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Professional Training in Beekeeping: A Cross-Country Survey to Identify Learning Opportunities

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Abstract: Habitat loss, climate change, and other environmental degradations pose severe challenges to beekeepers. Therefore, this sector needs to rely on updated information so that the intervening actors can deal with the problems. In this context, and assuming that professional training can greatly help those acting in the beekeeping sector, this work intended to investigate the gaps in the updated knowledge of beekeepers and how these can be filled through lifelong learning. The research was conducted in seven European countries (Croatia, Estonia, Finland, Italy, Norway, Portugal, and Spain). The data were collected through a questionnaire survey translated into the native languages of all participating countries. The results revealed that the topics of highest interest are apiary health and pest control and the management of the colonies throughout the year. The beekeepers update their knowledge through family, complemented by professional training, with participants preferring in-person courses as well as, in the workplace or in internships. The learning methodologies they consider most useful are project-based learning and learning through gamification. The videos and paper books or manuals are particularly valued as learning materials, and practical exercises are considered the most helpful assessment format. Finally, considering the effect of sociodemographic variables on the learning experiences and preferences of beekeeping actors, it was observed that the country was the most influential of the variables under study. In conclusion, this work revealed valuable information that should be used to design professional training actions to help the professionals in the beekeeping sector enhance their competencies and be better prepared to manage their activities successfully.

Keywords: distance learning; mobile learning; professional learning; beekeeping; survey

Citation: Guiné, R.P.F.; Oliveira, J.; Coelho, C.; Costa, D.T.; Correia, P.; Correia, H.E.; Dahle, B.; Oddie, M.; Raimets, R.; Karise, R.; et al. Professional Training in Beekeeping: A Cross-Country Survey to Identify Learning Opportunities. *Sustainability* **2023**, *15*, 8953. https://doi.org/10.3390/su15118953

Academic Editor: Giacomo Falcone

Received: 21 April 2023
Revised: 24 May 2023
Accepted: 31 May 2023
Published: 1 June 2023

1. Introduction

Beekeeping is a key sector from multiple perspectives. Sustainability is one of the relevant aspects linked with the roles of bees and, consequently, beekeeping activities. Bees are important pollinators for many crops and plants. It is estimated that bees and other pollinators are responsible for one-third of the food we eat. By maintaining healthy bee populations through beekeeping, the pollination of crops is ensured, leading to greater

food security and more sustainable agriculture. On the other hand, bees play a critical role in maintaining biodiversity by pollinating wildflowers and other plants. This helps to maintain healthy ecosystems and support other wildlife. Keeping bees helps support local biodiversity and contributes to the preservation of ecosystems. Bee products such as honey, beeswax, propolis and royal jelly have antimicrobial properties. By using these products and other natural beekeeping techniques, beekeepers can reduce the need for synthetic pesticides and other chemical treatments that can harm the environment and human health. Finally, in the social sustainability dimension, beekeeping can provide sustainable livelihoods for people in rural and urban areas. It can be a low-cost, low-impact form of agriculture practised on a small scale. By providing a source of income and livelihood, beekeeping can help support local communities and contribute to sustainable development [1–6].

Beekeepers face many challenges in maintaining their apiaries in good equilibrium, increasing productivity, enhancing performance, and being more competitive in the context of globalization. Since many beekeepers' businesses are of a small dimension and greatly contribute to the social development of rural populations, providing them with proper training is essential to help them cope with the sector's challenges. Investing in lifelong learning (LL) and professional training (PT) might make the difference between a successful business or a failure [7–9].

The human s capacity to learn and accumulate knowledge from a wide amount of information that is considered relevant is enormous. The human brain's capacity to learn and accumulate knowledge is closely related to synaptic plasticity, which refers to the ability of the connections between neurons, called synapses, to change in response to experience. When learning new things or acquiring new information, the human brain forms new connections between neurons or strengthens existing ones, which is known as synaptic potentiation. This allows for people to encode and store new information in long-term memory. Synaptic plasticity is influenced by various factors, including the frequency, intensity, and duration of neuronal activity, as well as the age, genetics, and environmental factors of the individual. Thus, the capacity of the human brain to learn and accumulate knowledge is intimately linked to the ability of its synapses to adapt and change in response to experience, which is a fundamental aspect of synaptic plasticity. With increased learning and experience, more connections are formed in the brain, strengthening and accumulating more knowledge over time. 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 LL process [10–14].

LL refers to the ongoing and voluntary pursuit of knowledge and skills throughout one's life, beyond traditional classroom education. It is an attitude and approach to learning that recognizes that learning is not just limited to formal education but can take place through a variety of experiences and activities such as work, hobbies, personal interests, and social interactions. LL is becoming increasingly important in today's rapidly changing world, where new technologies, information, and industries are constantly emerging. It allows individuals to adapt to changing circumstances, keep up with the latest trends and developments, and improve their personal and professional prospects. LL involves a commitment to personal development and self-improvement, and can bring numerous benefits, such as increased knowledge, improved job performance, better social and communication skills, increased confidence, and a sense of personal fulfilment. LL encompasses different analytic perspectives: the social organization of learning and individual learning. These indicate the way in which past definitional concerns related to formal, non-formal and informal learning. The recognition of learning outcomes must be modern and consider eventually contrasting viewpoints, in the European context as well as from the global perspective [15–18].

PT encompasses the process of building knowledge, skills and competencies, either on an individual person or in a group or team. PT can have a significant impact on an indi-

vidual's personal and professional development, as well as on his organization/company. Some of the key impacts of professional training are improved job performance, career advancement, increased job satisfaction and motivation and enhanced organizational performance. Overall, PT can have a positive impact on both individuals and organizations, leading to improved job performance, career advancement, job satisfaction, and organizational performance. Effective training improves not only knowledge and skills but also attitudes and resilience [19–22].

The beeB project—Foster for beekeeping bridges through innovative and participative training, which was approved by the European Union under Ref. 2019-1-PT01-KA202-060782, aims to contribute to the technical training of beekeepers and other agents involved in the beekeeping sector, as well as providing appropriate tools in mobile-learning (m-learning) contexts, to improve beekeepers' ability to manage their businesses successfully. The project team integrates six partners from different European countries and encompasses the identification of needs and the development of training opportunities, facilitating beekeepers' access to distance learning courses, platforms and content. In this context, the aim of this work was to identify the needs of those acting in the beekeeping sector and understand how these needs can be fulfilled through lifelong learning. Additionally, differences will be identified according to the country or other sociodemographic variables of the participants. These elements will offer valuable information for the design of courses and other learning tools that will be easily available for use by all stakeholders in the beekeeping sector to enhance their knowledge and skills.

2. Materials and Methods

2.1. Instrument Used for the Research

The questionnaire used for the present research was divided into six sections:

I. Experience in beekeeping (10 questions);
II. Training needs (3 questions);
III. Experience in beekeeping training activities (3 questions);
IV. Use of distance learning technologies and tools (3 questions);
V. Distance learning tools (4 questions);
VI. Sociodemographic characterization (6 questions).

The questionnaire was first produced in Portuguese and validated through a pre-test with 50 participants through direct interviews. The final instrument was then obtained after this pre-test. Before general application, the questionnaire was translated into the native languages in the seven countries where the data were collected, following a back-translation methodology.

This research paper is focused on professional training and its relationship with the sociodemographic variables, addressing questions from parts II–VI.

2.2. Data Collection

The survey was applied to beekeepers in different countries (Croatia, Estonia, Finland, Italy, Norway, Portugal, Spain) as a part of the project Beeb—Foster for beekeeping bridges through innovative and participative training (2019-1-PT01-KA202-060782), approved and developed by the Polytechnic Institute of Viseu, as leading partner.

