



Perceptions of the students' learning and evaluation process in an e-learning course in Food Preservation Technology: a study case in a Food Consumption MSc

Tiago A. Fernandes^{1,2,3}  · Fernando J. P. Caetano^{2,3}

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Abstract

Food Preservation Technology is a main module within a course integrated in a Master of Science program in Food Consumption at Universidade Aberta, Portugal. The pedagogical model adopted at Universidade Aberta encourages open practices such as teamwork and participation at the forums for learning exchange. E-learning and b-learning tools are increasingly used in the actual global world, providing the students with a great opportunity to study from distance and submit their digital works or assignments for evaluation. However, in this case the distinctive evaluation of each student and classification with the respective grade may seem to be a significant problem for the teachers. During this module for each assignment topic, every student chose a different subject related to their professional or academic interests. This gives the student a chance to improve scientific knowledge within each topic and to further explore the proposed subject. Herein we have analysed how the different assignments that students completed within this module can reflect students' commitment to study and actively seek for their own knowledge. Besides, the following points were also taken into consideration: (1) the difficulties that a teacher might have when evaluating students' submitted assignments; (2) the tools that the teacher has to differentiate the quality of different assignments; as well as (3) the description of how grades can be differentiated between the students. The assignments were both teamwork and individual work that resulted from previous learning activities. In this paper, we have thus tried to understand the main limitations that students have to overcome while working on the evaluation assignments. The analytical data retrieved from the assignment's forums reveal that only a very small part of information exchanged has a constructive nature and adds value to the work to be done. From the analysed data of the works presented by the students, it is evident that they did not use an accurate bibliographical state-of-the-art list. We also debate the teamwork evaluation process within the e-learning system and its relationship with the contemporary state-of-the-art of each discussed theme, namely Drying and water activity control, Chemical preservation, Curing, Pickling, Smoking, Fermentation, Modified atmosphere, High pressure processing, Ohmic heating, Irradiation, Membrane processing, Pulsed electric fields, and Microwave processing.

Keywords Food Preservation Technology · Food Industry · Assignment Evaluation · Network Learning · E-learning

Extended author information available on the last page of the article

Introduction

Universidade Aberta (UAb), Portugal, has the mission to create, transmit and disseminate the culture, knowledge, arts, and science and technology in the service of society. This is achieved through the study, teaching, traineeship, research and the provision of services, meeting the expectations of a vast majority of people seeking to increase their level of knowledge and technical skills. In 2007, the Universidade Aberta developed its own Virtual Pedagogical Model (MPV) for a university of the future. This model is a response to the challenges of distance learning model, which includes four premises of distance education: student-centred learning, the prevalence of flexibility, interaction, and the principle of digital inclusion (Pereira et al. 2007).

The Virtual Pedagogical Model at UAb

Back in 2007, Universidade Aberta adopted an e-learning based pedagogical model for all its graduation and post-graduation courses (master and doctorate programs) ending the old distance learning system and adopting a completely digital model. This new pedagogical model (Pereira et al. 2007) has some differences depending on each study program. For the graduation courses, this pedagogical model is completely asynchronous, while for the post-graduation courses the synchronous activities are often used. This is essentially due to the number of enrolled students. The smaller number of students in the post-graduation programs makes it possible to have a direct contact between the teacher and the students although there might be a significant issue to overcome if students are located in geographical places with a significantly different time zone. There have been efforts at the UAb's community to analyse the learning results in different MSc programs, each one having its own particular issues. The objective consisted in better understanding and overcoming learning difficulties, needs and attitudes inside the forums and, most important, to pay special attention to the overall quality of the post-graduation programs (Miranda and Teixeira 2006; Oliveira and Morgado 2012; Pereira et al. 2012).

How is the student population characterized at UAb?

Most of the students at Universidade Aberta are adults and full-time employees, each one having his/her own highly stressing professional activity. Therefore, e-learning in higher education can be extremely important for everyone to achieve their personal goals. There are several different programs (bachelor, master and doctorate) offered by Universidade Aberta in scientific areas as different as history, social sciences, environmental sciences, education, mathematics and statistics, as well as education for sustainable development, among others. Naturally, each student can enrol in the area that suits his/her interests the most (Amador et al. 2015; Azeiteiro et al. 2015; Oliveira and Caetano 2018).

As stated before, these students are adults that often have families and a professional life with a great deal of responsibilities. This way, the time needed to attend classes is extremely limited, due to the use of e-learning methodology that prevents the need for travel and allows study at any time of the day. For some students the study time needed for each course and to conclude the master's, is extremely limited. However, they have

great motivation to conclude the master course and each registered dropout occurs only in extreme situations.

Sometimes the students are in their forties or even fifties which may also be an indicator of several important aspects:

1. A huge gap in time since the last time they frequented a university;
2. Their knowledge of English language might be insufficient, which severely limits an ability to read scientific articles, as they are mostly in this language;
3. Finally, and most importantly, due to a long nonattendance in any higher education institution, the students might not be proficient in using several digital tools such as a VPN connection and a digital learning environment itself, as well as the search for and work with scientific literature.

This means that the teacher has to be more available to help and support them with their difficulties, absence of autonomy, and to cherish their effort.

Despite these issues indicated above, these students are however very concerned with the sustainability subjects being somehow present in the messages exchanged in the forums and in the reports submitted to be evaluated (Caetano et al. 2018). In fact, some of the students of this master course were previously enrolled in an environmental sciences graduation course and try to merge their knowledge with the scientific themes they are more interested in with a relation to master in food consumption sciences (Vaz-Fernandes and Caeiro 2019).

The purpose of the Food Preservation Technology module

In this article, we present an overview of the module Food Preservation Technology, which is a part of one of the courses of the e-learning Master program in Food Consumption Sciences at Universidade Aberta (UAb) in Portugal. This module is completely online and it is therefore important to assess the results of the various e-learning tools used to teach the module content and try to understand how to improve the used evaluation processes. Food Preservation Technology is a module that aims to analyze the procedures and unit operations used in the food industry for the preservation and transformation of the raw materials into food, taking into account the specificity of the industries operating in these fields and their methodologies to ensure the food quality and safety.

Historical aspects of Food Preservation

From ancient times, humankind has felt the necessity to preserve food. Over centuries, humans have faced situations that made the access to food a critical matter. Human life depended on the ability to preserve food during a long winter or drought (Nunmer 2002). Therefore, whether in day-to-day situations or even in extreme situations such as those originating from a war or sailing for extended periods, preserving food has always been a vital issue. One can even say that some of the greatest advances in terms of food preservation were developed in critical periods such as those of war. Some examples are: drying (or dehydration) (Bourdoux et al. 2016); the use of salt in meat and fish (corresponding to preservation by the use of chemical additives) (Yadav and Singh 2012); preparation of pickles which is also a form of chemical treatment for preservation (Acosta et al. 2014); smoking (Woods 2003); the use of seasoning (Gottardi et al. 2016; Martínez-Graciá et al.

