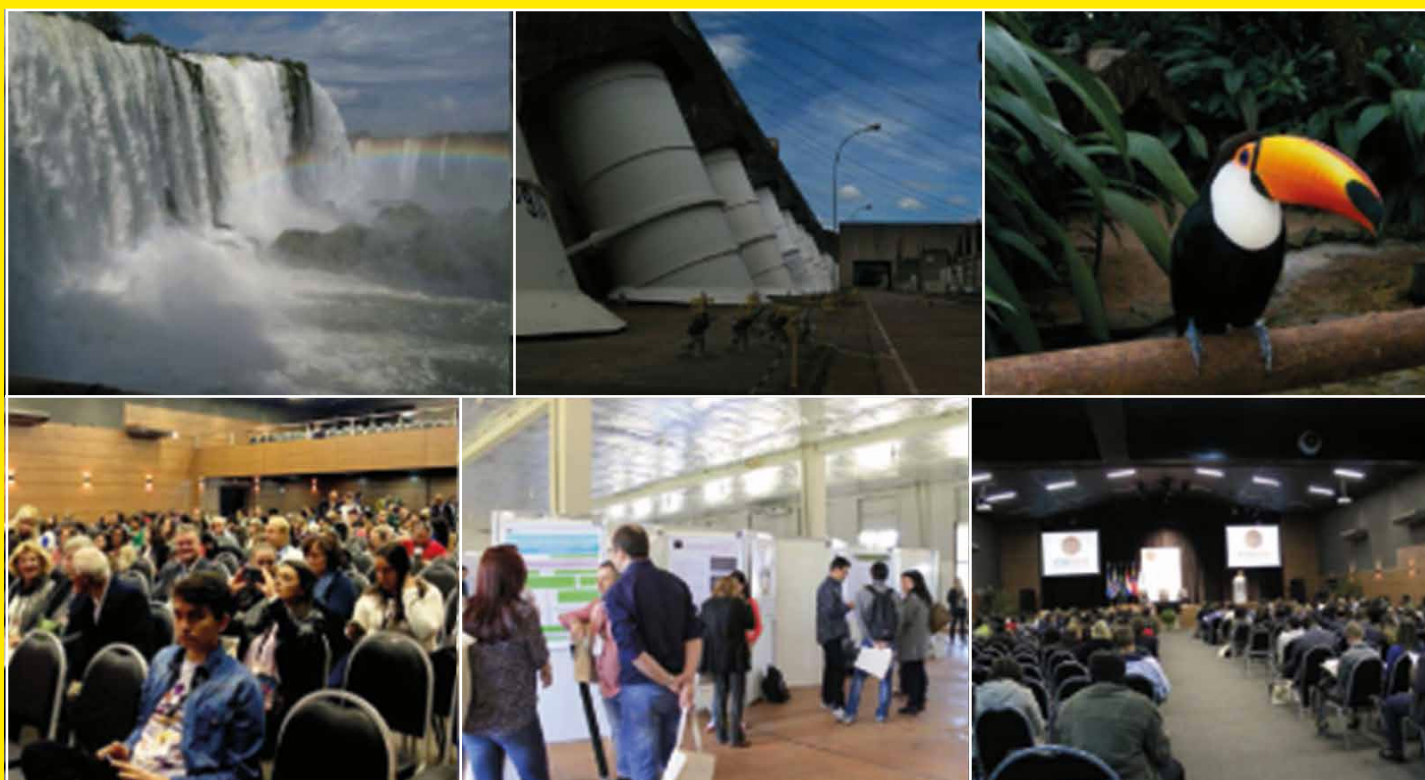


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2nd International Congress on Science Education - a question of balance within teaching and learning of science?

In August this year (2014) I was privileged to be present at the 2nd International Congress on Science Education held in Foz du Iguacu, Brazil. This was a major conference with over 700 participants and proved to be a great success and a real opportunity for participants to meet colleagues from 'across the world' to share experiences and ideas. The Congress was a fantastic experience for me that allowed me to meet with a large number of science education practitioners and enthusiasts from South America and beyond as well as an opportunity to revisit the spectacular Iguacu Falls and to visit the amazing Itaipu hydroelectric power station. I trust that most participants left the Congress with the feeling that they had had a memorable experience, learned some important things, made some new friends and professional contacts and were refreshed to start the new academic year with enthusiasm and new ideas. This Congress was a very appropriate way to mark the first fifteen years of publication of this journal and I would like to congratulate the Editor – Prof. Yuri Orlik – and his colleagues on reaching this latest 'milestone' and hope that this is the beginning of the next successful five (15!) years.

I was surprised, and stressed, when I learned that the opening lecturer for the Congress was delayed in Atlanta without a visa for entry to Brazil and I was asked to provide the opening address. The subject of my talk related to the importance of continued learning by science teachers and was exemplified by a selection of things I had learned since I retired from teaching more than ten years ago. Indeed the text of my intended presentation was substantially changed from the one printed in the 'Proceedings of the Congress' (2014 – details below) since I had come across a surprising behavior of carbon dioxide gas in balloons *after* I had written the first draft of my intended presentation. (If you were not at the Congress and would be interested in some more details of this you are invited to send me an email and I will provide a copy of my draft article. Hopefully a version of this article will be published in this Journal eventually.)

After my presentation I was approached by a colleague from the audience to say that the important message he had received from my talk was the importance of seeking an appropriate BALANCE within teaching and learning of science. This was indeed part of my talk, but not what I thought was a main message. However, this event caused me to review my own thinking about balance and I will take this opportunity of exploring this a little more in this editorial: My own concern for this was stimulated many years ago by an article by Sam Rachelson (1977) although I have tended to broaden its application beyond the parameters covered in his paper. Indeed, I now believe that there are few areas of science education (or of education more generally) where an extreme view along any dimension is the appropriate. Two, that come to mind where the extreme of the continuum is to be preferred include (a) honest – dishonest (Honesty is always preferred?) (b) engaging – boring (Engaging is always preferred, although occasionally teachers and/or students may *need* simply to deal with mundane tasks that they can carry out without much thought or stimulation?)

The following paragraph is taken directly from my talk:

“Balance. There is always an issue in finding an appropriate balance, which suits the teacher and the pupils (ideally all of whom need to be involved) and the subject matter:

Following instructions	and	Exploring
Being told	and	Discovering
Certainty	and	Tentativeness
Rigidity	and	Flexibility
Listening	and	asking questions / expressing opinions.

Perhaps most important is a mutually respectful relationship between pupils and teacher (and between students) which allows balances to be negotiated.”

Three examples of important dimensions along which balance needs to be sought will suffice here.

It is often maintained, and I believe it, that the ideal is for students to be interested and *intrinsically motivated* to learn. However this seems to be an unrealistic aspiration for most of us. To some extent we need some external motivation such as an imposed deadline (otherwise this editorial would never be written), a need to pass an examination or to complete a task for a client/boss/spouse. Ideally we need to find an appropriate balance – although I would argue that unless we have some intrinsic interest in the task in hand the level of success and of personal satisfaction will be severely limited.

Some years ago a group of primary school teachers was seconded to my Department at Manchester Metropolitan University for a whole term to experience a full time programme of practical science exploration and investigation. (One memorable investigation into a bar-magnet, found in a box, surprised us all since it had a north-pole at each end and a south-pole two thirds of the way up!) All the teachers engaged in the programme with enthusiasm, but it soon became apparent that they wanted some 'more conventional' science teaching too. They were interested, more willing to ask questions, but wanted information and ideas much more quickly. We needed to adjust the balance between 'discovering' and 'being told' urgently.

Uncertainty and certainty. I believe the role of uncertainty in science is undervalued, particularly in examinations and in the specification of National Curricula. If there is always one correct answer (and/or 'teacher always gets it right') there is little opportunity for students to exercise 'critical thinking' or to have their own ideas. Clearly there is need for balance since too much uncertainty makes learning science frustrating and pointless.

Hopefully this provides some food for thought and that readers can provide their own examples. It seems that throughout the educational process, as in good nutrition, we need a *balanced diet* to ensure healthy growth. Education is, however, even more complex since we all have differing abilities, needs and interests which change and develop as we grow and the situations in which we live change. Also the variety of knowledge, skills and ideas is boundless and constantly developing. The balance points will never remain constant and will constantly need renegotiation. One constant need we have for a fulfilling human/humane life is that we need to keep learning.

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¿Cómo desarrollar acciones de autoevaluación en el alumno desde el proceso de enseñanza-aprendizaje de la física?

¿How to develop students' actions of self-evaluation from the teaching-learning process in physics?

ESPERANZA ASENSIO CABOT

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Resumen

En el artículo se presenta la investigación en el proceso de enseñanza-aprendizaje de la física en la universidad de Ciencias Pedagógicas "Félix Varela Morales" de Villa Clara, Cuba, la cual abordó el perfeccionamiento de dicho proceso, a partir de una propuesta didáctica centrada en la aplicación de métodos y procedimientos para desarrollar en los alumnos acciones de autoevaluación de su propio aprendizaje. Se describen las ideas teóricas fundamentales que sustentan la propuesta y la metodología empleada, así como el pre-experimento pedagógico desarrollado, que aportó valiosos datos, tanto cualitativos como cuantitativos, los cuales mostraron que la asimilación de los contenidos físicos en los alumnos tuvo un comportamiento más favorable después de introducida la propuesta.

Palabras clave: acciones de autoevaluación, aprendizaje, contenidos físicos, pre-experimento pedagógico.

Abstract

The article presents the research developed in the teaching learning process of physics in the University of Pedagogical Sciences "Félix Varela Morales", Villa Clara, Cuba, which dealt the improvement of this process, from a didactic proposal centered in the application of methods and procedures to develop in the students' actions of self-evaluation of their own learning. Some ideas from the theoretical frame and the methodology applied in the research are presented, as well as, the pedagogical pre-experiment developed that contributed valuable data, both qualitative and quantitative. This showed that the assimilation of the physical contents in the students had a more favorable behavior after of the introduction of the proposal.

Key words: actions of self-evaluation, learning, physical contents, pedagogical pre-experiment.

INTRODUCCIÓN

El perfeccionamiento del proceso de enseñanza-aprendizaje de las ciencias y en particular de la disciplina física, es un tema que reviste una especial significación, dadas las limitaciones que presentan los alumnos en la comprensión de los conocimientos y en el desarrollo de habilidades en la resolución de problemas, así como en la motivación y el desarrollo de vivencias afectivas positivas (Asencio, 2012) (Huey-Por et al., 2007) (Orlik, 2007) (Méheut & Dimitris, 2004) (Gil et al., 2005) (Duit & Treagust, 2003) (Greca & Moreira, 2002) (Hammer, 2000) (Fischer, 1997).

Son múltiples las investigaciones, innovaciones y experiencias pedagógicas de avanzada, que desde diversas aristas, se han dedicado al estudio de las problemáticas referidas y han ofrecido aportes significativos para el enriquecimiento de la didáctica de las ciencias y sus didácticas particulares en los diferentes niveles educativos. Precisamente, este artículo presenta la investigación desarrollada en el proceso de enseñanza-aprendizaje de la física en la universidad de Ciencias Pedagógicas "Félix Varela Morales" de Villa Clara, Cuba, la cual abordó el perfeccionamiento de dicho proceso tomando como eje central el desarrollo de acciones de autoevaluación de los alumnos con el propósito de elevar la calidad del aprendizaje de los contenidos físicos.

Las ideas más actuales en el campo de la didáctica general y la didáctica de la física, que enfatizan en el perfeccionamiento de la calidad del proceso de enseñanza-aprendizaje reconocen la importancia de la consideración del alumno como centro de dicho proceso, destacando su papel activo en el mismo y en la autoevaluación de su propio aprendizaje (Kramarski et al., 2013) (Tausan, 2012) (Michalsky, 2012) (Crasovan, 2011) (Meyer, 2010) (Almeida & Moreira, 2008).

La autoevaluación del alumno constituye una vía esencial para desarrollar la independencia y el ejercicio de la valoración propia (Mitjans, 1995), así como tiene una influencia significativa en la motivación, las vivencias afectivas positivas en los alumnos, así como en su comportamiento y en la calidad de su aprendizaje (Taut, 2007) (Nicola & Macfarlane, 2006)

(Sperling et al., 2004).

Las prácticas de la autoevaluación en el aula favorecen que los alumnos sean más responsables y reflexivos (Dochya, Segersb, & Sluijsmansc, 1999) (Klenowskia, 1995) y propician también el desarrollo de sus potencialidades metacognitivas, cuestión de vital trascendencia para elevar su aprendizaje, su praxis cotidiana y su posterior actividad profesional (Kramarski et al., 2013) (Michalsky, 2012). La autoevaluación puede contribuir a la mejora del aprendizaje del alumno al elevar su nivel de regulación, cuando en su comportamiento logra que el planteamiento de metas, la toma de decisiones, la persistencia, el esfuerzo, la autoestima, entre otros factores, se correspondan favorablemente de manera plena en su relación con la realidad, con los demás y consigo mismo (Kitsantas, Robert, & Doster, 2004) (Schunk, 2003) (Nieves, 1999).

Las ideas expresadas en esta síntesis conforman el marco teórico que sustenta la investigación que se presenta seguidamente.

METODOLOGÍA

El diseño experimental que se empleó en la investigación fue el pre-experimento pedagógico (Sampiere, Collado & Lucio, 2006), en el cual, el mismo grupo actúa como control antes de introducir la variable independiente y como experimental después que la misma ejerció las influencias previstas; se eligió este diseño debido a que existía un solo grupo en el año en el que se realizaría la experiencia, con una matrícula de catorce estudiantes, en el cual la propia investigadora y autora del presente trabajo realizaba funciones como profesora de física. Se empleó un enfoque mixto (cuantitativo-cualitativo) en la recogida y análisis de los datos.

Como variable independiente se consideró el desarrollo de acciones de autoevaluación del alumno, mientras que la asimilación de los contenidos físicos por los alumnos fue seleccionada como variable dependiente de la investigación. A continuación se precisarán brevemente los aspectos generales que caracterizaron a las variables mencionadas.

El desarrollo de acciones de autoevaluación del alumno

Las acciones de autoevaluación del alumno como variable independiente de la investigación que se describe en el presente artículo, fueron introducidas durante el proceso de enseñanza-aprendizaje de la asignatura física IV (óptica) en el cuarto año de la carrera de la formación docente. Previamente al desarrollo del pre-experimento pedagógico fue desarrollado un entrenamiento para preparar a los alumnos que participarían en la investigación, el cual estuvo centrado en los aspectos que se mencionan en el cuadro que sigue.

ASPECTOS DEL ENTRENAMIENTO A LOS ALUMNOS

- La rememoración de contenidos teóricos relacionados con aspectos generales sobre los procesos cognitivos, afectivos, volitivos y metacognitivos necesarios para poder realizar las acciones de autovaloración.
- La presentación del diseño general de las acciones que se pretendían desarrollar, destacando en especial, los indicadores seleccionados para medir la asimilación de los contenidos y el método para el autocontrol de las tareas del trabajo extraclase.
- La realización de autocaracterizaciones de los alumnos, tomando en cuenta: lo motivacional-afectivo (motivos, intereses, propósitos, proyectos futuros, estados de satisfacción, entre otros), lo cognitivo-instrumental (nivel de la atención, capacidad de observación, características de la memoria y del pensamiento, desarrollo de habilidades y otros), lo volitivo (planteamiento de metas, toma de decisiones, esfuerzo volitivo, entre otros) y lo valorativo (responsabilidad, honestidad, laboriosidad, incondicionalidad y otros).

Desde una perspectiva general la propuesta didáctica introducida estuvo dirigida hacia la aplicación de métodos y procedimientos que propiciaran en los alumnos el desarrollo de acciones de control y valoración a través de las actividades docentes previstas en el programa de la asignatura, lo cual permitiría que gradualmente se consolidaran y perfeccionaran las acciones de autoevaluación.

Entre los métodos usados en las actividades docentes fue privilegiado el diálogo abierto entre el profesor y los alumnos, para promover el intercambio de ideas, opiniones y juicios de valor acerca de los temas en discusión. Asimismo, fueron empleadas con frecuencia las técnicas de dinámica grupal y la organización de los alumnos en pequeños grupos cooperativos, que favorecieron el incremento de las interacciones entre los alumnos; dentro de las funciones de esos pequeños grupos o equipos se encontraba el control y la valoración del trabajo de los integrantes del mismo a partir de los criterios que cada uno de ellos tenía del trabajo de los demás y del suyo propio.

Las formas adoptadas para controlar el trabajo extraclase de los alumnos que consideraban en primer término la autovaloración del propio alumno, así como la valoración periódica de las actividades desarrolladas en el proceso de enseñanza-aprendizaje, constituyeron vías importantes para desarrollar las acciones de autoevaluación. Es de destacar además, que la ejecución sistemática de consultas para analizar los resultados de las evaluaciones frecuentes y parciales, así como otras tareas que se exigía entregar por escrito, resultó de gran importancia para que los alumnos reflexionaran acerca de los errores cometidos y las causas de los mismos, propiciando el planteamiento de metas concretas para mejorar la calidad del aprendizaje.

Las cuestiones señaladas tuvieron una influencia positiva en el desarrollo de acciones de autoevaluación en los alumnos, pero, quizás lo más novedoso de la propuesta didáctica introducida en la investigación, fue la autoevaluación del alumno empleando los mismos indicadores para medir la variable dependiente, realizada en cuatro momentos durante el pre-experimento, correspondiendo el primero con el inicio del mismo y el cuarto con el final.

De esta forma, los alumnos evaluaban cómo transcurría su propio proceso de aprendizaje de acuerdo con el nivel de dominio alcanzado en los aspectos considerados y reflejaban por escrito en sus registros individuales la valoración cualitativa y cuantitativa de cada indicador, de acuerdo con las escalas seleccionadas. Además, en cada una de las etapas señaladas, conjuntamente con la autoevaluación del alumno se realizaba la evaluación por parte del profesor utilizando en ambos casos los mismos indicadores, lo que permitió establecer las comparaciones correspondientes entre los valores asignados.

En general, el empleo del registro de autoevaluación del aprendizaje permitió que el propio alumno expresara de forma escrita sus reflexiones acerca de la marcha de su aprendizaje, facilitando el seguimiento sistemático del mismo, reconociendo sus avances y dificultades, para tomar las medidas oportunas y el planteamiento de propuestas para su mejora.

La asimilación de los contenidos físicos por los alumnos

La asimilación de los contenidos por los alumnos, como variable dependiente de la investigación debía considerar los elementos que integran dicho componente del proceso de enseñanza-aprendizaje: conocimientos, habilidades, sentimientos y valores. La evaluación en la asimilación de los conocimientos y habilidades se podía realizar a partir del nivel alcanzado por el alumno en el dominio de los conceptos y las leyes físicas, así como en la solución de problemas. La asimilación de los demás elementos del contenido que conllevan a la formación de sentimientos y valores, no era posible evaluarlos en el lapso de tiempo dedicado a la asignatura, ya que estos requerían de cambios trascendentes que se alcanzan a más largo plazo.

Atendiendo al diseño experimental seleccionado, los cambios operados en la variable dependiente se evidenciaron al comparar dos estados del sujeto en distintos momentos, antes y después de ejercidas las influencias de la variable independiente. En el cuadro que sigue se describen los indicadores y escalas consideradas para medir.

Un aspecto importante a considerar durante la aplicación de la propuesta de la investigación, que aportó elementos valiosos para medir la variable dependiente fue la autoevaluación del alumno acerca de su aprendizaje, la cual como se planteó con anterioridad se realizó en cuatro momentos durante el desarrollo del experimento.

INDICADOR 1: DOMINIO DE LOS CONCEPTOS FÍSICOS.

Nivel bajo (1): Puede seleccionar los conceptos fundamentales del tema pero presenta insuficiencias en sus caracterizaciones y relaciones. Nivel medio (2): Puede seleccionar y caracterizar los conceptos estudiados pero presenta insuficiencias en las relaciones de orden jerárquico entre ellos y en su aplicación.

Nivel alto (3): Puede seleccionar y caracterizar los conceptos estudiados y aplicarlos en diferentes situaciones.

INDICADOR 2: DOMINIO DE LOS FENÓMENOS FÍSICOS Y SUS LEYES.

Nivel bajo (1): Puede describir solo algunas características de los fenómenos estudiados presentando insuficiencias en el establecimiento de las leyes, en la valoración de la significación y en la aplicación.

Nivel medio (2): Puede explicar los fenómenos y las leyes que se manifiestan de forma cualitativa y valorar su significación, pero presenta insuficiencias en el análisis cuantitativo y en su aplicación.

Nivel alto (3): Puede explicar los fenómenos y las leyes que se manifiestan en los mismos de forma cualitativa y cuantitativa, así como valorar su significación y aplicarlas en diferentes situaciones.

INDICADOR 3: SOLUCIÓN DE PROBLEMAS FÍSICOS.

Nivel bajo (1): Presenta insuficiencias en la interpretación de la información y en su valoración, por lo que no puede realizar la modelación, ni solucionar las situaciones planteadas.

Nivel medio (2): Interpreta la información y realiza la modelación, aunque presenta insuficiencias en la emisión de hipótesis, en la elaboración y ejecución de estrategias de solución en algunas situaciones planteadas.

Nivel alto (3): Interpreta la información y realiza la modelación, es capaz de emitir hipótesis, elaborar y ejecutar estrategias, así como contrastar resultados en diferentes situaciones analizando las perspectivas abiertas.

VALORACIÓN INTEGRAL DE LA VARIABLE DEPENDIENTE.

Nivel bajo (1): Cuando el alumno alcanza un nivel bajo, al menos en uno de los indicadores considerados.

Nivel medio (2): Cuando el alumno en los indicadores evaluados alcanza las combinaciones posibles, excepto las consideradas en los niveles bajo y alto.

Nivel alto (3): Cuando el alumno alcanza un nivel alto en todos los indicadores considerados.

RESULTADOS Y DISCUSIÓN

En la investigación descrita fueron aplicados diversos instrumentos, tales como: guías de observación, encuestas, entrevistas en profundidad, entrevistas grupales, pruebas pedagógicas y psicológicas, análisis de documentos, entre otros, que ofrecieron valiosos datos, tanto cualitativos como cuantitativos, que permitió conocer el estado de los sujetos implicados en el estudio con respecto a la variable dependiente, antes y después de introducir los cambios.

Del análisis realizado desde el punto de vista *cualitativo* podemos resumir, que en general todos los alumnos manifestaron avances positivos en el dominio de conceptos y leyes, así como en la solución de problemas. Dadas las limitaciones que el espacio de este artículo tiene, no es posible analizar en toda su riqueza, las valoraciones realizadas por los alumnos, sin embargo, por la importancia y novedad que representó el registro de autoevaluación se hará referencia brevemente al mismo.

Como se apuntó anteriormente el registro de autoevaluación, constituyó un elemento clave para la sistematización y consolidación de las acciones de control valorativo del alumno, al quedar reflejadas en forma escrita sus principales ideas y criterios acerca de su propio proceso de aprendizaje; entre los instrumentos que conformaron el registro, se destacaron: la autocaracterización realizada antes de iniciar el experimento pedagógico, el autocontrol de las tareas orientadas como trabajo independiente, así como la autovaloración cualitativa de su aprendizaje en las etapas consideradas, atendiendo a los indicadores mencionados. Como ejemplo de este último aspecto mencionado se presenta un fragmento de las valoraciones del alumno V.G.L.

“En el indicador I, a través del estudio del tema pude seleccionar correctamente los conceptos fundamentales definiendo las propiedades de esos conceptos; fui capaz de relacionar los mismos y establecer la jerarquía entre ellos; sin embargo *presenté dificultades en la representación gráfica* desde el punto de vista de las magnitudes y sus dependencias unas de las otras, aunque ya posteriormente pude vencer esa dificultad, en la escala valorativa que mide este indicador me encuentro en el *nivel 2*. En el indicador II, presento dificultades para elegir el modelo físico que permite explicar el fenómeno, sin embargo puedo describir los rasgos generales y esenciales que se manifiestan en el fenómeno donde está presente la ley; identifico correctamente las magnitudes que intervienen en la ley o ecuación y conozco la relación que existe entre ellas pero *no puedo precisar correctamente* los límites de aplicación de las leyes o ecuaciones, por lo que ubico en el *nivel medio (2)*. En el indicador III, interpreto la información y soy capaz de hacer la modelación correspondiente, pero *no puedo emitir hipótesis* sobre la explicación del fenómeno, aunque puedo elaborar estrategias de solución y ejecutar las acciones; *no he reflexionado sobre las perspectivas abiertas* para resolver otros tipos de problemas, en general me ubico en el *nivel 2*”.

En otro momento posterior del curso este propio alumno expresa:

“En el indicador I he alcanzado un *buen dominio de conceptos* ya que soy capaz de definir las propiedades generales y esenciales, así como establecer las relaciones entre ellos; a partir de estos conocimientos puedo resolver hasta nuevas situaciones; por ello me ubico en el *nivel 3*. En el indicador II, puedo explicar los fenómenos estudiados y las leyes que se manifiestan en los mismos, pero en *algunos casos presenté limitaciones* para resolver nuevas situaciones, por lo que me ubico en el *nivel 2*. En lo que respecta al indicador III, en algunos casos presento problemas con la modelación, pero *he logrado mejorar en cuanto a la emisión de hipótesis*. Al igual que en el segundo indicador presento *algunas limitaciones ante la resolución de nuevas situaciones por lo que me ubico en el nivel 2*. En general *considero que el trabajo que hemos desarrollado en este curso es de suma importancia, ya que nos ha permitido conocernos desde otro punto de vista, somos capaces de valorar nuestro aprendizaje y desarrollar habilidades que hasta este momento no habían sido desarrolladas*. Ojalá que pueda ser extensivo a otros profesores, me queda una gran experiencia”.