The sample was selected from all the potentially interested people in the different countries included in the study. The target group comprised people linked to the beekeeping sector, either beekeepers, academia members, or those dealing with bee products' transformation and commercialization, as examples. This also included people who participated in activities other than beekeeping, those who recently engaged in this sector or those who have beekeeping as a complementing activity to their other principal activities.

The questionnaire was delivered in paper form, face-to-face, during training or dissemination events organized by beekeepers' associations or companies in each country. Additionally, online tools were used to complement the data collection and reach a wider audience among those connected with the beekeeping sector.

A total of 313 valid responses were obtained considering the whole set of countries. In the case of variable age, cases in which the participants did not indicate their age were excluded. For variable sex, cases where the participants identified themselves explicitly with men or women were considered. In the case of variable education, and due to the very low representativeness of the group basic school (only 3%), basic classes plus secondary school were merged into a single class.

2.3. Data Analysis

The non-parametric tests U-Mann–Whitney and Kruskal–Wallis were used to compare quantitative variables between two groups or three or more groups, respectively. Non-parametric tests were used in the present study due to the low number of cases in some groups, inequality of group dimensions and non-verification of normality distribution. Chi-square tests were used to test the differences between some categorical variables. For all data analysis, the software SPSS, from IBM Inc. (version 28), was used, complemented by Excel 2016. The level of significance considered was 5%.

3. Results

3.1. Sample Characterization

Data were collected from six European countries participating in the European Erasmus+ project beeB (Foster for beekeeping bridges through innovative and participative training/Ref. 2019-1-PT01-KA202-060782), namely: Croatia, Estonia, Finland, Italy, Norway, Portugal, and Spain. Figure 1 shows how the participants were distributed among the countries included in this study. The percentages varied from 5% for participants from Finland (n = 15 out of 313 participants) to 24% for participants from Norway (n = 74 out of 313).

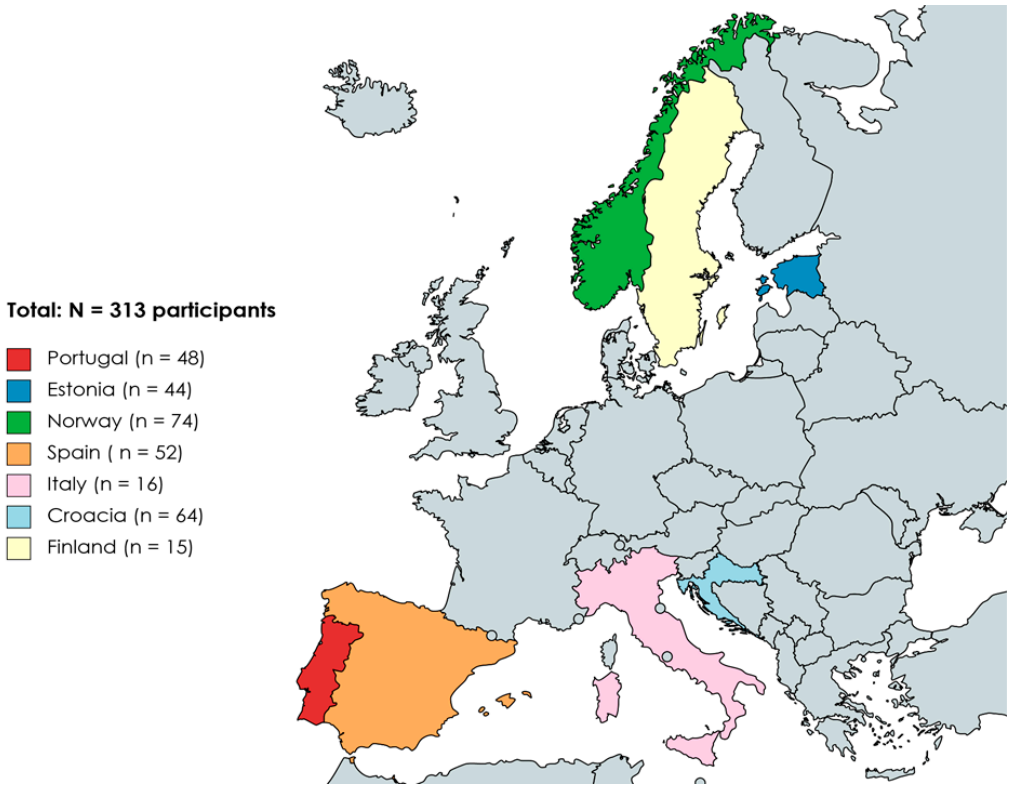

Figure 1. Geographical location of the countries included in the study and the corresponding number of participants.

Figure 2 shows that most of the participants in the survey (68%) had ages ranging from 31 to 59 years old, followed by those aged over 60 years (18%), and the class under 30 years had a lower expression (9%). The majority were male (74%), with only about one-fourth

(23%) females. Concerning the education level, 59% had a university degree, 35% had completed secondary school, and only 3% had a very low level of education (basic school). Concerning the income, the distribution by classes was more even, with 38% having an income between 15 and 50 thousand euros per year, 25% having an income lower than 15 thousand EUR/y and 23% over 50 thousand EUR/y.

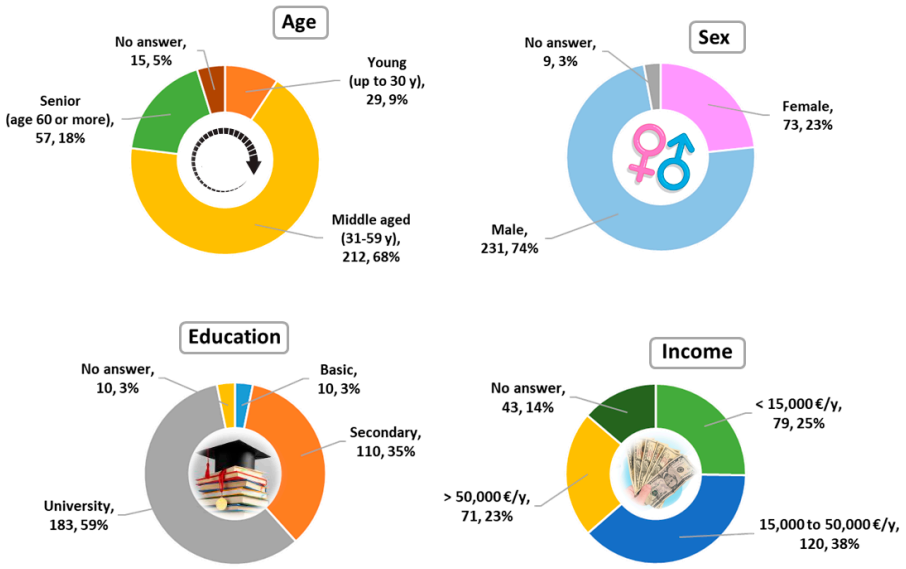

Figure 2. Sociodemographic characterization of the participants.

3.2. Access to the Internet in the Apiaries

The participants were questioned about whether they had access to internet in their apiaries, with the results presented in Figure 3. No significant differences were found between countries regarding access to the internet in the apiaries. Nevertheless, most participants in Italy (92.3%) and Finland (91.7%) have internet in all apiaries. Portugal and Spain are the countries with less internet access in the apiaries (69.8% and 68.6%, respectively). Considering all data (countries), mean access to the internet covers 78.9% of the apiaries.

