Revista Iberoamericana para la Investigación y el Desarrollo Educativo
ISSN 2007 - 7467

https://doi.org/10.23913/ride.v11i21.683

Artículos Científicos

Aprendizaje ecológicamente basado en casos

Ecologically Case Based Learning

Aprendizagem ecologicamente baseada em casos

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Resumen

Los estudios de caso se han utilizado en la educación científica como una forma para desarrollar en los estudiantes las habilidades de pensamiento crítico y para la resolución de problemas complejos. Sin embargo, existe poca documentación respecto a si este método de enseñanza está teniendo el impacto deseado en los estudiantes, específicamente los que atienden cursos de ecología vegetal. Para evaluar la posible influencia de la utilización de casos en la enseñanza de la ecología de la invasión, el presente estudio integró algunas estrategias docentes interactivas, tal y como: *1)* el aprendizaje basado en casos, *2)* la educación basada en campo y *3)* la vinculación de la investigación con la educación durante su impartición. Los estudiantes abordaron sesiones de tópicos ecológicos diversos y concluyeron actividades indagatorias y estudios de caso sobre plantas invasoras en escenarios de campo locales para un real y avanzado entendimiento de la ecología de la invasión y ayudar a que desarrollaran sus habilidades de pensamiento, a la par de que pudieran relacionarse e interactuar con su entorno inmediato. Los métodos de evaluación para el desempeño de los alumnos estuvieron enfocados en la activa participación y efectiva ejecución de las actividades, ejercicios breves, y colaboración de pares en los estudios de caso, y en la intervención como evaluadores de cada sesión, del trabajo de campo y de los aspectos generales del curso. Los resultados de este estudio indican que los estudiantes

mostraron una actitud abierta para el aprendizaje basado en casos, y que este método de enseñanza les ayudó a desarrollar la habilidad de pensamiento requerida para diagnosticar y resolver problemas reales de invasión a nivel local, al mismo tiempo que los conectó con el resto del contenido del curso.

Palabras clave: aprendizaje basado en indagación, ecología de la invasión, plataforma educativa Eminus, trabajo de campo.

Abstract

Case studies have been used in science education as a way to develop student´s critical thinking and problems solving skills. However, there is little evidence on whether this teaching method is having the desired impact on students, particularly those attending plant ecology courses. The present study incorporated some interactive teaching strategies such as *1)* case-based learning, *2)* field based education, and *3)* research based education, in order to evaluate the possible influence of the case teaching method in an invasion ecology course. Students addressed diverse ecological topics lectures and completed inquiry learning activities and case studies on invasive plants that were taught in local field scenarios to achieve a real-world and advanced understanding of invasion ecology and helping students develop critical thinking skills at the same time they interact with their immediate environment. Students evaluation methods were focused on their active engagement and effective performance in all learning activities, quick exercises, authentic peer collaboration in case studies, and their participation as reviewers for each class session, field work, and general course aspects. The results from this study indicate that students had open attitudes toward the case studies teaching approach, and that this method helped them develop their critical thinking ability required to diagnose and solve complex and real local invasive plant problems while actively engaging them in the science course content.

Keywords: inquiry-based learning, invasion ecology, “Eminus” educational platform, field work.

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Resumo

Os estudos de caso têm sido usados no ensino de ciências como uma maneira de desenvolver habilidades de pensamento crítico nos alunos e resolver problemas complexos. No entanto, existe pouca documentação sobre se esse método de ensino está tendo o impacto desejado sobre os alunos, especificamente aqueles que participam de cursos de ecologia de plantas. Para avaliar a possível influência do uso de casos no ensino da ecologia da invasão, o presente estudo integrou algumas estratégias interativas de ensino, como: 1) aprendizagem baseada em casos, 2) educação baseada em campo e 3) a ligação entre pesquisa e educação durante a sua entrega. Os alunos abordaram sessões sobre diversos tópicos ecológicos e concluíram atividades de investigação e estudos de caso sobre plantas invasoras em locais de campo, para uma compreensão real e avançada da ecologia da invasão e para ajudá-los a desenvolver suas habilidades de pensamento juntamente com que eles poderiam se relacionar e interagir com seu ambiente imediato. Os métodos de avaliação para o desempenho dos alunos foram focados na participação ativa e execução eficaz das atividades, exercícios breves e colaboração entre pares nos estudos de caso e na intervenção como avaliadores de cada sessão do trabalho de campo. e dos aspectos gerais do curso. Os resultados deste estudo indicam que os alunos mostraram uma atitude aberta em relação à aprendizagem baseada em casos e que esse método de ensino os ajudou a desenvolver as habilidades de pensamento necessárias para diagnosticar e resolver problemas reais de invasão localmente, ao mesmo tempo. que os conectou ao restante do conteúdo do curso.