Por otra parte, los resultados *cuantitativos* de la investigación pueden apreciarse en las Tablas 1 y 2.

Tabla 1. Indicadores antes del experimento

Ind/ No A	1	2	3
1	1	2	2
2	1	1	1
3	1	1	1
4	2	2	2
5	1	1	1
6	1	1	1
7	1	1	1
8	2	1	1
9	2	1	1
10	1	1	1
11	2	2	1
12	1	1	1
13	2	2	2
14	2	2	2

Tabla 2. Indicadores después del experimento

Ind/ No A	1	2	3
1	3	3	3
2	2	2	2
3	3	3	3
4	3	2	2
5	2	2	2
6	3	3	3
7	2	2	2
8	2	2	2
9	3	3	3
10	2	2	2
11	3	3	3
12	2	2	2
13	3	3	3
14	3	3	3

Del análisis comparativo entre los datos que aparecen en las dos tablas se observa que 12 alumnos subieron de nivel en todos los indicadores, mientras que un alumno alcanzó un nivel superior en dos indicadores y solo un alumno subió en un indicador manteniendo el nivel medio en el resto. La comparación entre los indicadores antes y después puede observarse también en los gráficos que aparecen seguidamente.

Un análisis más profundo de los datos que aparecen en las Tablas 1 y 2 fue realizado mediante la prueba de Wilcoxon, utilizando el paquete estadístico SPSS; lo anterior se resume en el cuadro que sigue.

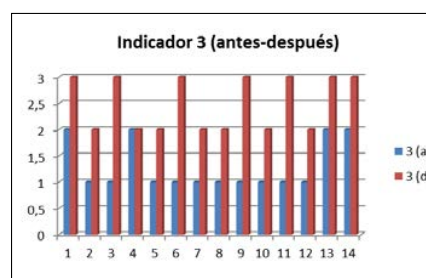
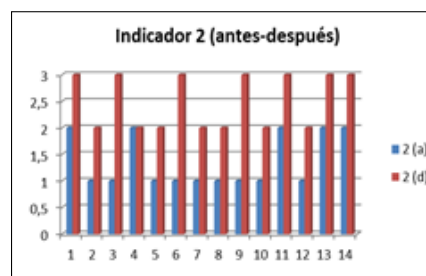
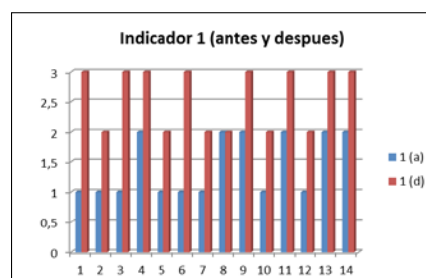


Tabla 3. Indicador 1

No	ESTADO 1		ESTADO 2		ESTADO 3		ESTADO 4	
	A	P	A	P	A	P	A	P
1	2	1	2	2	2	2	2	3
2	1	1	1	1	2	2	2	2
3	2	1	2	2	2	2	3	3
4	2	2	2	2	2	2	3	3
5	2	1	2	1	2	1	2	2
6	1	1	2	2	2	2	3	3
7	1	1	2	1	2	1	2	2
8	2	2	2	1	2	1	3	3
9	1	2	2	2	2	2	3	3
10	1	1	2	1	2	2	2	2
11	1	2	1	2	2	2	3	3
12	2	1	2	2	2	2	2	2
13	2	2	2	2	2	2	3	3
14	1	2	2	2	2	2	3	3

Tabla 4. Indicador 2

No	ESTADO 1		ESTADO 2		ESTADO 3		ESTADO 4	
	A	P	A	P	A	P	A	P
1	2	2	2	2	2	2	2	3
2	1	1	1	1	2	2	2	2
3	1	1	1	2	2	3	3	3
4	2	2	2	2	2	2	2	2
5	2	1	2	1	2	2	2	2
6	1	1	2	2	2	2	3	3
7	1	1	2	1	2	2	2	2
8	2	1	2	1	2	1	3	2
9	2	1	2	2	2	2	3	3
10	2	1	2	2	2	2	2	2
11	1	2	2	2	2	2	3	3
12	2	1	2	1	2	2	2	2
13	2	1	2	2	2	2	3	3
14	1	2	2	2	2	3	3	3

Tabla 5. Indicador 3

Nº	ESTADO 1		ESTADO 2		ESTADO 3		ESTADO 4	
	A	P	A	P	A	P	A	P
1	2	2	2	2	2	2	2	3
2	2	1	2	1	2	2	2	2
3	1	1	2	2	2	2	3	3
4	2	2	2	2	2	2	2	2
5	2	1	2	1	2	2	2	2
6	1	1	2	2	3	2	3	3
7	1	1	1	1	2	2	2	2
8	2	1	2	1	2	2	2	2
9	2	1	2	2	2	2	3	3
10	2	1	2	2	2	2	2	2
11	2	1	2	2	2	2	3	3
12	2	1	2	1	2	2	2	2
13	2	2	2	2	2	2	3	3
14	1	2	2	2	2	3	3	3

Para la comparación de los datos se plantearon las siguientes hipótesis:
 Ho: no existen diferencias significativas en el grupo experimental antes y después del pre-experimento con respecto a los indicadores seleccionados.

H1: El grupo experimental tiene un comportamiento más favorable después del pre-experimento en los indicadores seleccionados.
 Para la aplicación de la prueba se consideró como nivel de significación 0,01, por lo que el nivel de confiabilidad fue del 99%. Los resultados obtenidos en la para cada indicador muestran que en todos los casos existen diferencias significativas entre los datos, por lo que se acepta la hipótesis alternativa (H1), que considera que el comportamiento de cada indicador es más favorable después del pre-experimento con respecto al inicio del mismo, con una confiabilidad del 99%.

Además, se hará referencia brevemente a los resultados de la autoevaluación cuantitativa de los alumnos de los indicadores seleccionados en los cuatro momentos considerados, los cuales se resumen en las tablas 3, 4 y 5, en la cual aparecen también las evaluaciones del profesor. Si se comparan las autoevaluaciones de cada alumno en el tránsito por los estados señalados es posible advertir, que en la mayoría de los casos se reconocen cambios hacia niveles superiores, lo cual constituye otro elemento que aporta a la validación de la investigación. Por las limitaciones del espacio del artículo no es posible profundizar en el análisis de los datos que ofrecen estas tablas, del cual pueden inferirse otros resultados interesantes relacionados con las visiones de los alumnos de sus propios cambios en cada uno de los indicadores seleccionados.

Con relación a la comparación entre los valores de la autoevaluación del alumno y la evaluación del profesor se pudieron obtener los coeficientes de casos coincidentes para cada indicador, los cuales aparecen en la tabla 6. El análisis de la tabla muestra que existió un incremento gradual del valor del coeficiente a medida que transcurría el proceso que evidencia una elevación en la coincidencia de la autoevaluación de los estudiantes y la evaluación del profesor, lo cual aporta elementos acerca de la tendencia positiva en el desarrollo de las acciones de control y valoración por parte de los alumnos.

La evaluación integral de la variable dependiente fue obtenida tomando en cuenta las escalas valorativas descritas con anterioridad. En la tabla 7 se muestran los niveles alcanzados por cada alumno en la evaluación integral de la asimilación de los contenidos, antes y después del experimento pedagógico. Como se aprecia, antes del experimento 12 estudiantes se encontraban en el nivel bajo y 2 se encontraban en el nivel medio; después del experimento 9 estudiantes alcanzaron el nivel medio, mientras que 5 estudiantes se ubicaron en el nivel alto.

La comparación de los datos de la tabla y el gráfico correspondiente nos permiten apreciar que 6 alumnos subieron del nivel bajo al nivel medio, 2 alumnos subieron del nivel medio al alto, mientras que 5 alumnos subieron del nivel bajo al alto. Solo se presentó un caso en el cual se mantuvo el nivel medio; este caso correspondió a un alumno que presentó problemas de salud que limitaron su participación en las actividades realizadas.

CONCLUSIONES

Un análisis integral de los resultados cuantitativos obtenidos en la evaluación de los indicadores seleccionados, así como el análisis de contenido y triangulación de los datos cualitativos, permite apreciar que la variable dependiente asimilación de los contenidos, tiene un comportamiento más favorable después del experimento pedagógico con

respecto al inicio del mismo.

Es importante destacar que la investigación también fue validada por un grupo de 30 expertos que ofrecieron criterios favorables acerca de la misma, lo cual contribuyó a disminuir la influencia de la subjetividad de la investigadora, quien como profesora del grupo y autora de la propuesta, mantuvo fuertes lazos de implicación afectiva y de compromiso con la investigación desarrollada.

Asimismo, son reconocidas limitaciones del diseño experimental seleccionado, el cual tiene un grado de control mínimo, por lo que podían haber existido otras variables (ajenas) capaces también de generar cambios. Es preciso dejar claro que el proceso de enseñanza-aprendizaje es un proceso muy complejo en el cual influyen múltiples factores, de ahí que no es posible establecer relaciones seguras de causalidad entre la variable independiente y la dependiente en esta investigación.

No obstante, se considera que quizás el aporte fundamental de la investigación pueda estar en su valor metodológico, al mostrar cómo opera la propuesta didáctica en la práctica y sus posibilidades de aplicación no solo en el proceso de enseñanza-aprendizaje de la física, sino también en otras disciplinas del área científica. Es importante destacar también, la trascendencia del tema tratado en la formación de profesores, por lo que representa la formación y desarrollo de acciones de control y valoración como habilidades propias de la profesión docente, así como en el valor de la propuesta didáctica como modelo de actuación en su trabajo futuro como profesor.

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Testing Students' Chemistry Knowledge by Web-Based EChemTest

Evaluación de los conocimientos por EChemTest basado en Web

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Abstract

Active and intensive chemistry curricula designing at a higher education level has been done during several years to achieve comparable degrees around Europe. Universities have now implemented for a few years in practice the new curricula derived from the Bologna process. During this process common learning outcomes have been defined both at the degree level as well as at a single course level. To evaluate chemistry competence in those core areas a set of computer-based tests, EChemTest, have been developed and provided by the European Chemistry Thematic Network Association (ECTNA). These tests are now applied in research-based teaching in chemistry.

Key words: research-based teaching, EChemTest, web-based teaching, chemistry knowledge

Resumen

El diseñar de planes de estudios de química activa e intensiva en Europa a nivel de educación superior, se efectúa durante varios años para lograr las graduaciones comparables. Las universidades han implementado desde hace algunos años en la práctica los nuevos planes de estudio derivados del proceso de Bolonia. Durante este proceso los resultados del aprendizaje común se han definido tanto a nivel de grado como a un solo curso. Para evaluar la competencia de química en esas áreas básicas de un conjunto de pruebas informatizadas se han desarrollado EChemTest y proporcionado por la Asociación Europea de Química (ECTNA). Ahora, estas pruebas se aplican en la enseñanza basada en la investigación en química.

Palabras clave: enseñanza basada en la investigación, EChemTest, enseñanza en internet, química

INTRODUCTION

A large-scale university degrees reform came into force in autumn 2005 when universities all over Europe renewed their curricula to adhere to the Bologna Declaration. The greatest change was to build up two cycle degrees (3 + 2): Bachelor of Science (3 years) and Master of Science (2 years). In chemistry, several European Universities have put a lot of their expertise into developing compatible, comparable and transparent curricula. The European Chemistry Thematic Network Association (ECTNA) and a group of teaching oriented chemists have supported Universities in an EU funded projects called Tuning Educational Structures in Europe 1-4 (2001-2009) (González, 2003) and other projects: ECTN Core Chemistry: teaching methods and assessment 1999-2001, ECTN3 Future of Master of Science in Chemistry 2004-2007 and ECTN Objective 1: Pre university chemistry evaluation tests 1997. These works consist of a methodology to (re-) design, develop, implement and evaluate study programmes. In these projects the common content of first degree courses in chemistry across Europe were identified. During this renewal the workload and learning outcomes in chemistry were carefully specified both at the degree level as well as at a single course level (Tuning 2008, link). The bachelor degree has been valid for job markets in UK, and the Bologna process has made it more popular also in other European countries. A survey of the employability of chemistry first cycle graduates shows that the bachelor degree is now a true exit point to the labour market in the entire Europe (Employability Book, 2009, link).

The standardisation work of degrees has been expanded and now all three degree cycles (bachelor, master and doctor) have been defined. The curricula are described in terms of workload, level, learning outcomes, competences, profiles and teaching methods (González, 2003, Tuning 2008, link). The main objective of this extensive renewal is to get transparent degrees and encourage students' and teachers' exchange programmes. Also enhancing quality assurance on the programme and degree level was targeted.

During the Bologna process, the chemistry Eurobachelor® - (180 ECTS) (Eurobachelor Label, link) and Euromaster® degrees (120 ECTS) (Euromaster Label, link) were designed. In these degrees the core areas and the scope of study are defined so that they are comparable in

European terms. One of the objectives was to increase the mobility of student exchange in a way that studies in other European universities can be more easily credited into the degrees without increasing the study years significantly. The Department of Chemistry at the University of Helsinki has been actively involved in this collaboration and was granted the first Eurobachelor® license in Europe in 2005. The Euromaster® license was granted in 2008. Licenses are valid for five years, after which they must be re-applied from ECTNA or their co-agencies (Chemistry Eurolabels, link).

To evaluate these learning outcomes and chemistry students' knowledge and skills, a set of computer-based tests, EChemTest, have been developed and distributed by the ECTNA. The tests are structured into three levels (pre-university levels 1 and 2, Bachelor level 3 and Master level 4) each in three difficulty grades. The individual tests cover over five chemistry topics (analytical, biological, inorganic, organic and physical chemistry).

Professional career evolution as well as life-long-learning process is also important perspectives for the test development. More than 130 major chemistry university departments from over 30 European countries have participated in designing and developing the process (Salzer, 2005). Currently there are thousands of questions available in English in the various chemistry domains. Translations are available in altogether 21 languages. These translations also enable the evaluation of understanding chemistry in a foreign language. The bachelor level, level3, tests cover the major fields of chemistry and there are five chemistry domains which are considered to evaluate the chemistry knowledge after Eurobachelor studies. The sixth domain is chemical engineering.

EChemTest can be used as a tool for measuring the knowledge of a **professional worker:** of progression at work, of self-evaluation for motivation and starting a formal course, or taking a national examination ; **student:** of evaluation of the chemistry knowledge as well as the understanding of chemistry in a foreign language, to undertake a period of study in another country, or to evaluate competence at a European level ; **citizen:** to pursue life-long learning.

At the University of Helsinki EChemTests (Level 2) are applied in research-based teaching in chemistry to assess the chemistry knowledge of first year students right in the beginning of their university studies. Our research interest is focused on how these curriculum reviews have succeeded at the University of Helsinki and what kind of teaching methods best support the cumulative chemistry knowledge construction and achievement of learning outcomes.

THE STRUCTURE OF THE ECHEMTEST DATABASE

EChemTest is a one hour test composed of up to 30 questions of different types, taken at random from a large question bank, covering the European Core Chemistry Program at three different levels equivalent to (EChemTest, link):

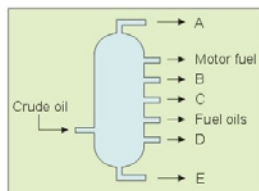
- a person at the end of compulsory education (Level 1, General Chemistry 1)
- a person at the beginning of university studies (Level 2, General Chemistry 2)

- a person at the end of the core chemistry syllabus at the university level as defined in the **Chemistry Eurobachelor** (Level 3, Analytical Chemistry; Biological Chemistry; Inorganic Chemistry; Organic Chemistry; Physical Chemistry)

- a person at the end of master's degree in one of the specialised chemistry area in agreement with the **Chemistry Euromaster** requirements (level 4)

The test is designed to measure different types of learning: recall and understanding of facts, application of knowledge and evaluation and synthesis of information. It consists of several different types of questions: multiple choice, multiple response, numeric, text, graphical 'hot-spot', drag and drop, matrix and ranking/matching. No special computing skills are required to take the test, apart from being able to use the mouse to point and click, or the keyboard to type single word or numeric answers (Figures 1 and 2).

The following schematic diagram represents the fractional distillation of crude oil (crude petroleum) in industry. The letters A to E denote different products obtained from the distillation.



Question: Which **one** of the fractions A to E contains hydrocarbons with relative molecular masses in the range 50 to 70 ?

Answer:

Calculate how many grams of CaC_2 lead to 22 g of ethanal.



Relative atomic masses:

$A_r(\text{H}) = 1.01$ $A_r(\text{O}) = 16.00$

$A_r(\text{C}) = 12.01$ $A_r(\text{Ca}) = 40.08$

Answer:

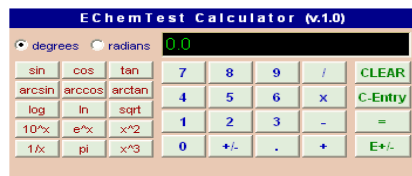


Figure 1. An example of an *EChemTest* Level 2 question.

Figure 2. An example of an *EChemTest* Level 2 question. An on-line calculator is provided by *EChemTest*.

Questions for Level 1 and 2 tests were designed and prepared by a large group of European chemistry teachers from upper secondary schools and higher Education areas from all European countries. To start, contemporary European chemistry curricula were examined at school level. Because of the different industries (chemical manufacturing, mining, pulp and paper etc.) and natural resources, curricula in the various European countries differ slightly. Tests were based on chemistry curricula common to 80% of countries. Questions were pre-tested by students in different countries to define the appropriate difficulty categories.

Tests have been produced by using the commercially available software QuestionMarkPerception®. This software support institutions of higher learning with a range of assessment management capabilities for measuring, analysing and documenting knowledge, skills, abilities and attitudes (Questionmark, link). Questions have been translated into 21 different European languages and are available on-line for ECTNA member Universities and Institutes (EC2E2N, ECTNA & ECEENA Members, link). Tests are administered by nine testing centres around Europe (Testing Centres, link). These testing centres are ready to set up tests upon request. To get acquainted with a computer based *EChemTest*, *Demotest* version is available on-line for everybody (*Demotest*, link) after registration at no cost.

We report in this article our aims and tools conducting Level 2 tests which are designed to evaluate the level of competence in chemistry equivalent to

that of a person at the start of university education. The test consists of 30 questions covering the 10 topics (library) given below, with 10 questions in each of the three categories of difficulty: introductory (memory, basic concepts and knowledge), intermediate (basic knowledge applications, logical thinking), advanced (problem solving and complex interaction) (General Chemistry 2, link).

Atomic structure: Atomic model, isotopes - Electron cloud (orbitals s, p, d, f) - Periodic table - Periodic properties of elements - Amount of substance, Mole, Avogadro's constant

Chemical reaction: Chemical equation, balancing equations - Reaction series, chemical calculations (masses, volumes, mole concentrations) - Transition complex, activation energy - Determination of rates of chemical reactions - Factors affecting reaction rates - Catalysis (homogeneous, heterogeneous, enzymatic catalysis)

Chemical bonding: Electronegativity - Ionic, covalent and metallic bonds - Dipole-dipole bond, hydrogen bond - Dispersion forces (van der Waals bond)

States of matter: Changes of states - Models of solid and gas states - Laws of gases - Solutions - Concentration

Acids and bases: Protolysis - Conjugate acids and bases - Acidity and basicity - pH of aqueous solutions, Ionic product of water K_w - Acid-base equilibrium, use of dissociation constants K_a and K_b to calculate the pH for weak acids and bases - Titration curve - Buffer solutions

Energy: Endothermic and exothermic reactions - Enthalpy - Energy of formation - Hess's law

Redox reactions: Oxidation and reduction - Oxidation number - Coefficients in Redox equations - Activity series of metals - Electrode potentials - Electrolysis (Faraday's law)

Chemistry of elements: Characteristic properties of elements and compounds in groups I...VIII - Trends in properties of elements and compounds in main groups and in period 3 - Transition metals (existence of several oxidation states, compounds)

Chemical equilibrium: Dynamic nature of equilibrium - Homogeneous equilibrium (Chatelier's principle, changes of pressure, temperature and concentration) - Equilibrium constant

Organic chemistry: Homologous series - Functional groups and the corresponding compounds - IUPAC Nomenclature- Structural and stereo isomers - Organic reactions (substitution, addition, elimination, polymerization : addition and condensation, reactions of functional groups)

TECHNICAL ISSUES AND QUALITY CONTROL

At the beginning of the *EChemTest* development work it was decided not to develop "just another" computer-based platform, but we choose QuestionMarkPerception® software, a professional assessment management system allowing us to provide a fully reliable Internet service, such as authoring, delivering, scheduling, reporting etc. and allowed us to concentrate our efforts on the content and data structure.

QuestionMark®, the professional company, provides the technologies according to regulatory compliance, enabling us to securely measure our candidate's knowledge, competences and skills; based on learning outcomes fulfilling our needs and goals (student monitoring, certification, customized tests) (Questionmark, link).

As previously described our approach led to a Euro-curriculum proposal in Chemistry at 4 different levels. In order to face the assessment needs by covering all topics in a uniform way, it was agreed in the 1997 Helsinki meeting to build up a database frame matching our Euro-Curriculum structure and following a taxonomic-like approach. A large campaign involving students and institutions from several countries was first conducted to analyse the process and draw the best possible quality service guidelines, serving recognition and credibility. To achieve this goal throughout a consistent framework, we setup a number of standard points for our databases and assessments, now commonly accepted as working and drawing rules

- **Euro-Curriculum topics.** A Set of libraries covering one scientific curriculum topic "Level-Domain-Difficulty" providing a flexible, powerful, adaptable and updatable frame for the future.

- **Taxonomic approach.** Increasing difficulty and progressive scoring throughout the test: introductory (memory, basic concepts & knowledge), intermediate (basic knowledge applications, logical thinking), advanced (problem solving and complex interaction).

- **Online Services.** Provided at local Member Institutions for standard monitoring, and at dedicated Test Centres approved by ECTNA (MoU)

for Certification purposes. Web-based test structure and delivery of an one hour test duration, composed of up to 30 questions extracted at random from the database described above, providing a standard scoring evaluation and a powerful Statistical Analysis tool, Interactive Questions permitted by the Java technology, and ensuring diversity with several types of questions.

- **Test Centres (TC).** Having Examination protocol (Administrative, Monitoring Technical resources,), in the 9 TC in operation (Amsterdam, Cracow, Helsinki, Lyon, Madrid, Perugia, Reading, Thessaloniki, Vienna). To manage all the system, we organized a centralized Supervision and Administration unit exists, with permanent local teams of Manager, Administrator, Advisor, Reporter.
- **High Quality Services.** Quality assurance according to CAA rules require the maintenance and upgrading computer rooms to current standards and a HelpDesk service which is provided by the EChemTest Experts and QuestionMark® (compatibility, sustainability, upgrade) support.

HOW TO APPLY EChemTEST IN RESEARCH-BASED TEACHING

Research-based teaching can be approached several ways. Healey (Healey, 2005) differentiates between research-led, research-oriented and research-based curricula. In a research-led curriculum students learn about research findings. The curriculum content is dominated by staff research interests, and information transmission is the main approach to teaching. In a research-oriented curriculum students learn about research processes. The curriculum emphasises both the process of knowledge creation and the learning process. In a research-based curriculum students learn as researchers through inquiry-based activities. The division of roles between teacher and student is minimised. In Chemistry, research-based teaching is often carried out with simulation-of-research or other research-like activities (Goedhart, 2009).

According to the strategy of University of Helsinki 2010-2012,

“... teaching will be based on scholarly research. The provision of teaching will be drawn from multi-disciplinary research information on university-level teaching and learning. The objective of teaching and guidance is a student-focused, deep learning process that creates the basis for life-long learning.”

At the University of Helsinki, research-based teaching means that teaching and assessment practices are based on research university pedagogy. This overlaps with evidence-based teaching and is a part of research-based educational development. Our teaching derives from intensive research in teachers' own discipline and is strongly related to their own research areas. We also try to integrate students into the existing research projects as early as possible already at the bachelor level.

We are currently carrying out statistic studies about using the EChemTest session results and they will be published later. Our initial task is to assess the level of chemistry knowledge of our new students when they start their studies. Our aim is to follow up the progress of our students' specific subject knowledge and to enhance and improve the learning process by applying research-based teaching in chemistry. We want to examine if there are any gaps between their knowledge and the first university course learning objectives. We are also interested in what kinds of approaches to learning and studying our students have (Marton, 1976, Entwistle, 2001). Our aim is to elaborate teaching methods which encourage our students to deep learning and meaningful knowledge construction. We also want to keep track on how the curriculum renewal has succeeded. For those objectives EChemTests provide an excellent tool to carry out the research.

With these web-based tests we can monitor the students' chemistry knowledge accumulation at the end of primary school up to bachelor's thesis of higher education. At the figure 3 is shown how average scores

per question are distributed in General chemistry level 1 test taken in upper secondary school. The students made the test by using iPads.