2015; Jessica Elizabeth et al. 2015); fermentation (preparing wine, bread, etc.) (Hugenholtz 2013; Terefe 2016); preservation in alcoholic beverages (Grumezescu and Holban 2019) or the use of sugar to make sweets, jams, etc. (Yadav and Singh 2012). The food preservation is thus the process of handling, reducing and preventing its waste and better understanding the principles of major preservative factors for foods (Leistner 2000). However, it should not be thought that all microorganisms are harmful—many types of them live among us and with us and can be used for our own benefit on some preservation techniques, particularly those that make use of (benign) bacteria or fungi to maintain the nutritional value of food as well as its texture, color and taste.

Food preservation involves the growth of bacteria, fungi and other organisms but also slows down the oxidation of fats (which causes rancidity), inhibits the natural aging and color loss that may occur during food preparation (browning enzymatic reactions—browning the fruit). Some methods of preserving food require sealing the container after treatment to prevent further contamination.

Expectations from the students in this course

It is expected that students, upon completion of this curricular unit, will be able to evaluate the procedures and the unit operations, as they are used in the food industry in the transformation and preservation of the raw materials in foods, considering the specificity of these industries and the methodologies to ensure the food quality and safety. To assess the students' progress during the semester they were asked to do three different assignments. The first one was made in groups of three students (teamwork), the second in groups of only two and finally the third one was an individual work. The professor asked students to choose their assignment subjects, after providing some programmatic content, according to a pre-established calendar, also stimulating discussion related to the topic in each forum for 1 week. Generally, students had between 1 and 2 weeks to prepare and submit their work for evaluation.

Since this module uses an e-learning methodology, the number of students, which are enrolled in each year, is usually under fifteen and the dropout, mainly due to professional and familiar/personal reasons, is sometimes significant. This article reports the data obtained in two lecture semesters, in 2016 and 2018. In 2016, 12 students were enrolled in the master program, while in 2018 there were only 10 students enrolled.

Content topics

The module of Food Preservation Technology was planned into four distinct topics over 11 weeks according to the following table:

Topic	Duration (weeks)
1. Introductory concepts	2
2. Traditional methods	3
3. Industrial processing	3
4. New technologies for food preservation	3

During the first 2 weeks, students are provided with introductory texts to contextualize or recall concepts such as: Properties of solids, liquids and gases; Material transfer; Fluid flow; Heat transfer; Water activity; Effect on nutritional properties; Packaging and its importance. During this period in which the first topic is taking place, students have access to several learning resources available through the learning managing system used at UAb and familiarize themselves with the exchange of messages in the forum. In the first forum, the teacher instructs students to watch a video about water and its properties and launches a debate among the students enrolled in the course. During this period, there are no assignments for evaluation. The second topic, related to the traditional methods of preservation, takes place from the third to the 5th week, and presents the first evaluation activity; group work composed of three students is carried out, after reading, studying and discussing the available texts and articles. The students in each group are asked to choose their own theme related to traditional preservation methods.

The third topic takes place from the 6th to the 9th week and learning resources related to several Industrial Processing are made available to the students. They are: Kinetics of thermal degradation of physical–chemical and microbiological reactions in foods; Heat transfer; Processes by application of heat; Bleaching; Pasteurization; Sterilization; Evaporation and distillation; Extrusion; Drying and dehydration; Cooking and roasting; Frying; Processes by heat removal; Membrane Separations; Extraction. In this topic, students have to work in groups of two.

The fourth topic addresses 'New technologies for Food Preservation' including thermal and non-thermal processes. The skills to be developed are built on self-learning based on the free exploration and analysis of the various materials presented and also based on the discussion between students and students/teacher of the subjects in the learning platform, designed to accompany students and guide their study. The evaluation is based on individual work related to the topic. The bibliographic review is an important aspect of these three assessments. The methodology of the assessments as a learning tool is based on three challenges: (Rodríguez-Gómez and Ibarra-Sáiz 2015)

1. Students' involvement in assessing their learning in a transparent manner, encouraging dialogue by assessment modalities such as self and peer assessment;
2. Feedforward incorporation by the professor with strategies and comments that provide information about assessment results to enable students to take a proactive approach in their progress;
3. Quality design of assessment tasks.

Methodology for the assignments

For all three planned working assignments, the following information was given to students. They should use scientific bibliography and the search should start by using B-on and any other scientific search engines to find relevant articles for the topic, such as: ISI Web of Knowledge, Google Scholar, BioOne, SciELO, etc. To access the online Libraries, students need to configure their browser to use the University's proxy server, using a VPN connection to be able to access these sites and get the articles. Students should not forget language and scientific rigor, and identification of the bibliographic references. The report should have maximum of 15 written pages using Times New Roman font (or equivalent) with size 12. Two very important attention notes are given to students:

1. Reports must include bibliographic references;
2. Plagiarism will be verified with suitable tools (text available only for the 2018 class).

Students are also encouraged to develop their own ideas and concepts.

As indicated, for the first assignment, students were organized in groups of three elements. Each group had the possibility to choose a specific subject related to the global themes: (1) Traditional Methods of Food Preservation, (2) Food Preservation Processes and Techniques, and (3) New Technologies for Food Preservation. They had to develop and submit their work within 2 weeks.

For the second assignment several guidelines were also given, and the topics could include historical aspects, advantages and disadvantages, explanations of physical and chemical phenomena that occur within each process, etc.

The third assignment had also the same guidelines being, however, an individual task.

All activities were developed within the virtual class environment, using learning digital systems that allow the interaction, distribution of information and management of learning spaces—we must recall that the students are located worldwide, not physically close to each other, as in the same city. In order not to give any priority to situations of one-to-one communication, in particular between a student and the teacher, students were encouraged to systematize their doubts in forums and then post any questions, so anyone could take part in the discussion. The teacher provided additional feedback to the students to contribute to their learning.

Plagiarism detection of students' submitted assignments was performed using Turnitin[®] Feedback Studio, an Internet-based plagiarism detection service which is fully integrated in the UAb learning platform system.

Results and discussion

The themes chosen by the students for each assignment

Assignment 1: Traditional Methods

For the first assignment students had the chance to choose from a wide-open number of themes concerning the Traditional Methods for food preservation (see Table 1). The majority of the students chose to work a theme related to salting (62.5%), while the smoking preservation method was the second selected theme (25%). Only one group chose drying and pasteurization. It is very curious that salting topic was the most presented report, since Portugal is located by the sea, and has a secular tradition in fish salting, particularly cod, which is highly appreciated and strongly rooted in the Portuguese culture and food used in the present day.

Assignment 2: Food Preservation Processes and Techniques

For the subsequent assignment, students had the chance to choose, once again, from a wide-open number of themes about Preservation Processes and Techniques. The majority have chosen to write about pasteurization (75%), while freeze-drying was the second most often selected (25%) topic. Only one group chose freezing and drying subject (Table 1).