Palavras-chave: aprendizagem baseada em investigação, ecologia de invasão, plataforma educacional Eminus, trabalho de campo.

Fecha Recepción: Enero 2020 **Fecha Aceptación:** Julio 2020

Introduction

The planning of educational programs in the field of ecology very often faces the lack of opportunities that allow to achieve a real connection with students and cultivate their motivation in solving ecological problems. Problems of this nature are complex, and many times this leads to a great variety in their approach, interpretation and possible solution (Abrahams, Gillis and Taylor, 2000). In addition to this, in class, laboratory and field sessions, teachers try to cover the main concepts and keywords in ecology, however, often the examples provided come from distant places and are of minimal local relevance and interest to most students served.

Much of the support for the teaching practice of applied science courses comes from a variety of anecdotal experiences, now digitally documented with the support of information and communication technologies (ICT), on the conduct of various practical activities carried out in an environment of particular field (Yadav et al., 2007). Teachers who have experienced and employed these teaching practices in their science courses may personally be able to confirm an increase in students' more motivated participation in the field, and in some cases, in their performance. However, it is necessary to maintain permanent documentation on the effectiveness of these teaching practices throughout a wide pedagogical context (Bilica, 2004). In this sense, the teaching of scientific content from cases, and combining and using field work, can provide numerous opportunities in a real context so that all the students involved can obtain authentic and valuable learning experiences, and reach a understanding that in other scenarios it would be impossible to obtain (Hall, 1995; Yadav and Beckerman, 2009).

Traditionally, the field activities and practices developed in the different faculties within the Veracruzana University have focused on the application outside the classroom of the students' technical skills in a series of modules, exercises and planned practices in the different regions. of the state to which the educational institution has coverage. However, relatively recently, our teaching approach has been transforming and a true educational innovation has been achieved in the teaching and learning processes inside and outside the classroom (López, 2016, 2018). Teaching practice in field work has taken a very productive turn; now it allows students to be the main implementers in achieving their own learning, and to exercise those same skills but in a local context, relating more to their immediate environment, applied to the real world, and focused on research.

C With the aim of presenting the application of ecologically case-based learning, and considering the local relevance to our learning activities in the field, an exploration is made and some teaching strategies are integrated, namely: 1) case-based learning, 2) field-based education and 3) linking research with education. Here is a description of how these teaching styles are used throughout a plant ecology course at the university level, the characteristics of the course, and student assessment. Likewise, a sample of the evaluation formats of the sessions, of the fieldwork and of the course in general applied to obtain feedback from the students is presented, and the main academic results are pointed out with the intention of providing information to others. teachers interested in the development and application of this teaching dynamic in similar curricular plans and programs.

Characteristics of the course and its applications in the field

The Institute of Biological Research of the Veracruzana University, located in Xalapa, in the state of Veracruz, Mexico, offers permanently an educational offer that links applied research work in the field of biological sciences with teaching activity. Under this bonding context and with a flexible and innovative educational model, a diverse range of courses is offered through a competency-based curriculum training program.

The Weed Ecology course is one of the university educational experiences offered by this elective academic training program with a teaching origin at the aforementioned institute. The description of the course with its field applications is available in Table 1.

Tabla 1. Descripción del curso de Ecología de Malezas y su aplicación en el campo de la ecología de la invasión.