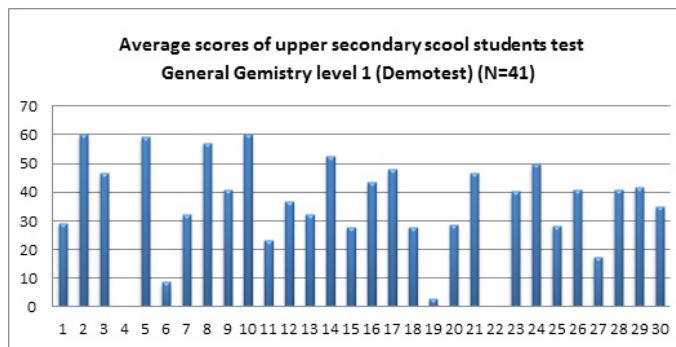


Figure 3. Average scores of upper secondary school students General Chemistry test Level 1 Demotest (max 60 points/question).

The advantages of using EChemTests are the easy set-up of tests and versatile possibilities of analysing and reporting the test results. Students appreciate the immediate feedback they get of their success.

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Innovación en evaluación de aprendizajes: evaluación por estaciones en un curso de toxicología veterinaria

Innovation in assessment of learning: evaluation on stations in a course of veterinary toxicology

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Resumen

En los últimos años en el curso de toxicología y enfermedades toxicológicas de la carrera de veterinaria de la Universidad de la República (Uruguay) se han incrementado las actividades prácticas a partir de un mayor número de grupos y de la inclusión de nuevos temas por lo que se implementó una innovación en el sistema de evaluación por estaciones del curso práctico. El propósito de este trabajo es describir la primera experiencia de evaluación por estaciones del curso de toxicología. Las estaciones fueron quince y se ubicaron en forma de circuito. Los estudiantes pasaron de una estación a la otra, sucesiva y simultáneamente, al escuchar la señal que así lo indicaba cada 90 segundos. En las estaciones los estudiantes observaron plantas frescas, hongos, fotos, placas de cromatografía, y contestaron preguntas: de opción múltiple, completar espacios y respuesta corta, en su hoja de respuestas. La preparación de la evaluación por estaciones insumió mucho tiempo, pero permitió evaluar 255 estudiantes en 4 horas y facilitó sustancialmente la corrección. Los estudios estadísticos comparando las pruebas parciales teóricas con las pruebas prácticas (herbario y evaluación por estaciones) permiten concluir que estas últimas son pruebas complementarias de las primeras.

Palabras clave: Evaluación de aprendizajes, evaluación por estaciones, toxicología veterinaria.

Abstract

In recent years practical activities of the course of Toxicology and Toxicological Disease of the career of Veterinary Medicine of the Universidad de la República (Uruguay) has been risen by increasing the number of groups and including new topics so that an innovation in the evaluation system was implemented, the "evaluation on stations". The purpose of this paper is to describe the first experience of "evaluation on stations" in the course of Toxicology. The stations were 15 and were placed in the form of a circuit. Students went from a station to another, successively and simultaneously, and change to the next station at a signal every 90 seconds. At the stations students observed fresh plants, fungi, photos, chromatography plates, and answered multiple choice questions, filled in blanks and wrote short answers in their answer sheets. The preparation of the assessment tool took long time, but allowed the testing of 255 students within 4 hours and substantially facilitated marking. Statistical studies comparing the partial theoretical tests with the practical tests (Herbarium and evaluation on stations) allow the conclusion that the latter complements the former.

Keywords: Assessment of learning, evaluation on stations, veterinary toxicology.

INTRODUCCIÓN

¿Qué evaluamos? ¿Cómo evaluamos? ¿Por qué o para qué evaluamos a los estudiantes?, son preguntas que todos los docentes en algún momento debemos contestar(nos). Las respuestas a estas preguntas, seguramente, están determinadas por nuestras concepciones, implícitas o explícitas, sobre el aprendizaje y la enseñanza y, también, por el contexto institucional en el cual desarrollamos nuestra actividad como docentes.

¿Qué evaluamos? En la educación formal la evaluación generalmente se limita al control del aprendizaje de los estudiantes, es decir la verificación de la incorporación de los contenidos por parte de los estudiantes. Contenidos conceptuales, que tienen que ver con el campo del saber, contenidos procedimentales, del campo del saber hacer y contenidos actitudinales que abarcan el campo de los valores.

A nivel universitario los dos primeros han ocupado el lugar de privilegio en la evaluación y sólo en algunos casos se han ido incorporando a la evaluación los contenidos actitudinales.

¿Por qué y para qué evaluamos? Los propósitos de la evaluación son básicamente tres: diagnosticar, monitorear y acreditar los aprendizajes y, simultáneamente, aunque no siempre ocurre, retroalimentar los procesos de enseñanza.

La evaluación diagnóstica se realiza al inicio de los procesos de enseñanza y de aprendizaje para conocer el punto de partida, el cumplimiento de los prerrequisitos respecto a un curso, un módulo, un tema, etc.

La evaluación formativa o de seguimiento permite monitorear el avance (o no) de los aprendizajes de los estudiantes y retroalimentar los procesos de enseñanza mientras éstos se llevan a cabo.

La evaluación sumativa o de acreditación se realiza al final de los procesos de enseñanza y de aprendizaje y supone tanto decisiones pedagógicas como sociales.

¿Cómo evaluamos? El tipo de contenidos a evaluar y la función que se le atribuye a la evaluación, junto con el contexto institucional, condicionan muy fuertemente los instrumentos que se van a usar para realizar las evaluaciones. Instrumentos tradicionales como las pruebas orales, pruebas escritas, pruebas de ejecución o instrumentos alternativos como el portafolio, el debate, la solución de problemas, el proyecto, etc.

Steiman (2008:169, 170) sostiene que es imprescindible considerar las especificidades disciplinares para decidir cómo evaluar y específicamente en el ámbito de las ciencias exactas y naturales enumera algunos criterios que habría que tomar en cuenta a la hora de elaborar los instrumentos de evaluación, por ejemplo: inclusión del vocabulario específico de la disciplina, interpretación de gráficos y tablas, identificación de relaciones, formulación de hipótesis, identificación de variables, relación entre variables y conceptos, fundamentación de procedimientos y de cálculos, contrastación de resultados, etc.

Orlik (2002) por su parte destaca que los criterios fundamentales a tomar en cuenta en las evaluaciones son cinco: evaluar los objetivos planteados, evaluar tanto los contenidos como los procesos de incorporación de esos contenidos, evaluar el pensamiento, el razonamiento de los estudiantes y no sólo los resultados o las conclusiones a los/las que los estudiantes arriban, favorecer la buena educación a través de la evaluación y evaluar todos los tipos de contenidos, no sólo los conceptuales.

El término evaluación ha sido asociado a múltiples significados, por un lado a la idea de control y poder que ejerce el sistema educativo sobre los estudiantes a través de los docentes y, por otro lado, a las funciones de categorizar, calificar o clasificar estudiantes.

Santos Guerra (1998:16) sostiene que el proceso de evaluación encierra mecanismos de poder que son ejercidos por el profesor y la institución. *Porque quien tiene capacidad de evaluar establece los criterios, los aplica de forma e interpreta y atribuye causas y decide cuáles han de ser los caminos de cambio.*

Elola y Toranzos (2000) mencionan cinco funciones que cumple la evaluación.

La función simbólica: asociada a la finalización de una etapa.

- La función política: porque a partir de la evaluación se toman decisiones.
- La función de conocimiento: en tanto se incrementa el conocimiento de los objetos de evaluación en la medida que la búsqueda de indicios de comprensión exige profundizar en la complejidad de los objetos a evaluar.
- La función de mejoramiento: de los procesos o los fenómenos que se evalúan.
- La función de desarrollo de capacidades: al promover el desarrollo de las competencias implicadas en los procesos de evaluación.

Estas cinco funciones difícilmente son visualizadas con facilidad por los docentes y los estudiantes. Seguramente la mayoría de ellos relacionan la evaluación de los aprendizajes con un momento clave de cualquier curso o actividad curricular (seminario, tesis, etc.) y muchos catalogan la evaluación como una tarea complicada o conflictiva, de hecho gran parte

de la bibliografía aborda este tema desde esa perspectiva. Rodríguez Neira (2000) por ejemplo, plantea la problemática en torno a la evaluación de los aprendizajes, dejando claramente establecido que existe un marco de discusión siempre abierto en torno a esta temática. Díaz Barriga (1990) agrega un aspecto de gran trascendencia en relación con la problemática de la evaluación, la pérdida de la dimensión pedagógica de las pruebas de evaluación que habitualmente se utilizan.

En la facultad de veterinaria, actualmente, son pocos los docentes que trabajan la evaluación como un proceso continuo que acompañe los procesos de enseñanza y de aprendizaje, aun cuando así se plantea en el plan de estudios vigente.

Camilloni (1998) sostiene que la evaluación debe ser parte del proceso didáctico y permitir a los estudiantes tomar conciencia de los aprendizajes adquiridos y a los docentes, interpretar las implicaciones de la enseñanza en esos procesos de aprendizaje. Las mayores dificultades en este sentido las tienen los estudiantes ya que, en general, visualizan la evaluación como un acto que les permite avanzar en sus estudios, de allí el interés sólo por aprobar y no por saber.

Brown y Glasner (2003) por su parte hacen referencia a la complejidad de la evaluación a nivel universitario, realizan un análisis crítico de la forma de evaluar en las instituciones de educación superior y proponen algunas alternativas de mejora.

Bonsón y Benito (2005:88-90) señalan que en la universidad (española) la evaluación se concibe únicamente como un “mecanismo acreditativo” y en relación a la percepción de los estudiantes citan un estudio realizado por Fernández Pérez (recogido por Zabalza, 2001) en el que los estudiantes manifiestan que en general la evaluación consiste en un único examen final, tradicional, en el cual predominan las preguntas memorísticas, sólo interesan los resultados pero no los procesos que se emplean para llegar a ellos y “se percibe el examen como algo poco relacionado con el ‘conocimiento real de la disciplina’ y con el ‘ejercicio profesional’.”

Biggs (2006:178) sostiene que la perspectiva de los estudiantes y de los profesores sobre la evaluación es sustancialmente diferente ya que, en general, los profesores asumen la evaluación como el final del proceso que comienza con la formulación de objetivos, continua con la realización de las actividades de enseñanza y culmina con la verificación del cumplimiento de los objetivos mediante la evaluación. Para los estudiantes en cambio la evaluación es el punto de partida ya que el tipo de evaluación condiciona las actividades de aprendizaje que los estudiantes deciden poner en práctica para obtener el resultado esperado, la aprobación.

Un ámbito propicio en la facultad de veterinaria para la discusión, entre los docentes, de los distintos aspectos involucrados en la evaluación son las actividades de formación didáctico-pedagógica a cargo del Departamento de Educación Veterinaria (DEV).

A la discusión general sobre la evaluación debemos agregar una particular, sobre los instrumentos de evaluación (los medios que permiten obtener la información para luego realizar una valoración y emitir un juicio sobre aquello que se pretende evaluar), el momento en que se aplican y el procesamiento de los resultados; ya que la eficacia de la evaluación depende de la pertinencia de la combinación de los instrumentos, de la oportunidad en la que se aplican y del análisis de los resultados posteriores. (Camilloni, 1998).

La validez y la confiabilidad son dos características de particular importancia a la hora de seleccionar un instrumento de evaluación, cualidades que pueden definirse siguiendo a Camilloni, como:

Se dice que un instrumento de evaluación es válido cuando evalúa lo que se pretende evaluar con él. Como un instrumento es utilizado para apreciar ciertos logros de aprendizaje de un cierto grupo de alumnos en una cierta circunstancia y en un cierto momento de su proceso de aprendizaje, la validez de un instrumento no puede ser determinada de manera absoluta, sino siempre en relación con su adecuación a los propósitos y situación específica de su aplicación. (Camilloni, 1998:76)

Se dice que un instrumento de evaluación es confiable cuando une exactitud en la medición y sensibilidad para la apreciación de la presencia y las diferencias de magnitud de los rasgos que mide. (Camilloni, 1998:85)

Existe un número muy importante de instrumentos de evaluación y varias clasificaciones de los mismos. Generalmente estos instrumentos se dividen en dos grandes categorías (Hermida, 2007:179):

Instrumentos Tradicionales:

- Pruebas orales (de respuesta abierta o dirigida);
- Pruebas escritas (no estructuradas, semiestructuradas y estructuradas);
- Pruebas de ejecución (proyectos, demostraciones, simulaciones).

Instrumentos alternativos:

- Los que incluyen el registro de observaciones (listas de cotejo, escalas de rango, matrices, etc.)
- Los que incluyen la valoración de desempeños (portafolios, diarios, etc.). En la facultad de veterinaria se pueden encontrar ejemplos de la mayoría de estos instrumentos, principalmente de los tradicionales:
- Pruebas escritas estructuradas (Opción múltiple, Verdadero – Falso, etc.)
- Pruebas escritas semi-estructuradas (preguntas abiertas de respuesta corta)
- Pruebas escritas no estructuradas (preguntas abiertas sobre un tema, elaboración de trabajos monográficos)
- Pruebas orales (desarrollo de uno o varios temas)
- Pruebas de ejecución (prácticas de laboratorio, clínicas, etc.)
- Combinaciones de pruebas (escrita y oral; escrita y de ejecución, etc.)

Si bien no hay muchos trabajos publicados relativos a la evaluación y a los instrumentos de evaluación utilizados en la facultad de veterinaria, uno de ellos (Ungerfeld, 2005) puso en evidencia que los estudiantes lograban mejores resultados cuando se utilizaban instrumentos alternativos que cuando los instrumentos usados eran los tradicionales. El estudio se llevó a cabo en el curso de fisiología (Área III de la carrera) a partir de la comparación de los resultados obtenidos en las evaluaciones parciales tradicionales y la evaluación (alternativa) del seminario de investigación que era una de las actividades del curso. La utilización de un sistema de evaluación diferente y la mayor motivación de los estudiantes en los seminarios, ya que participaban más activamente en su formación, podrían explicar los mejores resultados en el seminario de investigación. Ungerfeld (2005) sugiere la necesidad de revisar los instrumentos tradicionales de evaluación de los aprendizajes (parciales escritos con preguntas cortas) que utilizan los docentes y de realizar cambios en el sistema de evaluación.

El cambio en el sistema de evaluación de un curso en general no es sencillo de implementar ya que no siempre los fundamentos para realizarlos son sólidos, ni los docentes están en condiciones de diseñar nuevos instrumentos de evaluación sin un adecuado asesoramiento. El Departamento de Educación Veterinaria (DEV) ha colaborado con distintos equipos docentes, entre ellos el grupo de epidemiología, para realizar el cambio del sistema de evaluación de los estudiantes: se pasó de un sistema basado en pruebas de preguntas abiertas a un sistema estructurado de preguntas de múltiple opción debido al aumento de la población estudiantil y la disminución del equipo docente de la disciplina.

El equipo del DEV y los docentes de epidemiología trabajaron juntos en la elaboración de las preguntas, la evaluación de los resultados obtenidos, la adecuación del instrumento de evaluación para futuras ediciones, así como en la construcción de un banco de ítems que quedó a disposición de los docentes. Uno de las principales conclusiones del trabajo fue que cuantitativamente no variaron de forma significativa los estudiantes que ganaron el curso o exoneraron el examen pero sí se observó que los mejores estudiantes obtenían con mayor frecuencia calificaciones de excelencia (Caamaño y col. 2004) lo que permite inferir que este sistema posibilita mejores calificaciones, mientras que con el sistema anterior era muy difícil obtenerlas.

El propósito de este trabajo es describir cómo se evaluaron los estudiantes en el curso toxicología y enfermedades toxicológicas de la facultad de veterinaria Universidad de la República (Uruguay) y compartir la experiencia de la evaluación por estaciones correspondiente al curso práctico 2009.

La evaluación de los aspectos prácticos tradicionalmente se ha llevado a cabo mediante pruebas individuales, orales (generalmente), que se caracterizan: por insumir mucho tiempo (especialmente en condiciones de masificación), por abarcar cuestiones puntuales (a veces un único caso) y por ser poco objetivas. Presentan además como limitaciones importantes su baja confiabilidad y validez.

La Evaluación Clínica Objetiva Estructurada (ECO) o el Objective Structured Clinical Examination (OSCE), diseñado por Harden y Gleeson en 1979 (citado por Vecchi, 2002:473), es un tipo de evaluación que permite abarcar distintos tipos de conocimientos y habilidades clínicas en una única instancia de evaluación y hace posible evaluar, en forma objetiva, un alto número de estudiantes simultáneamente.

La estructura de la ECO es un circuito constituido por sesiones evaluativas llamadas estaciones (de 8 a 20) que los estudiantes recorren, pasando de una estación a otra sucesivamente. El tiempo disponible en cada estación es limitado y se determina previamente a la instancia de evaluación.

En cada estación los estudiantes se encuentran con una situación o caso clínico diferente que deben resolver. Además en cada estación hay un evaluador que registra en una grilla el accionar de cada estudiante de acuerdo a criterios preestablecidos. La discusión de los criterios y el entrenamiento previo de los observadores intenta neutralizar al máximo la subjetividad de los observadores.

De Serdio Romero (2002:127) sostiene que la *potencia de este formato radica en la mezcla de métodos de evaluación, de manera que es capaz de explorar suficientemente tres de los cuatro niveles de la pirámide de Miller: saber, saber cómo y demostrar cómo*. El nivel del “saber” tiene que ver con el conocimiento, se apoya en la memoria factual. El nivel del “saber cómo” refiere a la competencia, es decir a poder tomar decisiones y solucionar problemas a partir del conocimiento. El nivel del “demostrar cómo” corresponde al desempeño, demostrar lo que el profesional realiza en distintas situaciones de su práctica profesional. (Vecchi, 2002: 473,474).

La Evaluación Clínica Objetiva Estructurada ha sido instrumentada con buenos resultados en varias disciplinas médicas (Medicina, Odontología) y en diferentes países (Uruguay, Chile, Argentina, Canadá, Reino Unido y Francia a modo de ejemplo), Duerson y col. (2000) analizaron el impacto de 9 años de implementación del ECOE. Existen experiencias en disciplinas como obstetricia y ginecología en la Escuela de Medicina de Leicester en el Reino Unido y al comparar el resultado de evaluaciones tradicionales con la ECOE, se observaron diferencias en los desempeños entre ambas formas de evaluación pero se llegó a la conclusión que éstas deberían ser complementarias. (Konje y col., 2001)

La ECOE ha sido modificada con el fin de poder evaluar aspectos prácticos (no clínicos). Esa modificación se ha denominado Examen Práctico Objetivo Estructurado y se conoce como OSPE (Objective Structured Practical Examination), (Ananthakrishnan, 1993). Esta modificación deja de lado los aspectos puramente clínicos para centrarse en aspectos prácticos y el énfasis no está puesto únicamente en el resultado de un procedimiento práctico sino también en el proceso que se realiza para llegar a ese resultado.

A partir de la ECOE y el OSPE surge otra forma de evaluación que hemos llamado evaluación por estaciones. Conserva la estructura en forma de circuito constituido por estaciones, la posibilidad de abarcar un amplio rango de aspectos prácticos y, porqué no, también teóricos, permite evaluar a muchos estudiantes en poco tiempo y mantiene la objetividad característica de la ECOE y el OSPE.

El curso de toxicología y enfermedades toxicológicas comprende una carga horaria total de 90 horas que incluyen 42 clases teóricas y clases prácticas que se han incrementado de 6 a 10. No sólo se ha aumentado el número de clases prácticas, sino que se ha aumentado la cantidad de grupos, se han actualizado los contenidos y como consecuencia se han incluido los siguientes aspectos: seguridad en el laboratorio, búsqueda en internet y discusión de casos clínicos.

La evaluación del curso, hasta el año 2008, se realizaba mediante dos parciales con preguntas cortas abiertas y un ejercicio de caso clínico y la entrega (individual o grupal) y defensa (individual) de un herbario de plantas tóxicas. En los parciales se evaluaban principalmente los contenidos teóricos. Si bien los porcentajes de exoneración y ganancia del curso desde el año 2005 en general habían sido buenos, se pensó en buscar un sistema de evaluación complementario para los prácticos, que jerarquizará los mismos y valorará una actividad hasta el momento sub evaluada.

En el curso 2009 el sistema de evaluación incluyó dos parciales, para evaluar los aspectos teóricos de la disciplina, a los que les correspondía el 80% del puntaje total, una prueba práctica, para evaluar los aspectos prácticos de la disciplina, (evaluación por estaciones) cuyo puntaje era el 15% del total y la presentación y defensa del herbario, para evaluar el reconocimiento de especies vegetales tóxicas, con el restante 5% del puntaje. El mínimo en cada prueba para lograr la exoneración del examen (no tener que rendirlo) se mantuvo en 65% y para la ganancia del curso y así tener la posibilidad de rendir el examen, un promedio de 50% de todas las evaluaciones.

MATERIALES Y MÉTODOS

Para elaborar e implementar el sistema de evaluación por estaciones del curso práctico de toxicología, el equipo docente con el apoyo del DEV realizó varias reuniones de planificación y discusión de la nueva instancia de evaluación que se intentaba poner en práctica.

En la primera reunión la discusión se centró en la necesidad de implementar una forma de evaluación de los aspectos prácticos de la disciplina, que no se realizaba hasta ese momento.

La incorporación de un nuevo componente en el sistema de evaluación de un curso no siempre es aceptada con facilidad por lo que se resolvió, que a modo de prueba se le asignara un 15 % del puntaje total de la evaluación del curso. Por supuesto que este porcentaje no significa que el equipo docente considere que los aspectos prácticos sólo abarcan el 15 % del total de los conocimientos disciplinares sino que por ser la primera vez que esos aspectos serían evaluados ese porcentaje permitiría evitar oposiciones y largas discusiones. Los cambios en la educación y en el sistema de evaluación en particular siempre son lentos y controvertidos.

En la primera reunión se decidió también usar el ECOE como forma de evaluación de las actividades prácticas.

En las tres reuniones siguientes se discutieron fundamentalmente los contenidos específicos a evaluar, los niveles cognitivos que se pretendía alcanzar, el número de estaciones que se usaría y el tipo de “actividad” que se propondría en cada estación.

A partir de la quinta reunión se trabajó la elaboración, corrección, selección y organización de las “actividades” de cada estación. Se diseñó la prueba preliminar (simulacro), se decidió el salón en el cual se realizaría la prueba, el número de circuitos y la forma de convocar a los estudiantes (voluntarios) que participarían en el simulacro. Se diseñó la hoja de respuestas y se definieron las respuestas esperadas para cada una de las “actividades” planteadas.

El simulacro fue realizado por 12 estudiantes voluntarios que estaban cursando la materia. Se fijó un tiempo de 70 a 90 segundos por estación y se seleccionaron algunas preguntas y materiales para cada estación de modo de verificar el grado de dificultad de los materiales elegidos, el tipo de pregunta y el tiempo en cada estación.

En una reunión posterior al simulacro se ajustó el tiempo, se modificaron y eliminaron algunas “actividades” y se diseñó la prueba definitiva.

La prueba se realizó en las dos salas de disección del área de anatomía, se formaron 3 circuitos simultáneos de 15 estaciones de distinto tipo, con fotos, ejemplares frescos de especies vegetales, preguntas de múltiple opción y para rellenar espacios y dispositivos correspondientes a técnicas de reconocimiento de químicos (placas de cromatografía, lupa estereoscópica con hongos).

En cada estación el estudiante encontró (junto al ejemplar vegetal, foto, etc.) la consigna escrita que debía contestar (por escrito) en su hoja de respuestas. Dicha hoja fue retirada por los estudiantes en la primera estación que visitaron y fue entregada al finalizar el recorrido, completando previamente la información referida a su identificación.

Se evaluaron 255 alumnos, que pasaron en tandas de 45 (15 %). El tiempo total de la prueba, incluyendo la preparación de las estaciones y el tiempo entre tanda y tanda de estudiantes, fue de 4 horas.

El análisis estadístico consistió en el cálculo del índice alfa de Cronbach y el análisis de la matriz de correlaciones inter-elementos.

RESULTADOS Y DISCUSIÓN

La calificación promedio en la evaluación por estaciones fue 10,51/15 con un desvío estándar de 2,34. El 71,3 % de los estudiantes obtuvo una calificación superior a la establecida para exonerar el examen, el 20,9 % de los estudiantes alcanzó un puntaje que le permitió aprobar el curso y sólo el 7,8 % de los estudiantes no logró el mínimo exigido para la aprobación.

El análisis estadístico del sistema de evaluación del curso, tomó en cuenta los puntajes obtenidos por los estudiantes en las dos pruebas parciales correspondientes a los aspectos teóricos del curso (parcial 1 y parcial 2) y en las dos pruebas correspondientes a los aspectos prácticos (herbario y evaluación por estaciones).

El índice alfa de Cronbach tipificado = 0.677 (anova F = 3023.49, p valor = 0.0000) lo que muestra una fiabilidad global de la prueba moderada.

Del análisis de la matriz de correlaciones inter-elementos (ver fig. n° 1) resulta que parcial 1 y parcial 2 aparecen bien correlacionados entre sí (0.661) mientras que muestran tanto parcial 1, como parcial 2, correlaciones bajas con herbario y estaciones. Por otra parte aparece una asociación significativa (0,721) entre herbario y estaciones. Estos resultados podrían estar indicando que las pruebas (parcial 1 y parcial 2 por un lado y, herbario y estaciones por otro) evalúan cosas diferentes.

	parcial1	parcial2	herbario	estaciones
parcial1	1,000	0,661	0,044	0,186
parcial2	0,661	1,000	0,137	0,315
herbario	0,044	0,137	1,000	0,721
estaciones	0,186	0,315	0,721	1,000

Fig. 1. Matriz de correlaciones inter-elementos

Por lo tanto para verificarlo se realizó un análisis factorial (en componentes principales, método Ward, con rotación Varimax, los test previos de KMO y Bartlett fueron significativos. Los dos primeros factores explicaron el 84% de la varianza total y fueron los que se extrajeron. Los pesos factoriales para cada variable en la composición de cada factor pueden verse en la figura n° 2.

