Journal of Turkish Science Education, 2022, *19*(2), 428-437.
DOI no: 10.36681/tused.2022.129

Moroccan Secondary School Students' Abilities in Classifying Plants

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ABSTRACT
Several studies have been carried out regarding secondary school student's abilities in classifying plants in Latin-based countries, but never in the Arabic world. The aim of the current study is to measure Moroccan secondary high school students' abilities in classifying plants. The data were collected by administering a task individually to 230 Moroccan secondary school students aged between 14-16. The students were asked in the written task to determine the class of five plants and to give some commons names of gymnosperms and angiosperms classes. We provided students with an identification key in order to help them. The data was performed from a quantitative perspective in order to detect statistically significant about Moroccan students' abilities in classifying plants. We found that Moroccan secondary school students have poor botanical classification knowledge and serious problems towards botanical identification and recognition of species' morphological characters. Therefore , we conclude that they had difficulties to distinguish between gymnosperms and angiosperms plants and also between mosses and the ferns.

ARTICLE INFORMATION
Received:
03.02.2021
Accepted:
29.04.2022

KEYWORDS:
Classifying plants, secondary school, abilities, Arabic students.

To cite this article: Zghida, N., Lamrani, Z. & Janati-Idrissi, R. (2022). Moroccan secondary school students' abilities in classifying plants. *Journal of Turkish Science Education, 19*(2), 428-437.

Introduction

Several studies have been carried out regarding botanical classification in secondary school in Europe and America, but never in the Arabic countries. Then, numerous systems of classification have been proposed in Latin-based languages (Li & Roth, 2002; Mishra & Jain, 2016), Thus, the binomial name of species is established in Latin-based languages. Nevertheless, the biology classification (taxonomy) faces many challenges due to the difficulties related to the complex morphology of Arabic language, such as its derivational and inflectional nature, the presence of diacritical marks, the absence of capital letters and the lack of Arabic resources. Therefore, a study about how Arabic student classify the living beings and highlight their abilities would be very interesting.

For better understanding the natural world, the determination of the taxon which belongs to plant or animal species is an essential process (Dallwitz et al., 2002). Therefore, the biological classification allows us to make order for the diversity of plants and animals into coherent units named taxa that have widely accepted names and whose members share important properties (Ruggiero et al., 2015). Plants, like animals or any other biological group, are scientific concepts,

developed by the society and evolved as the human construction of scientific knowledge. In fact, constructing a scientific classification, is to settle on an explanation of the live world (Orange-Ravachol, 2007). Species' identification is a fundamental requirement for learning and understanding biodiversity (Randler, 2008). In fact, species' identification knowledge that students can use in their local environments is proven to promote botanical literacy (Nyberg & Sanders, 2013; Stagg et al., 2014).

The botany has long been a neglected aspect of biological education in curricula, textbooks and courses from primary school to university level. The cycle is self-perpetuating, with biology teachers neglecting botany because of its absence in their own formative education (Drea, 2011; Hershey, 2002). Also, the pre-service teachers' earlier school experiences induced some difficulties to utilize intuitive folk taxonomy and semantic similarities as their main criteria of classification (Öztürk, 2016). Plants are under-represented in biology textbooks and other media (Perez et al., 2010; Uno 2009). Plants rarely feature in popular science media or in cartoons, films and games (Hershey, 2002). They are portrayed as passive organisms, inferior to animals because they appear to be unable to react to stimuli and defend themselves (Nantawanit, 2011).

Other previous studies have indicated that the amount of animal content is more than plant content. In the life sciences sections of two popular United States undergraduate textbooks, photos of animals were more numerous and diverse than those of plants, as well as being three times more likely to be labelled by species, with plants labelled by plant part or life form (Perez et al., 2010). There were more than twice the number of examples of animals relative to that of plants and the animals were more likely to correspond to scientifically appropriate classification categories (Schussler et al., 2010). In addition, humans have a natural visual tendency to be "Plant Blind", that is, plant characteristics such as lack of movement and face, their uniform color and spatial grouping, and the fact that they are generally not harmful, lead to the elimination by humans from their conscious attention (Wandersee & Schussler, 2001). The contact between modern society and the natural environment is decreasing (Sampson & Clark, 2008), thus resulting in a decrease in the interactions between students and their natural environment. As such, there is an urgent need to include this in the educational curriculum (Dadvand et al., 2015) since science cannot be taught effectively without a thorough understanding and knowledge of the parts studied.