Información sobre curso Ecología de Malezas	Número de créditos	Horario	Periodo de oferta educativa	Lugar
Número de registro del curso (NRC): 53357 Profesora: Dra. Isabel López Zamora La experiencia educativa (EE) de Ecología de Malezas se ubica en el área de formación de elección libre y brinda al estudiante un aprendizaje interactivo en el campo de la ecología de la invasión. Esta EE pretender desarrollar en el estudiante diversas habilidades de indagación e investigación científica para abordar, enfrentar y resolver con bases científicas y análisis crítico cualquier problema de invasión biológica y promover acciones precautorias para minimizar los impactos generados por las plantas invasoras en nuestro ambiente.	El curso ofrece un total de seis créditos que están distribuidos en sesiones de clase de dos horas teórico-prácticas que se llevan a cabo dentro y fuera del aula.	Martes y miércoles de 9:00 a 11:00 h	Febrero-junio 2019	El sitio de reunión se lleva a cabo en las instalaciones del Instituto de Investigaciones Biológicas de la Universidad Veracruzana, y a lo largo del curso se realizarán visitas frecuentes a las áreas naturales cercanas al campus, donde los estudiantes podrán explorar y conocer escenarios reales con presencia de especies de plantas invasoras que habitan en su entorno local.
Unidad de competencia: El estudiante aprenderá a detectar la				

presencia de especies de plantas invasoras y monitorear a corto plazo su invasión e impactos en ecosistemas seminaturales y sujetos a intenso manejo para generar estrategias encaminadas al manejo y control integral de la invasión. Subcompetencia 1: El estudiante reconoce el proceso de invasión e identifica a las especies de plantas invasoras en diversos hábitats, mostrando el manejo con entendimiento de conceptos de invasión y de la descripción diagnóstica de las especies. Subcompetencia 2: El estudiante desarrolla la habilidad para realizar monitoreo de invasión biológica en condiciones naturales y aplicar con éxito los protocolos de monitoreo para la detección oportuna de la invasión y sus impactos ecológicos. Subcompetencia 3: El estudiante alcanza un conocimiento profundo sobre la problemática de invasión biológica y es capaz de proponer				

planes estratégicos de control como alternativas de solución a diversos casos de invasión				
Contacto: http://www.uv.mx/iib/dra-isabel-lopez-zamora/				

Fuente: Elaboración propia

The course is open to all students and has no curricular prerequisites. It can be of great interest to most students enrolled in Biology, Agronomy, Geography, and Engineering, and those interested in environmental studies and fieldwork. Students (maximum 12) take the course in regular educational periods; they record a permanence of 15 weeks during the school calendar.

A combination of tools is applied to evaluate the performance of students throughout their stay in the course, including: the execution of activities in the field (preparation, collaboration, attitude), evidence of field work (notes, collection of copies), written reports of learning activities and presentation and oral defense of their results. This structure is considered to integrate their own motivation and learning performance, and also promotes authentic teamwork collaboration and group participation, as well as facilitating the evaluation of their performance.

Methodological approach

In the last five years, it has been tried to achieve the objective of maintaining a teaching under authentic and permanent transformation in the teaching and learning processes; offer a course with educational content that is supported by field work experience, linked to real-world situations and research in the field of ecology and enriched with the support of ICT and technologies for learning and knowledge (TAC) inside and outside the classroom (López, 2019).

The course offers a unit of competence divided into three subcompetences, which represent the educational content, and which students potentially develop throughout their school stay. The main elements that make up the fieldwork for the course are directly associated with these subcompetences, and include three sessions with interactive learning activities, exercises and assignment of local ecological case studies. The sessions cover various

ecological topics, and are carried out in the field and require the student's participation in the practical (such as, for example, collecting plant specimens and establishing sampling units). The sessions are linked to research and projects to monitor the invasion in the short and long term. The topics of the sessions are diverse, which are described in Table 2.

Tabla 2. Tópicos abordados en las tres sesiones del curso de Ecología de Malezas (NRC: 53357). Periodo escolar: febrero-junio 2019.