Table 1 Themes chosen for projects in each assignment (both classes, 2016 and 2018)

	Theme	Submitted assignments	%
1st assignment	Salting	5	62.5
	Smoking	2	25.0
	Fermentation	1	12.5
	Drying	1	12.5
	Pasteurization	1	12.5
2nd assignment	Pasteurization	6	75.0
	Freeze-drying	2	25.0
	Smoking	1	12.5
	Freezing	1	12.5
	Drying	1	12.5
3rd assignment	Modified atmosphere	5	27.8
	Irradiation	4	22.2
	Ultrasound	3	16.7
	Membrane filtration	2	11.1
	Pulsed electric fields	2	11.1
	Hydrostatic pressure	1	5.6
	Ozonation	1	5.6

Individual work 3: New Technologies for Food Preservation

For the individual report students had the chance to choose, from a number of themes about New Technologies for Food Preservation. The 18 individual reports submitted over two academic years deal with: Modified atmosphere, Irradiation, Ultrasound, Hydrostatic pressure, Membrane filtration, Ozonation, and Pulsed electric fields. It can be mentioned that the most popular themes, which were repeated more often were: Modified atmosphere (27.8%), Irradiation (22.2%), and Ultrasound (16.6%). Subjects such as Membrane filtration and Pulsed electric fields were addressed in two different reports, whereas identified as less popular themes, Hydrostatic pressure and Ozonation, were addressed only once over these two academic years.

From the choices of themes, it should be noted that recurrent themes were identified, which may have to do with cultural aspects of the student population or with the accessibility to the information for the assignments' elaboration. The following themes stand out for each assignment: Traditional Methods—Salting and Smoking Preservation Methods; Food Preservation Processes and Techniques—Pasteurization; New Technologies for Food Preservation—Modified Atmosphere and Irradiation.

In general, all students were able to prepare an adequate document with well developed content. Although, there was evidence of the deficient use of a correct scientific language or the incorrect use of measurement units, in many cases.

However, other parameters were used to detected failures and with this information we were able to give feedback to students in order to improve or correct their assignments. The first tool implemented, a preventive one, were the group forums. Using forums the teacher was able to monitor the teamwork progress, and make it possible to closely follow the assignment development. The first identified issue was related to students having resistance to learning the skills associated with collaboration. Teamwork or group work is often

Table 2 Analysis of students' forum posts

Group Type	1st assignment												
	2016 class					2018 class							
	A	B	C	D	Average	A'	B'	C'	D'	Average			
Total Forum posts	31	30	80	60	50.3	54	40	7	6	26.8			
Organizational	16	15	63	46	35.0	37	30	7	6	20.0			
Informative	15	15	17	14	15.3	17	10	0	0	6.8			
Group Type	2nd assignment												
	2016 class						2018 class						
	A	B	C	D	E	F	Average	A'	B'	C'	D'	E'	Average
Total Forum posts	31	11	48	32	42	36	33.3	23	5	4	6	6	8.8
Organizational	20	7	30	20	28	23	21.3	18	5	3	6	2	6.8
Informative	11	4	18	12	14	13	12.0	5	0	1	0	4	2.0

encountered with resistance in the academic environment (García et al. 2016; Brusa 2019). This fact can be observed in the messages exchanged between various groups. However, students do not use these forums in the best way, so the teacher had, during the 1st week, to inform students about the correct use of these forums in order to obtain more information, and exchanging messages between students, where possible. Nowadays, students have at their disposal numerous platforms to communicate with each other (e-mail, sms, messages, WhatsApp, Signal,...) and neglect the use of the forum tool in which teachers may have direct contact and identify the assignment progress. For these reasons, we felt the necessity to analyze the content of forums exchanged messages of each group.

Exchanged messages in forums

Students had at their disposal a forum only visible to each group and teacher. Messages in this forum were analyzed and provided some findings. There was no obvious pattern in the total number of messages. Some groups presented more information than others. However, the groups of the 2016 class exchanged more messages than the groups of the 2018 class. In Table 2 it is evident that the majority of the messages had a merely organizational content and a minority of the messages were informative and content related.

Similarly to the 1st assignment, for the 2nd assignment, all students had at their disposal a forum only visible to each group and the teacher. From the analysis of the number of posted messages in each forum it is possible to notice that, in overall, when working in pairs the students wrote less messages but there is a relative increase in the number of messages for informative purposes such as: Warning of changes of the work-in-progress report, references sharing, texts suggestion in order to complete assignments, etc. There is no obvious pattern in the total number of messages being shared. The B', C', D' and E' groups of the 2018 class did the report individually since their groupmate dropped out of the course which was the cause to have so few messages in the forum. Nevertheless, students were careful to share opinions and questions with the teacher in these restricted forums.

When well used these forums can play a very relevant role in the quality of submitted assignments. One reason is due to the fact that these forums are an open and direct window for discussion within the group and the teacher can follow the discussion and at any time can intervene with relevant information and help to the assignment.

Evaluation of bibliographic references

Another important aspect analyzed relates to the bibliographic references used by the students. In addition to evaluate the development of the subject and novelty, its origin (book, article, Internet sources, web pages, blogs, collaborative blogs, institutional web pages, commercial pages, or other such as conferences) was also analysed. The language of each reference was also classified as Portuguese (students mother tongue) or other language, which is, invariably, English.

From Table 3 it is clear that the four submitted works from the 2016 class, presented a significant number of bibliographical references, between 11 and 28. All groups presented books as bibliographical references and only two groups presented scientific articles as references. The use of Internet sources (web pages) is evident in all four presented works, though, group C presented 9 web links out of 15 references. All groups preferred to use most of the references in Portuguese. Group D presented the highest number of references, 28. Only Groups A and D were careful and included representative state-of-the-art references with less than 2 years. However both groups have a low number of citations.

From the bibliographic references presented, the class of 2018 revealed the same characteristics in the four submitted assignments (Table 3). They presented a number of bibliographical references—between 3 and 16. It is clear that Group C' did not support its work on bibliography by presenting only 3 references. Again, students preferred to present web pages or books as bibliographic support of their work. The use of web pages is evident in all the presented works, though, group B' presented 12 links out of 15 references. The majority of the groups, 3 in 4, preferred to present references in Portuguese; Group B' presented 14 references in Portuguese out of a total of 15. Only Group A' and B' were careful to present representative references (state-of-the-art) with less than 2 years. However, each group presented just a few recent references.

Figure 1 presents the average of the analyzed parameters for the bibliographic references exposed by all 8 submitted reports: on average, each paper presented 14 bibliographical references, 5.3 of which were books or chapters, 1.8 articles, 5.1 Internet pages and 1.1 conferences, posters or presentations. On average, 10.6 references were in Portuguese and only 0.6 were representative of the state-of-the-art of the topic addressed.

For the work of the two-person groups, related to Food Preservation Processes and Techniques, the class of 2016 presented some differences when compared to the previous work. As shown in Table 3, two groups, A and B, presented very limited bibliographical research and essentially based their assignment on Internet pages. Groups C and F had chosen to find scientific articles related to the addressed subject, however they did not present recent papers. In general, there was a continued reliance on using references in their mother tongue.

