International Conference on Research in Education and Science
www.icres.net May 18-21, 2023 Cappadocia, Turkiye www.istes.org

Professional Training in the Beekeeping Sector: Characterization and Identification of Needs

Raquel P. F. Guiné
CERNAS Research Centre, Polytechnic Institute of Viseu, Portugal,
https://orcid.org/0000-0003-0595-6805

Cristina A. Costa
CERNAS Research Centre, Polytechnic Institute of Viseu, Portugal,
https://orcid.org/ 0000-0001-8625-2206

Abstract: The beekeeping sector is demanding, requires knowledge and updated information to be able to deal with the challenges related with climate change, food scarcity, stress, pollution, and other harmful effects from the surrounding environment. Hence, this work intended to make a characterization of the needs in professional training in the beekeeping sector and how these needs can be fulfilled through courses and other actions to help beekeepers to maintain updated. The work was carried out in seven European countries (Croatia, Estonia, Finland, Italy, Norway, Portugal, Spain, Total), and the data was collected through a questionnaire survey, translated into the native languages in all the participating countries. The results revealed that the topics of highest interest for the beekeepers were apiary health and pest control and also colony management throughout the year. The most relevant sources of information were family and professional training/courses. The most valued forms of training were in-person and in workplace/internships, although the digital supporting resources were preferred instead of printed material. The learning materials most valued were videos but also books/paper manuals were considered relevant. The field visits were also greatly appreciated by the participants, and the most preferred assessment format was the realization of practical exercises. In conclusion, this work produced valuable information that can be utilized to design training actions and courses to the professionals in the beekeeping sector to enhance their knowledge and better prepare them to manage successfully their activities.

Keywords: Distance learning, mobile-learning, professional learning, beekeeping, survey.

Citation: Guiné, R. P. F., & Costa, C. A. (2023). Professional Training in the Beekeeping Sector: Characterization and Identification of Needs. In M. Koc, O. T. Ozturk & M. L. Ciddi (Eds.), *Proceedings of ICEMST 2023-- International Conference on Education in Mathematics, Science and Technology* (pp. 905-921), Cappadocia, Turkiye. ISTES Organization.

Introduction

The capacity of the human brain to learn and accumulate knowledge from a wide amount of information

considered relevant is enormous. It is the synaptic plasticity of the brain that enables it to learn new representations as well as to eliminate previously learned information, constituting a foundation for shaping memory and learning that culminates in the Lifelong Learning (LL) process (Abbott & Nelson, 2000; Gryshchuk et al., 2022; Parisi et al., 2019). LL encompasses different analytic perspectives as such: the social organization of learning and individual learning. These, indicate the way past definitional concerns related with formal, non-formal and informal learning. The recognition of learning outcomes must be modern and consider eventually contrasting viewpoints, namely in the European context as well as from the global viewpoint (Evans & Kersh, 2023).

Present trends seem to indicate that the time for distinguishing learning according to formality of context is outdated. Although this approach has been very relevant in the past to overcome obstacles in the early development of LL systems, in the present society and in view of the novel trends and challenges is now seen as archaic, and the multi-faceted LL requires novel approaches in changing learning environments and social practice beyond initial schooling (Evans & Kersh, 2023). According to Baker et al. (2023), the challenge of LL is to enabling a system to learn and retain knowledge regarding a multiplicity of tasks during its operational lifetime.

Professional training (PT) encompasses the process of building knowledge, skills and competences either being on individual persons or in a group or team. Controlling knowledge is vital to realize that knowledge brings empowerment, which is the basis for meeting existing and future demands and challenges. Technological developments, educational innovative methodologies and modern learning are on the path from using technology to increase knowledge (Ekúndayò & Tuluri, 2011). The development of human competences through training promotes quality, efficiency, and effectiveness and at the same time motivates the professionals, leading to make a commitment with increasing productivity (Segret, 2009). Effective training improves not only knowledge and skills but also attitudes and resilience (Bhavsar-Burke et al., 2022).

The project beeB - Foster for beekeeping bridges through innovative and participative training, was approved by the European Union with Reference no. 2019-1-PT01-KA202-060782, and intends to give a contribution for the technical training to beekeepers and other intervening agents in the beekeeping sector, as well as to provide adequate tools in contexts of mobile-learning (m-learning), to improve the capacity of beekeepers to successfully manage their businesses. The project team includes six partners from different Europeans countries, and it encompasses identification of needs and development of training opportunities, facilitating the beekeepers to access courses, learning platforms and contents on a distance learning basis. In this context, the aim of this work was to undertake a survey using a questionnaire to gather information about the beekeeping activity, past experience in professional training in the context of mobile learning, and most valued forms of training in different countries. These elements will bring valuable information to design courses and other learning tools to make easily available to use by all those interested in beekeeping sector, to improve their knowledge and skills.

Materials and Methods

Instrument for Data Collection

For this survey a questionnaire was used, because it constitutes an advantageous way to collect data related to social behaviors. The questionnaire was firstly prepared in Portuguese and then it was translated into the languages of the participating countries and applied to people in each of the countries of the study (Croatia, Estonia, Finland, Italy, Norway, Portugal and Spain).

Sampling Procedure

The sample was obtained from all the potential people of interest in the different countries participating in the research. The target group was composed of people who engage in activities related to the beekeeping sector, either professionally or as a complement to their other main occupation or means of livelihood. The questionnaires were delivered in person but also complemented with some responded through internet. The participation of the respondents was voluntary and in the end 313 consented valid questionnaires were obtained, distributed by the different countries as: Croatia (n = 64), Estonia (n = 44), Finland (n = 15), Italy (n = 16), Norway (n = 74), Portugal (n = 48), and Spain (n = 52).

Results

Sample Characterization

The sample consisted of people aged between 17 and 82 years old, being on average 48±13 years. The mean value for age was higher in Norway (55±12 years) and lower in Italy (41±12 years). Most of the participants in the study were male (73.8%), with a lower percentage of women (23.3%), and some participants did not answer this question (2.9%). The country where the highest percentage of women was registered was Estonia (where 35.7% of the participants were female), while in Spain the lowest percentage of women was encountered (only 10.0%). With respect to education level, 58.5% have a university degree, 35.1% have secondary school, and only 3.2% had a very low level of education (basic education). There were still 3.2% of participants who did not indicate their level of education.

It was in Norway that the highest level of education was predominant, with the highest percentage of participants having a university degree (81.9%), while in Spain the lowest percentage of participants with university degree was found (42.0%). Regarding the type of activity that the participants have in the beekeeping sector, Table 1 shows the distribution for each country, considering that some of the participants indicated more than one of the activities and some other did not indicate any of these three possibilities.