Semanas	Sesiones	Actividades y ejercicios de aprendizaje	Fecha de ejecución y entrega de productos	Recursos e información
1 (Del 5 al 8 de febrero)	Introducción: bienvenida al curso de Ecología de Malezas	Bienvenida y breve introducción al curso: sus contenidos, competencias a desarrollar, dinámica de ejecución y evaluación de las actividades de aprendizaje práctico y participación en foros en línea. Aplicación en línea de la *primera encuesta* de aprendizaje para los estudiantes. Participación en foro introductorio.	5-8 de febrero	Consulta de la plataforma educativa institucional Eminus y portal educativo del curso
2-4 (Del 11 al 28 de febrero)	Proceso de invasión biológica y especies de plantas invasoras	Ejercicio de preparación: "Conociendo las estructuras vegetativas e inflorescencias de las plantas invasoras" Actividad de aprendizaje: "A la caza de las especies de plantas invasoras"	12-13 de febrero 19-20 de febrero y 26-27 de febrero 19-27 de febrero	Plataforma Eminus y portal educativo del curso

		Participación en foro de identificación diagnóstica		
5-6 (Del 4 al 15 de marzo)	Monitoreo de la invasión y sus impactos	Actividad de aprendizaje**:** "Diseñando un cartel educativo de 'Se busca'"	5-6 y 12-13 de marzo	Plataforma Eminus y portal educativo del curso
7-8 (Del 18 al 29 de marzo)		Actividad de aprendizaje**:** "Introducción a los impactos de las plantas invasoras" Ejercicios deductivos: "El misterio de la desaparición del lago" e "Historia de una invasión" Participación en foro de impactos de invasión	19-20 y 26-27 de marzo 20-27 de marzo	
9-13 (Del 1 al 12 de abril y del 22 al 30 de abril)	Control de plantas invasoras y estudios de caso	Actividad de aprendizaje: "Conociendo el monitoreo para el control de plantas invasoras" Participación en foro de control	2-3 y 9-10 de abril Monitoreo campo: 22-26 de abril Presentación: 30 de abril 10-30 de abril	Plataforma Eminus y portal educativo del curso
14-15 (Del 6 al 17 de mayo)	Control y manejo integral de plantas Invasoras	Actividad de aprendizaje**:** "Reflexiones sobre el impacto y control de las plantas invasoras"	7-8 y 14 de mayo	Plataforma Eminus y portal educativo del curso
16 (Del 20 al 24 de mayo)	Reflexiones finales del curso	Mesa redonda de discusión sobre estudios de caso Construcción de consenso grupal	21-22 y 28-29 de abril	Plataforma Eminus y portal educativo del curso

		Entrega de notas de campo/evaluaciones del curso Aplicación en línea de la *segunda encuesta* de aprendizaje para los estudiantes		

Fuente: Elaboración propia

Participation

From the beginning, students are presented with the scenario of biological invasion that will be studied throughout the course, and on which they will focus their attention to address real cases of the most dominant invasive plants in their locality.

At the start of each invasion case, students will be divided into four working groups. They will be supervised and receive support from the teacher throughout the session and culmination of the monitoring of the local invasion. To allow students to get involved, familiarize themselves with their immediate environment, understand the complexity of the ecosystems in which they are working, and reflect on how and when to manage the invasion of plants in such systems, each session will be taught directly linked educational content to the case study of local invasion.

Evaluations

The students focus on real cases that involve monitoring the invasion and its impacts, and alternatives for its management and control, both in local natural and semi-natural areas and in ornamental areas around the campus. In these cases, they approach from the determination of the possible trajectories of introduction of dominant invasive plants to the development of an action plan for the comprehensive control of these at the local level.

With each particular case of invasion, students will face a real environmental challenge, and must assess the composition of the invaded area, determine the state of invasion, its impact on the site and its use, and be able to formulate an action plan for the short and long term control that could be applied to meet local needs and avoid similar future invasion situations. When designing an invasion monitoring project, students should develop their ability to think

differently, from a new perspective, and consider other actions or strategies to control invasions in their locality.

Students are organized into small work teams (three or four members), and are assigned a particular position for the corresponding case study. They are instructed to take detailed field notes and to question the presenters in each session addressed throughout the course in order to collect evidence and data that may be useful to build a group case at the end of the school term. Each team is asked to carefully build and prepare a portfolio to defend their results and stance in an exercise to build consensus among participants during the last session of the course.

The performance of the work teams is subject to evaluation through the elaboration of rubrics with analytical criteria that include the content of the presentations, quality, consensus skills, as well as skills to communicate among peers, with teachers and members of the community.

Students are also graded on their participation as assessors for each session of the course presented, which is described below in Table 3. The results of that assessment are used by the course facilitator to assess how improvements can be made in the way of provide the sessions and their content.

