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Impacts of learning experiences within an online extension initiative on application of research-based principles by beef stakeholders

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Abstract

The objective of this study was to evaluate, characterize and quantify the learning experiences and subsequent application of research-based technologies by beef producers upon conclusion of an online extension certification program (44 Farms International Beef Cattle Academy, IBCA). Upon conclusion of the program, participants were invited to complete a structured interview. Interview transcripts (n = 19) were coded, categorized, and merged into four overarching themes: *Strengths*, *Struggles*, *Courses*, and *Geographical origin*. Within *Strengths*, the most frequent codes were *Connections*, *Application*, and *Instructor Experience*, with 61, 53, and 50 coded segments respectively. Within *Struggles*, the most frequent codes were *Time Management*, *Level of Knowledge*, and *Language issues*, with 27, 18, and 15 coded segments, respectively. For *Courses* in the program, the most frequently mentioned were *Nutrition, Reproduction,* and *Genetics*, with 35, 28, and 24 coded segments respectively. Correlation between codes was evaluated using Pearson and only statistically significant ($P \leq 0.05$) correlations were included in the matrices for network analysis. Interpretation of the generated network analysis map ($P \leq 0.05$; $Q = 0.468$) including all four categories of codes revealed close relationships between *Application* and the *Strengths* of *Time management, Instructor Experience,* and *Connections. Application* was also directly related to the *Courses* of *Reproduction* and *Genetics*, and the *Struggle* of *Student Engagement and Guidance. Geographical origin* was an important factor mediating different correlations. Developing countries (Brazil, Panama, Dominican Republic, and South Africa) were more closely related to the *Struggle* of *Tuition* cost, which, in turn was related to the perceived *Prestige* of the program. In Europe (Romania, Germany, and Kazakhstan), a stronger correlation to the *Struggles* of *Material Relevance* and *Language Issues* was described. Collectively, these results support the positive impact of a comprehensive and interactive extension initiative to leverage application of research-based principles by beef stakeholders around the world. Further, these outcomes indicate that the most valued aspects of the program regarding application are related to interpersonal experience with faculty and peers of the industry (*Instructor Experience* and *Connections*) and that perception of struggles and strengths is greatly influenced by socio-cultural aspects of the learning community.

Key words: application, extension, international, online education, research-based

Introduction

In general, educational initiatives within beef extension programs consist of brief and punctuated events such as workshops, conferences, field days, webinars, and more recently social media posts (Barton et al., 2017; Nelson and Llewellyn, 2018). Despite being informative and useful in many ways, these activities present limited opportunities for meaningful interactions among instructors and learners (Nelson and Llewellyn, 2018).

The relationship between community building, sense of self-belonging, and engagement of learners in meaningful construction of knowledge is well documented in the literature (Chuang, 2021). Thus, the commonly chosen avenues for extension education (workshops, conferences, field days, webinars, and social media accounts) may not be the most effective in fostering true engagement of participants and supporting the formation of a learning community and consequently, construction of knowledge.

As a reflection of this, there is an overall superficial engagement from beef stakeholders in extension programs resulting in an unsatisfactory adoption of novel technologies, which is often placed as an important cause for limiting the productivity potential of livestock operations (Braund, 1995). Thus, strategies to enhance application of research-based principles by beef producers and other stakeholders of the industry are warranted.

Based on the presented, we hypothesized that relevant learning experiences will have a positive impact on application of research-based principles by beef stakeholders. To evaluate this hypothesis, the objective of this study was to investigate perceptions of beef stakeholders as learners in an online, international, and comprehensive extension program. The approach proposed herein aims to elucidate motivations leading to application of scientific concepts with the goal of developing strategies to improve the effectiveness of similar extension initiatives.

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Materials and Methods

Extension Program Design

The program utilized as the object of this study (44 Farms International Beef Cattle Academy, IBCA) is an online extension certification hosted by Texas A&M AgriLife Extension and Texas A&M AgriLife Research, through the Department of Animal Science from Texas A&M University, located in College Station, TX. The program was established in the Fall of 2018 and runs in annual cycles, from late September to early August. It consists of eight courses in different subjects related to beef cattle production:

1) Global Beef Production
2) Cattle Welfare and Behavior
3) Forage Production and Utilization
4) Nutritional Management and Requirements
5) Reproductive Physiology
6) Breeding and Genetics
7) Health and Immunology
8) Beef Quality and Safety

These courses ran independently but were designed to form a cohesive and complementary body of knowledge to provide participants with research-based principles and novel technologies on beef cattle production.