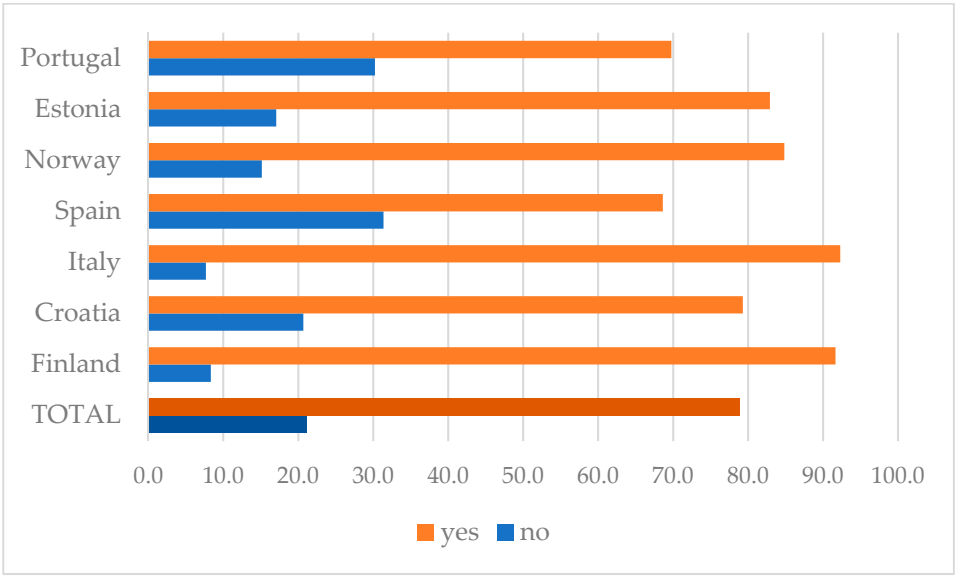

Figure 3. Country frequencies for access to internet in the apiaries (Chi-square test (level of significance $p < 0.05$); $p = 0.135$).

3.3. Use of Technologies and Purposes

The participants were questioned about how frequently they use mobile devices in their beekeeping activities, with the results presented in Table 1. Significant differences were found between countries for the frequency of utilization of mobile devices. Italy (62.5%), Croatia (61.7%) and Finland (58.3%) were the countries where the daily frequency of utilization of mobile devices was higher. Significant differences were also encountered between age groups for the frequency of utilization of mobile devices for beekeeping activities, with percentage of participants using them daily increasing as age decreased. Finally, the frequency of utilization of mobile devices was also found to vary significantly according to income, with increased daily usage for lower incomes.

Table 1. Group differences for frequency of mobile devices utilization.

Variable	Group	Percentage and Significance				
		Frequency of Utilization of Mobile Devices for Beekeeping Activities				
		Daily	1-2x/Week	1-2x/Month	Very Sporadically	Never
Country	Portugal	37.2	27.9	18.6	7.0	9.3
	Estonia	10.8	13.5	5.4	56.8	13.5
	Norway	10.0	25.7	20.0	34.3	10.0
	Spain	50.0	13.9	8.3	27.8	0.0
	Italy	62.5	6.3	0.0	12.5	18.8
	Croatia	61.7	3.3	8.3	23.3	3.3
	Finland	58.3	25.0	8.3	8.3	0.0
	Sig. [1]			<0.001		
Age	18–30 y	50.0	20.8	4.2	25.0	0.0
	31–59 y	37.8	17.0	10.6	27.7	6.9
	60+ y	20.4	14.3	24.5	28.6	12.2
	Sig. [1]			0.040		
Sex	Female	25.0	15.6	12.5	31.3	15.6
	Male	38.9	17.2	12.3	26.1	5.4
	Sig. [2]			0.054		
Education	Secondary	40.0	14.3	9.5	28.6	7.6
	University	32.9	18.0	13.0	28.0	8.1
	Sig. [2]			0.712		
Income	Low	52.1	8.5	5.6	26.8	7.0
	Medium	35.6	17.3	12.5	27.9	6.7
	High	15.4	27.7	18.5	32.3	6.2
	Sig. [1]			0.001		

[1] Chi-square test (level of significance $p < 0.05$). [2] Fisher's exact test (level of significance $p < 0.05$).

Table 2 shows the results of cross-tabulation between the sociodemographic variables and the reasons why the beekeepers use their mobile devices in beekeeping activities. Again, countries were shown to have significant differences for all the possible usages, while age and sex were variables that did not lead to significant differences. However, significant differences were found for the variable income, just like country. A higher income is associated with a higher percentage of utilization of mobile devices for all the tested reasons. Finally, significant differences were found between participants with a university degree from those with up to a secondary school education in the use of mobile devices to 'Take pictures', 'Make videos' and 'Use apps'.

3.4. Previous Knowledge and Experience in Training Activities

The results in Figure 4 show the mean value for the importance attributed to the different sources of information in previous knowledge. For the sources of information, the scale varied from 1 (most important) to 3 (least important), and the results indicated

that the most important source was 'Family', with a mean score closest to 1, while the least important was 'Seminars', with the highest mean score of 1.55.

Table 2. Group differences for motivations to use mobile devices.

Variable	Group	Percentage and Significance									
		Take Pictures		Make Videos		Do Research		Use Apps		Browse Specialized Platforms	
		No	Yes	No	Yes	No	Yes	No	Yes	No	Yes
Country	Portugal	36.1	63.9	75.0	25.0	22.2	77.8	63.9	36.1	58.3	41.7
	Estonia	0.0	100.0	0.0	100.0	0.0	100.0	0.0	100.0	0.0	100.0
	Norway	0.0	100.0	6.3	93.8	2.8	97.2	8.3	91.7	10.0	90.0
	Spain	35.3	64.7	62.9	37.1	31.4	68.6	71.4	28.6	45.7	54.3
	Italy	0.0	100.0	23.1	76.9	23.1	76.9	23.1	76.9	46.2	53.8
	Croatia	22.4	77.6	55.2	44.8	51.7	48.3	77.6	22.4	63.8	36.2
	Finland	0.0	100.0	0.0	100.0	0.0	100.0	0.0	100.0	0.0	100.0
	Sig. [1]	<0.001		<0.001		<0.001		<0.001		0.014	
Age	18–30 y	12.5	87.5	37.5	62.5	18.2	81.8	57.9	42.1	68.4	31.6
	31–59 y	17.8	82.2	45.0	55.0	24.6	75.4	59.5	40.5	49.1	50.9
	60+ y	15.6	84.4	60.0	40.0	40.0	60.0	65.0	35.0	50.0	50.0
	Sig. [1]	0.792		0.313		0.146		0.880		0.294	
Sex	Female	10.9	89.1	35.1	64.9	24.3	75.7	51.9	48.1	61.5	38.5
	Male	18.2	81.8	48.6	51.4	26.1	73.9	61.4	38.6	50.8	49.2
	Sig. [2]	0.237		0.194		1.000		0.394		0.390	
Education	Secondary	25.9	74.1	59.0	41.0	30.9	69.1	68.9	31.5	56.5	43.5
	University	9.2	90.8	35.0	65.0	24.1	75.9	51.8	48.2	46.3	53.7
	Sig. [2]	0.002		0.002		0.326		0.036		0.254	
Income	Low	16.1	83.9	52.5	47.5	40.0	60.0	72.7	27.3	67.3	32.7
	Medium	22.7	77.3	47.5	52.5	26.9	73.1	55.1	44.9	45.5	54.5
	High	4.1	95.9	20.8	79.2	8.3	91.7	38.9	61.6	37.5	62.5
	Sig. [1]	0.017		0.027		0.003		0.021		0.023	

[1] Chi-square test (level of significance $p < 0.05$). [2] Fisher's exact test (level of significance $p < 0.05$).