Table 1. Beekeeping activities of the participants in the study according to country.

Activity	Croatia (n = 64)	Estonia (n = 44)	Finland (n = 15)	Italy (n = 16)	Norway (n = 74)	Portugal (n = 48)	Spain (n = 52)	Total (n = 313)
Beekeeper	28	43	14	12	74	46	44	261
Technician	23	5	2	2	1	4	2	39
Merchant	13	5	1	1	1	3	0	24
Total	64	53	17	15	76	53	46	313

Identification of Training Needs

The participants were asked to identity from a list provided, which subjects they considered of higher and of lower interest in the context of training in the beekeeping sector, using a scale from 1 (very low interest) to 5 (very high interest). The results obtained are presented in Table 2, for the global sample. The subjects classified with the highest score by more participants are "Apiary health and pest control" (54.6% gave score 5), followed by "Colony management throughout the year" (42.0% gave score 5) and in third came "Reproductive management/Queens production" (37.1% of score 5). The subjects that were considered by more participants as not of interest were "Beehive production" (considered by 20.8% of participants as very low interest – score 1), followed by "Organic production mode" (17.4% of score 1).

Table 2. Level of interest in training subjects in beekeeping (N = 313).

Subject	→ Increasing Level of Interest →				
	1 (%)	2 (%)	3 (%)	4 (%)	5 (%)
Bee biology	10.8	12.9	20.4	25.4	30.5
Beehive production	20.8	15.2	19.0	18.3	26.6
Apiary health and pest control	4.3	6.0	9.3	25.8	54.6
Organic production mode	17.4	21.8	18.1	14.3	28.3
Meliferous flora	4.8	11.7	22.3	27.1	34.0
Apiary Installation	10.5	17.9	24.2	26.7	20.7
Colony management throughout the year	5.4	8.8	14.2	29.5	42.0
Production of bee products other than honey	9.8	12.7	19.6	22.8	35.1
Food management	8.8	14.6	19.3	27.1	30.2
Reproductive management/Queens production	7.6	12.7	13.7	28.9	37.1
Hygiene, health and safety at work in beekeeping	4.8	12.8	27.7	21.8	32.9
Legislation	8.9	12.3	27.1	28.4	23.3
Business skills	13.9	14.5	22.3	21.6	27.7

Considering the lowest score (1: very low interest) and the highest score (5: very high interest), Figure 1 shows the distribution according to country for all the subjects included in the questionnaire. The results for the lowest interest indicate that, for example, “Business skills” are not considered of interest for a great number of Spanish participants while “Beehive production” is not particularly relevant for Croatian participants. With respect to the highest interest, it was verified that a high number of participants in all countries consider “Apiary health and pest control” as very relevant, particularly for participants from Croatia, Norway and Portugal. Also “Colony management throughout the year” appears as very relevant for participants from most countries, in particular the same countries as before, Croatia, Norway and Portugal.

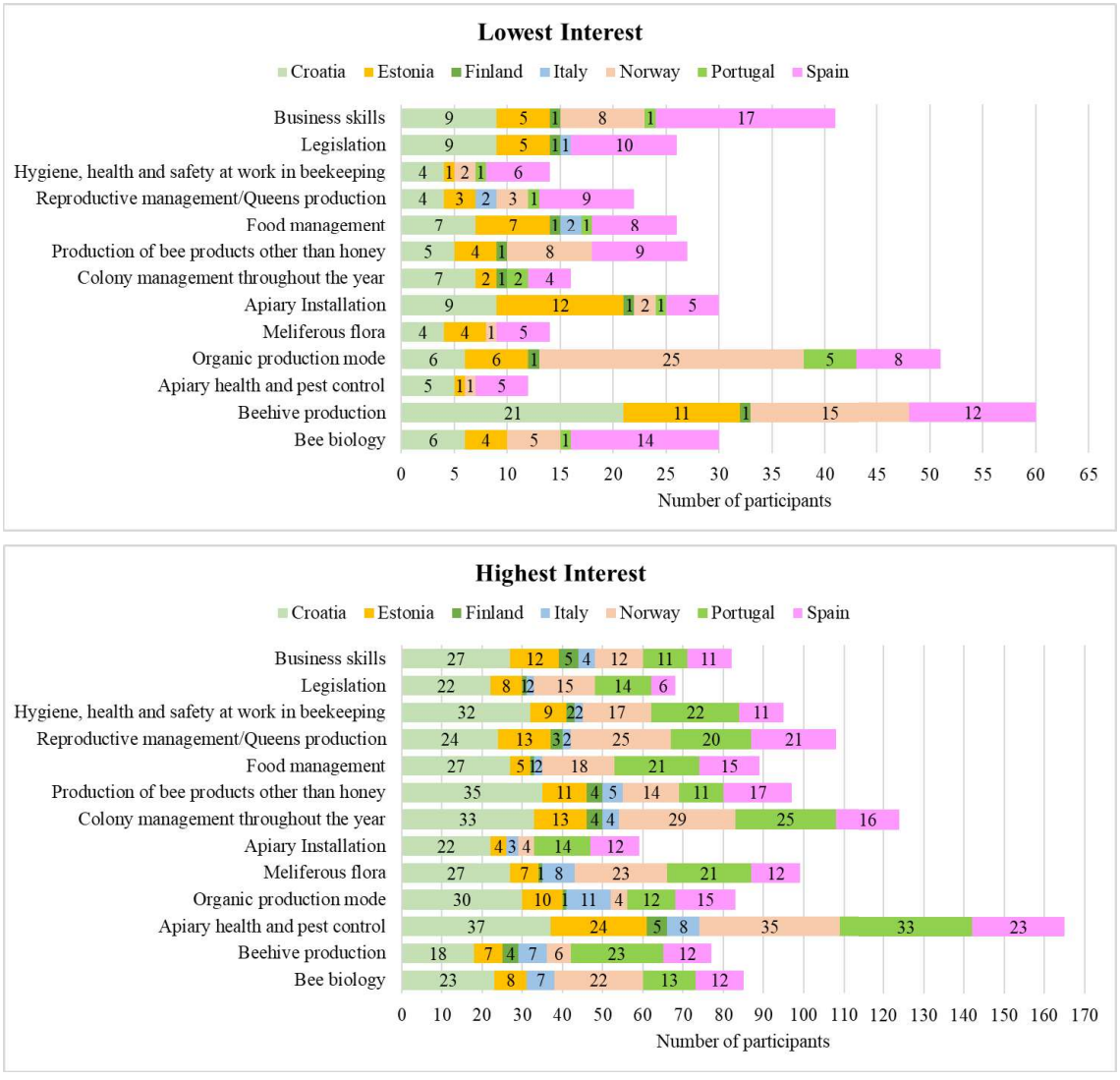

Figure 1. Subjects of lowest and highest interest in beekeeping professional training according to country.