It is easy to find contents written in Portuguese on the internet, and according to recent estimates, Portuguese is the fifth most used language on the internet, being overtaken only by English, Chinese, Spanish and Arabic (Internet World Stats 2020). Portuguese is usually listed as the sixth most natively spoken language in the world, with approximately 215–220 million native speakers and 250 million total speakers, and the third-most spoken European language

Table 3 Bibliographic references analysis for all assignments

	Group	Total refer- ences	Books	Articles	Internet pages	Others	Reference in Portuguese	State-of-the-art (<2 years)
1st assignment								
2016 class	A	14	4	3	6	1	11	2
	B	11	9	0	2	0	11	0
	C	15	4	0	9	2	14	0
	D	28	8	7	3	5	17	1
	Average	17	6.3	2.5	5.0	2.0	13.3	0.8
2018 class	A'	16	10	3	2	0	9	1
	B'	15	3	0	12	0	14	1
	C'	3	1	1	0	1	0	0
	D'	10	3	0	7	0	9	0
	Average	11	4.3	1.0	5.3	0.3	8.0	0.5
2nd assignment								
2016 class	A	5	0	1	4	0	0	0
	B	4	0	1	1	2	4	0
	C	21	7	6	1	2	15	0
	D	14	2	2	7	1	11	0
	E	15	7	2	5	1	15	0
	F	16	6	6	1	3	7	0
	Average	12.5	3.7	3.0	3.2	1.5	8.7	0
2018 class	A'	14	3	3	4	3	6	2
	B'	13	0	3	10	0	11	0
	C'	5	4	0	0	1	5	0
	D'	8	2	0	6	0	8	0
	E'	3	0	2	1	0	2	1
	Average	8.6	1.8	1.6	4.2	0.8	6.4	0.6
3rd assignment (individual)								
2016 class	A	6	1	0	5	0	5	0
	B	19	6	5	6	2	8	0
	C	6	1	4	1	0	0	1
	D	14	5	1	4	4	9	0
	E	7	2	3	2	0	0	0
	F	10	3	2	3	2	7	0
	G	7	3	3	0	1	4	0
	H	8	4	0	4	0	3	0
	I	1	0	0	1	0	0	0
	J	17	7	9	1	0	2	0
	K	14	0	4	1	9	9	0
	L	4	0	0	4	0	3	0
	Average	9.4	2.7	2.6	2.7	1.5	4.2	0.1

Table 3 (continued)

	Group	Total refer-ences	Books	Articles	Internet pages	Others	Reference in Portuguese	State-of-the-art (<2 years)
2018 class	A'	7	1	2	2	2	1	0
	B'	4	1	0	2	1	3	0
	C'	10	3	2	3	2	7	1
	D'	8	3	2	3	0	4	0
	E'	9	4	4	1	0	3	1
	F'	6	1	4	1	0	1	2
	Average	7.3	2.2	2.3	2.0	0.8	3.2	0.7

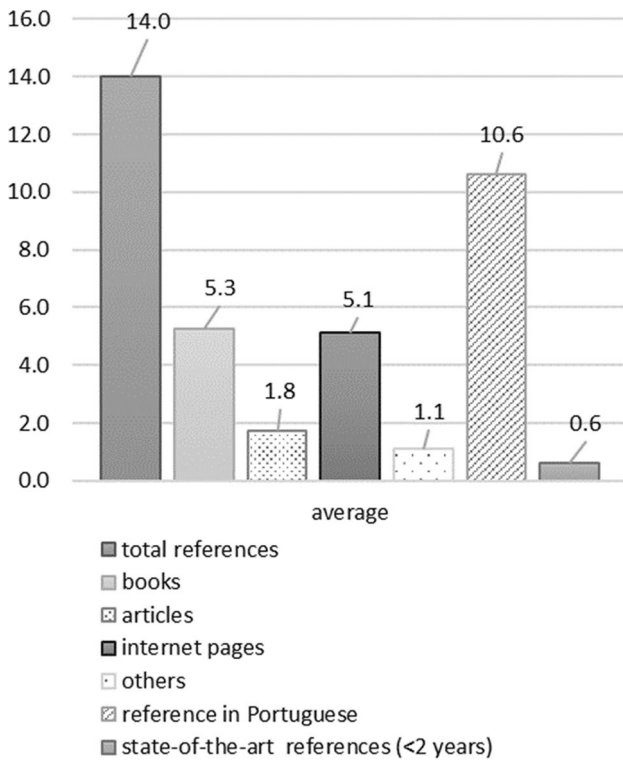
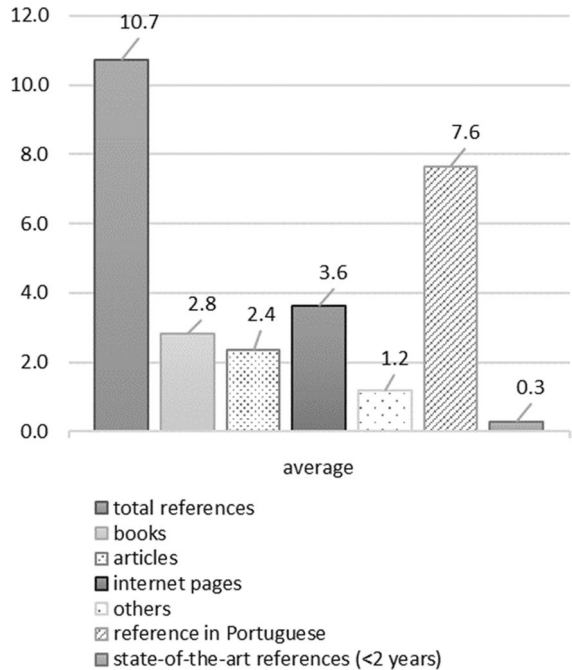


Fig. 1 Bibliographic reference average analysis column charts (1st assignment)

in the world in terms of native speakers (Branco et al. 2012; CIA World Factbook 2020). Most important journals with representative articles are generally written in English, since it is the language adopted by the scientific community, including the Portuguese scientific community. The use of references written in portuguese (the students' mother tongue) reveals the students' difficulties to find or read information in other languages. However, when the student uses

Fig. 2 Bibliographic references average analysis column charts (2nd assignment)



repetitively the use of texts in Portuguese this may indicate plagiarism or paraphrasing without citing authors. A paraphrase is a manner to formulate someone else's text or passage using a new statement and other words. The term itself is derived from Latin *paraphrasis*, which means "additional manner of expression". The more you master a language, the easier it is to paraphrase a sentence, and this may be related to reference choices made by the students. A paraphrase usually explains or clarifies the paraphrased text, and in this context the student is also learning and it can be encouraged.

The references cited in the reports of 2018 class presented the same flaws previously detected and a great dependence on texts written in Portuguese.