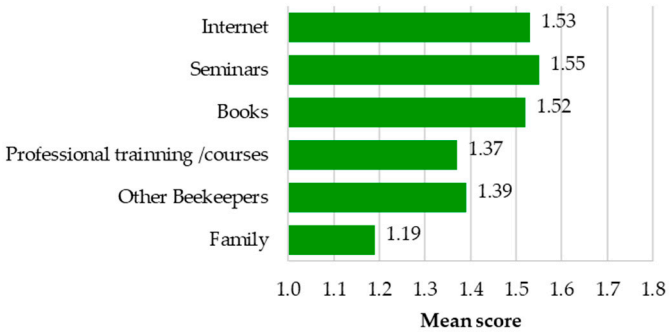

Figure 4. Level of importance of the sources of information.

Table 3 presents the results of the non-parametric statistical tests performed on the relations between the considered variables and the level of importance attributed to the sources of information in beekeeping. The results reveal that significant differences were found between countries for all sources of information'. For the other variables, differences were observed between groups for some of the sources of information.

Table 4 presents the results for cross-tabulation between the variables accounting for part experience in training in beekeeping and the sociodemographic variables under study. The results indicated significant differences between those who already participated in training activities and those who did not, according to country (higher participation in Norway—93.2%—and lower in Croatia—58.3%), age (higher percentage for older participants—83.6%—and lower for younger—51.7%), and income (higher participation for higher income—93.0%—and lower for lower income—71.1%). Regarding participation as a

trainee, significant differences were found according to country, education, and income (a higher percentage of participants were trainees in Estonia, with a university education and high income). Concerning the participation as trainer/coordinator, significant differences were found for country and age (higher percentage of participants from Portugal and Estonia and in the age group of 60+ years (Table 4).

Table 3. Group differences for the level of importance of the sources of information.

Variable	Group	Percentage and Significance					
		Sources of Information					
		Family	Other Beekeepers	Professional Training/Courses	Books	Seminars	Internet
Country	Portugal	32.00	64.50	65.83	55.50	21.50	43.95
	Estonia	35.05	134.56	115.50	112.53	46.36	88.66
	Norway	46.30	124.53	97.77	123.94	52.17	97.68
	Spain	32.00	64.50	63.00	55.50	21.50	40.50
	Italy	50.10	101.58	97.50	90.00	45.79	73.25
	Croatia	32.00	64.50	63.00	55.50	21.50	40.50
	Finland	70.00	113.13	63.00	139.00	52.17	93.33
	Sig. [1]	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Age	18–30 y	29.50	68.77	99.10	74.00	28.00	52.56
	31–59 y	34.58	89.24	78.78	81.61	27.11	53.70
	60+ y	29.50	101.54	80.95	83.28	41.72	75.44
	Sig. [1]	0.301	0.022	0.219	0.719	0.017	0.008
Sex	Female	39.79	102.58	90.82	104.97	29.36	60.42
	Male	32.74	86.11	78.74	75.72	30.15	57.36
	Sig. [2]	0.030	0.019	0.058	<0.001	0.898	0.628
Education	Secondary	32.86	79.09	79.50	69.06	27.30	51.77
	University	36.04	96.57	81.80	89.15	33.57	61.24
	Sig. [2]	0.260	0.006	0.698	0.002	0.101	0.072
Income	Low	29.11	66.93	68.97	54.61	27.83	42.39
	Medium	25.59	74.41	67.70	71.61	27.64	46.85
	High	35.17	101.19	83.35	91.50	35.83	79.06
	Sig. [1]	0.420	<0.001	0.042	<0.001	0.245	<0.001

[1] Kruskal–Wallis test (level of significance $p < 0.05$). [2] U-Mann–Whitney test (level of significance $p < 0.05$).

Table 4. Group differences for participation in training activities.

Variable	Group	Past Experience (Percentage and Significance)					
		Already Participated in Training Activities		Role: Trainee		Role: Trainer/Coordinator	
		No	Yes	No	Yes	No	Yes
Country	Portugal	8.3	91.7	77.3	22.7	0.0	100.0
	Estonia	16.7	83.3	0.0	100.0	0.0	100.0
	Norway	6.8	93.2	11.8	88.2	63.6	36.4
	Spain	32.0	68.0	48.1	51.9	82.7	17.3
	Italy	31.3	68.8	31.3	68.8	93.8	6.3
	Croatia	41.7	58.3	8.6	91.4	77.1	22.9
	Finland	20.0	80.0	58.3	41.7	8.3	91.7
	Sig. [1]	<0.001		<0.001		<0.001	
Age	18–30 y	48.3	51.7	50.0	50.0	65.0	35.0
	31–59 y	19.3	80.7	28.4	71.6	57.7	42.3
	60+ y	16.4	83.6	30.6	69.4	38.1	61.9
	Sig. [1]	0.001		0.118		0.047	

Table 4. *Cont.*

Variable	Group	Past Experience (Percentage and Significance)					
		Already Participated in Training Activities		Role: Trainee		Role: Trainer/Coordinator	
		No	Yes	No	Yes	No	Yes
Sex	Female	22.5	77.5	20.7	79.3	65.3	34.7
	Male	20.9	79.1	34.4	65.6	51.9	48.1
	Sig. [2]	0.743		0.054		0.107	
Education	Secondary	23.5	76.5	40.6	59.4	53.7	46.3
	University	20.4	79.6	23.8	76.2	55.2	44.8
	Sig. [2]	0.564		0.005		0.893	
Income	Low	28.9	71.1	39.1	60.9	56.9	43.1
	Medium	23.1	76.9	37.4	62.6	51.7	48.3
	High	7.0	93.0	13.6	86.4	58.7	41.3
	Sig. [1]	0.003		0.001		0.667	

[1] Chi-square test (level of significance $p < 0.05$). [2] Fisher's exact test (level of significance $p < 0.05$).

3.5. Identification of Training Needs

The respondents were asked to classify several topics for possible training modules according to their level of interest on a scale from 1 (little interest) to 5 (much interest). Figure 5 presents the average scores for each option, calculated as the mean value of the classifications attributed by all participants. The topics considered of the highest global interest were 'Apiary health and pest control', followed by 'Colony management throughout the year'. Topics of the lowest interest are 'Organic production mode' and 'Beehive production'.

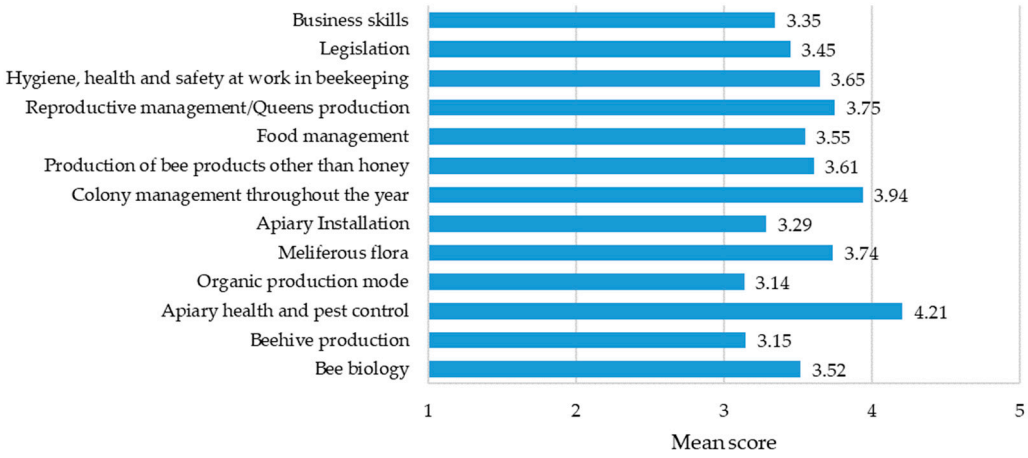

Figure 5. Level of interest in training subjects in beekeeping.