	Factor	Factor
	1	2
estaciones	0,89685	0,195741
herbario	0,925234	-0,00964694
parcial 1	0,0162411	0,915364
parcial 2	0,161919	0,896193

Fig. 2. Pesos factoriales de cada variable según factor

Con los scores factoriales, para estación – herbario (Primer Factor) y parcial 1 – parcial 2 (Segundo Factor), se realizó un análisis de conglomerado por observaciones por el método de Ward extrayéndose cinco clusters con un número balanceado de miembros en cada conglomerado (ver figura n° 3).

Fig. n° 3: Diagrama de dispersión de conglomerados (método de Ward, Distancia Euclídea)

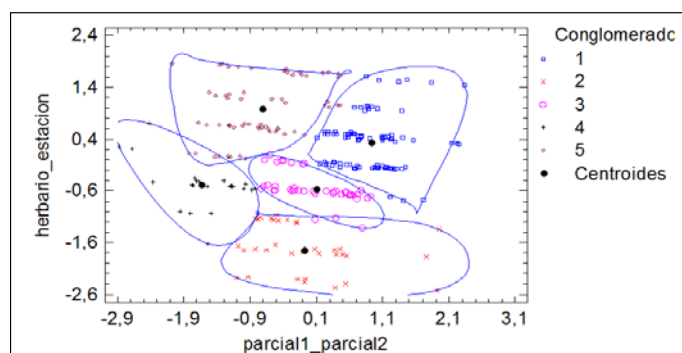


Fig. n° 3: Diagrama de dispersión de conglomerados (método de Ward, Distancia Euclídea)

El la figura n° 3 pueden apreciarse los conglomerados bien separados, mostrando grupos de estudiantes que presentan puntajes altos en ambos tipos de pruebas (cluster1), mientras que otros grupos tienden a tener mejor puntaje en una de las pruebas (cluster2, cluster 5).

Es posible concluir que la fiabilidad y repetibilidad de las pruebas en su conjunto es moderada, que existen dos grupos de pruebas que evalúan cosas diferentes, un grupo integrado por parcial 1 – parcial 2 y el otro compuesto por herbario – estaciones y que hay estudiantes que parecen ser más hábiles en alguna de esas pruebas.

CONCLUSIONES

La evaluación realizada por los docentes (Área de toxicología y departamento de educación veterinaria) y por los estudiantes del sistema implementado fue ampliamente satisfactoria.

Los estudios estadísticos comparando las pruebas parciales teóricas con las pruebas prácticas (herbario y evaluación por estaciones) concluyen que estas últimas son pruebas complementarias pero no sustitutivas de los parciales teóricos.

Se considera que el valor otorgado a la evaluación por estaciones (15 % del puntaje total) fue correcto para ser la primera experiencia, pero podría ser mayor para futuros cursos.

La evaluación por estaciones se ha seguido usando desde 2009 y los resultados han sido similares a los de la primera experiencia y la evaluación por parte de los docentes y de los estudiantes continúa siendo ampliamente satisfactoria.

En tanto, esta forma de evaluar los aspectos prácticos de una disciplina como la toxicología veterinaria, ha sido ampliamente satisfactoria para evaluar en forma objetiva un alto número de estudiantes en corto tiempo y ha permitido incluir en las instancias de evaluación un amplio rango de aspectos prácticos, importantes para la actividad profesional, es posible recomendar a los docentes de ciencias la utilización de esta combinación de instrumentos para la evaluación de los aprendizajes de los estudiantes.

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OSCE as a design enabling test for admission to the dental clinic

OSCE un diseño de prueba de habilitación de admisión a la clínica dental

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Abstract

The Objective Structured Clinical mode of Examination (OSCE) has many attributes that recommend its adoption for assessment of certain elements of competence (communication skills assessment or data interpretation) and generally applying an OSCE as an assessment tool is made for measuring clinical competencies. In this paper we show the design of OSCE enabling examination for admission to the clinic and care of dental patients by students in the 3rd year towards the career of dentistry, shown the integration and application of basic science to clinical science. The aim of realizing this enabling examination is to get information on performance and degree of achievement of the skills of our students in the middle of their course, allowing systematic analysis of our curriculum and quality assurance compliance of our graduate profile.

Key words: Objective structured clinical exam, student assessment, clinical skill, clinical competency exam, enabling test.

Resumen

El examen clínico objetivo estructurado (OSCE) posee muchos atributos que recomiendan su uso para evaluar ciertas competencias (evaluación de habilidades de comunicación o interpretación de datos) y la aplicación como herramienta evaluativa de competencias clínicas. En este artículo mostramos el diseño de un OSCE como prueba habilitante para el ingreso a clínica y atención de pacientes, por parte de los estudiantes de 3er. año de la carrera de odontología, reflejando la integración y aplicación de las ciencias básicas a la clínica. El objetivo de esta evaluación habilitante es obtener información sobre el desempeño y grado de cumplimiento de las habilidades de nuestros estudiantes a la mitad de la Carrera, permitiendo un análisis de nuestro currículo y aseguramiento de calidad del cumplimiento de nuestro perfil de egreso.

Palabras clave: examen clínico objetivo estructurado (OSCE), evaluación de los alumnos, habilidades clínicas, examen de competencias clínicas, prueba habilitante.

INTRODUCTION

Competencies are a bridge between education and practice and are both desirable goals from the educational point of view, practical and professional. These competencies point out the way it is expected that students learn and behave, in much the same way as in the future they should act professionally. Most assessment tools used in the current theoretical courses are unable to measure the three areas of competence, so the use of valid and reliable assessment tools, such as objective structured clinical examination (OSCE) is required (González, 2006).

The OSCE was designed by Ronald M. Harden and colleagues in 1975 and has since been developed and implemented worldwide, adapting to the particular circumstances in which teaching takes place in different faculties of the health area (Harden, 1979; Brown, 1999). The OSCE as an assessment tool in dentistry was implemented for the first time at the School of Medicine and Dentistry, University of Harvard, as a method of evaluation of problem-based learning in 1994, to evaluate the acquisition of specific skills related to patient care and attitudinal competences such as critical, problem solving and making hypotheses (Padraig, 2008). Initially this was conducted in the areas of periodontic, oral pathology, radiology, oral surgery and pediatric. Today, the OSCE has been introduced as an assessment tool in both the undergraduate and graduate students in various schools of dentistry.

This test consists of a group of examiners circulating a series of stations (among 10 to 20 stations, lasting from 5 to 10 minutes each) where they can observe the student interacting with patients to certify their clinical skills, thinking, problem solving, integrating a diagnosis, also communication and interpersonal skills, i.e., a comprehensive assessment which requires a professional in the field of dentistry (Manogue, 1998; Davenport, 1998). The design must allow the student to perform in a variety of situations.

The OSCE has several advantages, among which are:

1. Can be used as a diagnostic test or formative evaluation (Watson 1982).
2. Allows the evaluation of clinical skills without the typical biases of conventional methods of assessment of competencies, as it does in the context of the patient, with greater objectivity. Moreover, the diversity of content allows more areas to be evaluated in less time (Mossey, 2001; Triviño, 2002).
3. It allows assessment of a large number of students at the same time. (Triviño, 2002).
4. Allows measurement of objectives in all domains (cognitive, procedural and attitudinal) and involves a wide range of clinical domains present in study programs (Triviño, 2002).
5. There is no limit to the variety of clinical situations that may arise.
6. It has demonstrated widely reliability and validity (Roberts, 1990; Brown, 1987; Davenport, 1998).

Its main disadvantage is the cost required for its implementation, both time spent as human resources and materials required.

Since its start, the Faculty of Dentistry at the University of San Sebastian has incorporated problem-based learning (PBL) as a methodological strategy in the classroom where the student is the center of the learning process. The educational philosophy of our school recognizes the student as an individual person, unique, spiritual in nature, endowed with free will and volition. The School aims to train with the knowledge, skills and discipline-specific skills, necessary for correct practice. In addition, it helps with focus, to bring to light potential of thought, which enables them to lifelong learning. The course in dentistry has a duration of 6 years and has a curriculum divided into basic areas, pre-clinical and clinical, with subjects integrating basic areas and clinics. Similarly the basic clinical integration cycle from 1st to 3rd year of studies aim to integrate the knowledge gained in basic subjects and to apply to the daily work of the dentist. This is achieved by providing students with real clinical cases, which will motivate them to visualize relationships that exist between different subjects, channeling their own interests in every problem that they face, thereby achieving a holistic view of human and health problems.

To consolidate quality of our students in the clinical area is proposed to design an OSCE as an enabling test (in our case, at the end of 3rd year) that allows us to show the degree of cognitive skills, procedures and attitudes that have acquired students before the dental care of patients. These competencies are clearly established in the curriculum and are related to the graduate profile, which we propose as a school. The purpose of the OSCE as enabling test is configure a quality assurance system, to make sure the existence of conditions and substantiating the academic-formative development before clinical practice on real patients.

DESIGN OSCE

Design the OSCE, took 2 meetings per week for 3 months with the teachers of clinical courses, where they recorded the views and comments on the minimal competencies to be present by students at the end of the pre-clinical area (3rd year of the course). During these meetings the group worked on the basis of curriculum oriented to graduate profile and assessed the learning outcomes for each subject, that would allow the production of an OSCE test, enabling, inclusive and transversal to our curriculum.

At the end of 3 months, we clearly identified the skills that students should be able to play before admission to clinical and patient care. These meetings were concluded the following:

1. It defined the specific areas to be evaluated.
2. Assessable skills were determined (cognitive, procedural and attitudinal), to be present by a student about to enter the clinic and dental care of patients.
3. It determined the number and type of stations according to the cognitive, pre-clinical and attitude skills to be presented by students.

4. Support materials for each station were developed.
5. Assessment tools were made for each station according to the learning outcomes.
6. It established turnaround time at each station.
7. Human material and physical resources needed to implement the OSCE were established.

DESIGN OF STATIONS:

For the design of each station, we rely on three types of stations: a) the interactive stations, where students must interact with a series of dental materials or instrumental, thus providing a written response to a particular question; b) stations where the student must interact with a simulated patient and an examiner should judge their performance through a guideline of evaluation (Gerrow, 1997; Zartman, 2002); c) stations where students must interact with a 'phantom' for a given activity and is judged on its performance by an examiner.

The following describes the overall design of the proposed OSCE:

1. The test will consist of 15 stations arranged in numerical form that will signal the progression to be followed by students.
2. For each station a time of 3 to 5 minutes is stipulated.
3. At each station, tasks or procedures to be followed will be observed by examiners (clinical tutors) should adhere to a pre-assessment checklist developed and which fits the expected learning outcomes.
4. There will be testing on simulated patients according to the design of the station to occupy station problems. Also used are videos, radiographic and PowerPoint® presentations. This methodology allows all students to be measured with the same patients and the same tasks.
5. In the 15 stations the following will be considered:
 - a. Collection of data from medical records
 - b. Explanation to patient about the need for further studies.
 - c. General and intraoral clinical examination.
 - d. Collection of data to confirm or rule out a diagnosis.
 - e. Biosecurity
 - f. Oral and written expression.
 - g. Interpretation of complementary exams (laboratory reports, x-ray tests)
 - h. Therapeutic indications.
 - i. Treatment planning.
 - j. Attitude toward the patient (identification, treatment and greeting and language used)

- k. Selection problems and the relative proportion of semiotic aspects, pathophysiological, clinical and therapeutic will depend on the level at which students are in their course and what other aspects are desired.
6. Within domains we want to measure Interdisciplinary skills of students, we consider the 7 domains established by the Association for European Dental Education (2009) to be appropriate:
 - a. Professionalism
 - b. Social skills, communication and interpersonal
 - c. Information and knowledge
 - d. Collection of clinical information
 - e. Diagnosis and treatment plan
 - f. Establishment and maintenance of oral health.
 - g. Prevention and health promotion.

Table 1 shows the general design of each station; the clinical situations will be presented to students and assessment tools that we propose to use.

Rating systems for each of the stations of the OSCE were three assessment instruments: Likert scale, rubrics or rating scales and a list of matches or comparisons.

Likert scale will be use as an instrument capable of measuring knowledge and attitudes of individuals from a given area. This is a set of items presented as statements or judgments against which to measure the reaction of students who took the test. Each item is assigned a numerical value. Thus, the student obtains marks about the affirmation and eventually gets his mark total by adding the scores in relation to all assertions.

For the collection of data items, a rubric is used. This is an instrument that allows us to evaluate performance descriptors of the students. For this, we developed a two-way table that is ordered horizontally and vertically and which houses various performance criteria ranges (categories or levels). Within each range we included scores previously agreed according to various aspects to be evaluated. The preparation of the rubric will be held as follows:

1. Targets will be selected that underlying the task or job at hand.
2. It will identify all the possible criteria that represent the behavior expected performances of the students to carry out a task in an appropriate way.
3. Arrange the criteria for levels of effectiveness.
4. Assign a numerical value according to the level of execution.

Table 1. Proposed OSCE Stations for 3rd year students of the School of Dentistry, where we see clinical problems posed, resources and evaluation guidelines to be implemented.

Situation Problem	Clinical Skills	Cognitive Skills	Practical preclinical procedures	Communicational Skills	Attitudinal Competencies	Material	Evaluative instruments
Anamnesis	✓	✓	-	✓	✓	Simulated Patient	Likert
General physical Examination	✓	✓	-	✓	✓	Simulated Patient	Likert
Intraoral Examination	✓	✓	✓	✓	✓	Simulated Patient	Rubric
Panoramic Rx Examination	✓	✓	-	-	-	Negatoscope	Comparison
Radiographical Periapical Examination	✓	✓	-	-	-	Negatoscope	Comparison
Biosecurity	✓	✓	✓	-	-	Dental Box	Comparison
Dentistry Instrumental	✓	✓	✓	-	-	Dental Box	Comparison
Injury description	✓	✓	-	-	-	PowerPoint Show	Comparison
Microscopic description	✓	✓	-	-	-	PowerPoint Show	Rubric
Prescription formulation	✓	✓	✓	✓	✓	Simulated Patient	Likert
Pharmacology and systemic disease	✓	✓	✓	✓	✓	Simulated Patient	Likert
Operative Cavity	✓	✓	-	-	-	Phantoma	Comparison
Absolute isolation	✓	✓	✓	-	-	Phantoma	Comparison
Impressions	✓	✓	✓	-	-	Phantoma	Likert
Preclinical Endodontic	✓	✓	✓	-	-	Phantoma	Comparison

In addition to the two data collection instruments mentioned above we also used the Checklist, which consists of a list of issues to evaluate, content, skills, attitudes, concepts, among others. Where the purpose is to act as a mechanism for review during teaching - learning certain preset indicators and review of their achievement or lack thereof, then remedial action is possible. Thus, these instruments allow us to determine the quality of execution of students in specific tasks in the different seasons of the OSCE.

CONCLUSIONS

The OSCE is an assessment tool that involves several steps: identifying the competence to assess the situation and design OSCE stations, the instructions for the student and the instruction manual to the evaluator and finally assessment tools (evaluation guidelines) used for each station according to the cognitive objectives, procedures and attitudes established primarily.

The OSCE is a comprehensive assessment tool, multifaceted, multivariate and multidimensional, multidisciplinary in relation to situations; particularly in the area of Science and Health. The evaluation criteria used at each station are objective and valid, because they are determined on the basis of the objectives of different subjects and learning activities. It has a great advantage as skills assessment tool in all three areas, with high reliability. Moreover, it can be used across several courses that are presented simultaneously, by demonstrating to students the importance in the integration of modular content.

The disadvantage arising from designing OSCE for a career as dentistry, is that the knowledge and skills of the students are tested in compartments and thus, does not (NEED TO CHECK THIS!!!) permit study of the patient as a whole, since students must perform a specific task in clinical examination of the simulated patients. The method also has a high demand for examiners and patients, which is finally translated into a greater amount of human material, cost and time of preparation.

Having information about the performance and student performance of students in the mid-course as a school will allow us to perform analysis on our curriculum, through the revision and implementation of our programs as well as evaluation and quality assurance of our graduate profile. The literature has reported the use of the OSCE to measure clinical competence established, we propose the implementation of the OSCE as a diagnostic and training for students who complete the preclinical area of our curriculum, the way to ensure three issues: 1) Ensure the quality of students' education before dental care to patients in the clinic, 2) identify relevant information on School performance in various areas evaluated, allowing us to perform

changes in programs and learning outcomes that demonstrate weaknesses on competencies and 3) Should recognize the existence of deficits of our students in any of the training areas, implement remedial actions that allow us to enhance the strengthening of these skills and the specific requirements of different areas to ensure the quality of care dental patients attending our clinics.

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A simple method of water purification and energy extraction from organic wastewater: an application of green chemistry principles in everyday life

Un simple metodo de purificacion del agua y extraccion de energia de los desechos orgánicos en el agua: Aplicación de los principios de la química verde en la vida cotidiana

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Abstract

Green chemistry is deemed to be a very helpful response to the need to reduce the damage of the environment by man-made actions. Green chemistry comprises anything from: use of catalyst rather than stoichiometric reagents, reduction of waste, preventing chemical derivatives and others. The goal of this paper is to depict a straightforward way of broad dissemination/popularization of green chemistry principles in everyday life by carrying out an interesting and attractive experiment based on photocatalytic methodology for wastewater purification with the simultaneous synthesis of important chemicals.

Key words: green chemistry, chemical education, titanium dioxide, photocatalysis.

Resumen

La química verde es considerada como una muy útil respuesta a la necesidad de reducir el daño del medio ambiente por las acciones del ser humano. La química

verde abarca: uso de catalizadores en lugar de reactivos estequiométricos, reducción de residuos, prevención de los derivados químicos, etc. El objetivo de este artículo es describir en una forma directa los principios la química verde en la vida cotidiana a través de un interesante y atractivo experimento basado en un método fotocatalítico para la purificación del agua de sus desechos orgánicos con simultanea producción de compuestos químicos importantes.

Palabras clave: química verde, educación química, dióxido de titanio, fotocatalisis.

INTRODUCTION

Public in general are becoming extremely interested in the sustainability of our planet. As obvious for every person, the vital signs of our planet are declining everywhere, the reasons are many (Benedick et al., 2000), among them: a steady growth in population (estimated for the next 20 years

to be in the range of 10 billion people), industrial discharges, pollution of marine and fresh waters, ozone depletion, climate change or loss of forest leading to loss of biological species, etc. There is, however, an emergent generation concerned with pollution, greenhouse gases control and all related consequences of harmful human actions on our planet.

Environmental education is labeled the most effective way to respond to many environmental threats. A new field that comprises all the characteristics of environmental protection is green chemistry. The term green chemistry is known to be first used by Anastas (Anastas and Warner, 1998); its principles embrace directives to be followed by scientists and industrialists in order to apply them for the design of new technological processes that will be more friendly for our natural environment (Sheldon, 2005).

The main field of action of green chemistry is to reduce or eliminate chemical negative influences on the environment (Luque and Colmenares, 2013).

An important growing need for more benign processes in the chemical industry has become evident from resource scarcity and forecasted energy and water demand for the near future. This trend towards 'green chemical approaches' (Anastas and Kirchhoff, 2002; Clark and Macquarrie, 2002) and/or "sustainable technologies" (Brundtland, 1987) requires a switch from traditional concepts of process efficiency (which focus largely on chemical yields) to equally performing approaches that take into account both economic and efficiency values as well as waste reduction and avoidance of toxic substances. Apart from a deep understanding of the 'green chemistry' principles, it is very important to take into account the appropriate green metrics, including atom economy and E-factors (the ratio of the mass of waste per unit of product, commonly expressed as kg/kg), which address the amount of waste generated and also the nature of such waste (Sheldon, 2013).

Green chemistry is about (and not only):

Waste and Hazardous Substances Reduction

Use of Catalysts

Using Less- or Non-Toxic Reagents

Use of Renewable Resources

Use of Solvent Free or Recyclable Environmentally Benign Solvent systems

Due to the fact of an increased demand for chemicals, usually dependent on population growth (that surely leads to the destruction of the environment through contamination), there is a call for a "green" revolution in the chemical industry as well as a decline in the general use of chemicals in everyday life. This new "movement" is based on the use of more efficient chemical processes, chemical free procedures or chemical substitutes that help us keep the environment free of danger/damage.

Green chemistry in education

Green chemistry is emerging as a new interdisciplinary scientific "discipline"; yet the tough part is to convince chemists to learn to think environmental-friendly, especially when green chemistry implementation is rarely found. Few green chemistry books, as well as a handful of articles related to green chemistry education, have been published since 1994 (Ahluwalia and Kidwai, 2005).

The essence of the worldwide environmental-chemical education is a shift from knowledge-type teaching to effective teaching strategies capable of evaluative thinking, problem solving and taking a responsible action accordingly to an interdisciplinary/multidisciplinary approach.

A wise approach is to educate about green chemistry at the primary school level. Kids are more eager than adults to accept green principles,

especially when they are explained in a fun, colorful and straightforward way. They like to practice recycling, to see reactions taking place using every day household substances. Children usually get so much interested that they become the ideal instruments to convince adults to get in the green-environmental mood. Moreover, youth is generally more enthusiastic about securing a healthy Earth for future generations

Purification of water and simultaneously solar chemicals production from organic wastewater

Photocatalysis is a good example of green chemistry, moreover Titanium (titanium dioxide, titanium white)-based photocatalysis has been identified as a promising method playing an important role in solving many problems in water purification (Colmenares et al., 2009). The rational design and synthesis of multifunctional photocatalysts (e.g., TiO_2 -based technologies) can also open many multidisciplinary opportunities to carry out complex transformations in one-pot processes. As an example, the proof of concept of depolymerization of lignocellulosic biomass in wastewater followed by the subsequent photocatalytic selective oxidation of resulting oligomers to 'solar' chemicals. This novel route could potentially be a real green methodology combining wastewater detoxification with the parallel production of "solar chemicals" (storage of solar light energy in the shape of chemical energy) from organic waste (Colmenares et al., 2013).

Generally speaking a photocatalytic process can take place under ambient conditions, that is at about 30°C, under atmospheric pressure and the catalyst activated by sunlight (hence the prefix photocatalyst). In our photocatalytic process (Colmenares, 2013) conducted on waters polluted with biomass (from e.g. agricultural, forestry, textile industry residues), organic wastes are removed from water with the simultaneous production of carboxylic acids which in turn can be potentially used in the pharmaceutical and food industries. Thanks to our approach, students from different ages learn in a simple and joyful way how to clean polluted water into drinkable one. The main goal of this educative lab experience was to teach people (especially children) that we need to think in a different way about organic wastewater, not as "a problem" but as a "potential solution to a part of our problems" and this is absolutely possible thanks to the use of very simple tools such as our Sun (a renewable source of energy) and titania (Earth-abundant and environmental-friendly material). Applying those tools, people attending the Earth Day Festival (a festival held in Warsaw in 2012) learned that from water contaminated with a dye (e.g. *m*-Cresol purple as a model red dye from the textile industry) and a sugar (e.g. glucose as model compound from wastewater of food industry) we can, through photocatalysis (titania-based material prepared by our method Colmenares et al., 2013 and 150W ozone-free solar Xenon lamp), remove the dye completely (color disappearance) and transform the glucose into solar chemicals. (e.g. gluconic and glucaric acids, compounds later identified and quantified by Waters HPLC Model 590 pump equipped with a refractive index detector (Waters 2414 Refractive Index Detector). Separation was performed on a XBridgeTM Amide 3.5 μm 4.6x150 mm column provided by Waters. The mobile phase was Milli-Q water/acetonitrile (15:85 v/v) at a flow rate of 0.8 mL/min. The injection volume was 10 μL . Complementary for the analysis: Liquid chromatography-mass spectrometry (HPLC-MS, HPLC Prominence Shimadzu coupled with MS 4000 Q-TRAP Applied Biosystems)). The procedure followed was: In 150 mL of an aqueous solution (450 mL total glass photoreactor volume) containing 500 mg/L of glucose and 30 mg/L dye (*m*-Cresol purple), 200 mg of TiO_2 -based photocatalyst were added, mixed on a magnetic stirrer (900 rpm) and then irradiated with a 150W Xenon solar lamp (children taking part in this experience at the festival had glasses and gloves), after a couple of minutes a distinctive disappearance of the dye was observed (Fig. 1) and samples of water were taken to HPLC-MS analysis to corroborate

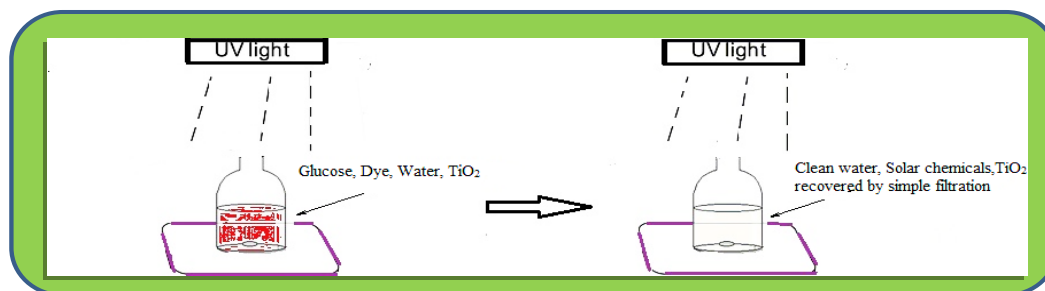


Fig. 1 This figure presents a visual description of the photocatalytic process carried out by the authors.

the presence of carboxylic acids (e.g. gluconic and glucaric acid) coming from glucose photocatalytic transformation. (Fig. 2a, 2b).