The participants were asked to rate different sources from where they acquire their knowledge, according to their importance, being the results presented in Table 3 for the global sample. All sources were classified by a

high number of participants as most important, with percentages varying from a minimum of 65.5% for "Books" to a maximum of 87.5% for "Family". The source which showed a highest percentage of participants classifying it as least important was seminars with 22.6%. Still, the percentage of participants classifying as most important was very high also (67.7%).

Table 3. Sources of information (N = 313).

Sources	Importance		
	Least important (%)	Important (%)	Most Important (%)
Family	6.9	5.6	87.5
Other beekeepers	8.7	21.3	69.9
Professional Training/Courses	12.0	13.2	74.9
Books	17.9	16.7	65.5
Seminars	22.6	9.7	67.7
Internet	21.2	11.0	67.8
Others	9.1	18.2	72.7

Figure 2 shows the classification of different sources as most important, according to country. The results indicate that 40 participants from Croatia rated as most important the "Other Beekeepers". This option was also chosen by 29 participants from Portugal and equal number from Spain.

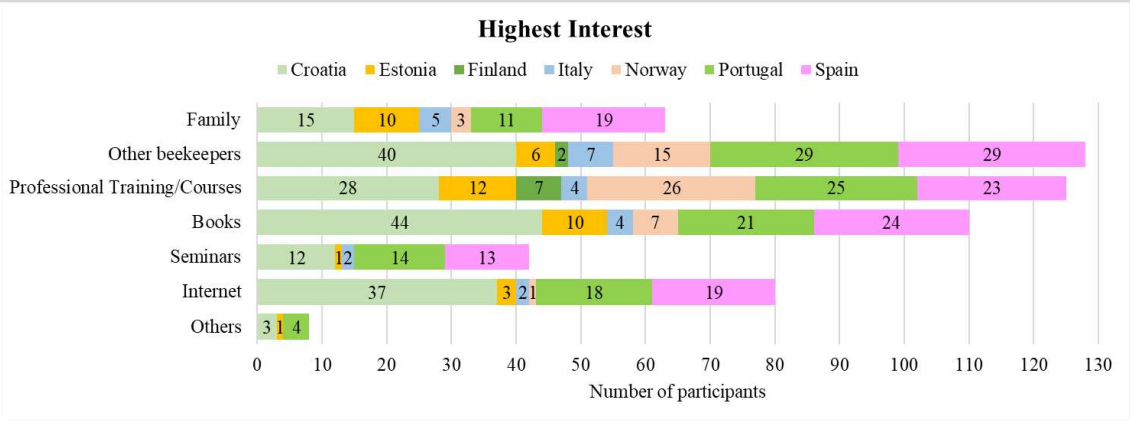

Figure 2. Sources of information of highest interest according to country.

One other aspect that was investigated related to the identification of the difficulties that the professionals experience in their beekeeping activities. The participants were asked to classify on a scale from 1 (most important) to 6 (least important) a set of possibilities presented to them, being the results reported in Table 4, for the whole sample. The difficulties scored with 1, the most important, were mainly "Market issues" (indicated by 28.7% of the participants) and "Access to land to install apiaries" (for 20.3% of the participants). The weight of

the materials was not considered most important by many participants (only 13.0% sored 1).

Table 4. Level of importance of difficulties encountered by beekeepers (N = 313).

Difficulties	→ Deceasing Importance →					
	1 (%)	2 (%)	3 (%)	4 (%)	5 (%)	6 (%)
Weight of materials	13.0	23.3	19.3	16.6	15.7	12.1
Hard hand work	18.8	22.2	23.9	16.7	9.8	8.5
Access to land to install apiaries	20.3	11.9	20.3	14.9	20.3	12.4
Market issues	28.7	11.5	16.7	17.2	15.5	10.3
Time consumed in management activities	18.1	26.1	19.7	14.7	16.4	5.0
Others	35.3	15.7	12.7	6.9	5.9	12.5

Figure 3 shows the major difficulties that beekeepers have to deal with in the course of their activity, according to country. For example, “Market issues” were considered of major importance by 19 participants from Estonia, but none from Croatia and only two from Spain. On the other hand, “Hard hand work” and “Access to land and apiaries” were classified as being of great importance by a high number of participants from Croatia (10 and 11, respectively), Norway (14 and 13, respectively) and from Spain (8 and 10, respectively).

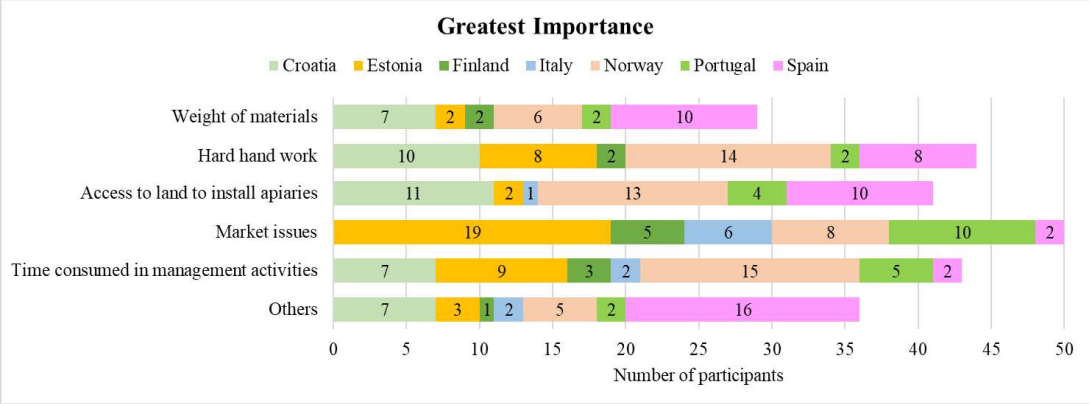

Figure 3. Major difficulties experienced by beekeepers, according to country.

Experience in Training Activities

Most of the participants in the study had already participated in training activities in the beekeeping area (78.6%), corresponding to 58.3% of the Croatian participants, 83.3% of Estonian, 80.0% of Finish, 68.8% of Italians, 93.2% of Norwegian, 91.7% of Portuguese and 68.0% of Spanish participants. Considering the whole sample, 178 participants had participated in training activities as trainee, and 109 had participated as trainer/coordinator. As for the distribution between countries, that is presented in Table 5.