The results in Table 5 show that country is the variable for which significant differences were found for a higher number of training topics in beekeeping. Topics such as 'Beehive production', 'Organic production mode' and 'Food management' showed significant differences between countries, with $p < 0.001$, but topics such as 'Meliferous flora', 'Apiary Installation', 'Production of bee products other than honey', 'Hygiene, health and safety at work in beekeeping', 'Legislation', and 'Business skills' had a p-value below the significance level ($p < 0.05$). Additionally, the variable sex showed significant differences for many topics, five. Regarding age, significant differences were found for three of the topics, and income revealed differences for two topics. On the other hand, no significant differences were found between the participants with a university education and those with a secondary school education for any of the topics considered (Table 5).

Table 5. Group differences for the level of interest in training subjects in beekeeping.

Variable	Group	Mean Rank and Significance												
		Bee Biology	**Beehive Production**	**Apiary Health and Pest Control**	**Organic Production Mode**	**Meliferous Flora**	**Apiary Installation**	**Colony Management throughout the Year**	**Production of Bee Products Other Than Honey**	**Food Management**	**Reproductive Management/ Queens Production**	**Hygiene, Health and Safety at Work in Beekeeping**	**Legislation**	**Business Skills**
Country	Portugal	142.62	201.49	176.81	164.65	173.38	166.15	167.33	158.71	181.07	157.84	174.40	174.43	165.68
	Estonia	119.75	122.25	158.72	136.78	114.98	404.43	127.96	126.34	112.93	138.23	136.30	129.76	155.47
	Norway	147.42	114.97	146.54	96.05	151.62	136.44	156.68	118.71	154.90	150.38	132.01	157.47	128.50
	Spain	122.00	142.68	133.63	151.81	130.69	146.75	128.02	130.20	138.58	142.83	122.12	112.68	118.60
	Italy	182.22	204.59	155.94	229.50	171.91	167.25	138.03	141.84	108.06	114.53	116.41	142.81	174.28
	Croatia	145.83	130.09	149.18	180.03	149.77	157.30	153.66	166.38	165.46	145.87	167.06	153.58	165.15
	Finland	116.04	177.08	131.23	126.35	111.73	116.73	143.69	145.38	102.27	154.12	147.65	117.08	169.77
	Sig. [1]	0.082	<0.001	0.180	<0.001	0.008	0.005	0.158	0.013	<0.001	0.642	0.006	0.007	0.010
Age	18–30 y	145.67	165.18	146.47	162.80	148.75	166.25	128.03	143.74	148.43	127.05	130.29	128.11	154.39
	31–59 y	137.85	141.01	145.00	142.18	141.49	138.95	144.30	137.69	142.00	140.73	140.53	143.00	145.89
	60+ y	109.77	117.73	141.62	123.13	129.81	111.45	135.85	113.59	133.47	138.87	137.95	137.38	123.24
	Sig. [1]	0.035	0.028	0.947	0.083	0.513	0.007	0.490	0.086	0.680	0.678	0.802	0.620	0.132
Sex	Female	156.50	133.16	153.51	160.45	160.28	153.42	160.77	133.82	144.13	153.51	154.93	162.47	146.06
	Male	129.40	143.45	145.55	137.06	137.01	134.58	138.59	135.40	143.96	137.54	136.64	136.21	143.34
	Sig. [2]	0.012	0.355	0.448	0.038	0.035	0.089	0.040	0.881	0.988	0.139	0.096	0.018	0.807
Education	Secondary	129.48	130.25	143.62	142.91	139.25	135.26	132.32	125.71	148.87	134.94	146.08	137.08	143.11
	University	138.32	146.06	148.32	141.43	142.90	139.74	149.81	139.46	139.42	144.62	136.16	145.03	143.74
	Sig. [2]	0.353	0.104	0.611	0.879	0.704	0.640	0.065	0.141	0.333	0.314	0.300	0.413	0.949
Income	Low	123.26	131.60	132.91	154.21	138.94	138.50	131.52	124.40	139.96	128.19	136.56	122.52	134.79
	Medium	115.33	132.30	130.28	133.39	118.64	119.22	122.75	121.69	119.63	124.00	125.44	122.12	131.66
	High	120.38	105.92	128.24	84.38	123.94	113.84	130.84	107.92	127.28	125.27	108.75	135.82	11.40
	Sig. [1]	0.735	0.035	0.917	<0.001	0.153	0.087	0.633	0.283	0.169	0.925	0.058	0.397	0.100

[1] Kruskal–Wallis test (level of significance $p < 0.05$). [2] U-Mann–Whitney test (level of significance $p < 0.05$).

The results in Figure 6 present the mean value for the interest attributed to the different forms of training activities on a scale varying from 1 (little interest) to 5 (much interest). The results indicate that the activities carried out in person are preferred by the participants, with the highest means score (3.94), while the distance training received the lowest score (3.06).

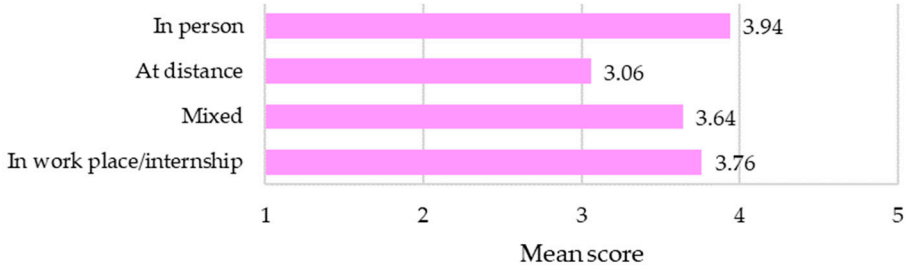

Figure 6. Level of interest according to the type of training activity.

Table 6 shows the results for the tests of group differences in training mode for the sociodemographic variables considered and reveals that country differences were statistically significant in all cases, i.e., for all types of training modes investigated. Higher means ranks were found for the 'In person' mode in Portugal (MR = 153.78), for the 'At distance' mode in Italy (MR = 167.44), for the 'Mixed' mode in Italy (MR = 152.75) and for more practical modes in Estonia (MR = 132.71 for the 'In work place/internship' mode). With respect to sex, significant differences were found for the 'At distance' and 'Mixed' modes. Finally, for education level, significant differences were encountered only for the 'At distance' mode, with this being preferred by people with a university degree.

Table 6. Group differences for preferences in training mode.

Variable	Group	Mean Ranks and Significance			
		In Person	At Distance	Mixed	In Workplace/ Internship
Country	Portugal	153.78	103.42	85.88	136.54
	Estonia	122.89	106.65	127.38	132.71
	Norway	103.08	122.85	114.98	123.72
	Spain	117.25	86.65	122.55	84.10
	Italy	123.91	167.44	152.75	116.94
	Croatia	135.51	129.72	128.83	110.51
	Finland	102.82	130.41	118.00	93.00
	Sig. [1]	0.007	0.002	0.017	0.015
Age	18–30 y	129.18	116.92	107.24	95.39
	31–59 y	116.75	114.12	113.59	112.57
	60+ y	115.50	103.73	113.31	122.63
	Sig. [1]	0.699	0.615	0.915	0.276
Sex	Female	130.66	138.78	131.79	123.75
	Male	117.26	105.89	110.01	111.42
	Sig. [2]	0.174	<0.001	0.025	0.198
Education	Secondary	120.10	96.55	108.86	111.66
	University	119.13	123.91	118.18	115.45
	Sig. [2]	0.910	0.002	0.279	0.656
Income	Low	109.27	100.18	106.38	105.75
	Medium	116.18	99.11	106.26	104.03
	High	99.87	115.20	101.59	103.97
	Sig. [1]	0.243	0.217	0.871	0.981

[1] Kruskal–Wallis test ($p < 0.05$). [2] U-Mann–Whitney test ($p < 0.05$).

