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THE KNOWLEDGE OF INVASIVE PLANTS AND ITS IMPORTANCE IN EDUCATIONAL USES

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Abstract

The colonization of natural spaces by invasive species is one of the environmental problems faced by many countries. Citizens' awareness is necessary to avoid or reduce this impact on the environment. The school is one of the places where awareness must be raised. However, the nuances of the problem are many and the teacher must have adequate training to be able to start any methodology with which you want to address the problem in the classroom, due to the diversity of situations. An example of this difficulty is posed by an experience carried out with students from the Degree in Primary Education of the University of Zaragoza, when dealing with the introduction of the plant *Ipomoea purpurea* in the province of Teruel. To this end, seeds of this plant were collected and made available to this teaching staff in training so that they could design an experimental activity aimed at primary school pupils between the ages of 8 and 10, which would allow them to explore the environmental variables necessary for their germination and their impact on the environment. At the end of the experience, the teacher training students valued this activity positively for the training of primary school pupils. However, they stated that they did not have sufficient biological knowledge to tackle this type of activity, nor adequate vocabulary or any other type of social, economic and political skills, which would facilitate them to debate and present their opinions in a rational way in relation to environmental problems.

Keywords: Primary education, teacher training, environmental impact, invasive species, Inquiry-based Science Education (IBSE).

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1. Introduction

The history of botany shows a huge number of vegetables that have been imported from other places, some plants that have grown in the new areas and have been *naturalized* or used in gardens and farms, to such an extent that it is sometimes hard to establish, just by means of botanical information, if a particular species is native to a specific region or has been introduced by people. Perhaps we should explain whether that naturalization has just been hastened by human action. In such a case we must resort to old texts in order to get some information.

On most occasions, the term *native* is used with no accuracy of the spatial dimension, to which the presence of a given species is referred, or of the temporal dimension, and thus, in the latter case, we have to interpret the concepts of *always* or *all the time*, which are inappropriate for scientific precision. Font Quer (1973) defined the term *alóctono (allochthonous)* concerning plants as *the ones that are not indigenous to the country where they grow*, but the very concept of country is subjective. The same author equated the meaning of native with that of endemic and considered both to be synonymous, although he stated that the most appropriate concept is the latter providing the area (*country, mountain range, island…*) is delimited.

The artificial displacement of plants amongst the continents of Europe, Asia, Africa and even Oceania has to be regarded as old as agriculture. The case of America has been later –we can trace it back to the early travel between this continent and Europe. Therefore, at least over the last five hundred years, a number of plants have moved at variable velocity throughout the planet, most of them in a voluntary way, some of them unintentionally. As the media improved, the volume of transported plants (seeds, fruits, stems…) increased, and nowadays the number of people who have travelled around the continents in the world is so large that custom controls cannot be effective, especially in regard to seeds, which can be carried in an unchecked or involuntary way on garments, pieces of equipment or shoe soles. Furthermore, deliberate actions should be considered.

In certain areas there are specimens of non-native plants that do not seem to cause any great ecological problems, mainly because of extreme weather amongst other environmental factors. In some cases, climatic conditions determine a very short vegetative phase, which produces a smaller number of seeds.

Invasive plants are an environmental problem, and as such, should be considered at school from early educational stages. Rivarosa and Perales (2006) recall that in 1977, the International Conference on Environmental Education, held in Tbilisi, stated that Environmental Education could not be imparted in the form of master lessons. Such initiation to the environment is done through problems posed by the functional activities of students and by the exploration of biosphere systems. Therefore, the resolution of environmental problems could be considered a methodological proposal for Environmental Education. It appears as a suggestive way for future teachers and practicing teachers to approach the recognition of problems, their global analysis, their link with social agents, and the possibility of acting for their resolution, in a systematic way.

Hoban (1997) suggests that the confidence of teachers in training does not increase by giving them more content in science, but by facilitating metacognition activities, where the teaching practice of specific scientific content is reflected upon. Moreover, only when teachers believe that science is necessary and

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important, when they have positive feelings about these issues, and when they themselves feel safe and able to teach them, without depending on too many contextual factors (training, time, materials, etc.), will they change and improve their teaching of scientific content (van Aalderen-Smeets, Walma van der Molen, & Asma, 2012).

2. Problem Statement

2.1. Information on two seeds- *Ololiuhqui* and *Tlitliltzin*-in old texts

Please replace this text with context of your paper.With the development of pharmaceutical botany and analytical chemistry during the 20th century, a lot of scholars studied the taxonomic identification of some plants that were used by indigenous peoples of the Americas for ceremonial. These species, which contained active compounds for medicinal purposes, sometimes caused drunkenness, visual hallucinations, and so forth. The first bibliographic sources were recorded by European chroniclers, priests or physicians over the 16th century onwards. Those authors related the remedies used by natives, particularly in some regions on the southern tip of North America, such as the so-called state of Oaxaca in southern Mexico. The use of these plants for certain rituals of healing has continued until the present day (Fagetti, 2012).