Each course was held for 4 to 5 wk, in a completely online setting. Each course was composed of pre-recorded video lectures, supplemental materials such as publications and open access books, and weekly nonmandatory 1-h long live sessions with the respective leading instructor and peers. Materials were provided to participants via a Learning Management System (LMS; Brightspace, D2L, Kitchener, ON, Canada) and the live sessions were hosted and recorded using a virtual meeting software (Zoom, Zoom Video Communications, Inc.). Recordings of these live interactive sessions were made available in the LMS along with other materials. Upon completion of each course over the period of 4 to 5 wk, a new course was initiated, with availability of new LMS site and scheduling of upcoming live interactive sessions, but participants still had access to previous course materials and instructors.

Weekly quizzes divided courses into 4 to 5 topics containing approximately 3 to 5 h of pre-recorded video lectures each. Materials for each topic were conditionally released upon obtaining a score of 80% or more in the previous weekly quiz, which allowed students to progress independently through the topics within each course. Weekly quizzes were set to show participants correct and incorrect answers upon conclusion and allowed them to have unlimited attempts.

The program also contained an experiential learning period, held in a completely in-person format. During the first week (Monday to Friday) of August, participants were invited to campus where they participated in workshops and field visits relating the course materials to real-life scenarios focused on application of knowledge. This experiential learning period also had an informal social and networking aspect in which participants were exposed to their own program peers and many other stakeholders of the beef industry to whom they could ask questions and exchange ideas with.

More specifically, during the Experiential Learning Period participants were enrolled in the Texas A&M Beef Cattle Short Course, which took place in the first three days of the week (Monday, Tuesday, and Wednesday). During these 3 d participants could engage in varied extension and learning activities of their own choosing, such as live demonstrations of low-stress handling of cattle, safe herbicide applications, and beef quality evaluation workshops. A selection of lectures by specialists about multiple themes related to beef cattle production was also available for participants to attend during the Short Course. On Thursday the activities involved forage quality evaluation and field visit to a reproductive technology facility located in Navasota, TX. Finally, on Friday, participants visited 44 Farms and learned about the history of the operation the technologies utilized to improve the genetic potential of their animals, and some of their marketing strategies. During the entire period, participants had the opportunity to interact and network with faculty members and stakeholders of the beef industry.

The design decisions for this program were made considering the characteristics of the targeted learner audience, a pool of participants diverse in socio-cultural aspects, but sharing the profile of nontraditional higher education students. A nontraditional higher education student is defined as an individual who fulfills one or more of the following requirements: 1) is 25 yr of age or older; 2) has not received degree-earning education in the last 5 yr; 3) holds a role as parent, spouse, caretaker, or paid worker. Traditional students can be defined as individuals typically between 18 and 24 yr of age who have recently received degree-earning education and whose main time commitment is dedicated to student duties (Tilley, 2014; Markle, 2015). Asynchronous materials that can be accessed at the learner's convenience and pace have been shown to be more adaptable to nontraditional students' lifestyle and adequate to mature learners who are more intrinsically motivated compared to younger, traditional college students (Merriam, 2001). In contrast, peer and instructor frequent interaction are supported as valid ways to scaffold deeper learning and an overall more satisfactory educational experience (Cotten and Wilson, 2006).

Data Collection

Approximately 1 mo prior to conclusion of the program and potential visit to campus, participants were invited to provide feedback via structured interview containing the following questions:

1) Why did you initially sign up for IBCA?
2) What were your expectations?
3) Talk about the quality of speakers and courses.
4) Who were your favorite instructors/speakers and why?
5) What was your favorite course and why? What did you gain from the course?
6) Was the program a worthwhile investment?
7) Did you implement or plan to implement anything you learned from the program?
8) Was remote learning a good fit for you? Why or why not?
9) Do you have any further comments, critiques, or suggestions?

