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Unit or project responsible for creating the innovation:
Science Teaching Innovation USAL (STI_Usal)

Theme:
- Technology enhanced learning
- Innovative student-centered approach to teaching

Title:
INNOVATION IN THE TEACHING OF PHYSICS AND CHEMISTRY: LEARNING BY DOING

Summary of the good practice:
This work shows briefly the planning followed in the subjects “Didactic”, “Innovation” and “Evaluation” in Physics and Chemistry owned to the Official Master´s Degree in Teaching in Secondary Schools, Vocational Training and Language Centers from the University of Salamanca. The main objective of the activities we program is for students to acquire the competences of the Master through active learning, turning the classroom into a laboratory where students are sometimes objects and others are the authors of the experience. The sessions are based in series of experiments in Physics and Chemistry. A methodology is followed through the culture of thought, fostering collaborative work, metacognition activities, mental maps, etc. It reflects the need to motivate the learning process, as well as to stimulate the creativity in future students. The sessions in the laboratory and the field trips cannot be absent from the activities. As a tool to measure physical magnitudes as well as to carry out and / or answer questionnaires, different Smartphone applications are used. The degree of acquisition of competences is evaluated by asking students to publish the results obtained in different virtual platforms such as on a YouTube channel:
(https://www.youtube.com/channel/UCwqaDfLBebKgdyTREtPl4mQ) in a personal blog of each student, or simply in an individual notebook. This way of organizing the subjects, contributes to bring to the classroom the passion that we feel for Physics and Chemistry as teachers. KEY WORDS: Physics and Chemistry Didactics, Active Learning, Experiments, Innovation, Evaluation.

Context of the good practice:
This work shows briefly the planning followed in the subjects “Didactic”, “Innovation” and “Evaluation” in Physics and Chemistry owned to the Official Master´s Degree in Teaching in Secondary Schools, Vocational Training and Language Centers from the University of Salamanca. About 10-15 students participate each year in these subject.

Rationale:
The fundamental reason is to transmit our passion for the teaching of experimental sciences to future teachers of High School education and provide them with different and innovative methodologies that allow them to involve and motivate adolescent students from high school in their own learning, in this educational stage in which other interests prevail.

Alignment with program and module learning outcomes:
1. To recognize the importance of teaching innovation, in the context of Secondary and Baccalaureate Education.
2. To acquire a vision of theoretical perspectives and methodological tools to innovate and to apply their results for the benefit of students.
3. To train students of the master’s degree to base, to design, to apply and to evaluate teaching-learning projects mediated by information and communication technologies.
4. To know the strategies to design experiences and simple projects for the teaching of science.
5. To know the meaning and how to apply quality indicators to revise, analyze results and improve teaching.

Resources (time and persons):
Science teaching Innovation USAL Group (STIUsal) involves different teachers and subjects of the Official Master´s Degree in Teaching in Secondary Schools, Vocational Training and Language Centers from the University of Salamanca : María Dolores Merchán Moreno professor from the Physical Chemistry Department at Faculty of Chemistry (University of Salamanca) Cristina Prieto

Calvo professor from the Fundamental Physics Department at the Faculty of Sciences (University of Salamanca) María Jesús Santos Sánchez professor from the Applied Physics Department at the Faculty of Sciences (University of Salamanca) The teaching takes place during the second semester of the Official Master´s Degree in the frame of three coordinated subjects of 3 ects each: Didactic in the specialty of Physics and Chemistry Evaluation in the specialty of Physics and Chemistry Innovation in the specialty of Physics and Chemistry

What were the main enabling factors (conditions) in creating and implementing the innovation?

The STIUsal Group is a team of teachers ideal to carry out innovation activities because its members are involved in the teaching of the "Official Master's Degree in Teaching in Secondary Schools, Vocational Training and Language Centers". In this situation they have the opportunity to teach and discuss with students in training to be future teachers, the innovative methods dedicated to teaching. The group of teachers is interested in improving their teaching work, and the members are open to familiarize with new emerging methodologies, in fact, many of the innovative methodologies that they explain in the classes of the University Master, are used in their under degree teaching work.

What were the main challenges in creating or implementing the innovation?

The main objective of the programmed activities is for the students to acquire the competences of the Master through active learning, turning the classroom into a laboratory where the students are sometimes object and others the authors of the experience. To develop strategies and extensive updated knowledge and in the didactics of Physics and Chemistry. To Train future teachers able to involve Secondary students in new didactic proposals adapted to their concerns. To contribute to the professional development of physics and chemistry teachers in the tasks of organizing courses and programs, creating materials, etc. To motivate the reflexion on the teaching practice.

What have been the main methods of dissemination so far?