Francisco Hernández de Toledo (1515-1587) prepared a handwritten text entitled *Historia de las plantas de Nueva España*, which was partially reproduced by several authors afterwards. All the various pieces derived from the work by Hernández have been compiled by López and Pardo (1996), and the most well-known texts are those by Recchi (1551), Ximenez (1615) and Nieremberg (1635). In these three works the morphological properties of *Ololiuhqui* are characterized.

Recchi (1551) provided a drawing in his description, and he called the plant *Coaxihuitl*, which means ‘snake-plant’, for its growth around any available support. Ximenez (1615) translated the text and he mentioned the so-called *Ololiuhqui* or *Coaxihuitl* seeds. He described the plant morphology and he observed its white flowers. He stated that

> […] es caliente esta planta en el cuarto grado, cura el mal francés mitiga los dolores, nacidos del frío resuelve las ventosidades e hinchazones, el polvo de la raíz mezclado con trementina expele el frío y es gran remedio para los huesos quebrados y desconcertados, y para las caderas relajadas de las mujeres, también sirve la simiente en la medicina porque molida y bebida o puesta en la cuenca cura las enfermedades de los ojos y también bebida provoca la lujuria, es de sabor y temperatura aguda y muy caliente (y es mejor molida y con leche y chile). (This plant cures the French disease, mitigates cold, it solves the windiness and swellings. The root powder mixed with turpentine expels the cold and is a great remedy for broken and bewildered bones. The seed is also useful in medicine because ground and drunk or put in the basin cures eye diseases and also drunk causes lust, it has a sharp taste and temperature and is very hot, and it is better ground and with milk and chili). (Ximenez, 1615, pp. 77-78)

Those seeds were supposed to belong to the genus Ipomoea until the middle of the 20th century, but in 1941 they were definitely identified by Richard Evans Schultes as a species of *Rivea corymbosa* (L.) Hallier f., which was afterwards denominated *Turbina corymbosa* (L.) Raf.

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In subsequent research on other similar plants, which were used as hallucinogens and medicines in the very region of Oaxaca, *Ipomoea violacea* was identified as the one that Mazatec people called *tlitliltzin* (Schultes, 1970). Although it was not mentioned much by the Spanish chroniclers, Ponce (1892) found the following:

> ([46]) Veben el ololiuhque, y el peyote, una semilla que llaman *tlitliltzin* son tan fuertes que los priva de sentido y dizen se les aparese uno como negrito que les dize todo lo que quieren. otros dizen se les aparese nuestro señor. otros los angeles (They drink ololiuhque, and peyote, a seed they call tlitliltzin. They are so strong that it deprives them of sense and they say that one of them appears as a black man who tells them everything they want. Others say that God or angels appears). (p. 11)

The seeds of the two species, *ololiuhqui* and *tlitliltzin* (*Turbina corymbosa* and *Ipomea violacea*, respectively) were supplied by mycologist Robert Gordon Wasson to Albert Hofmann in 1959, and the latter had discovered lysergic acid diethylamide (usually called LSD) in 1943 from other derivatives of ergot of rye, *Claviceps purpurea*. After an analysis of the seeds, several components similar to those of ergot, ergine and isoergine were discovered, as well as other minor elements (Schultes, 1970; Schultes, 1977; Schultes & Hofmann, 2000).

The presence of ergolinic alkaloids, similar to those found in ergot of rye, might be due to the presence of parasitic fungi of the same family (Clavicipetaceae) in the plants of the genus *Ipomoea*, which could cause the chemical compounds produced by fungus to be present in the seeds of *Ipomoea* (Arias, López, Bernal, & Castaño, 2011). Therefore, the presence of fungus in the milieu could determine the presence of alkaloids in the plant.

2.2. The case of the *Ipomoea purpurea* (L.)

The genus *Ipomoea* L. comprises an indeterminate number of species between 500 and 700. Climbing plants of this genus include species of American origin (Cullen et al., 2000), the taxonomy of which has been detailed by Guillot (2003).

One of these species is *Ipomoea purpurea* L. Roth, and it is present in the Iberian Peninsula. It was introduced in Europe from Mexico in 1629 for ornamental purposes, since it is appropriate to cover walls, fences, etc. (Sanz, Dana, & Sobrino, 2004). The plants have a large seed output and a high capacity for germination and growth; they are abundant in flowers with great decorative power, which favours their reproduction in gardens, and they have a high probability of becoming naturalized. This species is considered to be *allochthonous* (non-native) and *invasive*, therefore it could impact on ecology with *severe consequences from an environmental and anthropocentric standpoint* (Sanz et al., 2004). Its distribution in the Iberian Peninsula is concentrated in the Mediterranean coast and it does not largely affect inland areas, where temperatures are extreme, and rainfall is low and irregular. Likewise, its usual germination in ruderal soils should not touch any possible cultivation or human interests. Its presence in these environments should not be considered permanently stablished, rather, it is an ephemeral plant, at least in the most exposed areas, where it appears or disappears according to climate conditions.