A total of 32 participants from three different annual cycles of the program (2019, 2020, and 2021) were invited to provide interviews and, from those, 19 accepted the invitation. There were 8 interviews provided from the 11 participants who completed the program in 2019; 3 from the 4 participants

Table 1. Characteristics of transcript segments according to respective code assignment

Codes within categories	Characteristics of coded segments
Strengths	
STRNGTH —connections	Mentions about value of networking, meeting people or interacting with faculty and peers during the courses
STRNGTH—application	Mentions about application of concepts of the courses in their operations or within their role as stakeholders of the beef industry
STRNGTH—instructor experience	Experiences with instructors are mentioned in a positive way
STRNGTH—scientific concepts	Positive mentions of learning scientific concepts and/or research data associated with field practices
STRNGTH—information design	Positive mention about aspects of course materials
STRNGTH—practical examples	Positive mention of practical examples provided by instructors to support learning
STRNGTH—fair investment	Tuition cost is referred to as a fair investment
STRGNTH—prestige	Positive mention of recognition about instructors, institutions, and reputation of the program
STRNGTH—time management	Positive mention of how participants can manage their time during courses, such as adequacy of the workload or timeless access to course materials
STRNGTH—effective delivery	Positive mention of the online format of the program
Struggles	
STRGL—time management	Negative mention of how participants can manage their time during courses, such as inadequacy of the workload or fast-paced nature of lessons
STRGL—level of knowledge	Negative mention of the depth of knowledge of the courses, mainly as material being too advanced or complex
STRGL—language issues	Difficulty with aspects of the English language, mainly use of jargon and accent of instructors
STRGL—student engagement —guidance	Difficulty with other peers not engaging and need for more guidance during the courses
STRGL—information design	Difficulties with material style, format, or presentation
STRGL—material relevance	Lack of relevance of materials for that participant, mainly due to socioeconomic and environmental differences
STRGL—tuition	Tuition cost is mentioned as a difficulty for being too expensive
STRGL—technical, technology issues	Technological challenges are mentioned as a difficulty
STRGL—COVID, travel restriction	Difficulties imposed by the COVID-19 pandemic

who completed the program in 2020 and 8 from the 12 participants who completed the program in 2021.

Nineteen (n = 19) interviews were performed remotely using Zoom and recorded with participant consent, provided both via a written form and again, verbally, before the recording was effectively initiated. Participants (n = 19) were then prompted with each of the questions and allowed to provide a response. Each participant provided one single interview for this study and the audios of these interviews were recorded and are securely stored. Interviews were approximately 30 to 40 min in length, ranging from 20 min to 1 h. The duration of each interview was determined by the participants' disposition, with not a minimum nor a maximum time duration required by the interviewer. No minimum or maximum time duration for any of the questions was established and participants were allowed to provide information at their own discretion and will. All procedures described herein, and other aspects of participant recruitment and consent have been submitted to, and approved by an Institutional Board Review of Texas A&M University (IRB2021-1320D).

Data Processing

Audio files were transcribed into text using an artificial intelligence software (Otter.ai, Otter Voice Meeting Notes, Los Altos, CA). From these text documents, the portions corresponding to the responses from the interviewees were coded by a trained individual using a software program for computer-assisted data analysis of text and multimedia-based data (MAXQDA Analytics Pro 2022, VERBI Software, Berlin, Germany). Both inductive and deductive coding methods were utilized as described in the literature (Fereday and Muir-Cochrane, 2006). Codes were categorized into four categories: *Strengths* (STRNGTHS), *Struggles* (STRGL), *Courses* (COURSE), and *Geographical origin* (GEO). Explanation of specific characteristics of coded segments in the categories *Strengths* and *Struggles* are described in Table 1. In the category *Courses*, segments containing mentions of specific courses in the program were included in the code corresponding to the respective course.

For the *Geographic origin* category transcripts were grouped according to country of origin of respective participants, considering similar environmental and socioeconomic conditions (Table 2). Participants from Brazil (n = 4), Panama (n = 1), Dominican Republic (n = 1), and South Africa (n = 1) were coded under *GEO—Developing countries* (n = 7). Participants from United States (n = 6) and Canada (n = 1) were coded under *GEO—North America* (n = 7). Participants from Germany (n = 1), Romania (n = 2), and Kazakhstan (n = 2) were coded under *GEO—Europe* (n = 5). And participants from Australia (n = 2) were coded under the code *GEO—Australia*.

The entire codebook and code system were revised by two additional trained individuals to ensure quality and soundness of data. Coded segments without a unanimous consensus among all three evaluators were removed from the data.