Tabla 3. Formato de la evaluación aplicada al estudiante correspondiente a la sesión del proceso de invasión biológica y especies de plantas invasoras.

Nombre del curso: Ecología de Malezas	Número de registro del curso (NRC): 53357	Periodo escolar: febrero-junio 2019	Nombre del estudiante	Nombre de la actividad: "A la caza de las plantas invasoras"	Fecha de ejecución
1) A continuación se enlistan algunos planteamientos en relación con la ejecución de la sesión de aprendizaje.	Lee cada punto y decide si estás satisfecho o no, y a qué nivel.	Si no estás satisfecho, marca *1*	Si estás muy satisfecho, marca *4*	Si estás en un punto intermedio, marca un número entre 1 y 4	Si no tienes alguna opinión o el planteamiento no se aplica a la sesión que estás evaluando, marca *5*
Por favor, indica tu nivel de satisfacción con los siguientes elementos: - Estilo de presentación del instructor - Nivel de conocimiento del instructor - Nivel de preparación del instructor - El método de ejecución - La actualización del contenido de la sesión	Muy insatisfecho	Poco satisfecho	Generalmente satisfecho	Muy satisfecho	No sé / No aplica

- La relevancia de la sesión con temáticas reales - El interés estimulado por el contenido - El conocimiento obtenido de la sesión - El pensamiento crítico requerido para la sesión - El tiempo asignado para la sesión - La calidad de las instrucciones proporcionadas para actividades/ejercicios - El equipo proporcionado para completar actividades/ejercicios - El nivel de integración entre la ejecución y el contenido de la sesión					
2) En escala del 1 (pobre) al 10 (excelente), por favor da un puntaje general para esta sesión. Marca uno solo.	1-3 (pobre)	4-6 (regular)	7-8 (bueno)	9-10 (excelente)	

3) ¿Recomendarías esta sesión para futuras actividades de campo? Por favor marca *Sí* o *No* y explica. Marca uno solo.	Sí	No	Explica:		
4) ¿Tienes algunas sugerencias para mejorar esta sesión del curso? Por favor explica.					

Fuente: Elaboración propia

In addition, students are provided with a small format for a detailed evaluation of the fieldwork, as presented in Table 4.

Tabla 4. Formato de la evaluación aplicada al estudiante correspondiente a la ejecución del trabajo de campo en cada sesión abordada a lo largo del curso.

Nombre del curso: Ecología de Malezas	NRC: 53357	Periodo escolar: febrero-junio 2019	Nombre del estudiante	Nombre de la sesión: "Proceso de invasión biológica y especies de plantas invasoras"	Fecha de ejecución
A continuación, se enlistan algunos planteamientos en relación con la ejecución del trabajo de campo.	Lee cada punto y decide si estás satisfecho o no, y a qué nivel.	Si no estás satisfecho, marca *1*	Si estás muy satisfecho, marca *4*	Si estás en un punto intermedio, marca un número entre 1 y 4	Si no tienes alguna opinión, marca *5*
Por favor indica tu nivel de satisfacción con los siguientes elementos: - Plan y programa de campo - Asignación de estudios de caso - Asignación de notas de campo	Muy insatisfecho	Poco satisfecho	Generalmente satisfecho	Muy satisfecho	No sé

- Examinaciones prácticas breves/ejercicios - Nivel de organización - Horarios - Cómo se abordan dudas/preocupaciones - Ubicación de sitios de campo - Acceso a sitios de campo - Arreglos en campo - Seguridad en campo					
Observaciones adicionales:					

Fuente: Elaboración propia

A format for the official course evaluation is also included, as described in Table 5 below. All this allows students to provide their comments and feedback on aspects of the course that are not found in the generic evaluation of the courses. University.

Tabla 5. Formato de la evaluación oficial del curso aplicado a los estudiantes.