A) The Science Teaching Innovation participates annually presenting papers in different Conferences on Learning Innovation. The contributions in last 4 years are listed below:

XXXVI Reunión Bienal de la Real Sociedad Española de Física, organizado por la Real Sociedad Española de Física y celebrado Santiago de Compostela del 17/07/17 al 21/07/17.

XI Jornadas sobre enseñanza de la Física. “Los nuevos contenidos de la Física de Bachillerato LOMCE: Física Moderna y Estrategias de la Actividad Científica”, celebrado en la Universidad de Burgos, del 16/09/2016 al 18/09/2016 (15 horas).

20ª Conferencia Nacional de Física e 26º Encontro Ibérico para o Ensino da Física – FÍSICA 2016, organizado por la Sociedad Portuguesa de Física y celebrado en la Universidad de Minho (Braga) del 08/09/16 al 10/09/16.

“VI Jornada de Innovación docente de la Universidad de Valladolid. Los Universos Docentes”, celebrado en la Universidad de Valladolid, el 22/04/2016.

“4th International Conference on Technological Ecosystems for Enhancing Multiculturality, TEEM’16”, organizado por the Research GRoup in InterAction and eLearning (GRIAL) y el Instituto de Ciencias de la Educación (IUCE). Celebrado en la Universidad de Salamanca del 02/10/2016 al 04/10/2016.

“X Jornadas sobre enseñanza de la Física. Enseñanza y comunicación de la Física en el Año de la Luz”, celebrado en la Universidad de Burgos, del 18/09/2015 al 19/09/2015.

XXXV Reunión Bienal de la Real Sociedad Española de Física, organizado por la Real Sociedad Española de Física y celebrado Gijón del 13/07/15 al 17/07/15.

*“Dispositivos móviles como instrumentos para la adquisición de competencias en materias de Ciencias”, C. Prieto Calvo, M.J. Santos Sánchez, A. Hernández Encinas, M.D. Merchán Moreno, C. Rodríguez-Puebla, A. Queiruga-Dios.VI Jornada de Innovación Docente de la Universidad de Valladolid “Los Universos Docentes” Valladolid, Abril 2016, p 7-11 ISBN: 978-84-608-7351-8

“Motivando el aprendizaje de Física a través de Experiencias Sencillas en el Aula” M.J. Santos Sánchez, J.A. White Sánchez, S. Velasco Maillo. VI Jornada de Innovación Docente de la Universidad de Valladolid“Los Universos Docentes” Valladolid, Abril 2016, p 100 ISBN: 978-84-608-7351-8

“Uso de dispositivos móviles para experimentación en Física” M.J. Santos, C. Prieto, M.A. González, M.A. González, A. Hernández, M.D. Merchán, A. Queiruga-Dios Livro de Resumos20ª Conferência Nacional de Física e 26º Encontro Ibérico para o Ensino da Física – FÍSICA 2016. P

“Betting on innovation and experiments” A. Pérez Antón, M.J. Santos, M.D. Merchán, C. Prieto Poceedings TEEM´16 Fourth International Conference on Technological Ecosystems for Enhancing Multiculturality Salamanca, Noviembre 2016, p 839-845 ISBN: 978-1-4503-4747-1 doi>10.1145/3012430.3012615

"Motivating students of chemical engineering through a cooperative work recording educational videos" M.D. Merchán; M.M. Canedo; J. López-Gil; J.L. Usero, Poceedings TEEM´16 Fourth International Conference on Technological Ecosystems for Enhancing Multiculturality Salamanca, Noviembre 2016, p 839-845 ISBN: 978-1-4503-4747-1 doi>10.1145/3012430.3012610
“Experiencias innovadoras. Retos de Física en Twitter y Facebook” XI Jornadas sobre enseñanza de la Física. Los nuevos Contenidos de la Física de Bachillerato LOMCE: Física moderna y estrategias de la actividad docente, celebrado en la Universidad de Burgos, del 16/09/2016 al 18/09/2016
“Elaboración de material didáctico utilizando TIC’s como herramienta para motivar a los estudiantes que repiten matrícula para Grados en Ciencias” M.J. Santos, C. Prieto, T. Caramés, A. Hernández, M.D. Muñoz, M.D. Merchán; A. Queiruga-Dios. XXXVI Reunión Bienal de la Real Sociedad Española de Física, organizado por la Real Sociedad Española de Física y celebrado Santiago de Compostela del 17/07/17 al 21/07/17.
“Retos de Física en Twiter y Facebook” M.J. Santos, I. Iñiguez de la Torre-Mulas, C. Prieto. XXXVI Reunión Bienal de la Real Sociedad Española de Física, organizado por la Real Sociedad Española de Física y celebrado Santiago de Compostela del 17/07/17 al 21/07/17.
“PINDO: Proyecto de Investigación en la práctica DOcente” M.A. Queiruga-Dios, M.J. Santos Martín, J.J. Bullón Pérez, G. Rodríguez Sánchez, M.A. Hernández Encinas, A.M. Martín del Rey.VIII CIBEM Congreso Iberoamericano de Educación Matemática, celebrado en Madrid, del 10/07/2017 al 14/07/2017.