Table 5. Role of the participants in training activities, by country.

Activity	Croatia	Estonia	Finland	Italy	Norway	Portugal	Spain	Total
As trainee	32	33	5	11	60	10	27	178
As trainer/coordinator	8	12	11	1	24	44	9	109

The participants were also asked to identity from a list presented to them, which training mode they considered of least and most interest, using a scale from 1 (very low interest) to 5 (very high interest). The results obtained are presented in Table 6, considering the whole sample. The modes most valued by the participants were "In person" (45.5% scored 5, the highest level of interest) and "In workplace/Internship" (43.3% scored 5). Still, also the "Mixed" and "Distance" modes had some preferences (24.2% and 17.5% of score 5, respectively)

Table 6. Level of interest about different training modes (N = 313).

Training mode	→ Increasing Level of Interest →				
	1 (%)	2 (%)	3 (%)	4 (%)	5 (%)
In person	5.7	7.7	19.1	22.0	45.5
At distance	11.1	26.5	25.6	19.2	17.5
Mixed	3.0	11.9	27.5	33.5	24.2
In workplace/Internship	10.6	9.4	16.6	20.0	43.3

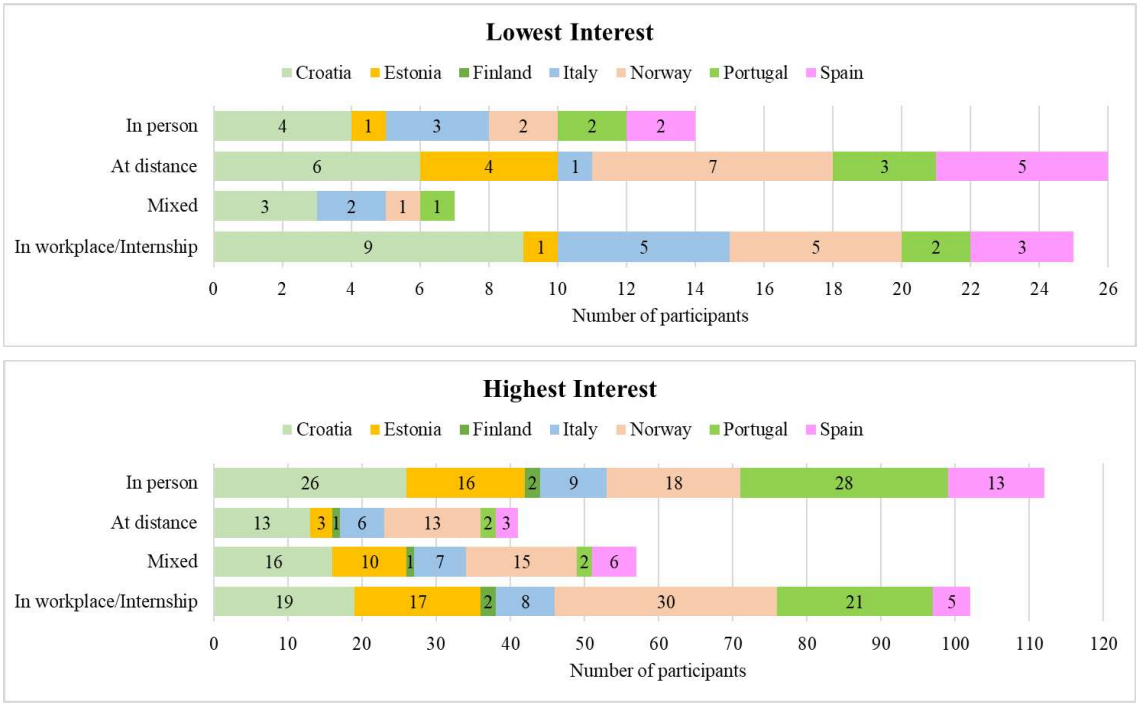

Figure 4. Modes of training with lowest and highest interest according to country.

Noticing the lowest score, 1 (very low interest) and the highest score, 5 (very high interest), Figure 4 presents the distribution according to country for all the different forms considered. A high number of participants classified the "At distance" mode as least important: 6 from Croatia, 4 from Estonia, 1 from Italy, 7 from Norway, 3 from Portugal and 5 from Spain. A similar trend was observed for the form of assessment "In workplace/Internship", which obtained also a high number of classifications as being of low importance: 9 from Croatia, 1 from Estonia, 5 from Italy, 5 from Norway, 2 from Portugal and 3 from Spain.

The results in Figure 4 also reveal that more participants from Croatia, Portugal or Spain attributed highest interest for "In person" mode when compared with the others. However, for the majority of the Norwegian and Estonian participants, the "In workplace/Internship" was considered the most important. Globally, the most valued form of assessment was "In person", rated as of high interest by 26 participants from Croatia, 16 from Estonia, 2 from Finland, 9 from Italy, 18 from Norway, 28 from Portugal and 13 from Spain.

Use of Distance Learning Technologies

The participants were asked how often they use their mobile devices in the ambit of the beekeeping activities. The results in Table 7 show, considering the whole sample, the highest percentage for daily utilization of mobile devices (36.1%) and only a small percentage (7.7%) say they never use them for beekeeping activities. When the results refer to the individual countries, countries where most beekeepers use mobile devices on a daily basis include Italy (62.5%), Croatia (61.7%), Finland (58.3%) and Spain (50.0%). Countries with a high percentage of participants that never or very sporadically use the mobile devices for beekeeping include Estonia (56.8% very sporadically and 13.5% never) and Norway (34.3% very sporadically and 10.0% never).

Table 7. Frequency of utilization of mobile devices in beekeeping activities, global and by country.

Frequency	Croatia	Estonia	Finland	Italy	Norway	Portugal	Spain	Total
Daily	61.7	10.8	58.3	62.5	10.0	37.2	50.0	36.1
1-2 times/week	3.3	13.5	25.0	6.3	25.7	27.9	13.9	16.8
1-2 times/month	8.3	5.4	8.3	0.0	20.0	18.6	8.3	12.0
Very sporadically	23.3	56.8	8.3	12.5	34.3	7.0	27.8	27.4
Never	3.3	13.5	0.0	18.8	10.0	9.3	0.0	7.7
Total	100	100	100	100	100	100	100	100

When asked what they used the mobile devices for, a great number answered to take pictures (n = 185) and to do research (n = 147) (Table 8). It is relevant to notice that participants could choose more than option in this question. When looking at the data by country, the trend is also verified, being these two the most frequent activities for the beekeepers in practically all countries, except Finland and Estonia, where making videos surpasses doing research, although with very close values, as it also happens with Italy.