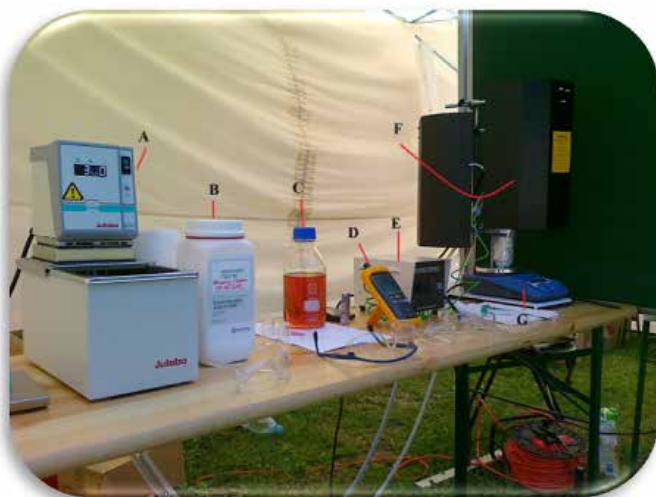


Fig. 2a Basic equipment used for the photocatalysis experience, from left to right: A) thermostat to maintain the solar lamp at room temperature, B) box with powdered Titania, C) bottle with the solution of dye + glucose, D) electronic thermometer, E) power supply for the solar lamp, F) photoreactor with shields to protect against UV radiation, G) magnetic stirrer.



Fig 2b. Dr J.C. Colmenares shows to the public present at Earth Day Festival, (<http://ichf.edu.pl/noblesse/DzienZiemi2012.html>) “easy-to-do and understandable” green photocatalytic method for water cleaning and solar chemicals production.

CONCLUSIONS

Growing demand for chemicals, worldwide added to the destruction of the environment, is placing increase pressure on the chemical industry (Tucker, 2010). Green chemistry is the most fundamental approach for preventing pollution and to ease the pressure on traditional chemical processes.

This manuscript reveals an easy and straightforward methodology used to popularize green chemistry principles to our society (children and adults with different levels of education). The authors’ achieved objective was to explain a complex scientific topic of the application of photocatalysis in water detoxification and valorization of organic wastewater to the general public in a vivid, interesting and simple way. The feedback from

the people visiting the Earth Day Festival in Warsaw was very positive and their understanding on the organic wastes complex problem (either in air, water or soil) as an important source of chemicals for our daily live was impressive.

We expect the approach here presented will become a gateway to make green chemistry trendy and interesting for the public in general and at the same time, it will also help implement further environmentally friendly chemical processes and product design.

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Teaching experience from a subject of social relevance: environmental sanitation - urban drainage

Experiencia de enseñanza a partir de un tema de relevancia social: saneamiento ambiental - drenaje urbano

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Abstract

This paper presents an educational experience which is based on a theme of social relevance. The project titled Sciences Today - a new meaning was developed in a public school in the city of Goiânia - Goiás (Brazil), for teachers and students and had as the main theme 'environmental sanitation' specifically urban drainage. Four groups composed of multidisciplinary faculty from diverse backgrounds were created with the intention of developing subprojects with educational practices aimed at exploring environmental sanitation with the students involved. Each group involved three high schools, a total of twelve classes. Of the four groups, only one has achieved the subproject proposed by members of the group effectively. The others had problems in the implementation of the subproject especially regarding its difficulty in fitting into the present school reality. However, despite the problems encountered, the school students involved in the project show increased interest in conserving the environment - which is verified in recorded videos and audios that are not objects of analysis in this article - demonstrating that environmental education can act as an agent of change in attitude especially when the students realize the integration between the content explored in the classroom and its socio-environmental relevance.

Key words: environmental education, formal education, environmental sanitation, urban drainage.

Resumen

Este artículo presenta una experiencia educativa que se basa en un tema de relevancia social. El proyecto titulado ciencias de la actualidad - un nuevo significado se desarrolló en una escuela pública de la ciudad de Goiânia, Goiás, entre profesores y estudiantes, tuvo como tema principal el saneamiento ambiental, específicamente el "drenaje urbano". Fueron formados cuatro núcleos multidisciplinares con la intención de desarrollar subproyectos con prácticas educativas orientadas a temas de saneamiento ambiental con los alumnos implicados. De cada núcleo participaron tres grupos de un total de doce clases. De los cuatro núcleos, sólo uno logró desarrollar el subproyecto propuesto de manera eficaz. Los otros grupos tuvieron problemas en la ejecución del subproyecto, especialmente en la adecuación a la realidad escolar. Sin embargo, a pesar de los problemas encontrados, todos los estudiantes se involucraron con interés en la conservación del medio ambiente, lo que demuestra que la educación ambiental puede actuar como un agente de cambio en la postura, especialmente cuando los estudiantes hacen la integración entre los contenidos estudiados en el aula y su relevancia socio-ambiental.

Palabras clave: educación ambiental, educación formal, saneamiento ambiental, drenaje urbano.

INTRODUCTION

Because they affect the destiny of humanity, environmental issues are growing global concerns. In recent decades, many social practices concerned with the environment have been instituted with legislations, government's programs and different NGO initiatives. There is a consensus, within education on the need to address this issue at all teaching levels (Carvalho, 2006) and now Brazilian Law 9795 has instituted the National Policy for Environmental Education (EE), which was regulated by Decree 4281, in June 25, 2002.

The purpose of this law was to fulfill the need of implementing an Environmental Education in all teaching levels, according to the Brazilian Federal Constitution (Brazil, 1988). Education is required to promote reflections, to build concepts, development, and application of methods and experiences to build new knowledge bases and essential environmental values for current and future generations. Thus, Environmental Education has become an important mediator between the educational sphere and the environmental field (Carvalho, 2006).

Today and especially in Brazilian public schools, school environments are often discouraging, with precarious infrastructure and pedagogical

and educational projects, which do not motivate students, as they do not take into account the reality of student's lives or their actual interests. Besides, education has few resources available, lack of career planning for its professionals, short time for teacher's qualification, and flat salary policies (National Council of Education – GO, 2009).

Thus this work intends to point out a methodological proposal focused on the proper insertion of EE within the formal education, using the multidisciplinary development centers that act by promoting ways to unite the knowledge of basic science to knowledge gained by students through their social, cultural, political and economic everyday experiences.

This research considers work with elementary and secondary education, since this community features, among others, two positive aspects for the implementation of a significant EE: the age of intellectual, cultural and social formation and the influence they wield in their nuclear family in perspective of cultural transformation and management changes through Environmental Education (EE). We understand EE, from this perspective, as a process with the challenge of creating conditions to include the different segments of society, striving to qualify people toward citizenship so that their critical stance enables them to participate in the environmental management process.

THE ENVIRONMENT AND THE TEACHING EXPERIENCE

This study is based on the positive resources obtained from a project developed on a small scale in 2009 at Jornalista Luiz Gonzaga Contart school, in the city of Goiânia - state of Goiás.

Most of the students from this school live in neighborhoods located at Pedreira water stream shores, which are already developed or under development stages, along with serious urban draining problems and a risk of sudden floods. This has already happened in 2008 (AMMA, 2008). Thus, in the search for developing a teaching proposal to reach students' life experience, the Environmental Sanitation - Urban Drainage topic was of great importance and it was chosen as the main topic for this project.

Jornalista Luiz Gonzaga Contart (CJLGC) School is located at Jardim Guanabara II neighborhood – Goiânia, GO, and it enrolls students from Elementary, High School, and EJA (Education to Young People). The group participating in the project was composed of a school community involved with problems that resulted from a consolidated urbanization scenario downstream at Pedreiras water stream, Jardim Guanabara I, II and III, Asa Branca, and condominium Aldeia do Vale, and upstream of the watercourse with an urbanization scenario including Vale dos Sonhos neighborhood, which suffers from erosions and floods.

The execution of the work counted on the collaboration of all morning class teachers (20 teachers), who received proposals for activities including 12 classes from High School with the total of 487 students in the age group from 14 to 18 years old. The students' activities were held in the same school period, with teachers' follow-up and extended to the afternoon and evening periods, with follow up from the 'stimulator advisor' from the Laboratory for Nature Sciences.

Characterizing the project

In 2009, the project used only one multidisciplinary nucleus (Figure 1) and worked on the development of a multidisciplinary nucleus of teachers. These teachers would guide students on the formulation of experimental projects on a laboratory scale, which could help to reduce environmental impacts caused by the urban drainage issue of neighborhoods located the Hydrographic Basin of Pedreiras stream, where largest part of this school community lives.

The pilot study collaborated on the preparation of the 2010 study. The pilot study made it possible to demonstrate to teachers that when working with EE, it is desirable to use relevant social topics such as urban drainage.

Furthermore, it was noted that working with multidisciplinary groups of teachers is important since it allows the expansion of knowledge on the subject. It also stimulates the applicability of basic sciences and indicates the importance of creating a link between social and academic institutions with basic education.

In 2010 the project created four nuclei (Figure 2) to improve and expand the original idea. The project, which at first covered only the afternoon and night periods, was extended to the morning school period, with

the collaboration of afternoon and night coordination. The project was implemented at the beginning of the school year (February), which made it possible for teachers and students to organize and plan the development of the project along with the activities proposed by the education office or by the teacher (activities in the classroom).

TODAY SCIENCE PROJECT - A New Meaning

Following the school year and the Political and Pedagogic Plan of the School, the project was divided in two modules (Module I and Module II), which were developed in the first and second semesters of 2010 school year. (Figure 3).

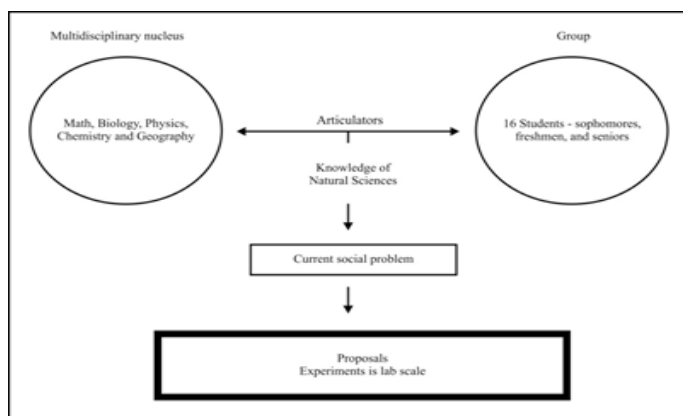


Figure 1: Project's Structure in 2009

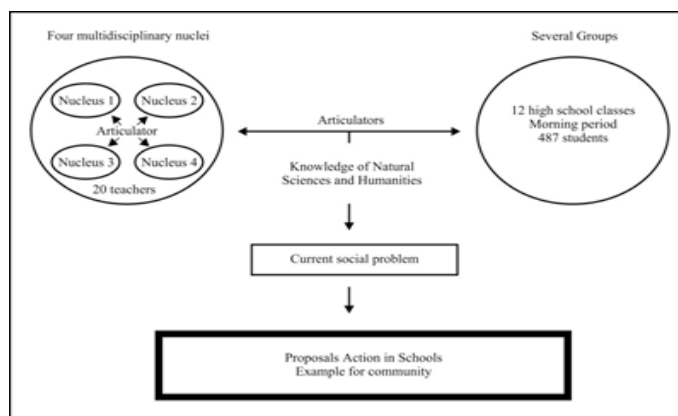


Figure 2: Project's Structure in 2010

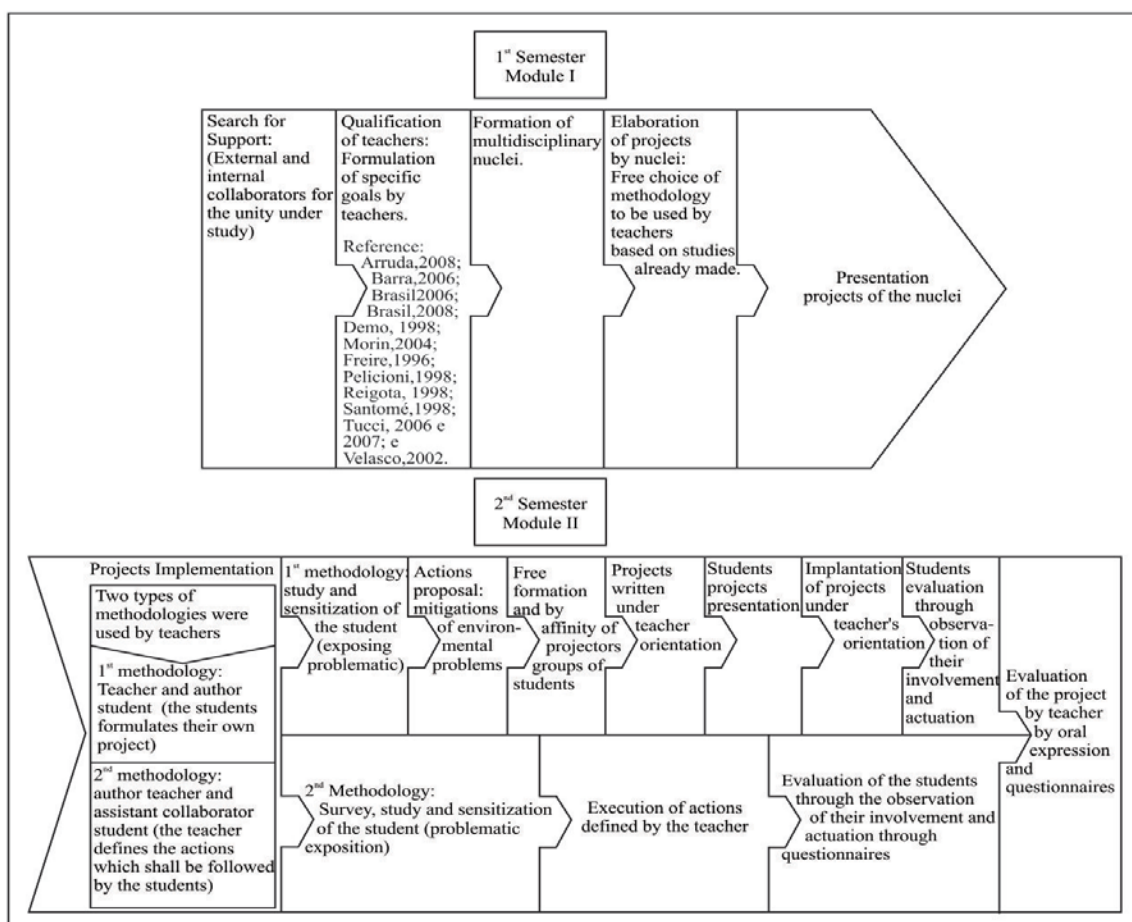


Figure 3: Summary of the methodology applied at Sciences Today Project - A New Meaning 2010.

RESULTS

We understand that EE practices and the application of the participation principle are one of the fundamental premises of water resources-integrated management. Thus, the purpose of this paper was to implement the development of a real and effective methodology, searching for a new meaning for the education through a teaching alternative from a theme of social relevance. It was important to consider the knowledge of students, who live in the neighborhood and coexist with urban drainage problems, to the development of this project.

Thus, this project worked with qualification and implementation stages of plans tuned to make students more aware of environmental issues related Urban Drainage of their surroundings, caused by disordered urbanization, collaborating then for the beginning of an ecologic individual development. Ecologic individuals are people that cultivate ecologic values in their life options and projects and that search to experience, in their daily lives, these ecologically oriented attitudes and behaviors (Rocha, 2001).

Starting from observations performed during activities, the following discussions and results were established:

- 1) The relations or link between Higher Education with the High School institutions, building connection bridges between different types of knowledge are desirable, but quite not present in our society. This relation makes feasible the teaching-learning process, and awakens in the student the desire to participate sooner in undergraduate activities. It also encourages knowledge about their future professional intentions, a fact confirmed by the interest of some students, after getting in touch with the subjects and activities approached by the Civil and Environmental Engineering courses during the project, as they were admitted in the respective colleges.
- 2) It is also very important to have financial resources, whether through agreements or through the educational institutional itself, which in this case is under State responsibility. Any work has costs, even low ones, with materials or professionals dedicated to perform them. School and teachers are asked to work with cross-sectional themes, but the means for the full development of such activities are not provided.
- 3) The school availability is vital in administrative and curricular aspects of the institution. The school needs to welcome to new ways of learning, making available spaces (labs, auditoriums, and others), students, teachers, and resources to make feasible positive results for learning, as well as to open spaces on their curricular planning for subjects experienced in the daily routine of students and community, performing them so all can understand precisely.

This was a partially surpassed challenge, as although the school as a whole (administration and teachers) was promptly made available to participate in the project, it is difficult to break through the 'content culture' of our teaching.

Thus, observing the construction and execution of the plans, the difficulty for schools to include planning time in-group is clear as they face pressures to meet school calendar days imposed by the education bureau. Also, school faces parents anxious for vacation end and the concept that teaching-learning only happens if there a blackboard full of activities and classrooms full of students sitting down in desks copying or listening the teacher at all times.

4) Teachers are one of the main parts of the project, since without their willingness to act as coordinators and mediators, no action can be applied and after all, they are the education professionals. We contend that the pedagogical work in the school, multi or interdisciplinary, must be a collective work. However, the high school teachers, frequently submitted to exhausting workloads and in several schools, teaching became a lonely work and breaking this routine demand efforts as well.

The group division into nuclei of multidisciplinary planning was the alternative found, because besides minimizing the problems mentioned, it has also helped to widen the view about the methodologies that could be applied to students. So, an opportunity was open, even in interdisciplinary moments. To keep an interaction between nuclei, directing them as part of a single work, it was necessary develop the role of an *articulator*.

The articulator was of great importance for the development of the project, meeting all mentioned nuclei, trying to keep interaction between them and verifying the teaching and material needs of the groups. The evaluation of the articulator's work showed that a team of articulators would improve the quality of the activities. Therefore, the proposal was to train a multidisciplinary team of articulators, which would improve the services to the nuclei, expanding the view of the nuclei's needs and making easier

the follow-up of activities and understanding of the projects proposals.

Another extremely important issue was the difficulty found on the execution of the plans. Even after reading and discussions of texts with the aid and orientation of NUPEC¹ and PPGEMA², the deadlock of putting it into practice arose. Based on readings and discussions, the group brought up a crucial point, that for the implementation of the plans, it would be necessary to adjust the basic disciplinary content of the subject to social relevance, so one of these, by any chance, would be favored over the other.

At that moment, the need of a qualified articulators' team was clear, for aiding each professor in his/her acting area and in his/her difficulties in analyzing and selecting the actual necessary and indispensable contents. Also, to aid in the adjustment between content and theme used.

- 5) Four multidisciplinary nuclei were formed where each one would assist three High School classes, twelve classes involved in the project (Table 1). Although the teachers' groups were responsible by the specific objectives formulated for the project, not all could achieve them after the nuclei were formed.

The teachers were free to choose the methodologies, so a nucleus was provided with advice concerning students' activities and research, and encouraging students to design their own actions. The other groups used a method where the teacher proposes the content, the answers and the actions ready for the students, leaving them in a comfort zone. However, the student assumes a role of assistant and not author and actor of their own ideas and actions. This type of methodology where the student is only an assistant was not appropriate for the EE process.

- 6) In the assistance stage of the projects in practice, there was the essential participation of a teacher called 'constructor teacher'. It is teacher with creative and multiple skills (handicraft, carpentry, lumber, construction) that works in cooperation with teachers' nuclei, connecting the theories created to solve a certain problem, implementing proposals written by students. The students learned techniques to build, in a creative and economic way, what they, through investigation and orientation of the teacher, concluded to be important to the community.

The constructor teacher provided the students with a range of activities necessary to implement their ideas, showing alternatives and possibilities to work on them, besides encouraging the autonomy and self-confidence of a common citizen, enhancing the importance to the society of people who are not only critical, but that also make things happen.

In the 2009 pilot study, the proposals made by students were implemented by the construction of experiments models in labs. In 2010, the students implemented their ideas by building full- scale what was proposed a solution, which could be followed as example by the school community and surroundings.

- 7) The aspect of the school environment improved in a reasonable and visible way. The students' part of the project demonstrated differentiated behavior regarding the preservation of environment, they showed interest in helping to reduce environmental impacts caused by Urban Draining problems of the Hydrographic Basin of Pedreiras Stream and also changes regarding the participation on school daily activities. There

- 1 NUPEC/UFG is a nucleus of research in the teaching of sciences that develops research and extension actions along with schools of Elementary Teaching of the State of Goiás. From NUPEC participated teachers formers of licensing courses of Chemistry, Physics and Biology, graduation and master students of these knowledge area and teachers from elementary teaching. In the year of 2006, NUPEC and the School of Civil Engineering of UFG had the Project "TEACHING OF SCIENCES FOR THE CONSERVATION OF THE NATURAL RESOURCES AND THE BUILT ENVIRONMENT" approved with FINEP resources. From the project, five schools of high school teaching from the city of Goiânia participated. The Jornalista Luiz Gonzaga Contart School is one of these schools that were incorporated to the project "TEACHING OF SCIENCES FOR THE CONSERVATION OF NATURAL RESOURCES AND THE BUILT ENVIRONMENT" as the sub-project SCIENCES TODAY- A New Meaning.
- 2 PPGEMA/UFG is the research Post-Graduation program in Environmental Engineering that has the objective of forming researchers, in master's level, which will contribute for the regional sustainable development, building and applying scientific and technological knowledge which integrate the Engineering and the Environment. It was represented through the participation of their teachers and students getting a master's degree, the School of Civil Engineering, in the sub-project SCIENCES TODAY- A New Meaning.

Table 1: Summary of the activities developed by the nuclei.