3.6. Preferred Tools for Distance Learning

When enquired whether the participants preferred digital or printed information about beekeeping for the purpose of lifelong learning and training activities, 177 said they preferred digital, and 136 preferred printed information. Countries where a higher number of participants prefer digital materials include 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.

The participants' opinions about the usefulness of learning methodologies, materials, and assessment forms are presented in Figure 7. The mean scores were obtained as an average of all participants, and the measurement scale ranged from 1 (little useful) to 5 (very useful). The results indicate that project-based learning was the methodology considered most useful by the participants (mean score of 4.21), followed by the use of games and other challenges through gamification (means score of 3.82). The short courses were the least valued by the participants (with the lowest mean score of 2.44). With respect to the learning supports, the most valued were 'Videos' and 'Books/Paper manuals', with mean scores of 4.03 and 4.00, respectively. Strangely, the 'Educational games' came in last (with a mean score of 2.28), being considered a less useful learning support, somehow contradicting the results of the previous question, where gamification was a much-valued learning methodology. Finally, concerning the assessment formats, the 'Practical exercises' obtained the highest mean score (3.95), while 'Paper tests/questionnaires' obtained the lowest score (3.11) (Figure 7).

Tables 7 and 8 present the results obtained for the non-parametric tests performed to investigate possible significant differences between the groups regarding the sociodemographic variables studied in relation to the usefulness of learning methodologies, supports, and assessment formats. For the learning methodologies (Table 7), significant differences were observed between countries for practically all options, except for 'Monitoring of pilot farms'. For example, Italian participants attributed the lowest level of usefulness to 'Group work' (MR = 40.94) or 'Forum/Chat' (MR = 46.41), while attributing the highest usefulness to gamification (MR = 193.38) and to 'Short courses' (MR = 166.19). The differences according to age were only significant for 'Field visits' and for 'Short courses' (both options rated as less useful by older participants). Differences according to sex were also encountered for the same two learning methodologies, 'Field visits' and 'Short courses', which were preferred by female participants (mean ranks of 148.92 and 154.18, respectively). For education level, significant differences were found only for 'Gamification', with this methodology considered more useful by participants with a university degree (MR = 148.03). Finally, for the classes of income, significant differences were observed only for 'Lectures' and 'Short courses', with these being less valued by participants with the highest level of income (mean ranks of 95.28 and 92.63, respectively).

The results in Table 8 show that, once again, country differences were the most relevant, with significant differences for practically all analyzed learning supports and also for most of the assessment formats considered. While participants from Italy scored with 'E-books', 'Technical leaflets' and 'Educational games' as most useful (mean ranks of 159.09, 215.78 and 182.06, respectively), participants form Croatia rates attributed the highest mean scores to 'Interactive platforms', 'Videos' and "Specific programs or apps' (mean ranks of 153.60, 162.22 and 148.22, respectively). Age differences were significant for some of the learning supports, specifically 'E-books' and 'Educational games', which were less valued by older people (mean ranks of 105.81 and 95.52, respectively). The older participants also attributed lower usefulness to the assessment based on 'Tasks/reports' (MR = 103.27). Regarding sex, significant differences were found for some learning methodologies, such as 'Interactive platforms', 'Books/Paper manuals', and 'Educational games', with all these being more valued by female participants (mean ranks of 154.95, 162.52 and 140.69, respectively). The level of education showed significant differences only for 'E-books', with the highest level of usefulness assigned by participants with a university degree. Finally, significant differences

were observed according to income for the 'Educational games', which were less valued by participants with the highest income level (MR = 89.49).

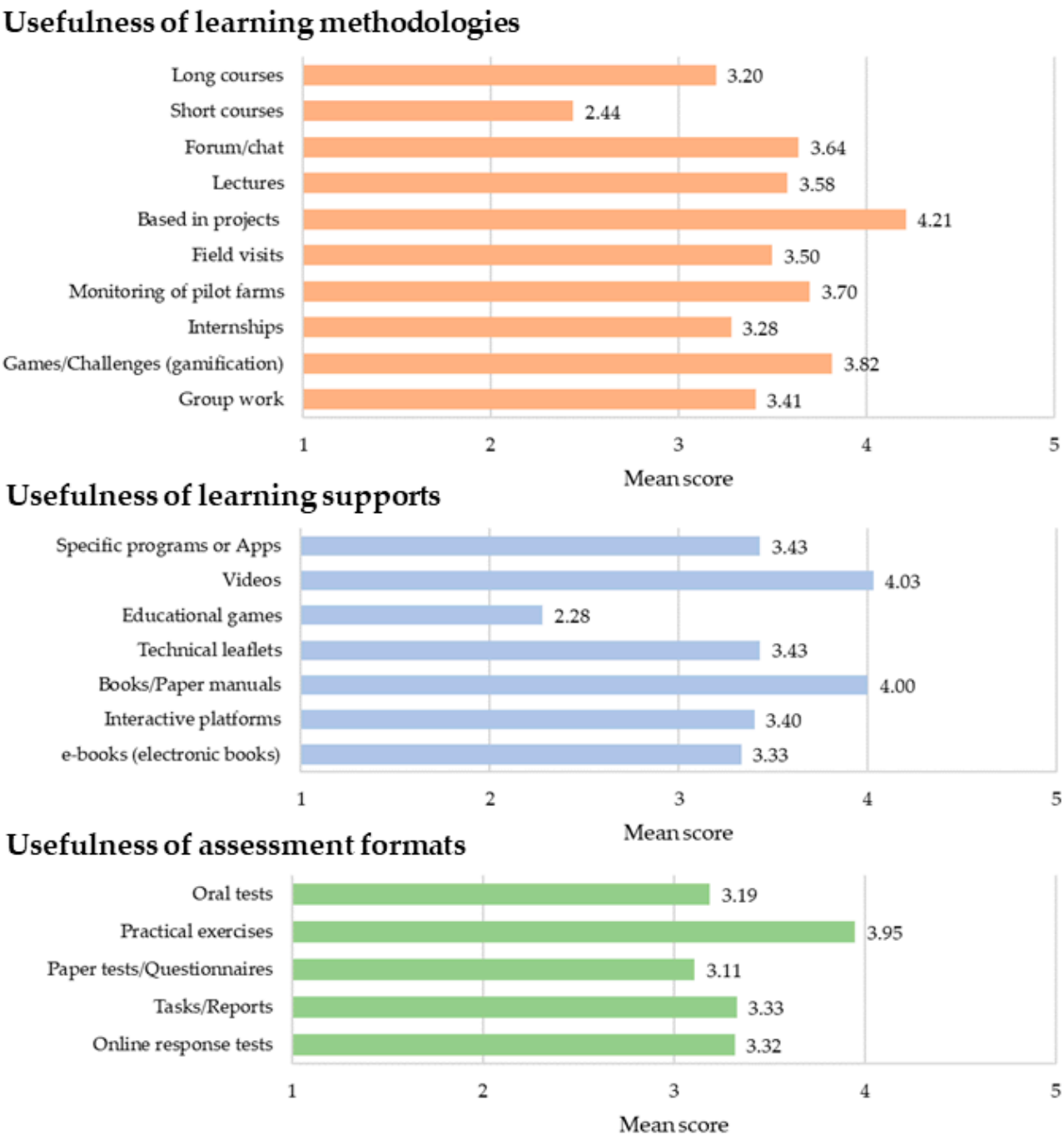

Figure 7. Rating the usefulness of learning methodologies, supports, and assessment formats.