Table 8. Uses of mobile devices in the beekeeping activities, by country.

Uses	Croatia	Estonia	Finland	Italy	Norway	Portugal	Spain	Total
Take pictures	45	28	8	13	46	23	22	185
Make videos	26	20	6	10	15	9	13	99
Do research	28	18	4	10	35	28	24	147
Use apps	13	4	5	10	11	13	10	66
Use specialized platforms	21	3	1	7	9	15	19	75
Others	1	8	1	1	6	3	3	23

The internet access in the apiaries was investigated, and the results showed that 21.1% of the global participants did not have internet in the apiaries, while 70.4% had access to internet, and 8.5% replied they had access in some of the apiaries but no access in others. Figure 5 shows the data separated by country, and reveals a similar trend, i.e., that the majority of participants in each of the countries have access to internet in their apiaries. There are also some participants who have access to internet in some of their apiaries, but not in all of them.

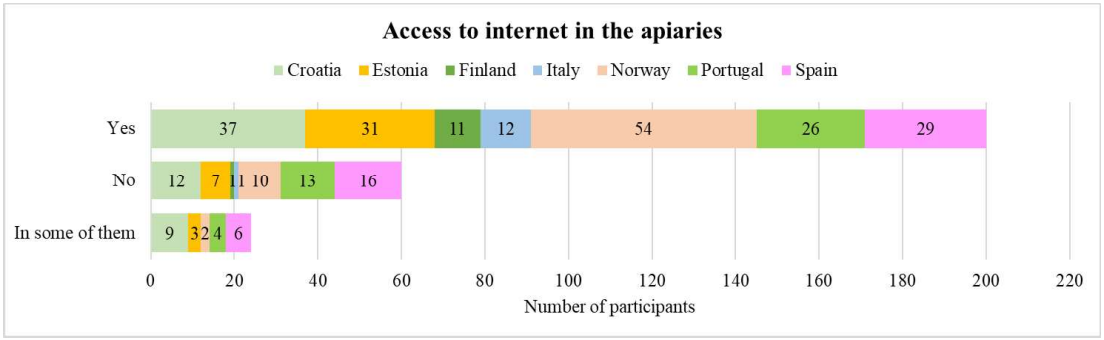

Figure 5. Access to internet in the apiaries, by country.

Tools for Distance Learning

When asked whether the participants preferred digital or printed information about beekeeping, 177 said they preferred digital and 136 preferred printed information. Figure 6 shows the preferred materials, according to the participants from the different countries. Countries where a higher number of participants prefer digital materials are Croatia (n = 44 against 17 who prefer printed), Finland (n = 9 against 5), Italy (n = 10 against 6), Portugal (n = 25 against 21) and Spain (n = 37 against 15). Contrarily, in Estonia and Norway, a higher number of participants prefer printed materials (Figure 6).

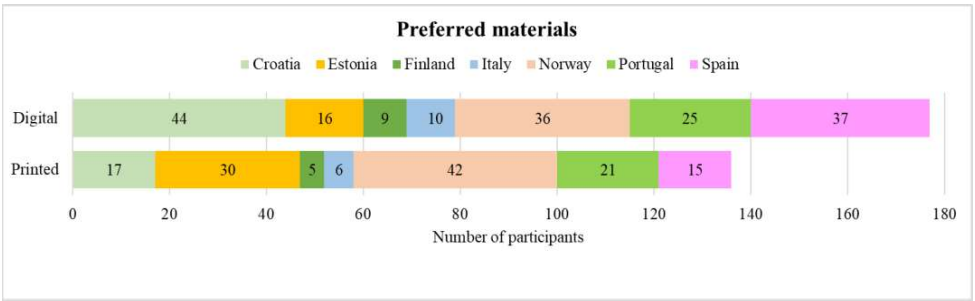

Figure 6. Preferred materials, by country.

The participants were asked about how they classified the usefulness of each of different types of learning materials, rating them on a scale from 1 (little useful) to 5 (very useful). These results are presented in Table 9. The participants rated as most useful the videos (41.8%), followed closely by books/paper manuals (41.4%). The least relevant materials were "Educational games", which had the highest percentage of low rating (38.7% of participants attributed score 1).

Table 9. Opinions about the usefulness of learning support materials (N = 313).

Material	→ Increasing usefulness →				
	1 (%)	2 (%)	3 (%)	4 (%)	5 (%)
e-books (electronic books)	13.1	15.7	23.5	23.5	24.3
Interactive platforms	7.9	16.6	24.2	28.5	22.7
Books/Paper manuals	3.2	6.0	19.3	30.2	41.4
Technical leaflets	9.1	13.5	25.5	29.2	22.6
Educational games	38.7	23.1	19.3	11.3	7.6
Videos	3.5	4.2	19.5	31.0	41.8
Specific programs or Apps	10.2	12.5	24.7	29.8	22.7
Others	42.1	7.9	21.1	13.2	15.8

Figure 7 presents the results for the learning materials rated most useful, by country. Considering the materials scored with highest value (5) for usefulness in each country, videos stand out particularly for Croatian and Spanish participants. Contrarily, books/paper manuals are particularly relevant for the Croatian, the Norwegian and the Spanish beekeepers (Figure 7).

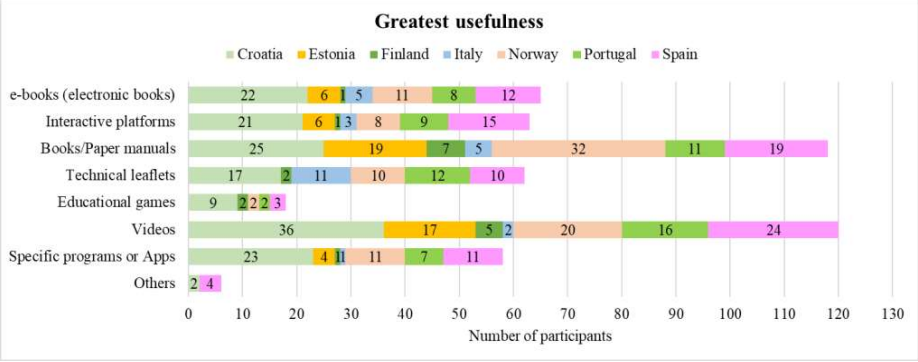

Figure 7. Learning materials rated most useful, by country.