NUCLEUS 01	Professionals' Area of Acting: Portuguese, Math, Biology and Pedagogy.	
	Planning: Planning as a project, titled "Water is Life Project".	
	Adequacy to the Proposal: It was the only one which fit well the proposal, analyzing the disciplinary contents and the implantation of socially relevant project that, in this case, it its Urban Drainage.	
	Used Methodology: It was used the project methodology, sensitizing and providing theoretical basis to the students, surveying the problem and after, helping the students writing their own projects.	
	Total of Classes Involved: Three classes with an average of 49 students each.	
	Results	<p>Development: The students wrote proposals for mitigating the draining problems at Pedreira Stream Basin; the projects were written and presented by students to teachers; from them the following projects arose EE project, one of irrigation and one of the alternative method for non-water proofing of the soil (creation of a orchard in small areas); The students performed their actions in morning and afternoon periods; EE speeches were performed by them and they made a recycling work which resulted on a waste bin for eac class of the school, they build a orchard and a nursery.</p> <p>Closure: They are preparing for the closure of the project producing presentation panels for exhibiting to the school community and surroundings.</p> <p>Evaluation: It was made in a continuous way by the observation of the participation and involvement of students and periodical meetings for discussing about the development and results of the activities they have proposed.</p>
NUCLEUS 02	Area of the acting professionals: Arts, Physical Education, Math and Chemistry.	
	Planning: A planning was written as a project titled "Landscaping at School Jardin'Arte".	
	Adequacy to the proposal: It was demonstrated an enormous difficulty of implanting the plan in the daily routine of the school's current classes, prioritizing the disciplinary contents. It is fact that it is complicated for the educator who was formed under a content's perspective, detach from the old and see the possibility of the new, without damages. Perhaps, this has occurred by the lack of planning time, and bigger aids of the articulator, besides, the nucleus could not harmonize the actuation of all the participants, factor that demonstrated the need of being in synchrony and partnership as the base of these formations (ELLIOT, 1996).	
	Used methodology: The work followed an idea formulated by the teachers' nucleus. The lack of opening for helping the students being the authors of their ideas on the development of the project may have been a limit factor of actuation and participation by the part of the students.	
	Total of classes involved: Three classes with an average of 49 students.	
	Results	<p>Development: The plan was applied, in a parallel way to the daily activities of the school, meetings were performed in weekends; the students interested by the project as it was exposed made a demonstration of how using the spaces for gardening instead of waterproofing the soil, taking into account the visual welfare.</p> <p>Closure: The preparation of the project's closure was made producing a presentation panel for the exhibition to the school community and surroundings.</p> <p>Evaluation: It was made in a continuous way by observation of the participation and involvement of students. The participation and income of students were low, compared to the average of students by worked class. Due to the separation made between the project and the school's activity, the students understood the importance of action and of their participation in the project.</p>

Continues

Continuation

NUCLEUS 03	Area of acting professionals: Physics, Spanish, Philosophy, Portuguese and Geography.	
	Planning: It was written a plan as a project, titled "Collection and Reuse of Rainwater".	
	Adequacy to the proposal: It fits well the teaching proposal, but it also demonstrated a slight difficulty of uniting base content and theme.	
	Used Methodology: On its work methodology, it was used the problem survey, but it was chosen to direct the students in programmed actions, in other words, it was not able to students to built their own solutions proposal. This methodology is the most common among educators, perhaps because it is less complicated than opening to guiding several ideas and by adjusting the student to a bigger control of their actions avoiding unforeseen issues. This method is shown as efficient about the sensitization and consequent critics of students, but inefficient in what concerns the development of attitudes which can plan effective actions in their social environment. It is interesting allowing the students to be involved in the problems and visualize their intervention capacity, intervening in fact, being teacher's responsibility the role of being the assistant and advisor.	
	Total of classes involved: Three classes with an average of 49 students each. Such students were from a 3 rd year of High School, factor that may have contributed to the low participation of the same. The fact is that the development of extracurricular activities does not have any value to entering a University and the 3 rd year students are found in a moment of pressure and expectation of a promising academic future, what does not left any space for thinking in social practices.	
NUCLEUS 04	Results	Development: The project resulted in educative messages about water and environment in general, which were written as graffiti in strategic points of the school, replacing the vandalism graffiti by art graffiti and educating the school community; there was the construction of rainwater collection and storage model which was connected to the orchard project, serving for it irrigation; this model has demonstrated a way of avoiding the rainwater impact over the soil, contributing for decreasing the superficial flow and also contributing for the not wasting potable water.
		Closure: They are preparing for the closure of the project producing presentation panels for exhibiting to the school community and surroundings.
		Evaluation: A low participation of students occurred in comparison to the quantity of nucleus' actuation rooms, reasserting the problem of limiting the students' creation, the fact they are about to take their <i>vestibular</i> tests (relative to SATs) and not motivated to develop extracurricular activities within this time period of their academic lives. However, the few ones that participated had a good and efficient performance.
NUCLEUS 04	Area of the acting professionals: History, Sociology and Geography.	
	Planning: A planning was written as a project titled "Documentary: The Inhabitants Surrounding Pedreiras Stream".	
	Adequacy to the proposal: There was a serious and typical problem from state schools today: due to a large board of sick professionals (problems arising, maybe, from the pressure of long work journey the professionals have to be submitted and if they want to have a more worth salary and due to the scenario they have to be submitted today), or also the lack of effective teachers, the nucleus is undone because it was formed by non-effective teachers (with contracts) or who took licenses due to health issues. Thus, the students that should be served by this nucleus had a partial participation in an indirect way (by the movement of other nucleuses). New teachers were hired but it was not possible to promote their adequacy to this program. It shall be clarified that it was not by lack of teachers planning or students involvement, but due to structural factors of the board of personnel that these nucleuses did not progress. It is a problem that was not foreseen and which shall be taken into account. It would be interesting that the maintenance of the board of educators during the year was prioritized, what would avoid damages like these. It is impossible to foresee certain types of diseases, but hiring more effective educators and maybe work with exclusive dedication model since a good remuneration could be a solution.	
	Used methodology: It was a good initiative, able to develop with students a documentary reporting the urban development and their consequent impacts, of Pedreiras Stream surroundings. With the aid of Municipal Agency of Environment GO and Strictu Sensu Program of Environmental Engineering PPGEMA/GO, they have notions of the basin limitation and its importance and they were also a field where they obtained orientations about the impacted status of Pedreira Stream and as Urban Drainage problems are closely connected to this status. At this moment, there was also the first contact of students with the surrounding population of the Stream who would be interviewed in this documentary.	
	Total of classes involved: Three classes with an average of 49 students.	
NUCLEUS 04	Results	Development: No results.
		Closure: No results.
		Evaluation: No results.

was improvement in grades, in interest and participation of students who, before the project, did not show any interest and were even anti-social, confirming the importance of contextualizing the school. As mentioned before, these evidences were recorded in audio and video. They are not presented here because they are not part of this article focus. All the school students that actively participated in the project went in trip field to a Permanent Reserve Area, where they constantly showed their concern and interest for environmental problems as well as awareness on preserving and using natural resources.

The following table presents a detailed description of the entire project development.

CONCLUSIONS

Educators need to realize and assume that their permanent condition as researchers and the purpose of their work should not concentrate their efforts only on passing knowledge on, but on the teaching learning process and on strategies that make easier for students to absorb knowledge. This is a basic assumption of the researchers and the project was planned to use EE as a vehicle to test the implementation of this in schools.

The student comes to the school with knowledge acquired by life experience, influenced by an entire social, cultural, and political context. Thus, it is necessary to take into account that actions and methodologies applied could positively influence when it is possible to aggregate, to common sense, knowledge from several sciences, in a contextualized and updated way. On the other hand, it can make no difference, when the link between types of knowledge does not happen and the formal education becomes an obligation for an uncertain future, offering a knowledge that many times is lost with time because it does not have any application.

Educating in the perspective of Environmental Education in schools is a task that demands institutional, political, and pedagogical efforts, among others, but it is not impossible to be performed. The experience presented herein shows a teaching alternative that although having limitations and challenges, showed that types of knowledge acquired in school could be useful today, disregarding the idea of futuristic education with no use for the present.

High school students are great actors on the preservation of the environment as they are in a stage of theoretical, conceptual, and political development. Besides, they behaved as co-authors of concrete actions on environment preservation, providing them the feeling of being useful and taking collective responsibility, which in turn open doors for new and old types of knowledge. This improved the student's outcome regarding the mandatory contents and improving his or her behavior and relationship with their environment. The experience showed in this study enable us to state that the environmental education is a science of social inclusion.

Environmental education is a great instrument for a sustainable management of Urban Drainage, since studying the environment provides an understanding of interactions between natural and social aspects, relations that include processes of cultural and technological creation, and transformation historical and political processes of nature and society. This is a fact that emphasises the importance of researching methodologies that meet Elementary Teaching formal education.

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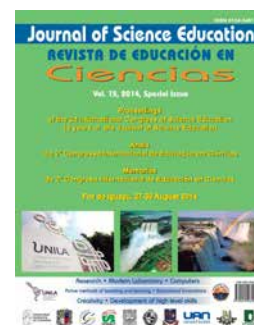
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Deep time: students' inventory and comparative analysis

Tiempo profundo: estudiantes, inventario y análisis comparativo

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Abstract

Time continues to attract a wide range of researchers from many areas, but its understanding from the point of view of education is still understudied. Assigned to James Hutton and away from biblical connotations, it remains difficult to clarify the concept of geological time to students from primary, secondary and even higher education. The present study aimed at: (i) building a Students' Deep Time Inventory (SDTI), (ii) proceed with the validation of this inventory, and (iii) conducting profile based comparative analyses related to the perceptions of students in the subject of deep time. The SDTI was organized in a 5-point Likert format answer items and it was applied to a sample of 410 secondary school students, following its validation by Portuguese teachers and students. The profiles related to the deep time conceptualizations were analysed by calculating the Coefficient of Simple Congruency and the Configurational Similarity Coefficient. The comparison of the profile analysis undertaken with three months interval, before and after lecturing on this subject, revealed very close profiles, and still far from the ideal profile as it is recommended in the specialist literature. The discrepancies that were found may be related to the little relevance that is attributed to teaching the subject or else to the conceptual difficulties inherent to the clarification of the concept. As such, future research is needed to elucidate the causes and to promote solutions.

Key words: deep time, inventory, comparative analysis, Portuguese students

Resumen

Tiempo profundo, sigue atrayendo a una amplia gama de investigadores de muchas áreas, pero su comprensión desde el punto de vista de la educación todavía está poco estudiado. Asignado a James Hutton y lejos de connotaciones bíblicas, sigue siendo la dificultad de precisar el concepto de tiempo geológico a estudiantes de educación primaria, secundaria e incluso superior. El presente estudio tiene como objetivo: (i) la construcción de tiempo profundo, inventario de estudiantes (SDTI), (ii) proceder a la validación de este inventario, y (iii) la realización comparativa basada en un perfil de análisis relacionados con las percepciones de los estudiantes en el tema del tiempo profundo. El SDTI se organizó en unos 5 puntos de formato Likert items de respuesta y se aplicó a una muestra de 410 estudiantes de secundaria, tras su validación por parte de profesores y estudiantes portugueses. Los perfiles relacionados con las conceptualizaciones tiempo profundo se analizaron mediante el cálculo del coeficiente de congruencia simple y el coeficiente de similitud configuracional. La comparación del análisis de perfil realizado con intervalo de tres meses, antes y después de dar una conferencia sobre este tema, reveló muy estrechos perfiles, y aún lejos del perfil ideal, ya que se recomienda en la literatura especializada. Las discrepancias que se encontraron pueden estar relacionadas con la poca importancia que se atribuye a la enseñanza de la materia o bien a las dificultades conceptuales inherentes a la clarificación del concepto. Como tal, se necesita investigación futura para dilucidar las causas y promover soluciones.

Palabras clave: Tiempo profundo, investigación, análisis comparativo, estudiantes de Portugal

INTRODUCTION

Most people are comfortable with the duration of time which corresponds directly to the human experience: seconds, hours, days, weeks, decades, centuries. Nonetheless, moving on to hundreds of thousands and millions of years take us far beyond the daily human experience and indeed, far from history (*sensu stricto*) and human existence (Trend, 2001a). The understanding of the geological time concept refers to many scientific fields, particularly Ecology, Cosmology and Evolutionary Biology (Dodick and Orion 2003a), Environmental Sciences (Trend, 2001a) and Geology. In historical terms, Cotner, Brooks and Moore (2009) actually stated Darwin's argument that ultimately, the history of life on Earth was based on Geology. In fact, as Trend (2000, p.541) puts it: "Geology is the science with the clear focus on deep time (all other sciences deal with time of shorter duration) and on the procedures of retrodiction." The notion of geological time is a matter that requires didactic exploration, both because of its very conceptual meaning in sciences and the implications that it

has in shaping the individual's social and psychological perspectives. Natural Sciences and Human Sciences both pose pertinent questions to the conceptualization of time within the individual and in his/her interaction with society. According to Truscott, Boyle, Burkill, Libarkin and Lonsdale (2006), students develop their concept of time according to their prejudices and sensorial conceptualization of formal or informal experiences, showing significant problems in conceptualizing geological time, particularly when it refers to the concepts of radiometric dating, relative and absolute time. Geological time (both absolute and relative) is conceptually difficult to understand (Cotner et al., 2009) but research has shown that the understanding of relative time is better than that of absolute time (Trend, 2000a; Truscott et al., 2006). Although, the problem of time is one of the most difficult concepts to learn in Geology (Schumm, 1991), little research has been conducted on the understanding of either deep time or on alternative conceptions of geological time (Trend, 2001b). Many studies and instruments have been developed to diagnose or evaluate the conceptual understanding of geological time by teachers and students. Since it is impossible to refer to all of these, we hereby present some of the more frequently quoted in the literature. Marques and Thompson (1997) attempted to diagnose Portuguese students' understanding of the origin and nature of the Earth and development of life by applying a written questionnaire to 493 pupils aged between 10-11 and 14-15. This instrument was divided into two parts: one with 14 questions dealing with the origin, nature and development of earth and the other comprising 11 questions, relating to the origin and development of life. Trend (2000), in evaluating conceptions of geological time among 179 pre-service primary teachers, applied a questionnaire to them, a sequence of two geo-events cards and a responding activity to objects. The same author in 2001 (Trend, 2001a), in investigating young people's perceptions of deep time, asked 17-year-old students to list the major events which they thought had taken place on planet Earth. In this study, he also asked students to construct their own concept map by arranging 24 cards and to write linking statements. Dodick and Orion (2003b) developed three different instruments to analyse cognitive factors that affect students understanding of geological time namely: (i) GeoTAT – Geological Time Aptitude Test, which consists of six multipart open geological puzzles that test diachronic thinking skills; (ii) TST – Temporal Spatial Test, a set of puzzles which test the relationship between spatial thinking and temporal thinking; and (iii) SFT – Strategic Factors Test, which consists of three illustrations representing pairs of three outcrops, that test the influence of dimensional factors on temporal awareness. Some years later, Semken et al. (2009) asked 70 respondents to interpret a logarithmically scaled walking timeline (the Million Year Trail) to plot precise time points scaled from recent times to 65 million years ago. In another study, Clary, Brzuszek and Wandersee (2009) used the validated Petrified Wood Survey (PWS: Clary and Wandersee, 2007) which explores students understanding of geological time, fossilization processes and evolution. It has been field-tested on multiple occasions and its validity and reliability have been well established. In aiming to analyse whether or not students' perception about deep time affected their acceptance of evolutionary theory, Cotner et al. (2009) electronically surveyed 400. These authors used the 20-item Measure of Acceptance of the theory of Evolution (MATE: Rutledge and Sadler, 2007) and the 10-item of Knowledge of Evolution Exam (KEE: Moore et al., 2009). In examining the problems that religious Jewish science teachers in Israeli high Schools have in dealing with geological time, Dodick, Dayan and Orion (2010) applied a questionnaire consisting of 35 questions organized in a five point Likert-type scale. In this questionnaire, the respondents were asked to state their level of agreement with understanding of scientific issue statements and philosophical approaches in Judaism towards science statements. All instruments referred to above were specifically developed for the research undertaken and to be applied in its specific context. Since the results obtained are tied to the situation in which they were uncovered

and the convenience sample used, the issue of transferability to other contexts should not be assumed a priori.

Purpose of the study: As referred in the previous section, several studies related to students' perceptions use various instruments to help the characterization of the students' perceptions of time in geology. However, these instruments are related to very unique formal learning environment formulations. Since there is no instrument capable of diagnosing Portuguese students' perception of the concept of geological time, this study aimed to establish an inventory and building upon this, to produce a comparative profile analysis on the concepts of geological time in secondary school students.

Research procedure: This study was conducted in three phases. The first phase was directed to produce the deep time inventory. The second phase aimed to validate the inventory of those conceptions. The third performed a profile analysis of the students' perceptions before and after deep time was formally taught in Geology classes.

Phase 1- Producing the inventory

Materials and procedure: The empirical data was obtained through the application of a set of seven questions derived from a literature review,

namely: (1) What is deep time?; (2) What role does time perform in History?; (3) Do you find any relationship between Religion and the age of the Earth?; (4) Explain any given example of a relationship between time and Geology; (5) How can you relate fossils with time?; (6) How can you measure time?; (7) Which areas of Science can use deep time? These were open questions and secondary school students answered them in approximately 45 minutes. The questions involved representations of time (both in individual and collective students' contexts) as well as their applications in their daily lives and learning processes.

Participants: The questions were addressed to a convenience sample consisting of 58 students (21 boys and 37 girls) from two schools: 34 students from School A (16 boys, 18 girls) and 14 students from School B (5 boys and 9 girls). Both schools were public schools in northern Portugal. All students attended science courses at secondary school and the age ranged from 16 to 18 years of age.

Methodology: The answers were subjected to content analysis undertaken by three of the research team members. Content analysis is a technique which includes a set of methodological tools that can be constantly improved and which applies to distinct discourses (Bardin, 1977), mainly in the area

Table 1: Students Deep Time Inventory items and Cronbach alpha

Time and Religion	01. The action of the Divine affects terrestrial phenomena. 05. The birth of Christ does not condition the calendar. (*) 08. The universe emerges with a big blast. 11. The age of the Earth corresponds to the age assigned by religion. (*) 15. The events on Earth do not depend on divine actions. 38. The origin of life corresponds to the origin of Earth. (*) 18. Reading the Bible does not allow any conclusion regarding the age of the Earth. 22. Life on Earth emerged many millions of years after its formation. 26. The divine action created the universe. (*) 30. The confirmation of the age of the Earth results from the action of scientists using geological methods. 33. Time measured in years is counted in relation to the birth of Christ, BC and AD. 35. Archbishop Ussher stated that the Earth was created 4400 years BC.	$\alpha = 0.61$
Time and Geology	02. Rocks remain unchanged over time. (*) 04. Ocean movements (transgression and regression) occurred throughout time. 06. Some fossil, such as coral, allow the characterization of changes in weather conditions over time. 09. Relative age is assessed using the principles of stratigraphy, such as the principle of superposition. 12. All rocks are evaluated through relative age. 14. The contours of continents, for example the coastlines, have remained over time. (*) 17. The fossils, such as trilobites and ammonites, are indicators of geological time. 39. The over exploitation of rocks, which are used to produce energy, is very fast, and leads to their depletion. 19. Sedimentary rocks remain unchanged throughout time. (*) 21. The formation of mountain chains is a lengthy process. 23. The degree of change in rocks caused by meteorization and erosion allows us to compare ages. 25. Living fossils allow the dating of rocks. (*) 27. Some types of fossils (age fossils such as trilobites, dinosaur footprints, ...) allow the determination of the age of strata. 40. The rhythm of consumption of rocks, such as coal, oil and natural gas, is similar to the rhythm of their formation. (*) 29. The formation of sedimentary rocks depends on the processes of erosion, transport and sedimentation, which occur over long periods of time. 31. You cannot measure the absolute age of rocks. 34. In geology, absolute age can be measured from the isotopes (Carbon-14, Uranium - 238, ...) within the rocks. 41. The configuration of the Earth, such as the formation of valleys, is the same throughout time. (*) 36. Since fossils are the remains of living beings, they are not used to date rocks. (*) 37. Living beings have remained unchanged throughout time, and are unable to give us any information regarding the climate of their time. (*)	$\alpha = 0.74$
Geological Events	03. The glacial periods caused the extinction of species. 07. The dinosaurs' extinction occurred as a consequence of changes in the Earth that resulted from a meteorite collision. 10. The formation of the solar system took place much later than the Big Bang. 13. The action of Man does influence life on Earth. (*) 16. Man witnessed the dinosaurs' extinction. (*) 20. Living beings do not dependent on the weather conditions of the planet Earth. (*) 24. Dinosaurs were extinct when Man appeared on Earth. 28. The dinosaurs' extinction resulted from human action. (*) 32. Man is contributing to the extinction of life on Earth.	$\alpha = 0.65$

Subtitles :(*) Items to be recoded.

of social sciences. Well defined objectives are included which through decoding of the message, helps to uncover ideas and conceptions within the text of the answers. Following the content analysis and to elaborate the empirical inventory of the students' conceptions on deep time, the researchers identified a list of items from the inventory to be used in the students' profiles before and after teaching about deep time. Thereafter, a spoken debate on each item took place between research members and the item's pertinence was evaluated under a theoretical framework supported by the literature.

Result: Some balance was seen in the first six questions. However, in the last question (which areas of science can use geological time), because the answers are direct and often consist of a listing of various sciences, we observe approximately the double of the occurrences. The next step was to debate each item in geology classes with the students ($n=58$), thereby assessing their pertinence under the light of theoretical framework. After a careful analysis, this preliminary version of the inventory had 41 items integrated in the following three subscales: time and religion; time and geology and geological events. The inventory was a 5 point Likert scale where 1 meant *strongly disagree* and 5 meant *strongly agree*.

Phase 2 Validating the Inventory

Methodology: In this phase researchers asked nine secondary school teachers of geology and two university professors to assess the inventory. The inventory was also applied and validated by eight final-year science secondary school students, with an average age of 17 years. This validation process was not timed, but both teachers and students took about 45 minutes.

Methodology: This stage analysed, in the 21st version of SPSS, the results obtained from the application of the SDTI, as well as the participants' perceptions. Methodologically, the researchers intended to perform a qualitative analysis, backed by significant quantitative data. To analyse the reliability the alpha of Cronbach was calculated.

Results: Neither teachers nor students presented any doubts regarding the interpretation of the items, which development was based with consideration to students' answers and previous studies. The Cronbach alpha values showing internal consistency of the rating-subscales ranged from 0.61 and 0.74 (table 1) indicating that the reliability was acceptable, namely because lower values were obtained in the subscales with less items (Lowenthal, 2001).

Although higher values of reliability are preferred, the fact that items were developed upon students' knowledge had contributed to clarify students understanding of the items and it has supported the reliability and the validity of the inventory (Gall, Borg and Gall, 1996).

Phase 3 - Profile analysis

Materials and procedure: The SDTI's final version (table 1) was applied in a two-step procedure. The first application occurred before teaching the geology related contents. The second application of the inventory occurred after teaching contents related to deep time (for example, measurements of time, age of the Earth, fossil and relative and absolute dating), which occurred in classes that totalled 180 minutes. The interval between these applications was three months. The teachers were advised to use the teaching methodology that they normally use as well as the same educational resources. In this way, the intervention mode of the teachers was lecture-based methodology and textbook reading.

Participants: In the fourth stage, a convenience sample consisting of 410 students (202 boys and 208 girls) was used from seven public schools in northern Portugal. Students attended science courses in secondary schools, having Geology classes. Ages ranged between 16 and 18 years old.

Results: A parametric statistical test (t test) and frequency analysis were undertaken. In agreement with the Lemos (1996) study, quantitative analysis was done and consisted of analysis of the profiles' congruency (C: Coefficient of Simple Congruency) and analysis of the profiles' configurative similarity (CS: Configurational Similarity Coefficient).

In that way, before analysis of the profiles, the t was realised to verify if significant improvements existed in the responses of the students after teacher intervention. The values obtained ($t = -7.972$; $p = 0.00$) indicate significant improvements with the average value rising from 246.2 to 254.3. Analysis of the students' results in each inventory subscale also permits significant improvements after the intervention (table 2) to be verified. To better analyze the effects of the intervention a profile analysis was conducted. Profile analysis is a multivariate statistical method to process and evaluate profiles in a specific area in order to obtain quantitative results (Serafini, 1998). Profiles result from the averages of the answers given to each of the

Table 2 – t text results

Classes	average		t test	
	pre	post	t	p
Time and Religion	44.5	47.9	-8.322	0.000
Time and Geology	75.4	80.6	-11.820	0.000
Geological Events	37.7	38.4	-2.719	0.007

items in each application of an instrument (for example an inventory). The Coefficient of Simple Congruency (C) quantitatively evaluates the distance between profiles and is defined as the proximity between the expected or ideal situation and that obtained. The values of C range from 0 to 1 with 1 being the perfect match in the profile evaluations. The interpretation of the Coefficient of Simple Congruency (C) is the following: 0.90-1.00 virtually perfect congruency; 0.70-0.89 high congruency; 0.40-0.69 moderate congruency; 0.20-0.39 low congruency; 0.00-0.19 virtually no congruency (Cernuzzi and Zambonelli 2008; Lemos, 1996; Serafini, 1981). A greater distance implies that we are far from the ideal profile. As stated by the referred authors (Cernuzzi and Zambonelli 2008; Serafini, 1988), a complementary coefficient is the Configurational Similarity coefficient (CS) which measures the grade of correspondence of the high and low values between different profiles in each subscale. When graphically represented, such values are easy to compare. Still, even when profiles have large distances between them, they can still have great similarities in their configuration. As in the Congruency Simple Coefficient, the values of Configurational Similarity range from 0 to 1 and the interpretation of its values is the same as the Coefficient Simple Congruency. In this study the profiles were analysed by comparing the Coefficient of Simple Congruency (C) in the profiles in each of the applications of the inventory with the Coefficient of Simple Congruency (C) of the ideal profile. As mentioned, this coefficient quantifies the distance between the profiles obtained from the answers in each application of SDTI and the ideal profile (which resulted from the maximum values of the inventory). In other words, the profile analysis carried out on in this study allowed the comparison of two students' deep time profiles (SDP before formal teaching profile and SDP after formal teaching profile) with the normative profile (scientific knowledge of *deep time*). The normative or ideal profile has a value of 100% (in our case having score 5 on the Likert scale) in all variables ($C=1$). The other profiles are directly related to the *real* values of the variables. As the questionnaire had 41 items, each profile evaluates 41 specific variables. The Configurational Similarity Coefficient was also obtained to measures the grade of correspondence of the high and low values between both profiles that obtained before formal teaching of deep time and that obtained after formal teaching. Note that for a better comparative analysis of the profiles before and after intervention, the results are presented as points linked by a line, as suggested by similar studies (Cernuzzi and Zambonelli 2008; Serafini 1988). Figure 1 shows the ideal profile and its comparison with profiles from each application – the 1st application done before formal teaching and 2nd application done after formal teaching of deep time content knowledge.

The polarity of the reversed items was corrected through the difference to the average. The profiles, as presented in figure 1, result from the averages of the answers given to each of the items, in the two applications. The Coefficient of Simple Congruency for the first application was $C=0.66$ and for the second application was $C=0.70$. Both values suggest a moderate congruency with the ideal profile even though the second application is related to a slightly better result. The Configurational Similarity Coefficient obtained was $CS=0.92$ which implies a virtually perfect congruency in some high and low points of the two applications of the SDTI, thereby giving more reliability to the study. Table 3 presents values of C and CS obtained considering the ideal profile and the two profiles obtained with SDTI's three subscales.

In table 3, the analysis of the Congruency Simple Coefficient (C) shows a moderate correlation in all subscales between the profiles of the students with the ideal profile, before and after the intervention. It is also possible to observe that the two obtained profiles are similar in high and low points, that is they have a high configurationally similarity in all subscales.