B) Through the tutorization of the Final Master's Thesis (TFM), the teachers of the innovation group try to plan and design the teaching using and putting into practice different strategies and innovative methodologies.

With which groups or organizations has the innovation been shared so far?

Secondary Education Schools of Salamanca University District: We maintain a relationship with the Secondary Education Schools of Salamanca University District, in which the students of the Master carry out internships. We collaborate with other innovative Secondary Education centers, which we invite to give a workshop to our students so that they can transmit their good teaching practices. University of Valladolid: We work together with Manuel Ángel González Delgado and Miguel Ángel González Rebollo, physic professors at the University of Valladolid. We collaborate in projects of teaching innovation, focused on the use of mobile as a tool to measure physical magnitudes. Physics Spanish Royal Society (RSEF): We are members of the Physics Spanish Royal Society (RSEF), within the "Group specialized in teaching physics", actively collaborating in the activities promoted by this organization.

Mainstreaming: What are the possibilities for extending and/or mainstreaming this innovation?

This proposal is not isolated, because all the teachers of this group try to implement the new teaching methodologies in all the subjects that we teach in different grades of the University of Salamanca A possible way to publicize this project is the material that is generated in the classes and that, in part, is available in a YouTube Channel created for that purpose:
https://www.youtube.com/channel/UCwqaDfLBebKgdyTREtPl4mQ Each student of these subjects creates a blog in "Diarium" where they collect the innovation activities that are most attractive to them. As an example: http://diarium.usal.es/jmartingar/?page_id=35 http://diarium.usal.es/raulferrero/blog/ The University of Salamanca collects the memories of all the innovation projects carried out in each course in the Gredos repository: https://gredos.usal.es/jspui/handle/10366/71990

Sustainability: Please comment on the sustainability of the innovation, including elements which need to be put in place to make this sustainable.

As shown by the classes in which small experiences are carried out to explain concepts, these are easily integrated into the class. The material of the experiments is cheap, is bought in any bazaar, and does not require sophisticated equipment. The use of these activities with undergraduate students, in parallel with the expository class has shown that far from wasting time (as might be expected), facilitates the acquisition of contents.

Evaluation: How have the success and impact of the innovation been evaluated? Is there an established way of continuous evaluation?

Every year, students receive a satisfaction survey for the evaluation of learning methodologies (among other aspects). These surveys show the degree of satisfaction obtained repeatedly over the years, both with the undergraduate students who are taken to the classroom master experiences and the students of the Master, who are also explained these methodologies of " learn by doing ", and how to put it into practice in their professional future.

Contributor's reflections: Briefly reflect on your innovation from your own perspective including its strengths and limitations/challenges of implementation/potential implication for wider practice.

Some of the proposed activities need competence in information and communication technologies, ICT. Experience indicates that current students have no difficulties in the use of ICT, however. Main difficulty for students is to communicate their experiences efficiently. The orientation on the most important aspects of the subject and its organization for a comprehensive exposition are the most laborious part of the teacher´s work. When doing cooperative work, MUPES students have recognized that the incorporation of collaborative methodology in the teaching process with respect to traditional teaching methods requires great dedication on the part of the teacher. On the one hand, the preparation of the experimental work, the tasks and their correction, on the other, the design and orientation of the tasks assigned to the groups. However, work is motivating because it is creative, and its application gives rise to new ideas. In addition, the results indicate that the established objectives are achieved quite effectively.

Does your unit or other units of your university have any plan to further develop this innovation? If yes, please briefly describe the plan.

The University of Salamanca is committed to the Innovation and Teaching Improvement Projects. Every year an offer is opened in this line with an economic budget to support these projects. Also, the Official Master´s Degree in Teaching in Secondary Schools, Vocational Training and Language Centers (MUPES) is committed to innovation, as evidenced by the fact that in each specialty there is an Innovation course of 3 ects. It is the Master with the largest number of students at the University of Salamanca (about 300) and 19 specialties.

If available, please provide a link to complete the description of the initiative.

Link to ResearGate:

https://www.researchgate.net/publication/325695283_INNOVACION_EN_LA_ENSENANZA_DE_FISICA_Y_QUIMICA_APRENDER_HACIENDO_INNOVATION_IN_THE_TEACHING_OF_PHYSICS_AND_CHEMISTRY_LEARNING_BY_DOING

The Educational Innovation Group participates annually in the public call of the University of Salamanca for the proposal of innovation projects and teacher improvement. These projects are usually aimed at improving teaching in the degree courses of which these professors are teaching: Degree in Physics, Degree in Biology, Degree in Chemistry and Degree in Chemical Engineering.