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Two ornamental varieties are found in the Mediterranean area, namely: *I. purpurea cv. Star of Yelta and I. purpurea cv. Crimson Rambler*, which have been mentioned in the region of Valencia since 1987 (Guillot, 2003, 2006).

In inland areas, where extreme weather might seem inappropriate for cultivation, they also grow, although they have a very short vegetative phase. Temperatures near 0ºC lead to the death of the plant. Since it needs a temperature around 18ºC, its delay in germination yields a very short stage of growth, flowering and seed development. Its presence is revealed in the province of Teruel (Guillot, 2009; Mateo, 1990, 2008). Gonzalo Mateo also stated that it is a climbing plant of American origin. Its cultivation has ornamental, for summer, in hedges and gardens. Some specimens sometimes appear in crops, always in warm areas (Mateo, 1990, 2008).

3. Research Questions

Invasive allochthonous plants are considered to be one of the environmental problems to take into account since they affect native flora, with which they compete, but also, because they have an impact on other living creatures that are dependent on both the damaged plant and the invasive one as parasitic species. Owing to economic concerns as well as environmental impacts, some plants brought from other places, which were once considered ornamental, are now regarded as harmful.

It might be desirable to reassess the concept of allochthonous, at least from an educational standpoint, and handle it, from the evolutionary viewpoint, as the ability of a species to develop in a given milieu *indefinitely*.

The aforementioned concepts can be studied with examples of invasive plants. Perhaps when we make value judgements about certain species because they are unknown somewhere, we should determine not so much if they are native as if they can cause some abrupt changes in the ecosystems that they overrun. Additional assessments may be performed from the standpoint of interest in the human race, and possibly with some brief information which could be distorted by rabid environmentalism.

In any case, from an educational perspective it seems to be interesting that the student body work on these concepts and be able to use specific words, which allow them to expound or discuss their knowledge, beliefs and views in that regard.

It could be relevant that the student body wonder if introduced species are capable of germinating, growing, competing with others, and so forth, so that they can assess and debate the appropriateness of these plants.

Active participation of citizens is essential, and good knowledge facilitates citizen behaviour suited to the seriousness of the situation. It is complicated to coordinate and reconcile behaviour patterns and actions without any real awareness of issues (McNeely, Mooney, Neville, Schei, & Waage, 2001).

4. Purpose of the Study

The objectives of this study are:

- To implement an experimental germination activity with seeds of an allochthonous invasive plant and an autochthonous plant with teacher training students.

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- To encourage a debate on invasive species and critical reflection on this environmental problem among primary school teachers.
- To encourage teacher training students to value their own teaching ability to develop these topics in the Primary classroom.

Research Method is presented in next section.

5. Research Methods

This section includes the followed research methodology.

5.1. Seed germination of *Ipomoea purpurea*

Seeds of this species have a dormancy period on account of their outer membrane, the testa. This part of the seed prevents water from entering, which determines the germination phase. In order to avoid this problem, we will have to scarify this hard layer of the seed chemically by contact with an acid, or by mechanical means with sandpaper, or by making a scalpel incision in the hilum area, or by soaking the seeds in water for 24-48 hours (D'Agostino, Gurvich, Ferrero, Zeballos, & Funes, 2012; García Lara, 1998; Sobrero, Fioretti, Chaila, Ávila, & Ochoa, 2003). According to D'Agostino et al. (2012), the optimum temperature for germination of seeds scarified with sandpaper appears to be 15º-25ºC, and the presence of light has no influence.

5.2. Methodology

Some seeds of *Ipomoea purpurea* were collected in the town of Teruel in October-November 2018. The fruits were obtained from specimens that were isolated and had made use of metal fences as a growth support. Exposure to sunlight was enough. Every treatment was repeated three times with ten seeds each one of them. They were sowed in Petri dishes containing filter paper and distilled water, and set in a furnace under controlled conditions of light and temperature. The seeds were subjected to temperatures of 5º-14ºC and 15º-25ºC, and under 12-hour photoperiods. The experiments lasted for 30 days. In order to consider the seeds germinated, the criterion followed was the appearance of 2-mm radicles (D'Agostino et al., 2012).

The experimental didactic stage and data collection were accomplished by some students of the Teaching Degree in Primary Education, in the Faculty of Human and Social Sciences, University of Zaragoza, Spain.