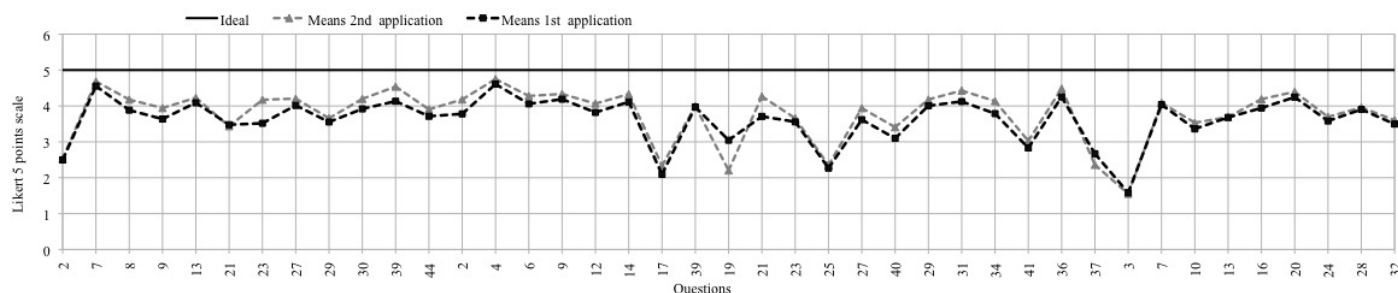


Figure 1: Comparison between the ideal profile and the profile in each application

Table 3 – C and CS values obtained considering SDTI's three subscales

Classes	C		CS
	1st	2nd	
Time and Religion	0.53	0.58	0.73
Time and Geology	0.57	0.66	0.74
Geological Events	0.65	0.66	0.87

Subtitle: C= Coefficient of Simple Congruency; CS= Configurational Similarity Coefficient

DISCUSSION

The methodology adopted in this study permitted the main perceptions of Portuguese students to be identified in relation to geological time. The study began with an elaboration of the Portuguese SDTI, which permitted an instrument to be obtained with 41 items distributed into three subscales (Time and Religion, Time and Geology, Geological Events). The formulation of the items resulted from the diagnosis conducted on the students, which had as its starting point some questions on geological time and was fine-tuned during the application of the second inventory. After concluding the elaboration of the SDTI, the intention was to evaluate the level of knowledge of the students on geological time either in relation to an ideal profile (5 mark points on the Likert scale in all items) or comparing the profile before and after the intervention of the teachers. The teachers conducted an intervention of 180 minutes and used the methods with which they usually teach Portuguese students – lecture-based methodology and textbook reading. It was hoped that the teaching methodology, associated with the strategies and educational resources traditionally used in the schools, permitted significant improvements in the results to be obtained. Such an expectation was based on the fact that teachers are aware of the difficulties associated with geological time, since these are mainly divulged by educational research. Two methods were used to examine students learning outcomes. In this way, the t test was conducted and an elaboration of the profiles realized, both to compare the results before and after the intervention. The t test revealed significant improvements after the intervention in all of the defined subscales. In the same way, the result of the student's scoring in the full inventory also revealed significant improvements. This result was explored through the comparative analysis of the student's profiles by subscale – the second analysis method chosen. The quantitative analysis indicated moderate correlations between the profile of the students, before and after the intervention, with the ideal profile. On the other hand, the values obtained indicated a high configurational similarity between the students' profiles, before and after intervention - that is, the lowest and highest scoring persisted even after the formal teaching. In other words, the results obtained permitted us to verify that the teaching of the conceptual contents (as indicated by the official curriculum and in accordance with the methodology normally used by teachers), permitted an improvement in the learning of the students' conceptions under this theme, but which is still some way off the ideal learning.

CONCLUSIONS

Building upon the literature's caution against the difficulty of perception of the concept of deep time by secondary school students, this research further

reinforces the issue by concluding that even after its formal teaching, students show little improvement. When students finish secondary school, some of their conceptions continue to be distant from the curricula requirements and desired knowledge. This situation reveals an education scanty directed towards understanding the conceptual contents inherent to deep time, not so much because teachers are unaware of the difficulties in understanding deep time, but probably more since they still lack the strategies necessary to help students overcome its conceptualisation. A curriculum revision may address the redefinition of which strategies to use and which contents to be addressed when teaching deep time, possibly promoting a greater connection with everyday life. Another path may consist of resorting to analogies between the time required in geological processes and the time needed in human processes. On the other hand, a curriculum design that builds upon the interdisciplinary approach of this subject may help to eradicate erroneous conceptions as well as to clarify the concept of deep time, particularly by establishing meaningful relationships to students.

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Elementary school teachers (early years) and didactic experimentation

Professoras dos anos iniciais do ensino fundamental e a experimentação didática

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Neste trabalho apresentamos parte de uma pesquisa realizada nos anos de 2010 e 2011, com professoras de Ensino Fundamental, do Estado de São Paulo, Brasil. Tal pesquisa teve por objetivo investigar as perspectivas didáticas das participantes, quanto à implementação de atividades práticas e experimentais nos anos iniciais do Ensino Fundamental. As atividades didáticas experimentais despertam grande interesse nos docentes, pois eles têm a esperança de que elas tornem suas aulas mais atrativas e com isso consigam maior atenção dos alunos. Contudo, apesar de parecer existir um consenso sobre a importância da experimentação no Ensino de Ciências, a vivência nas escolas evidencia a pouca utilização de atividades práticas, apesar da crença dos professores em seu caráter motivador e transformador. Entendemos que o papel da experimentação no ensino é oferecer condições para a construção de conhecimentos científicos, permitindo ao aluno fazer observações, coletar e organizar dados, formular hipóteses, compartilhar ideias e, talvez, rever algumas concepções prévias. Nesse sentido, o experimento didático seria utilizado para fomentar situações didáticas problematizadoras, em que os estudantes pudessem se engajar em atividades mais investigativas e menos contemplativas (HODSON, 1994). A pesquisa se desenvolveu em duas escolas de Ensino Fundamental urbanas de rede municipal, uma localizada na cidade de Marília (E1) e outra em Rio Claro (E2), ambas no interior do Estado de São Paulo, Brasil, com a participação de vinte e cinco docentes que atuavam do 1º ao 5º ano, sendo vinte e duas da E1 e três da E2. A análise de questionários e entrevistas evidenciou uma situação complexa. A carência da formação, bem como de material e a falta de espaço físico e curricular são fatores apontados pelas professoras como barreiras para a utilização desse procedimento didático. Entretanto a carência de conteúdo e a insegurança no trato com o conhecimento de Ciências parecem ser os principais fatores a impedirem e limitarem as ações educacionais de tais docentes. Percebemos, como apontado por Carvalho e Gil-Perez (1995), que a falta de domínio do conteúdo impede que os professores possam ser criativos e ousados, características importantes para a permanente inovação no Ensino. Tais dados apontam para a necessidade da melhoria das formações inicial e continuada, com a inclusão mais sistemática de conteúdos, materiais didáticos e reflexões metodológicas dirigidas especialmente aos docentes dessas faixas etárias, ações que entendemos terão implicações e melhoria para outros níveis de escolaridade.

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Palavras-chave: ensino de ciências. experimentação didática. formação de professores. ensino fundamental – anos iniciais.

Chemicals in junk food: a proposal for the teaching of chemical bonds by focusing STS

a química na junk food: uma proposta para o ensino de ligações químicas por meio do enfoque CTS

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Os Parâmetros Curriculares Nacionais (PCN) reforçam que o aprendizado de Química deve possibilitar ao aluno a compreensão tanto dos processos químicos em si quanto da construção de um conhecimento científico em estreita relação com as aplicações tecnológicas e suas implicações ambientais, sociais e políticas (BRASIL, 1999, p. 65). Nessa perspectiva o enfoque Ciência, Tecnologia e Sociedade (CTS) no ensino, contribuem para a aproximação entre os conteúdos científicos escolares e os conhecimentos que o cidadão deve ter para serem capazes de compreender e avaliar criticamente as implicações sociais dos avanços científicos e tecnológicos (BARDOSA, 2007). Dentre os diversos conteúdos inerentes a disciplina de Química, o estudo das Ligações Químicas é um assunto fundamental, pois por meio de seu entendimento e conhecimento é possível compreender as transformações que ocorrem em nosso mundo (TOMA, 1997). O objetivo deste artigo é apresentar parte dos resultados de um estudo em que se buscou promover o ensino de Ligações Químicas com ênfase nas ligações Iônica e Covalente em uma abordagem CTS. Para isso, partiu-se do tema social *Junk Food*, por ser um tema de preocupação contemporânea (obesidade, e outros danos à saúde causada pelo consumo excessivo de sal e açúcar). Em virtude do exposto, delimitou-se a seguinte questão norteadora: Quais as contribuições do enfoque CTS para o ensino de Ligações Químicas com ênfase nas ligações Iônica e Covalente? A abordagem metodológica foi qualitativa, de natureza interpretativa com observação participante. A coleta de dados se deu por meio de fotos, gravações de arguições orais, anotações de campo em protocolos de observação, questionários e análise dos trabalhos desenvolvidos pelos alunos. O estudo foi desenvolvido em dezoito (18) aulas, as quais interligaram os conceitos químicos de Ligações Químicas ao tema social controverso (*Junk Food*), de forma a promover as inter-relações dos aspectos da ciência, tecnologia e sociedade. Os principais resultados obtidos evidenciaram que o ensino de Ligações Químicas, por meio do tema social *Junk Food*, promoveu a valorização do conhecimento científico e a conscientização das aplicações científicas e tecnológicas aos fenômenos da vida cotidiana.

BARDOSA, Olga M.E.D. Açúcares e Gorguras-Estratégias e Recursos Didáticos para a sua abordagem no 1ºCEB 2007. 231 f. Dissertação (Mestrado em Educação em Ciências do 1º Ciclo do Ensino Básico) – Universidade de Aveiro, Portugal, 2007.

BRASIL. Parâmetros Curriculares Nacionais para o Ensino Médio. Brasília: MEC/SEMTEC, 1999. TOMA, Henrique E. Ligação Química: Abordagem Clássica ou Quântica. *Química Nova na Escola*. n.6, p.8-12, nov. 1997.

Palavras-chave: ensino de química; ciência, tecnologia e sociedade (CTS); ligações químicas; *junk food*, educação científica e tecnológica.

Campina Grande's (PB - Brazil) public school students' perception about intestinal parasites

Percepção dos estudantes de escolas públicas de Campina Grande (PB - Brasil) sobre as parasitoses intestinais

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Os parasitas intestinais estão entre os patógenos que mais frequentemente causam doenças entre os seres humanos, principalmente nas populações de baixa renda (Souza *et al.*, 2010). Na educação básica o ensino dos conteúdos da área de saúde tem sido tradicionalmente praticado nas disciplinas de ciências e biologia. De acordo com os Parâmetro Curriculares Nacionais (PCN) para a educação básica, a escola deverá promover a formação de atitudes e valores que permitam ao estudante um aprendizado autônomo. O objetivo é que, dessa forma, seja possível significar os conteúdos curriculares ensinados na escola em benefício da sua própria saúde e daqueles que estão a sua volta. No âmbito escolar o ensino dos conteúdos da área de saúde enfrenta problemas específicos, como a não aproximação à realidade dos estudantes. As práticas em sala de aula envolvendo as temáticas relacionadas ao corpo humano e à saúde são em sua maioria de natureza teórica ou não contextualizada. Tendo em vista este distanciamento, há necessidade de privilegiar modelos didáticos ancorados na abordagem problematizadora de ensino-aprendizagem para trabalhar estes conteúdos (Ramos, Struchiner, 2009). Nesta pesquisa objetivou-se identificar a percepção dos estudantes de ensino fundamental de duas escolas localizadas em Campina Grande/PB acerca da transmissão das parasitoses intestinais. A coleta de dados foi realizada por meio da aplicação de um questionário entre os estudantes. Os dados coletados foram categorizados e as respostas analisadas por meio da análise lexical, utilizando-se o software MODALISA 4.5. Após esta etapa desenvolveram-se as ações extensionistas, por meio da abordagem lúdica envolvendo encenação teatral e a distribuição de cartilha educativa abordando o tema 'doenças parasitárias'. Os resultados mostraram mudanças positivas em relação à percepção dos estudantes quanto às formas de transmissão e prevenção às parasitoses intestinais, levando a crer que promoveu um processo de compreensão dos mecanismos implícitos da transmissão e prevenção das doenças parasitárias, desenvolvendo a aprendizagem coletiva após a intervenção da educação para a saúde.

P. Ramos. M. Struchiner. Concepções de educação em pesquisas sobre materiais informatizados para o ensino de ciências e de saúde. *Ciência e Educação*. São Paulo, vol.15, n.3, p.13-27, 2009.

Palavras-chave: ensino em ciências; educação para a saúde; parasitas intestinais.

History and philosophy of science in physics teaching: a study about the historical and philosophical approaches in the classroom.

História e filosofia da ciência no ensino de física: um estudo a respeito das abordagens histórico-filosóficas em sala de aula.

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O uso de abordagens que fazem uso de História e Filosofia da Ciência (HFC) no ensino é amplamente incentivado, pois esse tipo de abordagem pode: tornar as aulas mais desafiadoras e reflexivas permitindo o desenvolvimento do pensamento crítico, fazer com que os alunos encontrem significado nos conteúdos, demonstrar que a ciência é uma construção coletiva, etc (Mathews, 1995). Com base nesses argumentos, espera-se que a inserção de abordagens

histórico-filosóficas possa contribuir para uma melhoria no ensino das ciências. Porém, o número de publicações que relatam resultados de investigações empíricas do uso de HFC em sala de aula ainda é pequeno levando em consideração o número de trabalhos publicados a respeito da temática HFC no ensino (Teixeira, Greca, Freire, 2011). Tomando como inspiração o trabalho de Teixeira, Greca e Freire (2011), o presente trabalho é fruto de uma investigação a respeito das publicações relacionadas à História e Filosofia da Ciência (HFC) no ensino de Física e tem por objetivo mostrar um panorama geral e atual das publicações, bem como um estudo mais detalhado das publicações que tratam de investigações empíricas do uso de HFC em sala de aula. Nossa busca se deu nos seguintes periódicos: *Ciência & Educação*, *Revista Brasileira de Ensino de Física*, *Caderno Brasileiro de Ensino de Física*, *Ensaio*, *Investigações em Ensino de Ciências*, *Revista Brasileira de Pesquisa em Educação em Ciências e Enseñanza de Las Ciencias*. Encontramos 63 artigos, que agrupamos em quatro unidades temáticas para facilitar a análise. Dos resultados, podemos afirmar que a maioria dos trabalhos publicados (63,5%) esta relacionada a discussões teóricas do uso de HFC ou a conteúdos de Física expostos com um viés histórico e/ou filosófico, o que pode ser de grande utilidade para os professores tanto para própria formação quanto no preparo de aulas, pois não será necessário fazer todo o trabalho de investigação histórica e/ou filosófica do conteúdo desejado. Quanto aos trabalhos que se dedicaram a investigações empíricas em sala de aula, formam uma pequena parcela (7,9%) dos trabalhos publicados. Esse resultado corroborou com os resultados da pesquisa feita por Teixeira, Greca, Freire (2011), indicando que uso de abordagens didáticas que fazem uso de HFC no ensino deve ser objeto de pesquisa na área, a fim de que possamos afirmar com mais segurança a eficiência dessas abordagens em sala de aula, bem como suas limitações. Os artigos que abordaram estudos empíricos de abordagens histórico-filosóficas em sala de aula mostraram bons resultados. As investigações indicaram que houve uma melhora nas ideias a respeito da Natureza da Ciência e na compreensão dos conceitos físicos envolvidos, levando a um aumento satisfatório no rendimento escolar.

MATTHEWS, M. R. História, filosofia e ensino de ciências: a tendência atual de reaproximação. *Caderno Catarinense de Ensino de Física*, Florianópolis, v. 12, n. 3, p. 164-214, dez. 1995.

TEIXEIRA, E. S.; GRECA, I. M.; FREIRE, O. Uma revisão sistemática das pesquisas publicadas no Brasil sobre o uso didático de História e Filosofia da Ciência no ensino de Física. PEDUZZI, L. O. Q.; MARTINS, A. F. P.; FERREIRA, J. M. H. (Orgs.) *Temas de História e Filosofia da Ciência no ensino*. EDUFERN, 372 p, 2012.

Palavras-chave: história, filosofia, ensino de física.

Mind maps: environmental perception in the solidarity economy environment

Mapas mentais: percepção ambiental no ambiente da economia solidária

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Em pleno século XXI, o homem ainda se depara com questões acerca de uma forma de vida ambientalmente insustentável e pouco saudável. Valendo frisar que os problemas socioambientais estão surgindo emergencialmente em escalas preocupantes para a coletividade mundial. Esta problemática é majorada por decorrência do modelo de vida vigente do homem contemporâneo, um modelo ainda antropocêntrico, cartesiano, reducionista e consumista. Sendo o consumismo o mais debatido na atualidade e relacionado intimamente com o sistema capitalista, pois segundo Karl Marx há uma cisão entre o Homem e a Natureza, manifestada na força capitalista nos processos de expropriação e dominação com as relações do homem e capital, como a alienação, a banalização da existência, a desumanização, o distanciamento do homem com o meio natural, etc.

O presente artigo é sobre uma pesquisa que investiga a percepção ambiental, partindo das concepções individuais do conceito de Meio

Ambiente de alguns adeptos da Central da Economia Solidária de Campo Grande MS, no que poderia vir a ser uma tentativa diagnóstica para uma ação pedagógica futura de Educação Ambiental. O grupo é constituído de um coletivo heterogêneo, com posições diferenciadas socialmente, com uma proposta de organização de produção e comercialização alternativa. Pois, desenvolvem atividades comerciais formais e não-formais caracterizadas pela socialização dos meios de produção e pela autogestão. Trabalhando com comunidades populares e outras coletividades como uma cooperativa de produção, consumo, comercialização e crédito.

No desenvolvimento da pesquisa foram utilizados os mapas mentais seguindo os critérios da metodologia Kozel (Kozel, 2007), os quais foram analisados segundo a decodificação das mensagens expressas nos mapas do público pesquisado. Foi realizada uma análise de cunho fenomenológico que procurou interpretar as mensagens dos mapas desenhados segundo o conceito de Meio Ambiente. “Os mapas mentais, nesse aspecto, podem ser considerados como aportes preciosos para o ‘fazer pedagógico’, sobretudo por oferecerem aos estudantes a interlocução como atores sociais e produtores do espaço geográfico” (Kozel, 2007).

Como a metodologia se mostrou eficaz como um diagnóstico *a priori*, as análises dos mapas mentais apresentaram nuances importantes e distintas em cada desenho, mostrando para o educador a importância de um planejamento direcionado ao coletivo para maior sucesso na aprendizagem da Educação Ambiental.

Kozel, Salete. Mapas mentais – uma forma de linguagem: Perspectivas metodológicas in: KOZEL, S. et al (org): Da percepção e cognição à representação. São Paulo. Terceira Margem, 2007. p.114-138.

Marx, Karl. O capital. Coleção Os economistas. São Paulo: Nova Cultural, 1988

Palavras-chave: mapas mentais; economia solidária; meio ambiente.

Mind maps as a methodology for raising environmental awareness and environmental conceptions of teachers responsible for the continuing education of municipal schools in Campo Grande (MS, Brazil)

Mapas mentais como metodologia para levantamento da percepção ambiental e de concepções de meio ambiente dos professores responsáveis pelas formações continuadas da rede municipal de ensino de Campo Grande (MS, Brasil)

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O artigo relata uma investigação voltada para o levantamento da percepção ambiental e das concepções de meio ambiente dos profissionais da Secretaria Municipal de Educação de Campo Grande (Mato Grosso do Sul, Brasil) responsáveis pelas formações continuadas dos professores da rede pública municipal. Trata-se de uma pesquisa baseada em dados qualitativos obtidos por meio do uso de mapas mentais como instrumento metodológico. Para a análise e discussão dos resultados foram avaliados os elementos encontrados nos mapas mentais, assim como a sua disposição, seguindo critérios próprios da metodologia Kozel (2007). De acordo com esta proposta metodológica de análise, os mapas mentais são instrumentos capazes de revelar as ideias que as pessoas têm do mundo, captando além da percepção individual, podendo refletir as construções sociais. Para a interpretação descritiva desses mapas, recorreu-se também à classificação das concepções de meio ambiente proposta por Reigota (2007). Os estudos de percepção ambiental, linha investigativa adotada neste trabalho para o levantamento de concepções e representações sobre meio ambiente, têm se constituído em importante ferramenta para a compreensão das relações entre natureza e sociedade. Como resultados da pesquisa, foi possível constatar que a maioria dos professores formadores do grupo investigado detêm concepções globalizantes sobre meio ambiente, percebendo-o como a interação entre a sociedade e a natureza. Entretanto, alguns professores ainda revelam concepções antropocêntricas e naturalistas sobre meio ambiente. As concepções sobre meio ambiente influenciam diretamente o ensino das ciências, assim como as práticas de Educação Ambiental (EA), pois no

processo educativo os sujeitos envolvidos carregam consigo e expressam valores imbricados dos pressupostos teóricos em que estão alicerçados. A EA, certamente, é considerada um dos meios mais indicados para se ampliar a noção de meio ambiente no contexto do ensino, de forma que o ser humano, ao referir-se ao meio ambiente, possa recuperar a compreensão de que também refere-se a si mesmo.

KOZEL, S. Mapas mentais – uma forma de linguagem: perspectivas metodológicas.

In: KOZEL, S.; COSTA SILVA, J.; GIL FILHO, S.F. (orgs). Da percepção e cognição à representação: reconstruções teóricas da geografia cultural e humanista. São Paulo: Terceira Margem; Curitiba: NEER, 2007. p. 114-138.

REIGOTA, Marcos. Meio ambiente e representação social. 3. ed. São Paulo: Cortez, 2007.

Palavras-chave: percepção ambiental; concepções de meio ambiente; formação de professores.

Mind maps as tools for the analysis of perceptions of social space and environment in the field of science and environmental education

Mapas mentais como ferramentas no campo de ensino de ciências e educação ambiental para a análise das percepções de espaço vivido e meio ambiente

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Este estudo caracterizou-se como uma pesquisa qualitativa sem intervenção, realizada com alunos das séries iniciais de uma escola pública do município de Campo Grande (Mato Grosso do Sul - Brasil) mediante a elaboração de mapas mentais, representados graficamente pelos educandos. A pesquisa teve o intuito de investigar a percepção dos escolares sobre o espaço vivido [bairro] e a respeito da construção cognitiva de meio ambiente, analisando-se as perspectivas do uso de mapas mentais para o campo do Ensino de Ciências e Educação Ambiental. Para a análise dos mapas mentais utilizou-se a *Metodologia Kozel* (KOZEL, 2007), a qual considera que a representação de um mapa mental resulta em uma linguagem que reflete em todas as suas formas, permeando pensamentos, atitudes e sentimentos tanto sobre a realidade percebida, como sobre o imaginário. A metodologia utilizada está ancorada no referencial teórico-metodológico de Mikhail Bakhtin (1986 *apud* KOZEL, 2007) e remete a leitura de imagens, construídas pelos indivíduos, cujos signos [linguagem, representação simbólica] provém de uma construção social. A análise dos mapas mentais oportunizou a reflexão sobre os conhecimentos dos educandos identificados em suas representações gráficas, os quais podem servir de ferramenta para o trabalho no Ensino de Ciências integrado à Educação Ambiental, partindo do contexto dos conceitos expressos pelos alunos. Por meio das análises foi possível verificar que apesar de cada indivíduo possuir determinadas associações específicas de representação para o espaço vivido e meio ambiente, algumas visões apresentam semelhanças, como no caso da identificação de problemas ambientais e da formação conceitual sobre meio ambiente. As semelhanças entre as visões são justificadas pela influência dos fatores sociais tanto do meio escolar, como da convivência no espaço comum do bairro. A utilização de mapas mentais mostrou-se, portanto, uma estratégia pertinente à análise das percepções de espaço vivido e do conceito de meio ambiente no que se refere ao trabalho no campo do Ensino de Ciências e Educação Ambiental. Em consequência, contribuiu para a reflexão a partir da construção cognitiva dos educandos sobre a realidade, favorecendo o desenvolvimento de práticas metodológicas que apontem alternativas para as problemáticas ambientais do cotidiano do educando, estimulando posturas críticas para as relações socioambientais e valorizando o estudo de conceitos relativos ao campo de Ciências.

KOZEL, S. Mapas Mentais – Uma forma de Linguagem: Perspectivas Metodológicas.

In: KOZEL, S.; SILVA, J. da C.; GIL, F. S. F. Da Percepção e Cognição à Representação – Reconstruções Teóricas da Geografia Cultural e Humanista. São Paulo: Terceira Margem; Curitiba: NEER, 2007.

Palavras-chave: mapas mentais; prática pedagógica; percepção ambiental; ensino de ciências.