Table 2. Code frequency within each category

Codes within categories	Frequency of coded segments
Strengths	
STRNGTH—connections	61
STRNGTH—application	53
STRNGTH—instructor experience	50
STRNGTH—scientific concepts	46
STRNGTH—information design	38
STRNGTH—practical examples	32
STRNGTH—fair investment	31
STRGNTH—prestige	30
STRNGTH—time management	24
STRNGTH—effective delivery	16
Struggles	
STRGL—time management	27
STRGL—level of knowledge	18
STRGL—language issues	15
STRGL—student engagement —guidance	10
STRGL—information design	8
STRGL—material relevance	8
STRGL—tuition	7
STRGL—technical, technology issues	6
STRGL—COVID, travel restriction	3
Courses	
COURSE—nutrition	35
COURSE—reproduction	28
COURSE—genetics	24
COURSE—forage	22
COURSE—welfare	16
COURSE—global beef production	7
COURSE—health and immunology	6
COURSE—beef quality	3
Geographical origin	
GEO—developing countries	7
GEO—North America	7
GEO—Europe	5
GEO—Australia	2

Statistical, Semantic Network and Cluster Analyses

Correlations between codes within categories were analyzed using Pearson Product-Moment Correlation of MAXQDA (Kuckartz and Rädiker, 2021). More specifically, frequency of codes in each document (i.e., transcribed interviews) were utilized as variables to generate the correlation coefficients (r) calculated by MAXQDA (Kuckartz and Rädiker, 2021), which are provided in the form of a table output displaying correlation coefficients, P-value and number of documents analyzed, for each and all pair of codes analyzed. This results table produced by MAXQDA is then processed using a spreadsheet software (Microsoft Excel, Microsoft 365, Redmond, WA) to generate matrices containing only the correlation coefficients from the significative ($P \leq 0.05$) correlations. An example of a correlation matrix is illustrated in Figure 1.

Correlation matrices were then utilized for the creation of semantic network maps using UCINET with Netdraw (Borgatti et al., 2009). Creation of network maps was based on generation of clusters using the Girvan–Newman algorithm (Girvan and Newman, 2002). Number of clusters within the map was determined using the highest Q value as deciding criterion (Rousseau and Zhang, 2008). Betweenness was elected as the centrality measure for each variable, which is reflected by node size, as well as for the entire map, reflected by the reported resulting Q-value (Rousseau and Zhang, 2008).

Results and Discussion

Code Frequencies

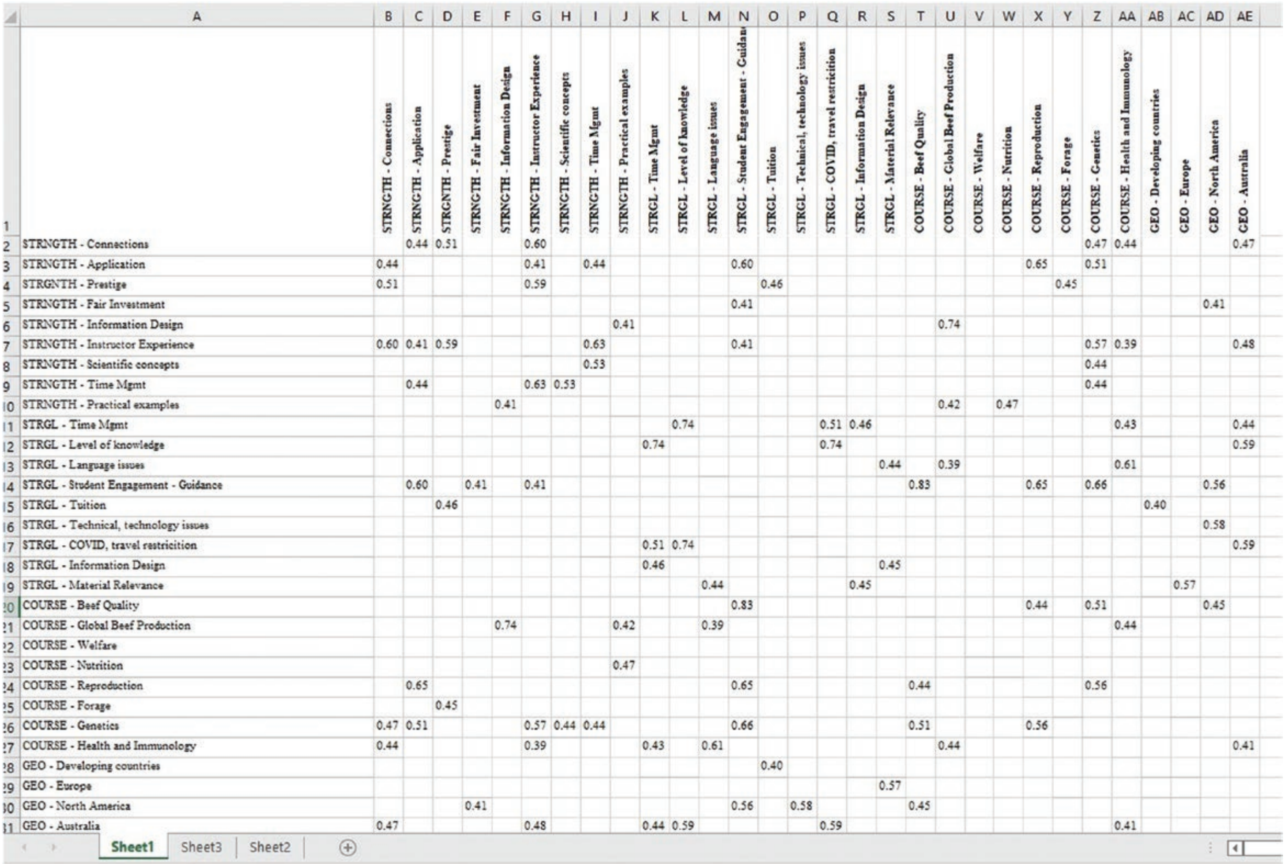
Code frequencies within each category are described in Table 2. As expected by design, *STRNGTH—Application* was among the most frequently used codes, cited 53 times. Participants were specifically probed to comment on application of knowledge constructed during the program on questions 5, 6, and 7. Another frequently mentioned aspect of the program was *STRNTGH—Instructor Experience*, with 50 coded segments. This was also expected because participants were directly asked about instructors on questions 3 and 4. In contrast, the code with greater frequency of all, *STRNGHT—Connections*, with 61 coded segments, was not directly addressed in any of the questions.