With respect to the learning methodologies, also the participants had to rate their usefulness on the same scale from 1 (little useful) to 5 (very useful). Table 10 presents the results for the whole sample. Higher percentages of the maximum score (score 5) were found for "Field visits" (49.7%), for "Internships" (35.9%) and for "Short courses" (34.5%). "Games/Challenges (gamification" was, among the methodologies proposed, the least valued, with 26.5% of participants scoring with lowest value of usefulness (score 1).

The methodologies scored for usefulness with lowest and highest values (1 and 5, respectively) in each country are shown in Figure 8. Major discrepancies were found for "Games/Challenges (gamification)", that were

considered as of low usefulness by many Norwegian participants (n = 23) but by few Italians or Finish (n = 2, in both cases). The Field visits were greatly valued in general, with a high number of participants from all countries attributing maximum score for usefulness: 36 from Croatia, 12 from Estonia, 9 from Finland, 7 from Italy, 24 from Norway, 27 from Portugal and also 27 from Spain.

Table 10. Opinions about the usefulness of learning methodologies (N = 313).

Methodology	→ Increasing usefulness →				
	1 (%)	2 (%)	3 (%)	4 (%)	5 (%)
Long courses	11.9	12.2	27.3	19.4	29.1
Short courses	5.3	6.3	23.6	30.3	34.5
Forum/chat	7.7	21.9	27.4	23.0	20.1
Lectures	2.2	10.0	29.7	31.5	26.5
Based in projects	5.2	16.0	28.4	25.0	25.4
Field visits	1.0	6.3	12.9	30.1	49.7
Monitoring of pilot farms	8.0	13.1	24.4	22.5	32.0
Internships	11.1	9.6	17.4	25.9	35.9
Games/Challenges (gamification)	26.5	29.2	25.8	12.5	6.1
Group work	12.5	11.8	31.8	29.4	14.5
Others	36.4	9.1	18.2	9.1	27.3

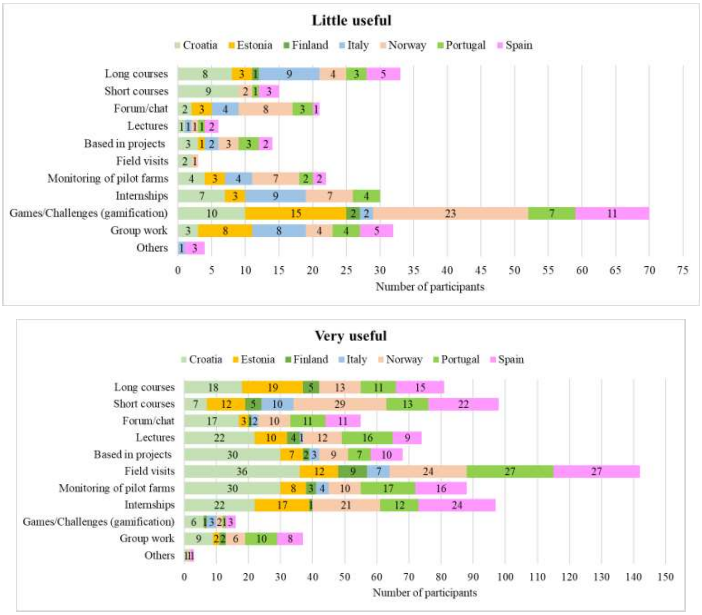

Figure 8. Learning methodologies rated lowest and highest for usefulness, by country.

Also the form of assessment of the learning outcomes in context of distance learning and self-learning, was investigated in this study. Table 11 presents the results, for the global sample, of the participants' opinions about which methods they considered most or least useful to assess learning outcomes, using the same 5 points scale previously described. The most valued form of assessment was "Practical exercises" (39.8% scored maximum, 5) while the least valued were "Online response tests" and "Oral tests", with around 11% of score 1, in both cases.

Table 11. Opinions about the usefulness of formats to assess the learning outcomes (N = 313).

Assessment format	→ Increasing usefulness →				
	1 (%)	2 (%)	3 (%)	4 (%)	5 (%)
Online response tests	11.3	16.0	27.3	21.1	24.4
Tasks/reports	6.1	15.5	34.1	28.0	16.3
Paper tests/questionnaires	9.3	19.7	34.6	23.0	13.4
Practical exercises	5.3	5.6	18.7	30.6	39.8
Orals tests	11.0	18.1	28.0	27.2	15.7
Others	27.8	22.2	22.2	5.6	22.2

The forms of assessment rated with the lowest and highest scores (1 and 5, respectively) were then analysed by country, and the results are shown in Figure 9. The "Online response tests" were not valued by participants from Spain and Croatia (n =10 and n = 8, respectively). The "Practical exercises" were considered very useful for a high number of participants from Croatia, Estonia, Norway, Portugal and Spain (n = 22, n = 23, n = 19, n = 18 and n = 25, respectively), but only two participants from Italy and four from Finland considered this assessment format very useful.

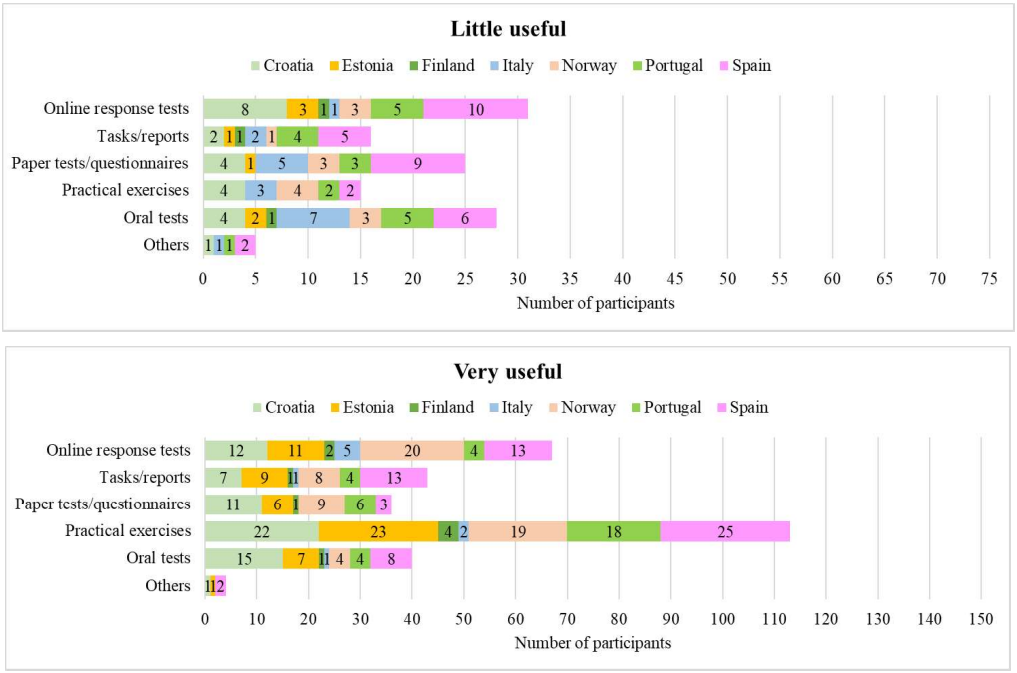

Figure 9. Assessment formats rated lowest and highest for usefulness, by country.