Nombre del Curso: Ecología de Malezas	NRC: 53357	Periodo escolar: febrero-junio 2019	Número de créditos: 6	Nombre del estudiante	Fecha de ejecución
A continuación, se enlistan algunos planteamientos en relación con la ejecución del trabajo de campo	Lee cada punto y decide si estás satisfecho o no, y a qué nivel.	Si no estás satisfecho, marca *1*	Si estás muy satisfecho, marca *4*	Si estás en un punto intermedio, marca un número entre 1 y 4	Si no tienes alguna opinión, marca *5*
Por favor indica tu nivel de satisfacción con los siguientes elementos: - Plan y programa del curso - Contenidos educativos - Competencias desarrolladas - Asignación de actividades, ejercicios de aprendizaje	Muy insatisfecho	Poco satisfecho	Generalmente satisfecho	Muy satisfecho	No sé

y estudios de caso - Conocimiento y preparación del instructor - Nivel de organización - Instrucciones proporcionadas - Cómo se abordan dudas/sugerencias - Recursos e información proporcionados - Disponibilidad del instructor para asesorías/consultas - Asigna por favor un puntaje general del curso: en escala del 1 (malo) al 10 (excelente)					

¿Recomiendas este curso a otros estudiantes?	Sí	No	Explica:		
Observaciones adicionales:					

Fuente: Elaboración propia

Results

The didactic tools that were used in the evaluation applied to the students allowed to detect some aspects about the planning and program of the course, the instructor's performance and about their perception on the usefulness of these to refine the educational plan of the real fieldwork that is immersed. in this invasive plant ecology course.

Most of the comments made by students about the overall course plan and program and assignment of invasion case studies indicates that they are generally very satisfied with the course plan and case studies; a couple of them indicated that they were not very satisfied.

Likewise, most of them commented, in their feedback sessions, that the actual cases of invasion allowed a better understanding of the concepts and terminology associated with the biological invasion process, and also allowed them to have a more realistic context in each session of class.

In relation to the data obtained from the course evaluations, these indicate that the implementation and adoption of these principles has been effective in understanding and understanding the content and resources provided throughout the course.

The process of planning and curricular development of the course was somewhat repetitive, since some aspects of its evaluation were also immersed in the conduction of the learning sessions, execution of the fieldwork corresponding to each session, and therefore, the comments , reflections and evaluations of the students were seriously and carefully consulted and considered in order to accommodate their recommendations to improve curriculum planning in the ways that they see fit for the achievement of their learning.

Through the process of continuous investigation and inquiry throughout the course, and considering the feedback of the students served and that of the instructor, it was possible to permanently maintain a continuity in the refinement and improvement of the curricular

development of this course. . Apparently, this process, according to the data provided in the evaluations, has some merit.

In addition to the importance of numerical ranges for the different categorical elements considered in the evaluations, they also helped provide general written perceptions of the various experiences that students acquire in a course that integrates actual fieldwork that It links them to their immediate environment. Some of the comments that were collected from their evaluations reflected a general motivation for work outside the classroom and in contact with nature, the easy location and access to field sites. However, from these comments it was also reflected that the most frequent dissatisfaction is the schedule in which it is offered: they would be more pleased if it started in the period of 11:00 h instead of 9:00 h to avoid delays in their arrival to the meeting point. The socialization of their concerns and their open dialogue with the instructor throughout the course facilitated the execution of all the learning activities, despite small overlaps in time that were resolved focally and did not affect group dynamics.

Through the appropriate examination and timely group discussion sessions of the different cases presented throughout the course, the students learned to identify real environmental invasion problems that are occurring in their local environment, to recognize key factors and their relationships, and be informed and alert of all aspects of the problem caused by invasive plants in our native ecosystems.

Discussion

The use of real cases of invasion as means of instruction and inquiry throughout the course greatly facilitated the development of diverse analytical skills by students as they explored their evidence and related to their environment as they learned. With this, it is possible to document that the students show a more positive disposition to learn towards the use of these ecological cases, such as those offered in this course. This teaching and learning methodology is not new; It has been adopted by many teachers and groups who continue to promote professional development to provide a real, innovative and quality learning experience that responds to the current demands of a society immersed in the growing information, communication and learning technologies (Lundeberg and Yadav, 2006).

It is clear that not all students take the time to write their comments and suggestions in the assessment formats that are applied, however, it is estimated that the majority of the group

served agrees with the interactive dynamics and the fieldwork carried out. . Outside of the schedule problem that was creatively attempted to address, students report strong perceptions about the benefits and experiences derived from the sessions addressed in the course, their motivation to be attending problems and relate to their immediate environment, to investigate scientifically and expose themselves to the real life research work and take part in the decision process as true researchers.