Situation of the Problem

Plant blindness is becoming a universal phenomenon among both adults and students(Borsos et al., 2021) .The majority of participants (90%) used no botanical terms in their written descriptions (Stagg & Verde, 2018). Participants had little experience of plant identification and their recognition of species' diagnostic (morphological) characters were poor (Stagg & Verde, 2018). The ability of the university students to recognize and name common wild flowers was very poor in England (Bebbington, 2005). Therefore, the evaluation of high school pupil´s ability relative to the classification of the plants is an important aspect of biological learning.

The students are particularly weak in the identification of botanical specimens, because certain teachers of biology are weak in this field, according to some studies (Bebbington, 2005; Stagg & Donkin, 2013). Moreover, the school curriculum of biology can also be a cause of this lack of competency, the plants are only used to illustrate the biological processes, rather than making attention to botanical diversity and its relevance for the current environmental problems (Stagg et al., 2009). Furthermore, many students find that the attribution of the specific names to the plants are particularly difficult (Bebbington, 2005; Cooper, 2008; Patrick & Tunnicliffe, 2011).

Aim of the Study

The focus of this research is to highlight secondary high school students' abilities to carry out a biological classification of plants in Moroccan context. So, we try to measure classification

knowledge and to know certain Moroccan pupils' difficulties to classify the plants. Our study aims to highlight the ability of secondary high school students in classifying plants in two high schools situated in a big city near the Mediterranean Sea in the north part of Morocco. However, numerous studies cited previously were carried out in Latin-based countries, but never in the Arabic countries, in order to highlight Arabic student's abilities in classifying plants.

Our study aims to give answers to the following questions:

How Moroccan secondary high school students classifying plants?

Are they able to classify plants according to taxonomical criteria?

Methods

Research Design

The research was conducted by the quantitative research in order to measure Moroccan secondary school student's abilities in classifying plants. The data were collected by administering a task individually to Moroccan secondary school students aged between 14-16. The students were asked in the written task to determine the class of five plants and to give some commons names of gymnosperms and angiosperms classes. We provided students with an identification key in order to help them. Typically, the city includes smaller gardens and surrounded by fields and mountains.

Population and Sample

The population of the current study comprised 2138 secondary high students from Tangier-Tetuan-Alhoceima regional academy of education and formation. The criterion sampling method was used in determining the study group for the experimental process, and there were 230 secondary high school students aged between 14-16, they were studying at two high school in the city of Tetouan in the northern part of Morocco. The criteria used in determining the study group of the research was that the participants were not attending courses on the botanical classification during our study.

Material

The data were collected by administering a test written for secondary school students. The development of the test is inspired from the Bebbington's work (2005) .The test was developed by using some evaluation activities of biology students book. It is constituted of 5 specimens of the familiar plants and their illustrations (table 1). Randler and Bogner (2006) were concluded that six to eight species are considered sufficient for an identification task.

Table 1

Specimens Used in the Test

Plants	Binomial name	Common name	Biological classification
1	*Ulva lactuca*	Sea lettuce	Green algae class
2	*Polytrichum formosum*	Polytrichum moss	Mosses class
3	*Polypoduim vulgare*	Common polypody	Ferns class
4	*Pinus sylvestris*	Pine	Gymnosperms class
5	*Zea mays*	Maize	Angiosperms class

In data collection, we note that classification criteria are given in the key. So, we try to measure the student's abilities, with regards to the classification knowledge, to identify the class of each plant on the picture. A well- designed key is meant to develop the ability to locate and

distinguish between the most relevant diagnostic characters for identification (Randler, 2008). We note that students were used the key identification in grade 7 (first school year of secondary middle school in Morocco).

Data Analysis

SPSS and Excel package programs were used in the data analysis related to the secondary school student's abilities in classifying plants. This software of descriptive statistics used for calculating the average marks and mean scores of study group and to highlight the distribution of students marks, percentage of correct answers for each specimen and number of classes identified by students. The mean scores of secondary school students were checked with average score 10/20.