This practical activity was freely chosen by two students and it was designed so that it could be put into practice with Primary School pupils (6-12 years), who decided on examining the variables involved in the seed germination. At their lecturers' suggestion, the students of the Teaching Degree selected two plant species: one of them is native and it is called *tardaneta* (white wallrocket), *Diplotaxis erucoides* (L.) DC., and the other is allochthonous and it is known as *campanilla morada* (purple morning glory), *Ipomoea purpurea* (L.) Roth.

The students performed a seed germination activity and they explored the optimal environmental conditions for germination.

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Once the activity was completed and after the three-week observation, they explained their experience and results to the remaining 44 students in the course.

Subsequently, by means of a risk assessment matrix (adapted from García de Lomas, Dana, Ceballos, & Ortega, 2014), all the students discussed the possibility of taking preventive measures against this species (Capdevila, Iglesias, Orueta, & Zilleti, 2006).

The debate focused on the factors that may be taken into account when applying the matrix, the use of concepts, and on the teacher training to debate these environmental and social issues with pupils aged 6 to 12.

6. Findings

The students checked the variables of light and temperature in the experimental design by fulfilling six samples of germination of each species, according to some variables and results, as shown in Table 01.

Table 01. Influence of light and temperature variables on germination of *Diplotaxis erucoides* and *Ipomoea purpurea* seeds.

LIGTH	**12 Hours**			**0 Hours**		
Tª (ºC)	**2º-8º**	**15º-20º**	**23º-27º**	**2º-8º**	**15º-20º**	**23º-27º**
Diplotaxis. Seeds sown	100	100	100	100	100	100
Diplotaxis. % germinat.	0	30	70	0	7	6
Ipomoea. Seeds sown	5	6	5	5	6	5
Ipomoea. % germinat.	0	16,7	60	0	16,7	60

In view of these results, there is evidence that in general the *tardaneta*, an invasive native plant, needs light to sprout, and it germinates in a progressive way depending on the temperature, starting at 15ºC. Nevertheless, light does not affect the purple morning glory, but it requires temperatures above 23º-25ºC to germinate.

When the students of the Teaching Degree were asked about the interest and opportunity to debate (in Primary School classrooms) on the problems of invasive species spread to certain milieus, they stated what is shown in Table 02. All students considered that it is possible to include these contents in Primary School curriculum. Additionally, the students were asked if they considered themselves to be qualified to undertake this kind of activities with Primary School pupils, and a hundred percent of the seventeen groups said no, since they had never dealt with invasive living organisms in class, and they did not have the necessary knowledge to do it.

Table 02. Students' opinion including these contents in Primary School curriculum.

Students opinion	**% Students**
Previous training is necessary	29,4
Adaptation of vocabulary it is necessary	41,2

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7. Conclusion

The great power for invasion and naturalization that some plants have in areas of natural development, such as *Ipomoea purpurea*, as well as their great potential to overrun the environment and to damage the crop economy of other plants (García Lara, 1998, p. 5), makes it necessary to bring them under control when their presence is detected in new milieus. The criteria followed to evaluate the risks of naturalization of a given species in a new place (Fuentes et al., 2014; Zenni, Wilson, Le Roux, & Richardson, 2009) may be used as a didactic resource to help learners generate knowledge through scientific approaches.

The students judge the activity fulfilment positively and they feel predisposed to learning. Nevertheless, they think the same as the lecturers who have fulfilled these activities: Future teachers don't have the necessary cognitive resources (they need previous training) to tackle problems in which they need to use a specific vocabulary that allows them to speak properly, as well as making use of biological, social, economic and political knowledge which makes it easier for them to debate and present their opinions in a rational way, by using a valid argument.

Historically, schools were not intended to develop critical thinkers, social inquirers and problem solvers, or active participants in environmental and political (or even educational) decision making. To simplify, their intended function was not to promote social change or reconstruction (Stevenson, 2007). First reason for that could be, on the one hand, the lack of preparation of teachers in the area of environmental education. On the other hand, a second reason for that situation could be their desire to comply strictly with educational regulations to avoid confrontations with the inspection, or to avoid complaints from families for carrying out activities that are difficult to evaluate with a qualification. The reality is that the school does not usually work on social science with respect to nearby environmental problems. First main goal of this work is that teachers in training have become aware of the difficulties involved in confronting this type of activity in the classroom and learn how to solve them. Together with this, they have become aware of the importance of school research methodology in the classroom for effective and emotional learning in the face of environmental problems. It is necessary to create and propagate more educational proposals similar to this one, so that teachers have examples that facilitate the implementation in the classroom of this type of experimental activities. This not only allows them to experience the environmentalization of the school curriculum, but also to appropriate cognitive and strategic tools for its implementation in the classroom, essential conditions for Environmental Education to become a palpable reality in schools (Rivarosa & Perales, 2006).

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