From the experience derived from this teaching practice, it is detected that at least half of the students served in each period of school offer discuss the importance of what they learned in the course to help them either decide or focus on some topic under study for your thesis projects, for the reception educational experience and for the reports of the provision of your social service.

Throughout the course, the application of the instructional method based on ecological cases allowed recognizing some of its strengths, among them it can be pointed out that this approach is a valuable educational tool for teaching and deep understanding of environmental issues through an analysis Detailed contextual of numerous events or conditions and their possible relationships in a specific place and real time (Haskett, 2001).

Our use of cases focused on the field of invasion ecology involved the investigation of a global real-life phenomenon, such as biological invasion by plants, which is creating an increasing threat to the diversity of flora and native fauna worldwide. Additionally, these cases managed to illuminate key themes and results that helped students predict future trends, and reveal previously unknown aspects of the natural environment that could be applied immediately in their environment, and also provided a practical way to understand an important research problem more clearly.

The execution and learning outcomes associated with the use of these cases demonstrate a significant increase in the acquisition of knowledge about science, particularly ecology, as well as a better ability to establish connections between multiple content areas and to visualize problems. real from different perspectives.

The cases analyzed helped facilitate learning about how ecology focused on invasive plants works. And they undoubtedly proved an improvement in learning outcomes by instilling in students curiosity to know and investigate, and to put into practice different skills related to critical thinking (Anderson, 1992). All this successively increased their understanding of the

key concepts handled in invasion ecology, taught in the course sessions, as well as fostered their ability to solve local invasion problems and apply the theory in practice.

It is widely recognized that cases have been used throughout history and in various disciplines to facilitate the achievement of knowledge and its dissemination (Tashiro and Rowland, 1997; Lundeberg and Yadav, 2006). The most effective cases have managed to facilitate multiple evaluations of a given situation, and lead to several equally viable and compelling conclusions, with different implications and actions. However, it cannot be disregarded that there are some obstacles that still need to be addressed when using case-based teaching and learning methodology within the dynamic classroom environment.

One of the main obstacles would be the lack of time for the timely preparation of cases to present. Most of the instructors or facilitators of the courses that adopt this method are those who are looking for and preparing all the materials and resources involved in their own cases. Additionally, the development of effective research and discussion questions for the construction of activities and case-based learning exercises represents an imposed challenge, and very often the study of cases is not subject to sufficient academic rigor, which many Sometimes it underestimates its effectiveness and credibility, which in turn represents another important challenge to overcome.

Conclusions

The dynamics of case teaching in real ecological settings has largely promoted motivation and an interest in learning how science works and its applications in nature, which can cover the current expectations of employers who they require students to have an applied and philosophical understanding of their discipline, while demonstrating an interest in safeguarding a sustainable environment.

The use of interactive learning sessions and teaching based on authentic ecological cases with field applications allowed students to integrate more easily their previous academic experiences with practical learning (“learning by doing”) in a new way and combining various pedagogical tools. , which also managed to connect them with their environment, all of which enriched their learning process.

Case teaching improved learners' motivation and interest in knowing and preserving their local environment, facilitating the connection between the real context and the course content. This also led to conceptual learning and the development of analytical skills

necessary for scientific literacy. The use of ecological cases also prepared them in their learning of key concepts about plant ecology and biology in general, helped students to deeply understand these concepts, and to develop their ability to think critically from examples, conditions, and real events. , analogies and models, as well as to identify basic principles with immediate application.

Inquiry and exploration of cases in real contexts were flexible instructional tools that provided meaningful learning, and that can be easily incorporated and adopted in all aspects of science courses at the university level and others of higher division, even when these do not include the field or laboratory work component.

The use of case-based teaching can help facilitate learning, reasoning from examples, analogies, models, events, real situations, and basic principles. Furthermore, the cases promote active learning, which fosters critical thinking skills, an area that still suffers from deficiencies in many contemporary learning environments.

The teaching experience explored in this study was significantly satisfactory to see that the students connected and motivated with the local ecological cases that were addressed in all the sessions of the course, and experienced their community participation with the analyzed biological system, seeking interconnections and formulating possible management strategies, as well as by planning other investigations of interest and feasible execution in your locality.

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