Findings

Students' Abilities in Classifying Plants

The findings showed that Moroccan secondary school students have serious problems in classifying plants. The highest score was 15.00 and the lowest score was 0. The students achieved an average of 6.71 points out of the maximum of 20.00 points (table 2).

Table 2

Average of Students' Scores

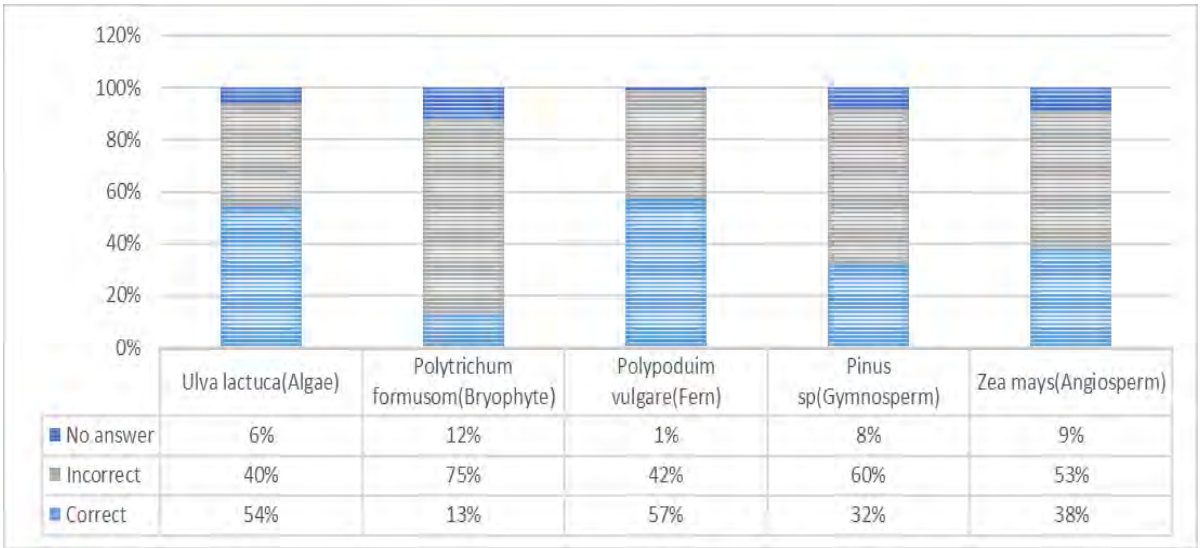
	N	Minimum	Maximum	Average	Standard deviation	Variance
Distribution of students' scores	230	0	15	6,71/20	3,203	10,258
N valid (listwise)	230					

These results showed that the botanical classification knowledge of most secondary high school students in this part of Morocco were poor despite our choice of the most common plants. The majority of students had difficulties to use classification criteria presented in the identification key for classifying plant despite they had used it in middle school (grade 7,12-13 years). These secondary high school students had fewer experiences of species identification and their classification knowledge was poor. These poor student's achievement are due often to the inadequate teaching-learning process. In this sense, the most biology teachers had difficulties about botanical classification (Bebbington, 2005; Stagg & Donkin, 2013).

Almost all students of secondary high school (87%) could not classify correctly "Polytrichum formosum" (a moss) (see fig.1). Less than Thirty-eight per cent could classify correctly that the pine tree and the maize plant belonging to the gymnosperms and angiosperms classes successively.

Figure 1

Percentage of Students Answers for each Plant used in the Test



	Ulva lactuca(Algae)	Polytrichum formusom(Bryophyte)	Polypoduim vulgare(Fern)	Pinus sp(Gymnosperm)	Zea mays(Angiosperm)
No answer	6%	12%	1%	8%	9%
Incorrect	40%	75%	42%	60%	53%
Correct	54%	13%	57%	32%	38%