Figure 2 presents the average of analyzed parameters for the bibliographic references exposed by all 11 submitted reports: On average, each work presented 10.7 bibliographical references, 2.8 of which were books or chapters, 2.4 articles, 3.6 Internet pages and 1.2 conferences, posters or presentations. On average, 7.6 references were in Portuguese and only 0.3 were representative of state-of-the-art articles concerning the addressed topic. There was a decrease in the number of bibliographic references used in the second work, not related, however, to its quality. It was observed a slight increase in the number of articles consulted and a decrease in the average number of references in the mother tongue.

Taking into account the analysis of the average values referring to the parameters studied in the bibliographic references, it was observed a decrease in the average value of the number of articles reported. Given the average values, there is no clear choice between books, articles or websites, all these parameters presented an average value of 2.5. The ratio Total of references vs mother language decreased to 2.3 for the individual report analysis, while the same ratio had the values of 1.3 and 1.4, for workgroup 1 and workgroup 2, respectively. The increase in the value of this ratio corresponds to a smaller use of references in Portuguese, as a result of the subsequent feedback from the teacher after each report (Fig. 3).

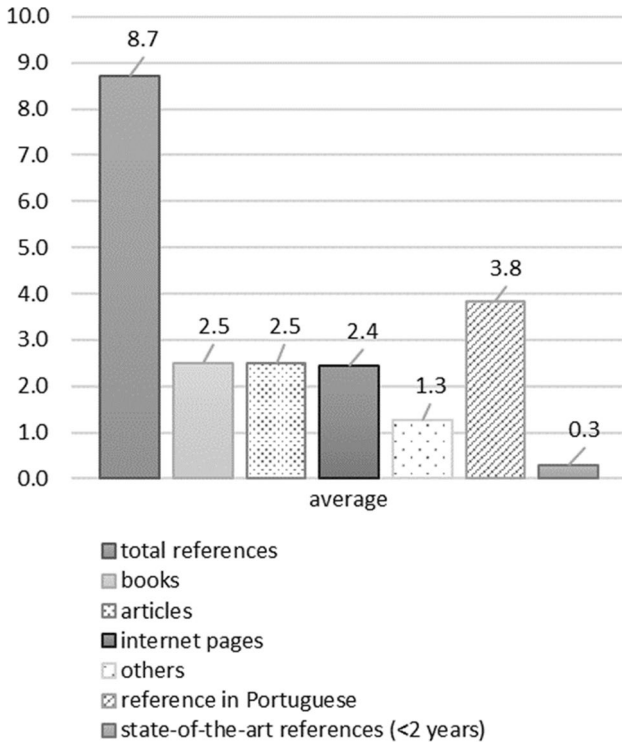


Fig. 3 Bibliographic references average analysis column charts for individual reports (3rd assignment)

Plagiarism analysis

The affirmation of UAb's pedagogical and methodological specificity involves ensuring that students' assessment processes are transparent and rigorous. Certain practices such as plagiarism are unacceptable at UAb, since this university operates predominantly based on digital networks. It is therefore fundamental for the development of the institution, strategically turned to the future, to ensure the correctness of students' procedures and behaviours.¹

The plagiarism software used in this module was Turnitin® Feedback Studio as a Moodle Plagiarism Plug-in. Turnitin® is a commercial web-based text-matching tool which matches a submitted document against current and archived student paper repositories and massive databases of articles, periodicals, journals and other publications. Plagiarism detection tool used provided a Similarity Report that provide a summary of matching or similar text found in the submitted assignment. Within this Similarity Report of Turnitin®, the tutor receives a 'Match Overview' that gives a breakdown of all the matches found on the submitted document and information regarding their origin. Therefore, matches were classified according to their origin: Internet sources, Articles and Student papers. It is also

¹ Despacho n.º 14355/2013, Diário da República, 2.ª série—N.º 215—6 de novembro de 2013, Regulamento Disciplinar, pp. 32,885–32,887.

Table 4 1st assignment plagiarism analysis

		1st assignment				
		Group	Match over-view (%)	Internet sources	Articles	Student papers
2016 class	A		5	4	0	1
	B		23	22	0	1
	C		24	23	0	1
	D		22	14	0	8
	Average (2016)		18.5	15.75	0	2.75
2018 class	A'		11	9	0	2
	B'		36	35	0	1
	C'		1	1	0	0
	D'		18	8	0	10
	Average (2018)		16.5	13.25	0	3.25
Average			17.5	14.5	0	3

important to note that even in cases where the report points a document free of correspondence, it does not necessarily guarantee that the text is plagiarism free. As the software can only assign matches to words, not concepts, the aptitude to paraphrase texts ensures that these forms of plagiarism remain undetected by text-matching software (Mphahlele and McKenna 2019; Al-Thwaib et al. 2020). Nevertheless, when the student is paraphrasing it also shows a critical reflection of his/her interpretation, an analysis, explanation or clarification of the paraphrased text.

For the Similarity analysis of assignments, the titles, names and bibliographic references were not taken into account as plagiarized text, and were not counted as a match. The analysis of the first assignment, Traditional Methods of Food Preservation, revealed that Internet sources were the main source of plagiarism, followed by student available papers. The analysis of the average value of Similarity (Match Overview) for both 2016 and 2018 classes were comparable: Text similarities matches less than 20, 18.5 versus 16.5%, respectively. The class of 2016 presented a standard deviation of 7.8%, while 2018 class had a standard deviation of 12.8%. Curiously, the 2018 class was informed about the use of a web-based text-matching tool and which may be correlated with three submitted assignments with a match overview of less than 20%, and one of these documents had a match overview of 1%. Nevertheless, from this analysis it was observed that two of eight of the submitted assignments presented an originality superior to 80%. A similarity index percentage always gives the impression that the analysis intention is to quantify or indicate the level of plagiarism. (Bretag and Mahmud 2009). Rather than quantify plagiarism, this text-matching tools can help the teacher to track the student's bibliographic or inspirational sources. With this information, the teacher will be able to understand which student has devoted more or less time and effort to the elaboration of their assignment document (Table 4).

Plagiarism analysis of the 2nd work, Food Preservation Processes and Techniques, revealed a related trend from the previous assignment: students used essentially Internet sources or student available papers as main source of plagiarism. From this analysis, the main difference is the greater use of internet available student papers as a source of plagiarism, 10.5 versus 6.3% (Internet sources) (Table 5).

Table 5 2nd assignment plagiarism analysis

		2nd assignment				
		Group	Match Overview (%)	Internet sources	Articles	Student papers
2016 class	A		37	4	0	33
	B		51	17	0	34
	C		15	4	1	10
	D		17	3	1	13
	E		80	12	1	67
	F		4	2	0	2
	Average (2016)		34	7	0.5	26.5
2018 class	A'		33	15	0	18
	B'		8	6	0	2
	C'		18	15	0	3
	D'		2	2	0	0
	E'		1	1	0	0
	Average (2018)		10.3	6.5	0.0	3.8
	Total average		24.2	7.4	0.3	16.5

The average value of Match Overview for the 2016 class was greater when compared to the 2018 class. It decreased from 34.0 to 10.3%. The class of 2016 presented a standard deviation of 28.7%, while 2018 class had a standard deviation of 6.8%. Regarding its originality of all submitted assignments, seven out of eleven presented an originality superior to 80%. Taking a look only to the 2018 class presented, the observed result is even better: three out of five submitted assignments present an originality superior to 92%. Any level of plagiarism is unacceptable, and since the software tool used to analyse students' text-matches in their work documents, we felt the necessity to instruct students that as long as appropriately cited, text-matches of up to 10% would be acceptable.