Table 7. Group differences for the level of usefulness of different learning methodologies.

Variable	Group	Mean Rank and Significance									
		Group Work	Games/Challenges (Gamification)	Internships	Monitoring of Pilot Farms	Field Visits	Based in Projects	Lectures	Forum/Chat	Short Courses	Long Courses
Country	Portugal	130.34	149.65	140.58	153.01	129.26	161.87	158.47	120.76	133.19	140.14
	Estonia	169.98	135.42	107.61	136.18	124.58	107.71	123.86	146.88	109.79	91.57
	Norway	135.88	160.39	121.42	133.21	113.16	123.02	106.43	128.16	111.80	125.31
	Spain	139.41	159.95	154.04	126.13	141.22	164.62	147.15	178.30	122.88	136.64
	Italy	40.94	193.38	105.25	87.66	83.72	137.84	99.25	46.41	166.19	69.33
	Croatia	137.75	84.08	168.13	150.50	171.23	151.19	166.02	135.58	156.46	135.92
	Finland	150.57	153.87	115.33	154.27	131.83	161.20	127.80	104.36	142.63	155.18
	Sig. [1]	<0.001	<0.001	<0.001	0.064	<0.001	0.001	<0.00981	<0.001	0.005	<0.001
Age	18–30 y	120.66	132.81	119.14	132.34	124.75	162.84	141.98	136.36	150.34	104.17
	31–59 y	137.80	136.49	136.15	133.97	136.51	134.28	135.69	132.92	132.04	122.34
	60+ y	124.09	138.62	121.00	137.57	107.65	135.35	117.56	115.17	98.05	131.21
	Sig. [1]	0.335	0.947	0.285	0.941	0.048	0.140	0.249	0.281	0.002	0.257
Sex	Female	149.67	152.89	149.19	146.60	148.92	152.69	142.67	142.88	154.18	133.63
	Male	132.20	136.37	130.57	134.55	127.46	137.34	133.81	129.86	122.71	122.40
	Sig. [2]	0.104	0.123	0.086	0.260	0.046	0.143	0.407	0.220	0.003	0.290
Education	Secondary	136.58	118.80	133.36	133.08	122.88	136.05	136.48	131.25	127.01	124.10
	University	131.61	148.03	130.39	134.56	132.71	138.37	130.00	128.44	126.20	121.48
	Sig. [2]	0.599	0.002	0.752	0.874	0.289	0.799	0.488	0.762	0.929	0.770
Income	Low	113.55	115.83	122.95	118.97	122.66	132.21	128.74	121.75	137.60	113.84
	Medium	129.04	117.24	119.49	120.21	122.77	126.79	129.62	121.24	117.68	112.14
	High	111.98	138.49	108.59	118.89	101.54	109.13	95.28	106.33	92.63	105.77
	Sig. [1]	0.177	0.082	0.430	0.989	0.089	0.095	0.003	0.299	<0.001	0.752

[1] Kruskal–Wallis test (level of significance $p < 0.05$). [2] U-Mann–Whitney test (level of significance $p < 0.05$).

Table 8. Group differences for the level of usefulness of different learning supports and assessment formats.

Variable	Group	Mean Rank and Significance											
		Learning Supports								Assessment Formats			
		e-Books (Electronic Books)	Interactive Platforms	Books/ Paper Manuals	Technical Leaflets	Educational Games	Videos	Specific Programs or Apps	Online Response Tests	Tasks/Reports	Paper Tests/ Questionnaires	Practical Exercises	Oral Tests
Country	Portugal	122.66	139.03	115.88	159.03	122.31	129.42	131.84	120.58	112.42	140.28	138.47	111.08
	Estonia	121.53	109.62	151.77	58.38	94.86	154.53	93.56	135.66	135.68	130.39	170.34	142.22
	Norway	119.61	124.98	154.83	135.92	106.82	130.34	115.81	158.88	132.85	146.41	124.52	125.88
	Spain	127.04	150.55	136.20	138.42	76.26	151.26	137.11	123.50	145.96	109.88	162.50	126.17
	Italy	159.09	143.84	132.88	215.78	182.06	89.69	120.81	131.16	115.56	76.00	85.22	68.19
	Croatia	157.51	153.60	136.07	144.71	133.68	162.22	148.22	132.27	135.17	144.81	134.37	142.80
	Finland	128.00	125.35	153.19	129.08	131.46	154.08	115.62	146.04	117.21	158.00	133.64	111.77
	Sig. [1]	0.064	0.083	0.233	<0.001	<0.001	0.018	0.013	0.197	0.453	0.005	0.001	0.006
Age	18–30 y	116.69	128.23	131.86	138.37	136.45	125.79	122.73	107.83	115.48	125.61	143.19	142.30
	31–59 y	136.94	136.97	139.61	134.66	116.11	142.78	126.36	139.26	135.27	133.99	139.44	121.13
	60+ y	105.81	116.65	127.50	112.67	95.52	126.63	108.31	118.92	103.27	113.29	118.76	112.95
	Sig. [1]	0.020	0.238	0.547	0.154	0.037	0.255	0.326	0.048	0.016	0.215	0.187	0.204
Sex	Female	135.95	154.95	162.52	137.16	140.69	149.58	135.83	150.54	141.44	134.95	150.57	124.12
	Male	130.81	130.61	134.26	133.67	108.97	138.93	122.84	131.82	127.54	133.01	135.85	125.98
	Sig. [2]	0.635	0.029	0.009	0.746	0.001	0.320	0.211	0.081	0.182	0.854	0.165	0.855
Education	Secondary	115.90	124.12	133.86	135.57	115.94	132.64	118.72	116.40	122.04	129.86	137.85	125.32
	University	136.94	138.38	139.73	129.85	113.70	142.21	126.26	144.83	131.60	130.90	134.88	119.87
	Sig. [2]	0.024	0.131	0.530	0.543	0.798	0.304	0.378	0.002	0.298	0.911	0.750	0.544
Income	Low	115.60	122.94	122.94	131.51	123.13	127.14	116.16	105.50	109.22	122.65	124.17	111.72
	Medium	123.60	122.81	120.29	114.22	101.93	127.35	110.26	123.60	116.79	112.34	127.09	116.54
	High	107.32	108.10	129.31	114.09	89.49	115.22	112.34	130.85	118.11	120.65	113.17	96.90
	Sig. [1]	0.297	0.326	0.686	0.199	0.006	0.460	0.838	0.073	0.683	0.542	0.400	0.156

[1] Kruskal–Wallis test (level of significance $p < 0.05$). [2] U-Mann–Whitney test (level of significance $p < 0.05$).

4. Discussion

Education constitutes a privileged way to increase productivity and competitiveness in multiple business areas, including beekeeping. LL is relevant not only from the professional but also from the personal point of view, providing opportunities for self-development and continuous improvement. Allying LL with PT allows for a constant, or at least a regular, valorization of the individual and their skills and competencies, providing tools to become more resilient and successful in all areas of professional development. e-Learning takes the lead and will continue to play a prevailing role in the construction of educational management systems and related learning environments [19,23].