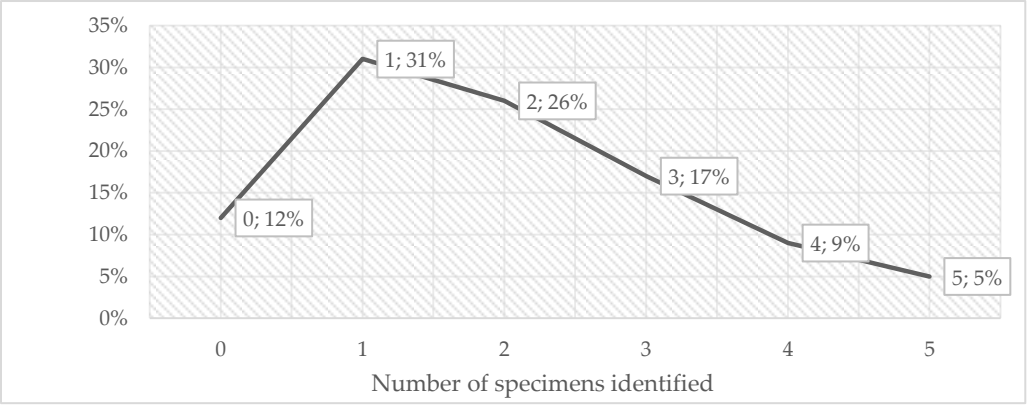
Over half of students (54%) have classified correctly the Polypoduim vulgare and Ulva lactuca. These result are due exactly to their frequent use within the curriculum of biology in the secondary school. More than sixty-two per cent classified incorrectly Pinus sylvestris and Zea maize.

According to this exploratory study, we noted that 12% of students could not classify any plant. Knowing that thirty-one per cent of study group were classified only a single plant, in particular the polypody species name (see figure 2). The recognition of plant species was low and students' knowledge about plants was poor. So, the students' familiarity in their daily lives with the five specimens was discussed.

We identified a confusion between the mosses and the ferns during the classification of Polytrichum formosum. In fact, several students classified it as a fern, justifying their answers by saying that it presents roots, which were actually rhizoids. Therefore, students could not distinguish between two plant structures that were generally required two classification attributes. Students used their existing mental models to name and classify plants (Tunnicliffe & Reiss, 2000).

Figure 2

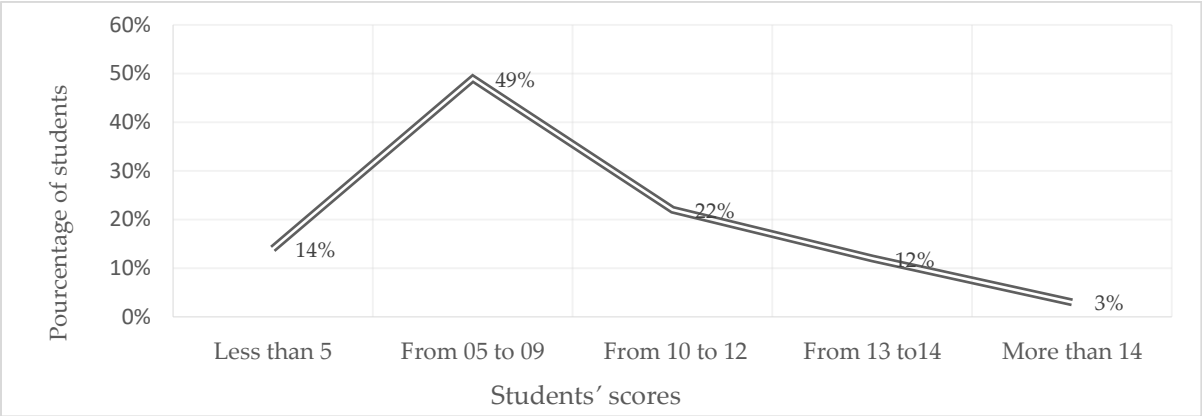
Number of Specimens Correctly Identified by Students



These results indicate that secondary school students have great gaps and an intensive weakness concerning the classification of the plants. Moreover, less than ten per cent of secondary school students could classify correctly four plants while only 5% have classified all the plants of the test correctly. These results confirm that the topic of plant classification was badly understood and that the students do not have sufficient knowledge to carry out a correct biological classification. Thus, in order to determine the pupils' abilities to classify plants, we tried to study the distribution of students marks obtained in the test (see Fig.3).