The analysis of the individual assignments on the subject New Technologies for Food Preservation (Table 6), revealed a plagiarism decrease from 2016 to 2018 class. The average value of plagiarism went from 33 to 17%. The class of 2016 presented a standard deviation of 29, while the class of 2018 had a standard deviation of 17, which is probably indicating that there are more students understanding the importance of not to copy content from elsewhere. It is still a concern that students continued plagiarize using other students' contents available at document repositories. The lack of criticism on content copied from Internet sources continues to be a major concern, especially since all the analysed texts were written in the students' mother language. Regarding originality superior to 80%, it was observed nine of eighteen submitted assignments, revealing that 50% of the individual assignments were probably more concerned with plagiarism.

In 2016, four from the twelve assignments presented match overviews of over 50%. In the year 2018, only one assignment was detected with a match overview above 50%, reflecting on submitted works with greater originality.

Most common plagiarisms detected in analyzed reports were related to:

Table 6 3rd assignment (Individual) plagiarism analysis

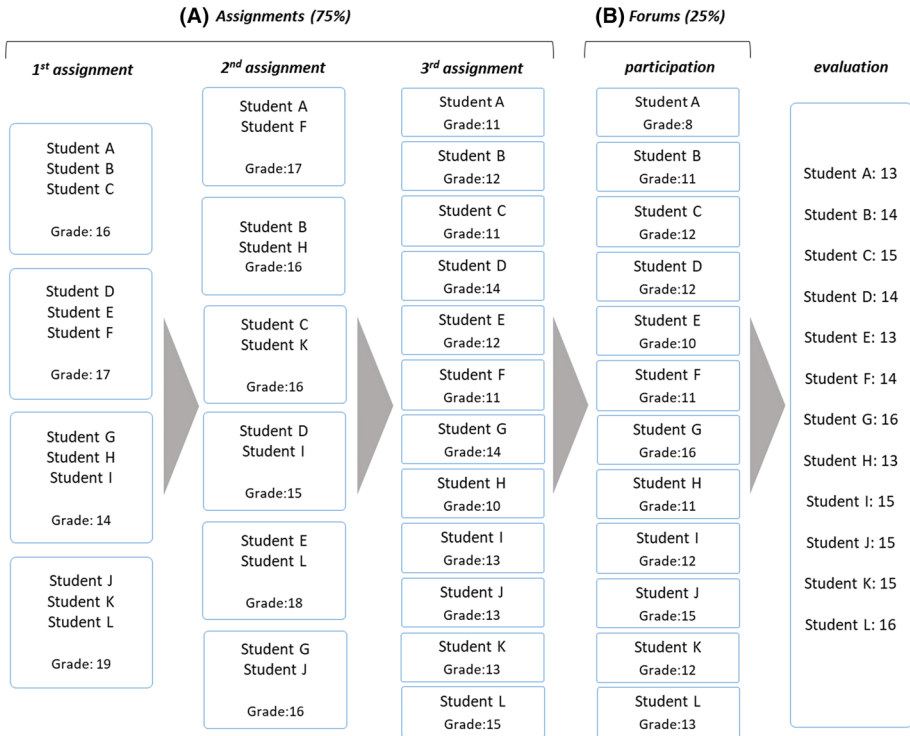
		3rd assignment				
		Student	Match Over-view (%)	Internet sources	Articles	Student papers
2016 class	A	13	8	0	5	
	B	52	2	1	49	
	C	1	0	1	0	
	D	77	69	0	8	
	E	7	1	0	6	
	F	26	19	0	7	
	G	44	15	2	27	
	H	53	49	0	4	
	I	0	0	0	0	
	J	90	18	9	63	
	K	24	11	2	11	
	L	9	4	1	4	
	Average (2016)		33.0	16.3	1.3	15.3
2018 class	A'	8	0	2	6	
	B'	23	14	0	9	
	C'	6	6	0	0	
	D'	51	14	0	37	
	E'	13	12	0	1	
	F'	1	1	0	0	
	Average (2018)		17.0	7.8	0.3	8.8
	Average		27.67	13.50	1.00	13.17

1. Cyber plagiarism (copy of part of students' papers and ideas from the internet);
2. Image plagiarism (use of an image without providing permission);
3. Paraphrasing (restatement with own words or changing a few words of original sentences).

There are other plagiarism detection tools available on-line as free web-based text-matching tool that teachers/tutors can use, such as: Dupli Checker, Copyleaks, Plagiarism Checker, Plagiarism Detector, PaperRater, Plagiarisma, Plagium, PlagScan, PlagTracker, Quetext, Viper.

The evaluation techniques and implemented evaluated parameters

One of the techniques implemented in this module was the difference in the group constitution for the three different assignments: two teamwork, the first with 3 elements, the second in pairs and the last an individual assignment. The members of the groups were never repeated giving to the students the possibility to work with different colleagues and finally to submit their own work. Through this method, the final grades of each student are differentiated and the authors believe this can reflect their commitment in a better way, individually or in groups. Two team works against one individual work



Scheme 1 Final evaluation with two parameters: (a) Three assignments to differentiate students evaluation (75%) and (b) Forum participation (debates + group forums) and Surprise Quiz

$$Evaluation = \left(0.75 \times \frac{1^{st} \text{ assign.} + 2^{nd} \text{ assign.} + 3^{rd} \text{ assign.}}{3} \right) + (0.25 \times \text{Forum Participation})$$

Scheme 2 Formula for evaluation calculus

attempt to better mimic a typical day-to-day work scenario, as many jobs involve team-work. Thus, three students who worked together in the first assignment will not share the same teams in the subsequent assignments and will probably have more independent and distinguished grades.

The final evaluation is the result of two other measurable factors. The first parameter (A) refers to the three submitted assignments, with a value of 75% of the final grade. The second parameter (B) with a value of 25% of the final grade is relative to the students' participation in forums and in a surprise quiz. The participation included: (a) participation in discussions developing personal comments, identification of fundamental ideas associated with the subject content, (b) contribution to interventions aimed at deepening the discussion, (c) justification of their own points of view based on consulted bibliography, (d) pertinent questions that allow subject discussion (Schemes 1 and 2).

A bibliographic search can be an important source of information and can indicate whether the student has done well to elaborate his assignment. For this parameter, scientific

articles are valued, recent articles that represent the state-of-the-art, as well as the use of books and the number of references. Although Internet sources and students' thesis can be translated as deficient bibliographic research and smaller quotations can be attributed.

