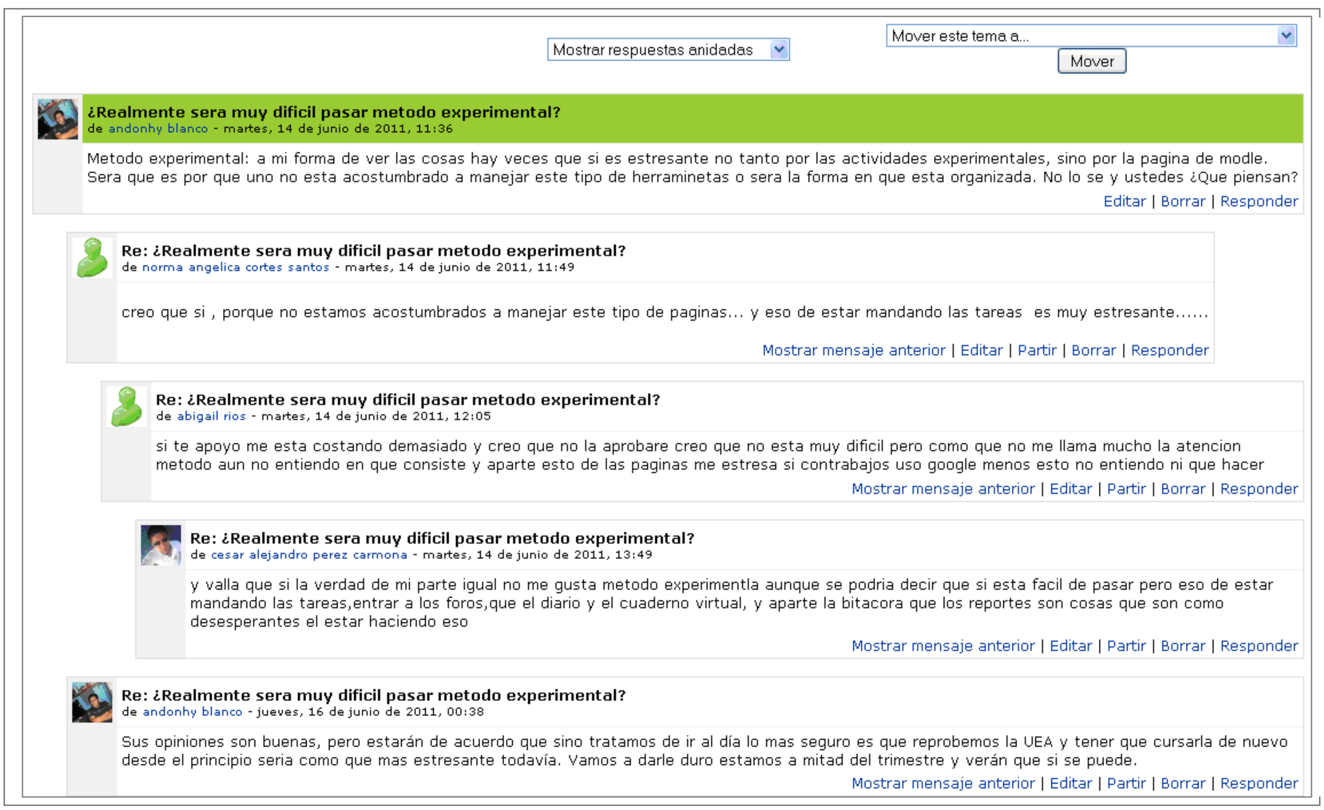

FIGURE 8. Opinion sharing among four classmates about how tough it is to pass the course.

V. ADVANTAGES AND DEMANDS

The permanence and availability of the materials in the virtual classroom allows the students to consult and use them at their own pace, as many times as it suits them throughout the trimester. The virtual classroom creates an environment of freedom which gives pupils the chance of permanent enquiry and exercising, contributing to their acquiring the necessary understanding and skills for the future generalization and systematic use of the concepts and skills in different contexts and situations in their academic and professional training.

Use of the didactic resources of the Moodle platform requires careful, continuous, attentive and rigorous work from the course facilitators, who need to be aware of each pupil's and the whole group's needs, to pay opportune attention to them through the course direction and emphasizing those materials that may help to remove and resolve concrete situations, even with the elaboration of new materials, but most importantly through the personal and daily attention to each pupil, the exchange of messages, the timely grading of homework, the reviewing of the questionnaires, and in general, maintaining the proper functioning of the virtual classroom.

VI. RESULTS

Over 50% of the initially unmotivated, disoriented, disorganized pupils, with no study or information search habits, in addition to total ignorance of metrological terminology and lack of experimental and collaborative skills, after a trimester begin to organize their activities in a realistic work timetable, to identify their own potential and began to use it through the virtual classroom activities. This motivates them and strengthens their self-esteem.