The integration of information technology (internet and other resources) and mobile devices used for learning (m-learning) with conventional education can have a significant impact on the improvement in LL capacity. It has been recommended that, particularly for rural environments, training programs for mobile education should address four main challenges related to the practical nature of the courses and specificity of learning environments, namely: scarce educational space and limited equipment; instructors and technicians with developed applied skills but without proper pedagogical support; the under-relevance attributed to parallel and additional experiences; unsatisfactory class management by the instructors and technicians. The agricultural sector and its related activities, such as beekeeping, are major contributors to the economies of many countries. Beekeeping, in particular, contributes through the great importance of bees as pollinators and regulators of biodiversity and ecosystems, and assumes an even greater role in global sustainability. Hence, a great challenge for the organizations teaching in this area might involve changes in the pedagogical methods adopted to address the needs and wishes of the students [24,25].

Despite the massive possibilities of distance learning methodologies having been acknowledged for many decades, it is also true that, until the year 2020, with the outbreak of COVID-19 pandemic, teaching methods continued to follow a mostly traditional approach based on in-person teaching inside a classroom. The pandemic brought an urgent need to shift rapidly from in-person learning systems to distance learning, supported by technology and digital content, causing an evolution not only in the technology itself but also in the didactic and pedagogical domains. Therefore, at present, professionals are more adapted to distance learning and innovative learning methodologies, as well as assessment formats [26–28].

Fischer et al. [23] describe a framework for reconsidering education, including novel components such as learning-on-demand or problem-based learning. The design of innovative learning approaches for the digital era entails meticulousness in designing learning experiences and evaluating them as a way to understand what effectively works, how it works, and why it works. The design of digital learning experiences is supported by multiple dimensions related to how learners interact with the digital tools they use, their learning environments, or services. These also relate to the pedagogical foundations leading to the established learning goals, the necessary activities to achieve those goals, and the chosen forms of assessment. Finally, it is necessary to investigate how learners interact with other peers and with instructors [29].

Distance learning tools for PT are particularly useful for active professionals, given their lack of time. Still, professionals feel a need to improve their knowledge, skills and competencies as a way to improve and expand their businesses and increase competitiveness, in addition to their natural desire to broaden their knowledge on certain topics [30–33].

Beekeeping is a complex activity once beekeepers manage upwards of 10,000 individual honeybees in a single colony. Honeybees are highly sensitive to environmental and seasonal changes and vulnerable to a range of diseases and pests. This makes beekeeping an activity that requires specialized skills and knowledge to ensure the health and productivity of honeybees [34].

In this work, beekeepers showed a preference for training needs on "Apiary health and pest control" and 'Colony management throughout the year". It can be explained by the high number of honeybee colonies lost every year and the beekeeper's will to increase the

productivity of their apiaries. Gray et al. [35] showed that Spain was the European country with the highest rate of colonies lost in the winter of 2019/2020, with 36.5%, followed by Slovenia (28.9%) and Portugal (22.5%). Varroosis is the most prevalent worldwide disease of honey bees, and an important cause of beehive loss, with a high economic impact on beekeeping activity [36]. Increasing beekeepers' knowledge of these two issues is crucial to improving beehives' productivity and, consequently, beekeepers' income.

Jacques et al. [37] highlighted beekeeper background and apicultural practices as the major drivers of honey bee colony losses and reinforced the need for beekeeper training to promote the best beekeeping practices. The research suggests that access to beekeeping training could be an important mechanism influencing honey productivity and beekeeping incomes [38–40].

Regarding training activities, beekeepers prefer "in person" courses, followed by "in workplace/internship", to b-learning or e-learning courses. Beekeeping requires mostly practical training, which can explain beekeepers' preference for training that is carried out "in person", rather than b-learning or e-learning. However, the classical modes of teaching cause beekeepers to fall into a passive learning pattern and increase the gap between the practice and theory [41].

Schouten and Caldeira [40] recommend that beekeeping training focus on practical skills' development over classroom theory-based activities. Concerning the preferred tools for distance learning, beekeepers prefer knowledge-based projects, followed by gamification, as learning methodologies. The preferred learning materials were videos and books. Finally, the preferred assessment form was based on practical exercises. E-learning involves online instruction without any face-to-face contact, and beekeepers can learn at their own pace with online resources [42]. Training through e-learning can be engaging and interactive, using videos, presentations, chat, library, and assessments, with the goal of maximizing the learner's experience in the beekeeping learning process [41].

Beekeeping training can be delivered in a range of modes, in-person, e-learning or b-learning. Independent of beekeepers' preferences, training is important to improve their knowledge and skills. According to Schouten and Lloyd [43], the learning programs should be adjusted in developing countries, considering the strong necessity of beekeeping knowledge and the limited conditions required to enable the implementation of bee management in the colonies.

Education and learning are important means of supporting the knowledge needed to improve beekeeping management and create value-added hive products due to the new techniques and technology being adopted [44,45]. Even in more developed beekeeping structures, evolution, research, and innovation are only possible with LL, which is provided by different formal and informal modalities [46]. In a study conducted in Nagano, Japan, by Uchiyama et al. [47], it was found that tacit knowledge within the family promotes explicit knowledge in an ageing society, leading to a relatively large number of bee colonies and a perception of the necessary ecological conditions for sustainable beekeeping. In fact, beekeepers' environmental knowledge remains the backbone of the activity's sustainability [48].

5. Conclusions

The results of this study indicated valuable directions to implement proper professional training for actors in the beekeeping sector. The topics of highest interest include the health of apiaries and control of pests affecting the apiaries and bee colonies, or the management of the colonies throughout the year, with different specifications according to the season. The beekeepers seek new information mostly through family but also through professional training, and the preferred forms of training include in-person courses, workplace training or internships. The learning methodologies they consider most useful include project-based learning and learning through gamification and related tools. With respect to the learning supports, videos and paper books or manuals are particularly valued, and the assessment format rated as most valuable is practical exercises. Another inveistigated

aspect was the effect of sociodemographic variables on the learning experiences and preferences of beekeeping actors, and in this respect, it was observed that the country was the most influential of the investigated factors.

The construction of courses adapted for mobile learning with adequate forms of assessment of the learning outcomes allows for the continuous updating of information, creation of knowledge, and development of skills that beekeepers consider essential for their activities. They want to take part in PT in topics they find crucial; therefore, the curriculum development needs to adapt to this reality. However, they find distance learning to be a useful means of training, but they recognize that complementing this with practical activities is necessary to achieve success, since these blended learning approaches bring together the best of the different approaches.

Author Contributions: Conceptualization, R.P.F.G.; methodology, R.P.F.G. and J.O.; software, R.P.F.G.; validation, R.P.F.G.; formal analysis, R.P.F.G.; investigation, R.P.F.G., C.A.C., H.E.C., B.D., R.R., R.K., L.T., S.B., E.B., I.S., M.O., C.C. and J.O.; resources, C.A.C.; data curation, R.P.F.G.; writing—original draft preparation, D.T.C., P.C., J.O., C.C. and R.P.F.G.; writing—review and editing, R.P.F.G.; visualization, R.P.F.G.; supervision, R.P.F.G.; project administration, C.A.C.; funding acquisition, C.A.C. All authors have read and agreed to the published version of the manuscript.

Funding: This research was funded by project beeB—Foster for beekeeping bridges through innovative and participative training (ref. ERASMUS+ 2019-1-PT01-KA202-060782). The APC was funded by FCT—Foundation for Science and Technology, I.P., within the scope of the project Ref. UIDB/00681/2020.

Institutional Review Board Statement: This research was implemented taking care to ensure all ethical standards and followed the guidelines of the Declaration of Helsinki.

Informed Consent Statement: Informed consent was obtained from all subjects involved in the study.

Data Availability Statement: Data are available from the first author (R.P.F.G.) upon reasonable request.

Acknowledgments: This work was developed under project beeB—Foster for beekeeping bridges through innovative and participative training (ref. ERASMUS+ 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.

Conflicts of Interest: The authors declare no conflict of interest.

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