Overall, assignment contents, besides meeting the intended purposes, were complete, and based on available contents. However, occasionally incorrect use of the scientific terminology was detected, or even a lack of consistency. One of the major problems identified related to the fact that students did not express their point of view, or their own ideas. This feedback was given to students after each work.

Similarly to other courses and scientific areas, where several online strategies have been adopted to achieve the best results with the students to increase their scientific knowledge (Oliveira and Caetano 2018) and also based on the work presented in this article, the following ideas and complements are suggested to improve this curricular module and to improve the less positive aspects detected:

1. Introduction of a new document similar to a scientific report structure;
2. Instruct how to carry out an accurate bibliographical research and emphasize its vital importance in a research work;
3. Introduction of an additional task, prior to the first assignment, in which students will have to make a bibliographic search to support a provided text with references;
4. To provide tools to raise students' awareness of the veracity of information obtained on the Internet—a new task will be given to them during the first assignment. In this additional task students should identify as wrong or correct some given texts taken from the Internet and articles sources related to the Topic 2 theme: Traditional Food Preservation Methods;
5. Solely the number of used references must not evaluate the quality of a student's work; however, students should be taught to support their written statements. The lack of bibliographic references justifies the introduction of a primer task to the first assignment requiring state-of-the-art references association and a minimum number of references from scientific articles. In the follow-up of the bibliographic identified issues, there should be a limit the use of some Internet sources besides scientific publications (e.g. blogs, collaborative blogs, commercial pages, web pages, etc....);
6. The application of a penalty, seems a successful way to help to prevent plagiarism. It should always be used in the next editions, as well at any similar courses with analogous evaluation patterns. In addition, articles on plagiarism should be shared in order to increase consciousness about plagiarism and ethical issues among our students.

Conclusions

This study identified a pattern of problems related to students' assignments, which can permit teachers to distinguish the grade given when considering quite similar submitted documents. From the analysis of these reports, along previous two editions of the Food Preservation Technology module, it was possible to suggest additional texts and students' tasks in order to improve scientific criteria and reduce identified systematic errors, such as: proper use of search engines, criteria to choose bibliographic references, inappropriate use of scientific notification or measurement units, and plagiarism.

In the case of a master degree course, such as the one reported herein, students were expected to look for recent references and whenever possible these should be scientific articles. The constant use of written references in Portuguese shows a poor preparation of students for English language, and may be considered a problem since English language is the most commonly used in ISI indexed scientific journals. Even most Portuguese speaking researchers publish their work in international journals, therefore in English, as it is the main communicating language for scientific research. The fact that some students chose to use mainly Portuguese publications as references for their assignments may mean that: (1) they may have difficulties with the English language which makes it harder to understand concepts; (2) using their native language (Portuguese) the students are able to conclude their assignments more quickly and within the scheduled time. The analysis of the bibliographic references presented in the students' works can also provide information about the assignment preparation and, as discussed, can be used to differentiate grades between works.

To improve students' scientific knowledge on how to correctly use the bibliographic resources and identify weaknesses of the analysed assignments during the last two editions of Food Preservation Technology module, the use of text-matching software increased students' awareness and make them more cautious regarding the veracity of the information obtained on the Internet. Improving the bibliographic search skills by using the adequate search engines will certainly reflect in students producing better reports and enhanced preparation for the upcoming research task in their master course. Plagiarism detection is a very informative tool that can provide accurate information about the originality of the work, and this information can be taken into account when evaluating the students.

To differentiate students' evaluation, three assignments tasks were requested with different typologies: (1) teamwork (three elements), (2) teamwork in pairs, and (3) an individual assignment. In these working groups, the group members are never repeated, thus allowing a more fair and accurate final grade for each student.

We also believe that although this article referred to a particular example of subject (i.e., Food Preservation Technology) and the respective student assignment tasks, it can be related effectively to other subjects, like the course of food chemistry and biochemistry, which students have to enrol in this master. In fact, all the suggestions presented herein can be applied to all the other master curricular units with similar evaluation criteria.

Despite many of these problems found in the submitted works, we believe that these free exploration challenges/problems of the assignments were very important for students' self-learning, thus also contributing to an increase of their scientific knowledge and preparation to complete their studies within the chosen master's program at Universidade Aberta.

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Authors' contributions TAF conceived and conceptualized the study with FJPC. Both authors participated in the project data gathering, analysis, manuscript preparation and revision. All authors have approved the manuscript for submission.

Availability of data and materials All data generated or analyzed during this study are included in this published article and its supplementary information files.

Compliance with ethical standards

Conflict of interest The authors declare that they have no competing interests.

Ethical approval All procedures involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