Technological profile of undergraduate students of natural sciences**Perfil tecnológico de acadêmicos de cursos de licenciatura das ciências da natureza**SÍLVIO LUIZ RUTZ DA SILVA; PATRÍCIA SATTIN GARROUBA
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Pesquisas recentes indicam que os espaços das tecnologias de informação e comunicação (TICs) como a internet devem ser vistos como um novo meio de expressão, concebido como veículo de diálogo e trocas comunicativas intensas e como espaço de construção de novas amizades, sociabilidade e flexibilidade. Estes espaços são responsáveis por uma nova forma de escrita e de percepção do tempo e do espaço, constituindo-se em formas inéditas de organizar e representar ideias. Nesta perspectiva as TICs constituem-se em recursos pedagógicos ou educativos, porque o indivíduo passa a ter autoria na sua produção, e sente-se estimulado a produzir, escrever e ler a produção dos outros. Assim é preciso analisar o processo educativo atual considerando a construção das identidades sociais e culturais mediadas pelas distintas matrizes midiáticas. Isto conduz a um novo modo de encarar a Ciência como uma atividade cotidiana especialmente para professores na a perspectiva da Ciência Pública com caráter Social. (ALMEIDA; 2001, CAXIAS, 2008, PORTO; 2006). Neste trabalho apresentamos o resultado de levantamento do perfil tecnológico de acadêmicos dos cursos de licenciatura em Biologia, Geografia, Química e Física da Universidade Estadual de Ponta Grossa, a partir de investigação de

como os mesmos utilizam os equipamentos tecnológicos que atualmente fazem parte do cotidiano da maioria das pessoas, como celulares, computadores de mesa, computadores portáteis e tablets. A pesquisa foi realizada no ano de 2013 com a aplicação de um questionário com perguntas como: (I) *Qual(is) tipo(s) de equipamento(s) possui?* (II) *Para qual(is) finalidade(s) você utiliza o(s) equipamento(s)?* (III) *Tem acesso à internet?* (IV) *Tem conta nas redes sociais?* (V) *Já usou estas redes em atividades educacionais?* Participaram da pesquisa 120 estudantes, sendo 20 do curso de Física, 30 do curso de Química, 30 do curso de Biologia e 40 do curso de Geografia. A análise dos questionários mostra que 98% tem acesso a internet, sendo que o celular e o notebook são os principais equipamentos utilizados (85%). O principal uso do celular é para jogos enquanto que pc's e notebooks são usados para estudo. 93% dos entrevistados tem conta nas redes sociais, sendo predominante o Facebook (98%). Entretanto apenas 17% responderam que fazem uso das TICs para atividades de ensino aprendizagem. Os resultados mostram que os futuros professores tem acesso amplo aos recursos tecnológicos, entretanto não os utilizam nas suas atividades de aprendizagem o que indica de maneira indireta que os cursos de Licenciatura não têm levado em conta o potencial das TICs no processo de ensino aprendizagem.

T. M. E. Porto. As tecnologias de comunicação e informação na escola; relações possíveis ... relações construídas. Revista Brasileira de Educação, v.11, n. 31, 43-57, jan./abr. 2006.

R. S. Caxias. Das tecnologias da informação à comunicação científica: críticas à nova cultura da pesquisa em educação. Em Questão, Porto Alegre, v. 14, n.2, 301-315, jul./dez. 2008.

Key words: education, learning, natural sciences, ICT, educational objects.

23rd ICChE and 9th Regional IOSTE for Central and Eastern Europe

The 23rd International Conference on Chemistry Education "Research, Theory and Practice in Chemistry Didactics" together with 9th Regional Symposium IOSTE (International Organisation for Science and Technology Education) for Central and Eastern Europe "Science and Technology Education for the 21st Century" took place on 15 – 17 September 2014 in Hradec Králové, Czech Republic. Both events were arranged by Section for Chemistry Didactics, Department of Chemistry, Faculty of Science, University of Hradec Králové (UHK) under patronage of the dean of Faculty of Science University of Hradec Králové Assoc. Prof. Pavel Trojovský, Ph.D. and The Working Group Teaching of Chemistry at Czech Chemical Society in honour of 50 years of the Department of Chemistry. The conference and symposium reassumes to regular international meetings of didacticians, teachers and students on chemistry didactics and related branches in Hradec Králové. The event was coordinated at present by international scientific committee with chairman Prof. Martin Bilek, Ph.D. (University of Hradec Králové, Czech Republic), Prof. Hana Čtrnáctová, Ph.D. (Charles University, Prague, Czech Republic), and other experts from different countries.

The program of the symposium and conference was divided into four plenary and then 20 sessions (parallel in English, Russian and Slavonic languages). More like 130 participants from 16 countries of all continents listened as plenary speakers 10 well-known professionals on science education. Vincentas Lamanauskas from Lithuania, Paul Webb from South Africa and Bruce Johnson from USA with Jan Čincera from Czech Republic presented in the first plenary session starting points for improving of science education in the 21st century. The second plenary session was focussed to challenges in chemistry education and contributions made by Pavel Doulík and Jiří Škoda from Czech Republic, Andreas Kometz with Michael Urbanger and Katrin Sommer from Germany. The third plenary session oriented to methodological aspects of science education hands on' with Andre du Plessis from South Africa and Raffaele Pisano from Italy and in the fourth plenary session Yuri Orlik from Brazil and Andrej Šorgo from Slovenia spoke about actual problems and perspectives of science education.

Three proceedings volumes contain about 100 papers recommended by double blind reviews. The first proceedings volume oriented to IOSTE contents 25 research and research oriented articles selected by reviewer's recommendation from more than 60 announced studies. The content is divided into five sections: Methodological and Historical Aspects of Science and Technology Education, Curricular Aspects of Science and Technology Education and Teachers' Training, ICT in Science and Technology Education and in Teachers' Training, Integration Tendencies in Science and Technology Education and in Teachers' Training and Inquiry Based Science Education. The second proceedings volume oriented to chemistry didactics contains 22 research and research oriented articles selected by reviewer's recommendation from more than 50 announced studies. The content is divided into three sections: Curricular Aspects of Chemistry Education and Chemistry Teachers' Training, Methodological Aspects of Chemistry Education and Information a Communication Technology in Chemistry Education and in Chemistry Teachers' Training. Finally, the third proceedings volume collects studies different orientation and types (research oriented articles in national languages, theoretical studies, overview studies, short information or methodical recommendations) and its content is divided into six sections: Curricular Aspects of Chemistry and other Natural Sciences Education and Teachers' Training, Methodological Aspects of Chemistry and Other Natural Sciences Education, Information a Communication Technology in Chemistry and Other Natural Sciences Education and in Teachers' Training, Integration Tendencies in Science Education and in Teachers' Training, Ecological and Environmental Aspects of Science Education and Inquiry Based Science Education. Information about availability of all proceedings volumes are accessible by e-mail to the organisational board chair (martin.bilek@uhk.cz).

MARTIN BILEK

University of Hradec Králové, Czech Republic

Organizing to the 2nd INTERNATIONAL CONGRESS OF SCIENCE EDUCATION for academic teachers, researchers, teachers from secondary and high schools as well as postgraduate students with major theme offers challenges for Science Education.

During four days, from 27 to 30 August 2014, with some 700 participants representing a huge variety of institutions from more than 20 countries, the Conference venue, Foz do Iguaçu - Brazil, was abuzz with ceaseless activity and discussions from the Opening to the Closing Ceremony, due to celebrate 15 years of the Journal of Science Education. It was inspired by the attendees' high degree of interest and involvement to discuss problems of Science Education (physics, chemistry, biology, mathematics, etc.) in the university and secondary (high school) education with experts and other specialists from America, Europe, Asia and other parts of the World, which highlighted their desire to address the equally important issues of Science Education.

The Congress was organized by the Federal University of Latin-American Integration, UNILA, Foundation the Technological Park of ITAIPU, FPTI and the Journal of Science Education, JSE, with participation and sponsorship of various scientific authorities from different countries.



The energy generated by 10 plenary speakers and 2 roundtables panelists from more than 10 countries from different continents, as well as the representatives of more than 20 countries (Brazil, Colombia, Argentina, Mexico, England, Italy, Paraguay, Uruguay, Poland, Russia, United States of America, Chile, Slovenia, Czech Republic, Spain, Philippines, Armenia, Mozambique, Venezuela, Ireland, Portugal, Germany, Saudi Arabia) surely served as the needed momentum to reinvigorate the science education field on the roads to both international cooperation for a better education.

It was also a delight to watch the students and youth participants take an active role in their 350 poster presentation and 300 oral communication.

The Congress had 11 workshops and 30 symposiums covering everything from Innovations in science education, Educational policy in science education, Active modern methods and innovations in science education, Quality of teaching and teacher training in science, Modern curriculum design in science education, Evaluation and assessment in science education, Scientific experiments and laboratories in teaching and learning, Educational technology, software and Internet, Popular education in science, Modern textbooks, Science learning, Research in science and mathematics education, Methodology of different natural sciences (physics, chemistry, biology, mathematics, ecology, geology, astronomy, biotechnology, environmental sciences, biomedical sciences, etc.), History and philosophy of science, Conceptual change in learning science, Popularization of natural sciences, Non-formal spaces in science education (technology parks, museums, zoos, botanical gardens, stations of science, planetary, clubs etc), Chess in School, Science Olympiads, Scientific tourism and other themes.

According to the chairman, Professor Yuri Orlik – UNILA - BRAZIL, the results were quite relevant.

"Multiple points of view and different alternatives on didactic teaching and learning in natural sciences and mathematics methodologies were exposed, and new ways of organizing laboratories, using the methodology of teaching, application of active methods, different variants of skills assessment and tests for science classes in elementary, secondary and higher education" he explained.

The Congress proceedings was published in the peer reviewed Journal of Science Education, JSE, (<http://www.accefyn.org.co/rec/jis>) bilingual and international, with authors from more than 60 countries and specialists with excellent track records in education and in the natural sciences from more than 23 countries in its scientific committees.

Prior to the event, on Tuesday (26), Professor Alan Goodwin, the Royal Society of Chemistry, England, gave the workshop "Chemistry in micro scale using disposable plastic syringes and plastic sheeting" to state school teachers of Foz Iguaçu and the region, and also the academic UNILA.

"The purpose of bringing teachers to the workshop was to nurture the innovation laboratory practice, updating content, and observation of new methodologies. It is a time for them to better themselves" says Neusa Lunkes, the staff of the Regional Education Center in Foz do Iguaçu – Paraná- Brazil, which classified the activity as a unique opportunity.

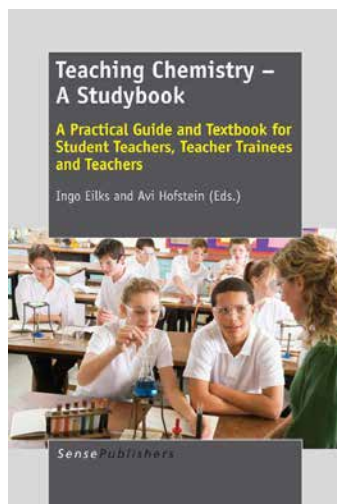
I would like to thank all participants, our partners in this endeavor, the organizing and scientific Committees, the volunteers and all its staff, as well as the sponsors and supporters for their comprehensive support for the 2nd International Congress of Science Education 2014.

I would like to take this opportunity to express my deep gratitude for all participants. We look forward to many years of fruitful cooperation and I look forward to our continuing productive cooperation to improve Science Education across the globe as we meet you again on the 3rd International Congress of Science Education.



AGNALDO ARROIO
University of São Paulo
IOSTE Representative for South America

Book reviews



Teaching Chemistry - A Studybook: A Practical Guide and Textbook for Student Teachers, Teacher Trainees and Teachers, edited by Ingo Eilks and Avi Hofstein. Sense Publishers: Rotterdam, The Netherlands, 2013. 336 pp. ISBN: 978-9462091382 (paperback). \$43.

Today we can find in many countries in their educational policies towards to scientific literacy, and also is the same for chemistry education. It aims to promote the student's engagement to a democratic society, making choices and understanding their lives. Most of these references are

pointing out to the relevance of teaching in real contexts and socio-scientific approaches. This book is edited and organized in 11 chapters from different authors from almost over the world. In this perspective it brings an overview of the chemistry education in different societies in a contemporary world. It is written in a scholarly style supported by extensive references from the literature based in researches. In this sense it provides an encouraging starting point for teachers and junior researchers' students undertaking scholarly studies in chemistry education, but also it offers support to in-service chemistry teachers. As highlighted by organizers "*Chemistry is essential for allowing all students a thorough understanding of the world around them, to enable them to contribute in societal debate about science and technology related issues, but also for offering career opportunities in the most effective and broadest way possible*".

These chapters focus on developing and updating prospective and practicing chemistry teachers' education. Each chapter articulates the discussion from general and science education theories called theoretical basis summarizing the major work and trends on each topic in a way that is accessible to a wide audience, and its application to examples from the chemistry classroom called the Practice of Chemistry Teaching. Also presents key sentences, tasks for self-assessment, and suggestions for further reading are included. Each chapter tries to respond to one of the general issues in the teaching of chemistry. This collection of chapters provide contemporary discussions of different aspects in chemistry education as curriculum, objectives and assessment, motivation, learning difficulties, linguistic issues, modeling in science, practical work, student active pedagogies, Information and Communication Technologies, informal learning, continuous professional development, and teaching chemistry in developing environments. It is not just based on teaching chemical content but also the chemistry as a science as how it works and the impact in our daily lives.

These chapters are organized to focus on the following questions and issues: – *How to allocate the chemistry curriculum between science and society*: this chapter deals with the issue related to the chemistry curriculum development and implementation. An overview about the different objectives and justifications is showed to provide opportunities for organizing chemistry curricula. A variety of curricular approaches are discussed to understand the better structure the curriculum based on the theories or history of chemistry, or to orient chemistry teaching employing everyday life contexts or socio-scientific issues.; – *How to justify formal chemistry education, to outline its objectives and to assess them*: this chapter deals with the learning progression and assessment presenting some possibilities how to structure learning objectives, and how to assess them to helping students to become chemically literate that goes beyond content and concepts in chemistry, but also brings higher-order thinking skills, attitudes and habits of mind and the role of chemistry in different contexts in life; – *How to motivate students and raise their interest in chemistry education*: this chapter is about questions of motivation and interest. It tries to argue what the chemistry teacher can do in order to make chemistry education more motivating to the learners by clarifying the different concepts of motivation, interest

and attitudes; – *How to balance chemistry education between phenomena and thinking in models*: this chapter deals with the question of potential students' misconceptions and the learning difficulties which are typical to chemistry teaching related to moving between the macroscopic world, the world of atoms and particles, and its related explanations using scientific models; – *How to deal with linguistic issues and heterogeneity in the chemistry classroom*: this chapter deals with the important issue of language in chemistry learning, making an attempt to address the particular issues of language and formal chemical language which are important for successfully learning chemistry. It discusses how to become able to communicate in and about chemistry by learning the special language of chemistry with its technical terms, formulae or modes of argumentation; – *How to learn in and from the chemistry laboratory*: this chapter characterizes the laboratory as a unique place for instruction, learning and assessment chemistry reflecting upon under which conditions operating in the chemistry laboratory offers opportunities for effective learning in chemistry education and introduce to the idea of inquiry-based science education; – *How to organize a classroom in a student-active mode*: this chapter focuses the methods of teaching pointing out the importance of student-activity (hands-on and minds-on), interaction and cooperation for effective learning through different respective pedagogies and examples; – *How to promote chemistry learning through the use of ICT*: this chapter is about the implementation of modern information and communication technology to improve chemistry learning based on the theory of multimedia supported learning and how chemistry education can benefit from using modern technologies. It presents and exemplifies visualizations in laboratories such as molecular modeling, data collection, and presentations; – *How to benefit from the informal and interdisciplinary dimension of chemistry in teaching*: this chapter opens school chemistry teaching beyond the classroom showing how school chemistry teaching can be enriched by learning in informal settings, like museums, industry visits, afternoon workshops in research laboratories, or just through television and print media. It highlights that chemistry education commonly fails to recognize or exploit the interdisciplinary nature of chemistry, for example the interface with other disciplines as biological sciences; – *How to keep myself being a professional chemistry teacher*: this chapter makes the reader cognisant of the fact that teacher learning is a lifelong enterprise. It is discussed why it is important to invest in teachers' continuous professional development. They also give examples of promising strategies and well working models to provide an opportunity for teachers reflection and learning about how new practices could be evolved or renewed from existing classroom practices; – *How to teach chemistry in emerging and developing environments*: this chapter acknowledges the working conditions of chemistry teachers in the diverse world providing many ideas and offer access to resources describing how student-active and successful chemistry teaching can be provided even if the resources and working conditions for the teachers are limited.

Chemistry teaching and learning differs from one country to another, sometimes even from one region within a country. In this sense the 27 authors brings a diversity of chemical education around the world.

Considering the positive aspects of this book is the effort done by these 27 authors to connect readers with different resources as resource lists, Internet resources, and a short list of suggested readings are included at the end of each chapter distinct from the extensive reference list that support it.

In general this book provides good ideas connected with contemporary and classical references and tools for beginning to improve chemistry teaching at all levels, since elementary school until tertiary level. And also the specifics will have the opportunity to use it, but to be decided based on the literature and initiatives specific to the teaching environment, considering the different perspectives and contexts presented by these 27 authors, all are chemistry and science educators, from 10 different countries. From all these reasons it is not a practical guide to solve all the problems related to teaching and learning chemistry or preparing the perfect teachers, nor the extensive reviews, it is not a handbook, for these subjects presented in this book. It is more than this, it is an important inspiration for all those people involved in chemistry education supporting them to making questions and trying to find solution for real problems in teaching and learning chemistry, enjoy the reading!

AGNALDO ARROIO

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INSTRUCTIONS FOR AUTHORS

The Journal of Science Education (REC) publishes articles, short communications and other original materials relating to the results of investigations and new experiences in the field of teaching natural sciences (Biology, Physics, Chemistry, Environment sciences, Biotechnology and other natural sciences), in secondary (high) school and university. Also investigations in the teaching of Mathematics, applied to education of the sciences. Opinions and discussions on the improvement of the national and international educational policy at all levels will also be welcomed.

Articles and short communications sent to the REC should not have been previously published or submitted for publication to other national or international Journals.

The principal sections of REC are:

- Innovations and modern active methods in the teaching of the sciences
- Design of the modern curricula
- Educational evaluation
- Laboratories and experiments in teaching
- Educational technology
- Educational policy in the teaching of the sciences
- Book reviews

A special section of the REC is: "Physics, Chemistry, Biology and integrated Sciences in your secondary (high) school". In this section, short communications on the sciences in secondary school life will be published:

- Innovations from teachers
- News of exams and evaluations
- Text books in science and other resources for teaching
- Weeks, days of natural sciences
- Educational games
- Science Olympiads etc.

The authors should fulfil the following instructions:

The word processed manuscripts of the articles, double spaced and written in English or Spanish should be sent in triplicate, in white paper (21,6 x 27, 5 cm), keeping margins of 3 cm. An electronic copy must be included on diskette (PC format)

The preliminary text of the article can be sent as a .doc file in the attachment by e-mail:

e-mail: oen85@yahoo.com

The text must be elaborated in Word for Windows or compatible word processors, using 12 points Times New Roman letters.

The work must have a maximum of 15 pages, included figures, tables and bibliography.

The language must be clear and accurate. The work should be written in an impersonal style.

The authors have to present the results, propositions and conclusions in a form that can suit better for teachers from different countries.

We recommend the following structure for article:

Title: no longer than 15 words; a translation of the title in Spanish or English must also be included.

Authors: names and surnames of the authors, the institution to which they belong, their electronics address (e-mail).

Abstract: not to exceed 200 words written in single paragraph. Key words: no more than five words; Resumen: a translation of the abstract into Spanish. Palabras claves: the translation of key words into Spanish.

The body of the text of the article must generally have the following parts:

- Introduction
- Methodology applied in the investigation
- Results and discussion
- Conclusions
- Acknowledgements
- Bibliography

Introduction:

general planning of the topic, objective or hypothesis of the investigation, references to relevant previous works.

Investigation methodology:

in case of investigations on new methodologies and innovations in sciences teaching the details of the organization of the pedagogic experiment or other methods of the educational investigation must be presented.

Results and discussion:

Supporting evidence should be presented together with the stated results of the pedagogic experiments, including tables, figures and photographs (black and white). and relevant statistical data. The discussion must be short and be limited to the key aspects of the work.

Conclusions:

should be based on results and if possible the solutions to the problem outlined in the introduction should be mentioned.

References in the text:

the name of the author and the year of issue, indicated between bracket (for example, (Moore, 1997)).

Bibliography: the list will be cited in alphabetical order.

Reference to books: authors, name of the cited book (in italic), editorial, city, country, year of the publication, cited pages.

Example:

Hanson, R., Molecular Origami. Precision Scale Models from Paper, University Science Books, Sausalito, AC, 1995, p. 3-4.

Reference to articles: authors, name of the article, name of the magazine (in italic), volume (in bold), number between square brackets, initial and final pages, year of publication.

Example:

Rugarcía, A., El ingeniero químico para el siglo XXI, Educación Química 9, [1], 46-52, 1998.

Short communications (3-6 pages) should generally contain the introduction with the problem planning, results, discussion, conclusions and bibliography. We especially recommend this form to teachers of the secondary (high) school.

The text of the article must be sent as a .doc file in the attachment by e-mail:

e-mail: oen85@yahoo.com

The mail address of the REC is:

Journal of Science Education

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INSTRUCCIONES PARA AUTORES

La Revista de Educación en Ciencias (REC) publica artículos, comunicaciones cortas y otros materiales originales como resultado de las investigaciones y experiencias nuevas en el campo de enseñanza de las ciencias naturales a nivel de escuela secundaria y superior (enseñanza de Biología, Física, Química y otras ciencias naturales, sobre educación en las ciencias del Medio ambiente, Biotecnología y otras ciencias integradas), y también investigaciones en la enseñanza de Matemáticas, aplicadas a la educación de las ciencias. También son bienvenidos materiales de opinión y discusión sobre el mejoramiento de la política educativa nacional e internacional de la enseñanza de las ciencias para los niveles de la escuela secundaria (bachillerato) y superior.

Los artículos y las comunicaciones cortas enviados a la redacción no deben ser publicados o enviados a otras revistas de nivel nacional o internacional.

Las secciones principales de la REC son:

- Innovaciones y métodos activos modernos en la enseñanza de las ciencias
- Diseño del currículum moderno
- Evaluación educativa
- Laboratorios y experimento (físico, químico, biológico) en la enseñanza
- Tecnología educativa, incluido el uso de Internet e informática educativa
- Política educativa y organización en la enseñanza de las ciencias
- Revisión de libros

Sección especial de la REC: "Práctica y vivencia de la Física, Química, Biología y Ciencias integradas en su colegio" En esta sección planeamos publicar comunicaciones cortas sobre la vida escolar en las ciencias:

- Hallazgos metodológicos de los profesores
- Logros educativos
- Libros de textos en ciencias y otros medios de enseñanza
- Semanas, jornadas, días de ciencias
- Juegos educativos
- Olimpiadas de ciencias y otros.

Los autores deben cumplir las instrucciones siguientes:

Los manuscritos de los artículos o comunicaciones cortas, escritos en español o inglés, deben enviarse por triplicado, en papel blanco, tamaño carta (21,6 x 27, 5 cm), a espacio doble, con márgenes de 3 cm. Debe incluirse la copia electrónica del trabajo en diskette.

El texto preliminar del artículo se puede enviar (el archivo .doc en attachment) via e-mail:

e-mail: oen85@yahoo.com

El texto debe ser elaborado en Word Windows para PC o aplicaciones compatibles, en letra Times New Roman de 12 puntos.

El trabajo debe tener una extensión máxima de 15 páginas, incluidas figuras, tablas y bibliografía.

El lenguaje debe ser claro y preciso. El trabajo debe ser escrito en un estilo impersonal.

Se aconseja a los autores, presentar las recomendaciones y conclusiones no sólo de carácter local, para que los materiales sirvan mejor a los profesores e investigadores de diferentes países.

Recomendamos la siguiente estructura del artículo:

Título: no más de 15 palabras. Debe incluirse la traducción del título al inglés.

Autores: nombres y apellidos de los autores, la institución a la cual pertenecen, dirección electrónica.

Resumen: no más de 200 palabras escritas en un sólo párrafo.

Palabras claves: cinco palabras claves.

Summary: una traducción del resumen al inglés. Keywords: la traducción de palabras claves en inglés.

La estructura del texto del artículo debe tener generalmente las siguientes partes:

- Introducción,
- Metodología aplicada para investigación
- Resultados y discusión
- Conclusiones
- Agradecimientos
- Bibliografía

Introducción:

planeamiento general del tema, objetivos de la hipótesis de la investigación, referencias a los trabajos previos relevantes.

Metodología aplicada para investigación:

en el caso de que la investigación sea sobre nuevas metodologías e innovaciones en la enseñanza de ciencias, deben ser presentados los detalles de la organización del experimento pedagógico u otros métodos de la investigación en la educación.

Resultados y discusión:

los resultados de los experimentos pedagógicos, incluido las tablas, figuras y fotografías (en blanco y negro). Se recomienda presentar los resultados con los cálculos estadísticos pertinentes. La discusión debe ser breve y limitarse a los aspectos claves del trabajo.

Conclusiones:

deben basarse en los resultados obtenidos; si es posible, mencionando las soluciones al problema planteado en la introducción.

Referencias (citas bibliográficas en el texto):

el nombre del autor y el año de edición, indicados entre paréntesis (por ejemplo, (Moore, 1997)).

Bibliografía: la lista se citará en orden alfabético.

La referencia del libro: autores, nombre del libro citado (en itálicas), editorial, país, año de la publicación, páginas citadas.

Ejemplo:

Hanson, R., Molecular Origami. Precision Scale Models from Paper, University Science Books, Sausalito, CA, 1995, p. 3-4.

La referencia a un artículo: autores, nombre del artículo, nombre de la revista (en itálicas), volumen (en negrillas), número entre paréntesis cuadrados, páginas inicial y final, año de publicación.

Ejemplo:

Rugarcía, A., El ingeniero químico para el siglo XXI, Educación Química 9, [1], 46-52, 1998.

Las comunicaciones cortas (3-6 páginas) generalmente deben contener la introducción con el planeamiento del problema, los resultados, la discusión, conclusiones, bibliografía. Recomendamos especialmente, esta forma para los profesores de los colegios.

Los textos de los artículos se envían como archivo .doc por correo electrónico oen85@yahoo.com

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