Discussion

Education is the pathway to increase productivity and competitiveness in any business area, including beekeeping. The beekeeper is the agent and the medium is variable, but undoubtedly that technology is becoming more and more relevant in the context of PT and LL. Among others, e-Learning already assumes the lead and it will increasingly play a dominant role in shaping student's management systems and the related

learning environments (Ekúndayò & Tuluri, 2011).

Although the enormous possibilities of distance learning have been known for many decades, it is a fact that until the outbreak of Covid-19 pandemic in the year 2020, teaching methods still followed to a great extent a traditional approach based much on frontal teaching in a classroom. But even before that the use of digital tools had been acknowledged as pivotal for achieving the required 21st century skills (Yorkovsky & Levenberg, 2022). This forced need to shift rapidly form in-person learning systems to distance learning based on technology, cause an evolution not only in the technology itself, but also in the didactic and pedagogical domains (Segbenya et al., 2022; Segbenya & Anokye, 2022).

The use of distance learning tools for professional training is very advantageous given the lack of time of professionals, who, nonetheless, still need to improve their knowledge, skills and competences, as a way to improve the health of their beehives and the quality of their products, to expand their business and increase competitiveness (Farida & Setiawan, 2022; Lee et al., 2019; Mahdavinejad et al., 2012; Shen et al., 2022). Additionally, managing beehives and bees has many challenges, due to the threats posed by climate change, the use of harmful substances, pests such as the Varroa mite, or those posed by predators such as the Asian wasp (*Vespa velutina*). The building of knowledge founded on updated information, most recent technological developments and scientific discoveries arises as a vital activity to all those intervening in the beekeeping sector (Leza et al., 2019; Malkamäki et al., 2016; Phillips, 2020; Robustillo et al., 2022; Zacepins et al., 2015).

Among the topics that beekeepers identify as most relevant in the context of lifelong learning and professional training, stand the apiary health and pest control, related to the health of the colonies, but also colony management throughout the year, with the differences according to season, namely the dichotomy autumn-winter/spring-summer, and also the reproductive management and production of queens. They feel that they need to improve their knowledge and be better prepared to deal with the problems that affect their beekeeping activities. New discoveries can bring light into novel approaches to improve bee health and increase colony performance (Hong et al., 2022; Jovanovic et al., 2021; Lo & Chiang, 2022). Also new findings are continually being released about the impact of invasive species *Vespa velutina* on honeybees, and how to minimize those effects (Leza et al., 2019; Poidatz et al., 2018). As such, all domains of knowledge linked with the beekeeping sector require continuous update for those involved.

The existence of courses for distance learning and adjusted assessment of learning outcomes, allows a continuous updating of information and development of competences, that are recognized as vital by beekeepers. They feel they want to engage in training activities in domains they find crucial, so curriculum development needs to adapt to this reality. Additionally, they find distance learning a useful means of training, but they recognize that complementing with practical activities is necessary to achieve success. These blended learning approaches are documented as bringing together the best of different approaches (Finlay et al., 2022; Geletu & Mihiretie, 2023; Truss & Anderson, 2023).

Conclusion

The results obtained through this questionnaire survey applied to actors in the beekeeping sector in different European countries, revealed that the topics of highest interest for the beekeepers are apiary health and pest control, but also colony management throughout the year. For the enquired, the most relevant sources of information are family, but they also get new information from professional training/courses. The most valued forms of training are in-person and in workplace/internships. Nevertheless, the digital supporting resources are preferred instead of printed material, as a way to increase sustainability. The most valued learning materials were videos, but also books (even e-books) or paper manuals were considered relevant. The field visits were also greatly appreciated by the participants, and the most preferred assessment format was the realization of practical exercises.

Recommendations

Based on the results revealed through this research, the valuable information concerning topics of interest, forms of delivering the classes, materials preferred, or modes of assessment of the learning outcomes, can be utilized to design training actions and courses destined to the professionals in the beekeeping sector, as a way to allow them expand their knowledge and better prepare to successfully manage their beekeeping activities.

Acknowledgements

This work was developed under project beeB—Foster for beekeeping bridges through innovative and participative training (ref. 2019-1-PT01-KA202-060782). The authors would also like to acknowledge support from the FCT—Foundation for Science and Technology, I.P., within the scope of the project Ref. UIDB/00681/2020, as well as the CERNAS Research Centre and the Polytechnic Institute of Viseu.

References

Abbott, L. F., & Nelson, S. B. (2000). Synaptic plasticity: Taming the beast. *Nature Neuroscience*, *3*(11), Article 11. https://doi.org/10.1038/81453

Baker, M. M., New, A., Aguilar-Simon, M., Al-Halah, Z., Arnold, S. M. R., Ben-Iwhiwhu, E., Brna, A. P., Brooks, E., Brown, R. C., Daniels, Z., Daram, A., Delattre, F., Dellana, R., Eaton, E., Fu, H., Grauman, K., Hostetler, J., Iqbal, S., Kent, C., … Vallabha, G. K. (2023). A domain-agnostic approach for characterization of lifelong learning systems. *Neural Networks*, *160*, 274–296. https://doi.org/10.1016/j.neunet.2023.01.007

Bhavsar-Burke, I., Dilly, C. K., & Oxentenko, A. S. (2022). How to Promote Professional Identity Development and Support Fellows-In-Training Through Teaching, Coaching, Mentorship, and Sponsorship. *Clinical*

Gastroenterology and Hepatology, *20*(10), 2166–2169. https://doi.org/10.1016/j.cgh.2022.05.043

Ekúndayò, O. T., & Tuluri, F. (2011). Learner Management Systems and Environments, Implications for Pedagogy and Applications to Resource Poor Environments. In *E-Learning Standards and Interoperability: Vol. 1 Chapter 25* (pp. 499–525). Hershey, Pennsylvania, USA: IGI Global. https://doi.org/10.4018/978-1-61692-789-9.ch025