Figure 3

Distribution of Students' Scores



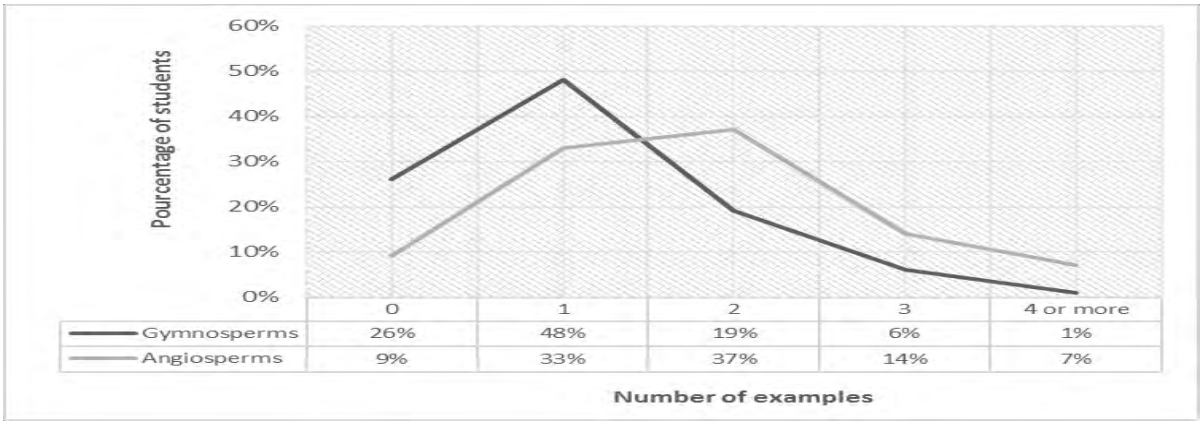
It is noted that 49% of students have marks from 5 to 9 and 14% of them less than 5 out of 20. That is to say, a total of 63% of the students achieved less than the average score (10/20). Moreover, only 50% of the students achieved more than 12 points out of the maximum of 20.00 points. According to our findings, we can say that in this part of Morocco, the outdoor learning is less often or does not exist and these students do not have the opportunity to see and handle plants in botanical field.

Common Names of Gymnosperms and Angiosperms Classes

This section of test aims to measure the students' abilities to determine common names of some plants among both gymnosperms and angiosperms (see Fig.4).

Figure 4

Number of Commons Names Recognized by Secondary School Students



The results obtained showed that 26% of the students could not cited any common name of some plants of gymnosperms and that 48% could only name one example of them. Moreover, only nineteen per cent could cite two common names and 6% of students gave 3 examples.

Relative to the angiosperms, the students cited more examples with regard to the gymnosperms. Only 9% of students could not cite any example while 33% cited a single plant of angiosperms. Moreover, an important percentage (37%) of students could give two common names of some plants but only 14% cited 3 examples of this class. We found that secondary high school students knew about angiosperms better than about gymnosperms. Thus, the abilities of these secondary high school students to name common plants about gymnosperms and angiosperms classes were poor. These results confirmed that these secondary school students could not achieve the classification knowledge adequately inside and outside of school.

Discussion

The present research showed that Moroccan secondary high school students have poor classification knowledge and serious problems towards botanical identification (Bebbington, 2005; Stagg & Donkin, 2013; Stagg & Verde, 2018). In fact, sixty-three per cent of students were achieved less than 10/20 (pass mark). The students achieved an average of 6.71 points out of the maximum of 20.00 points. These results confirm that the topic of plant classification is misunderstood and that students do not have sufficient knowledge to carry out a correct biological classification. Our participants had little experience of plant identification and their recognition of species' morphological characters were poor (Stagg & Verde, 2018). The students have lack in understanding the classification of the plants and they were less interested in plants with regard to animals (Schussler & Olzak, 2008; Strgar, 2007). In overall, students were fascinated by movements so they frequently had enormously more interest in mobile animals than seemingly immobile plants (Nantawanit, 2011).

These secondary high school students could not distinguish clearly between gymnosperms and angiosperms. Several of them were confused between these two taxonomic classes. These confusions were often due to the pupils' alternative conceptions regarding plant classification. In fact, the students were so much confused by the difference between seed and ovule, this lack of understanding affected their classification of gymnosperms and angiosperms (Yong-Jin Kim et al., 2011). Biology teachers do not teach for students that the ovary is a main classificatory criterion between gymnosperms and angiosperms and that the seed is a criteria shared between them because they are both members of the seedbearing plants. Therefore, students should learn earlier in their school career that the ovule is naked in gymnosperms. However, it is protected inside the ovary by the integument and the protective organs of the flower in angiosperms.