VII. CONCLUSIONS

We have used Moodle as a tool to reinforce learning of the Experimental Method course curriculum, in addition to allowing pupils to get some information and practice about learning theory and metacognition with the purpose of shortening the time for them to become independent learners. Many pupils initially resist to using Moodle due to its being unfamiliar and resisting to dedicate time to read the materials in it. We found that some pupils profit from the possibility to learn and self-evaluate their learning, while others have to be forced to even register to use it. We are convinced that, rather than leaving students completely on their own to learn, Moodle lets and requires the teacher-instructor-facilitator to be more in contact with the pupils and requires an enormous amount of work and thought to assemble the desired topics as a resource of either kind. But the results of using it in terms of improved understanding, knowledge and self-confidence are well worth it.

ACKNOWLEDGEMENTS

We are grateful to the colleagues at VIRTUAMI, the virtual classroom, for their support to solve troubles found in using Moodle. Special gratitude to Yolanda Campos Campos and Lourdes Sánchez de Tagle for sharing their experience in using CIT.

REFERENCES

[1] Eggen, P. D., *Estrategias docentes. Enseñanza de contenidos curriculares y desarrollo de habilidades de pensamiento* (Fondo de Cultura Económica, 2da. Edición, México, 2009).

[2] Sweller, J., van Merrenboer, J, and Paas, F., *Cognitive architecture and instructional design,* Educational Psycology Review **12**, 251-296 (1998).

[3] Hiebert, E. and Raphael, T., *Psychological perspectives on literacy and extensions to educational practice*, en Berliner, D. and Calfee, R. (eds,) Handbook of educational psychology, pp. 550-602, (Macmillan, Nueva York, 1996).

[4] Mayer, R.. *Cognitive theory for education: What teachers need to know,* en Lambert, N. & McCombs (eds.) *How students learn: Reforming schools through learner-centered instruction*, pp. 353-378, (American Psychological Association, Washington D. C., 1998).

[5] Bruer, J., *.Schools for thought: A science of learning for the classroom,* (MIT Press*, Cambridge,* 1993).

[6] Graham, S., Berninger, V, Weintraub, N. and Schafer, W. *Development of hand-writing speed and legibility in grades 1-9,* Journal of Educational Research, **92**, 42-49 (1998).

[7] Roblyer, M., *Integrating educational technology into teaching*, (Prentice Hall, 3ª. Ed. Upper Saddle River, Nueva Jersey, 2003a).

[8] Cuban, L., *How teachers taught: Constancy and change in American classrooms: 189-1980,* (Longman, White Plains NY, 1984).

[9] Schunk, D., *Learning theories: an educational perspective, (*Merrill/Prentice Hall, 4ª ed. Upper Saddler River NJ, 2004).

[10] Blumenfeld, P., *Classroom learning and motivation: Clarifying and expanding goal theory,* Journal of Educational Psychology, **84**, 272-281 (1992).

[11] Ferreiro, R., *Estrategias didácticas del Aprendizaje cooperativo, Método ELI*, *(*Trillas, México, 2010), p. 95.

[12] Bruning, R., Schraw, G, Norby, M and Ronning R, *Cognitive psychology and instruction,* (Prentice Hall, 4ª ed., Upper Saddler River NJ, 2004).

[13] Gagne, E., Yekovich C. and Yecovich F., *The cognitive psychology of school learning*, (Harper Callins, NY, 1993).

[14] Pintrich, P., Marx R. and Boyle, R., *Beyond cold conceptual change: The role of motivational beliefs and classroom contextual factors in the process of conceptual change,* Review of Educational Research **63**, 167-199 (1993).

[15] Brophy, J., *Motivating the subtleties of subjec-matter teaching,* (McGraw-Hill, Boston, 1998).

[16] Pintrich, P. and Schunk, D., *Motivation in education: Theory, research, and applications,* (Prentice Hall, 4ª ed. Upper Saddler River NJ, 2002).

[17] McDermott, P., Mordell, M and Sroltzfus, J., *The organization of student performance in American schools: Discipline, motivation, verbal learning and non verbal learning,* Journal of Educational Psychology **93**, 65-76 (2001).

[18] Stipek, D., M*otivation and instruction,* en Berliner, D. y Calfee, R. eds. Handbook of Educational Psychology, (MacMillan, NY, 1996), pp. 85-113.

[19] Good, T. and Brophy, J., *School effects,* en Wittrock (ed,) Handbook of research on teaching, 3r. ed., (Macmillan, Nueva York, 1986), pp. 570-604.

[20] http://virtuami.izt.uam.mx/moodle/login/index.php
http://virtuami.izt.uam.mx/moodle/course/view.php?id=138