Evans, K., & Kersh, N. (2023). Lifelong learning beyond initial schooling. In R. J. Tierney, F. Rizvi, & K. Ercikan (Eds.), *International Encyclopedia of Education (Fourth Edition)* (pp. 520–529). Elsevier. https://doi.org/10.1016/B978-0-12-818630-5.14061-8

Farida, I., & Setiawan, D. (2022). Business Strategies and Competitive Advantage: The Role of Performance and Innovation. *Journal of Open Innovation: Technology, Market, and Complexity*, *8*(3), 163. https://doi.org/10.3390/joitmc8030163

Finlay, M. J., Tinnion, D. J., & Simpson, T. (2022). A virtual versus blended learning approach to higher education during the COVID-19 pandemic: The experiences of a sport and exercise science student cohort. *Journal of Hospitality, Leisure, Sport & Tourism Education*, *30*, 100363. https://doi.org/10.1016/j.jhlste.2021.100363

Geletu, G. M., & Mihiretie, D. M. (2023). Professional accountability and responsibility of learning communities of practice in professional development versus curriculum practice in classrooms: Possibilities and pathways. *International Journal of Educational Research Open*, *4*, 100223. https://doi.org/10.1016/j.ijedro.2022.100223

Gryshchuk, V., Weber, C., Loo, C. K., & Wermter, S. (2022). Go ahead and do not forget: Modular lifelong learning from event-based data. *Neurocomputing*, *500*, 1063–1074. https://doi.org/10.1016/j.neucom.2022.05.101

Hong, W., Chen, B., Lu, Y., Lu, C., & Liu, S. (2022). Using system equalization principle to study the effects of multiple factors to the development of bee colony. *Ecological Modelling*, *470*, 110002. https://doi.org/10.1016/j.ecolmodel.2022.110002

Jovanovic, N. M., Glavinic, U., Delic, B., Vejnovic, B., Aleksic, N., Mladjan, V., & Stanimirovic, Z. (2021). Plant-based supplement containing B-complex vitamins can improve bee health and increase colony performance. *Preventive Veterinary Medicine*, *190*, 105322. https://doi.org/10.1016/j.prevetmed.2021.105322

Lee, K., Choi, H., & Cho, Y. H. (2019). Becoming a competent self: A developmental process of adult distance learning. *The Internet and Higher Education*, *41*, 25–33. https://doi.org/10.1016/j.iheduc.2018.12.001

Leza, M., Herrera, C., Marques, A., Roca, P., Sastre-Serra, J., & Pons, D. G. (2019). The impact of the invasive species Vespa velutina on honeybees: A new approach based on oxidative stress. *Science of The Total Environment*, *689*, 709–715. https://doi.org/10.1016/j.scitotenv.2019.06.511

Lo, C.-C., & Chiang, C.-S. (2022). Application of the artificial bee colony algorithm to power contract capacity optimization. *Microprocessors and Microsystems*, *93*, 104621. https://doi.org/10.1016/j.micpro.2022.104621

Mahdavinejad, M., Ghasempourabadi, M., Ghaedi, H., & Nikhoosh, N. (2012). Formal Architectural Education and Training Professional Technicians (case study: Iran). *Procedia - Social and Behavioral Sciences*,

51, 454–458. https://doi.org/10.1016/j.sbspro.2012.08.188

Malkamäki, A., Toppinen, A., & Kanninen, M. (2016). Impacts of land use and land use changes on the resilience of beekeeping in Uruguay. *Forest Policy and Economics*, *70*, 113–123. https://doi.org/10.1016/j.forpol.2016.06.002

Parisi, G. I., Kemker, R., Part, J. L., Kanan, C., & Wermter, S. (2019). Continual lifelong learning with neural networks: A review. *Neural Networks*, *113*, 54–71. https://doi.org/10.1016/j.neunet.2019.01.012

Phillips, C. (2020). The force of Varroa: Anticipatory experiences in beekeeping biosecurity. *Journal of Rural Studies*, *76*, 58–66. https://doi.org/10.1016/j.jrurstud.2020.04.002

Poidatz, J., López Plantey, R., & Thiéry, D. (2018). Indigenous strains of Beauveria and Metharizium as potential biological control agents against the invasive hornet Vespa velutina. *Journal of Invertebrate Pathology*, *153*, 180–185. https://doi.org/10.1016/j.jip.2018.02.021

Robustillo, M. C., Pérez, C. J., & Parra, M. I. (2022). Predicting internal conditions of beehives using precision beekeeping. *Biosystems Engineering*, *221*, 19–29. https://doi.org/10.1016/j.biosystemseng.2022.06.006

Segbenya, M., & Anokye, F. A. (2022). Challenges and coping strategies among distance education learners: Implication for human resources managers. *Current Psychology*. https://doi.org/10.1007/s12144-022-03794-5

Segbenya, M., Bervell, B., Minadzi, V. M., & Somuah, B. A. (2022). Modelling the perspectives of distance education students towards online learning during COVID-19 pandemic. *Smart Learning Environments*, *9*(1), 13. https://doi.org/10.1186/s40561-022-00193-y

Segret, J. A. L. (2009). The Management of the Human Resources and the Quality of the Services. In *Encyclopedia of Human Resources Information Systems: Challenges in e-HRM: Vol. 1 Chapter 92* (pp. 640–648). Hershey, Pennsylvania, USA: IGI Global. https://doi.org/10.4018/978-1-59904-883-3.ch092

Shen, C.-C., Yeh, C.-C., & Lin, C.-N. (2022). Using the perspective of business information technology technicians to explore how information technology affects business competitive advantage. *Technological Forecasting and Social Change*, *184*, 121973. https://doi.org/10.1016/j.techfore.2022.121973

Truss, A., & Anderson, V. (2023). The navigational challenges of a blended learning approach to teaching in business and management. *The International Journal of Management Education*, *21*(1), 100733. https://doi.org/10.1016/j.ijme.2022.100733

Yorkovsky, Y., & Levenberg, I. (2022). Distance learning in science and mathematics—Advantages and disadvantages based on pre-service teachers' experience. *Teaching and Teacher Education*, *120*, 103883. https://doi.org/10.1016/j.tate.2022.103883

Zacepins, A., Brusbardis, V., Meitalovs, J., & Stalidzans, E. (2015). Challenges in the development of Precision Beekeeping. *Biosystems Engineering*, *130*, 60–71. https://doi.org/10.1016/j.biosystemseng.2014.12.001