We also identified a confusion between the mosses and the ferns during the classification of Polytrichum formosum. In fact, several students classified it as a fern justifying their answers that it presents roots, which they are really rhizoids. Therefore, students could not distinguish between two plant structures that are generally two classification attributes. Students used their existing mental models to name and classify plants (Tunnicliffe & Reiss, 2000). In this sense, students are based on the shape and size of the plant when classified (Askham & Leonard, 1976). The key of determination presented to the students is a dichotomous key, which indicates that the presence or the absence of the roots is a classificatory criterion between the mosses and the ferns.

Other result showed that more than half of the students could classify correctly lettuce of sea (Ulva lactuca). This result is a little surprising because there is no course within the curriculum of biology on secondary school, containing the study of algae. Normally, the shape of the green algae is particularized what facilitates their identification. The students did not have problems to classify ferns. In fact, the attributes of the fern were clear and easily identifiable. Generally, the Polypoduim vulgare is a plant which was cited several times in the textbook, in particular, to show the life cycle of the plants.

Our participants recognized angiosperms better than gymnosperms, they cited more common names of angiosperm plant but they had difficulties in giving examples of gymnosperms. In fact, this result is explained by the extensive diversity of angiosperms class species in Morocco compared with that of gymnosperms. Thus, the students know commons name of some plants of angiosperms more than gymnosperms.

The students would presumably focus on the size, color, or form as categories of classification, were combined some additional elements of pieces and textures (Bartholomé & Bromme, 2009). In this sense, many students used "non-taxonomic" criteria, such as habitat and locomotion to classify animals even after learning the categories of the biological classification (Zghida et al.,2019). Indeed, the teachers need to help students to teach by encouraging them to describe and comment the anatomical characteristics of the less obvious plants. In other words, students can be helped to observe more carefully and with greater accuracy. For example, teachers might point out that fungi are not green, mosses do not have flowers and conifers have cones (Tunnicliffe et al., 2000).

The poor pupils' results were due often to the inadequate teaching-learning process. Normally, the most teachers of biology are weak relatively to botanical classification (Bebbington, 2005; Stagg & Donkin, 2013). Therefore, they must improve their knowledge relative to topic studied (Darling- Hammond, 2000). In this sense, the cause of botany neglect has often caused by botany being uninteresting (Schussler & Olzak ,2008; Strgar, 2007). Therefore, the teachers who do not have an interest according to plants how will teach it to students. Normally, teachers who had less interest and poor classification knowledge, were able to transmit it to students (Hershey, 1996). Therefore, the biology teachers need to use the new teaching materials and methods in order to increase the students' plant knowledge and their interest towards plants (Fritsch, 2015).

Conclusion

The Moroccan secondary high school students had poor classification knowledge and serious problems towards botanical identification. These results confirm that the topic of plant classification was misunderstood and that students did not have sufficient knowledge to carry out a correct biological classification. The students who participated in the study could not distinguish clearly between gymnosperms and angiosperms, and several of them were confused between species that belongs to these two taxonomic classes.

Purpose of Research

We propose some recommendations to improve students' classification knowledge:

- Biology teachers should be explained how to use the key of identification for bringing out the necessary data in order to help high school students in classifying plants.
- It is essential to elicit the difference between mosses and ferns explaining their characteristics. Also, the clarification of features between gymnosperms and angiosperms is needed;
- It is fundamental to give several common names of plants belonging to gymnosperms class.
- It is recommendable for students to see common plants of gymnosperms class in botanical field.
- The students were asked to make research outside of school via Internet for better understanding the botanical world and to carry out a collection of the most common plants in order to improve their classification knowledge.
- It is recommendable to apply "Which plant am I?" game in order to increase students' plants knowledge, while motivate them to become familiar with more plants (Borsos, 2018).

Limitations of Research

Our research has some limitations:

- Due to COVID-19 situation, we could not have an insufficient sample size for statistical measurements.
- Lack of previous research studies on the topic in Arabic world.

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