References

- Acosta, O., Gao, X., Sullivan, E. K., & Padilla-Zakour, O. I. (2014). Pickled egg production: Effect of brine acetic acid concentration and packing conditions on acidification rate. *Journal of Food Protection*, 77(5), 788–795. <https://doi.org/10.4315/0362-028X.JFP-13-362>.
- Al-Thwaib, E., Hammo, B. H., & Yagi, S. (2020). An academic Arabic corpus for plagiarism detection: Design, construction and experimentation. *International Journal of Educational Technology in Higher Education*, 17, 1. <https://doi.org/10.1186/s41239-019-0174-x>.
- Amador, F., Martinho, A. P., Bacelar-Nicolau, P., Caeiro, S., & Oliveira, C. P. (2015). Education for sustainable development in higher education: evaluating coherence between theory and praxis. *Assessment and Evaluation in Higher Education*, 40(6), 867–882. <https://doi.org/10.1080/02602938.2015.1054783>.
- Azeiteiro, U. M., Bacelar-Nicolau, P., Caetano, F. J. P., & Caeiro, S. (2015). Education for sustainable development through e-learning in higher education: Experiences from Portugal. *Journal of Cleaner Production*. <https://doi.org/10.1016/j.jclepro.2014.11.056>.
- Bourdoux, S., Li, D., Rajkovic, A., Devlieghere, F., & Uyttendaele, M. (2016). Performance of drying technologies to ensure microbial safety of dried fruits and vegetables. *Comprehensive Reviews in Food Science and Food Safety*, 15, 1056–1066. <https://doi.org/10.1111/1541-4337.12224>.
- Branco, A., Mendes, A., Pereira, S., Henriques, P., Pellegrini, T., Meinedo, H., Trancoso, I., Quaresma, P., Strube de Lima, V.L., & Bacelar, F. (2012). *A língua portuguesa na era digital—The portuguese language in the digital age, META-NET white paper series*. G. Rehm, & H. Uszkoreit (Series Eds.), ISBN: 978-3-642-29592-8, Springer. Retrieved from <http://www.meta-net.eu/whitepapers>.
- Bretag, T., & Mahmud, S. (2009). A model for determining student plagiarism: Electronic detection and academic judgment. *Journal of University Teaching and Learning Practice*, 6(1), 49–60. Retrieved from <https://eric.ed.gov/?id=EJ867296>.
- Brusa, J. L. (2019). An experiential-learning lesson to encourage teamwork and healthy practices. *Journal of Microbiology and Biology Education*. <https://doi.org/10.1128/jmbe.v20i2.1668>.
- Caetano, F. J. P., Oliveira, C. M. B. P., Araújo, M. F. F., & Rêgo, M. C. F. D. (2018). *Towards climate change awareness through distance learning—Are young portuguese and brazilian university students vigilant?* (pp. 261–273). https://doi.org/10.1007/978-3-319-70199-8_15.
- CIA World Factbook, Internet, 26/03/2020. <https://www.cia.gov/library/publications/the-world-factbook/geos/xx.html>.
- García, M. G., López, C. B., Molina, E. C., Casas, E. E., & Morales, Y. A. R. (2016). Development and evaluation of the team work skill in university contexts. Are virtual environments effective?. *International Journal of Educational Technology in Higher Education*. <https://doi.org/10.1186/s41239-016-0014-1>.
- Gottardi, D., Bukvicki, D., Prasad, S., & Tyagi, A. K. (2016). Beneficial effects of spices in food preservation and safety. *Frontiers in Microbiology*, 7, 1394. <https://doi.org/10.3389/fmicb.2016.01394>.
- Grumezescu, A., & Holban, A.M. (2019). *Preservatives and preservation approaches in beverages: Volume 15: The science of beverages*. Academic Press, ISBN: 9780128166857.
- Hughenholz, J. (2013). Traditional biotechnology for new foods and beverages. *Current Opinion in Biotechnology*, 24(2), 155–159. <https://doi.org/10.1016/j.copbio.2013.01.001>.
- Internet World Stats, Internet world users by language—Top 10 languages. Internet, 26/03/2020. <https://www.internetworldstats.com/stats7.htm>.
- Jessica Elizabeth, D. L. T., Gassara, F., Kouassi, A. P., Brar, S. K., & Belkacemi, K. (2015). Spice use in food: Properties and benefits. *Critical Reviews in Food Science and Nutrition*, 57(6), 1078–1088. <https://doi.org/10.1080/10408398.2013.858235>.
- Leistner, L. (2000). Basic aspects of food preservation by hurdle technology. *International Journal of Food Microbiology*, 55, 181–186. Retrieved from <http://envismadrasuniv.org/Physiology/pdf/Basicaspectsoffoodpreservation.pdf>.
- Martínez-Graciá, C., González-Bermúdez, C. A., Cabellero-Valcárcel, A. M., Santaella-Pascual, M., & Frontela-Saseta, C. (2015). Use of herbs and spices for food preservation: Advantages and limitations. *Current Opinion in Food Science*, 6, 38–43. <https://doi.org/10.1016/j.cofs.2015.11.011>.

- Miranda, R., & Teixeira, A. (2006). Capítulo 8 • Qualidade No Ensino a Distância. *IAM L3: Getting Started with Open and Distance Learning* (pp. 93–99). Retrieved from https://repositorioaberto.uab.pt/bitstream/10400.2/461/4/Capitulo8_IAML3.pdf.
- Mphahlele, A., & McKenna, S. (2019). The use of turnitin in the higher education sector: Decoding the myth. *Assessment and Evaluation in Higher Education*, 44(7), 1079–1089. <https://doi.org/10.1080/02602938.2019.1573971>.
- Nummer, B. A. (2002). *Historical origins of food preservation*. Retrieved May 5, 2019, from National Center for Home Food Preservation website. https://nchfp.uga.edu/publications/nchfp/factsheets/food_pres_hist.html.
- Oliveira, C. M. B. P., & Caetano, F. J. P. (2018). Desafiando o Paradigma do Ensino da Química: o contributo da Universidade Aberta de Portugal. *Revista Pesquisa e Debate Em Educação [RPDE], Dossier Ensino de Ciências Da Natureza e Matemática*, 8(2), 275–291. Retrieved from <http://www.revistappg.p.caedufj.net/index.php/revista1/article/view/245>.
- Oliveira, T., & Morgado, L. (2012). Aprendizagem Colaborativa nos Fóruns online—Estudo de Caso no Ensino Superior. *Conferência Online de Informática Educacional* (p. 45). Retrieved from https://repositorioaberto.uab.pt/bitstream/10400.2/3436/1/toliveira_linamorgado_COIEDebook.pdf.
- Pereira, A., Morgado, L., Caeiro, S., & Martinho, A. P. (2012). Quality assurance in higher education in Europe. In G. Ubacchs (Ed.), *NetCu handbook: Guidelines for organising networked curricula* (pp. 99–107). Retrieved from <http://hdl.handle.net/10400.2/6937>.
- Pereira, A., Quintas-Mendes, A., Morgado, L., Amante, L., & Bidarra, J. (2007). *Modelo Pedagógico Virtual da Universidade Aberta; Para uma Universidade do Futuro*, Universidade Aberta (pp. 1–112). Retrieved from <https://repositorioaberto.uab.pt/bitstream/10400.2/1295/1/ModeloPedagogicoVirtual.pdf>.
- Rodríguez-Gómez, G., & Ibarra-Sáiz, M. S. (2015). *Assessment as learning and empowerment: Towards sustainable learning in higher education*. https://doi.org/10.1007/978-3-319-10804-9_1.
- Terefe, N. S. (2016). Food fermentation. *Reference Module in Food Science*. <https://doi.org/10.1016/b978-0-08-100596-5.03420-x>.
- Vaz-Fernandes, P., & Caeiro, S. (2019). Students' perceptions of a food safety and quality e-learning course: A CASE study for a MSC in food consumption. *International Journal of Educational Technology in Higher Education*. <https://doi.org/10.1186/s41239-019-0168-8>.
- Woods, L. (2003). *Smoked foods—Principles, encyclopedia of food sciences and nutrition* (pp. 5296–5301). <https://doi.org/10.1016/b0-12-227055-x/01093-2>.
- Yadav, A. K., & Singh, S. V. (2012). Osmotic dehydration of fruits and vegetables: A review. *Journal of Food Science and Technology*, 51(9), 1654–1673. <https://doi.org/10.1007/s13197-012-0659-2>.

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Affiliations

Tiago A. Fernandes^{1,2,3}  · Fernando J. P. Caetano^{2,3}

✉ Tiago A. Fernandes
tiago.a.fernandes@tecnico.ulisboa.pt; tafernandes@fc.ul.pt

Fernando J. P. Caetano
fernando.caetano@uab.pt

¹ Departamento de Química e Bioquímica, Faculdade de Ciências, Universidade de Lisboa, Campo Grande, 1749-016 Lisbon, Portugal

² Centro de Química Estrutural, Instituto Superior Técnico, Universidade de Lisboa, Av. Rovisco Pais, 1049-001 Lisbon, Portugal

³ Departamento de Ciências e Tecnologia, Universidade Aberta, Rua da Escola Politécnica, 141-147, 1269-001 Lisbon, Portugal