Within the category *Struggles*, the most frequently used codes were *STRGL—Time Management; STRGL—Level of knowledge,* and *STRGL—Language issues*, with 27, 18, and 15 coded segments, respectively. In the category *Courses, the* most frequently coded were *COURSE—Nutrition, COURSE—Reproduction,* and *COURSE—Genetics,* with respectively 35, 28, and 24 coded segments each.

These code frequencies are supportive of our hypothesis, as aspects of a relevant learning experience, such as positive interactions with peers and instructors (*STRNGHT—Connections* and *STRNTGH—Instructor Experience)* were frequently mentioned by participants, alongside with aspects of application of knowledge (*STRNGTH—Application*). The difficulties reported by the participants, represented by the category *Struggles,* provide an overview of aspects that could be modified in the program and serve as consideration for other extension programs when designing comprehensive online courses.

Regarding codes in the *Courses* category, frequently utilized codes perhaps represent courses in which participants found greater interest. Feed costs and reproductive success are important drivers of overall profitability in beef cattle operations (Ramsey et al., 2005; Rodgers et al., 2012). Genetic selection utilizing novel technologies such as genomic testing is an efficient strategy to increase genetic merit and value of commercial herds (Berry et al., 2016). These are some possible justifications for the increased interest of participants in these courses (Nutrition, Reproduction, and Genetics), compared to, for example, Health and Immunology, in which the benefit of preventive health measures may be less evident.

Another possible cause for greater interest from participants in specific courses is the effect of instructor. Instructor's behaviors and teaching strategies have been reported to influence students' learning experience and perception of courses (Martin et al., 2018). However, data was not coded for specific instructors in the present study and such mentions were coded under their respective course and or *Instructor*



	STRNGTH - Connections	STRNGTH - Application	STRGNTH - Prestige	STRNGTH - Fair Investment	STRNGTH - Information Design	STRNGTH - Instructor Experience	STRNGTH - Scientific concepts	STRNGTH - Time Mgmt	STRNGTH - Practical examples	STRGL - Time Mgmt
STRNGTH - Connections		0.44	0.51			0.60				
STRNGTH - Application	0.44					0.41		0.44		
STRGNTH - Prestige	0.51					0.59				
STRNGTH - Fair Investment										
STRNGTH - Information Design									0.41	
STRNGTH - Instructor Experience	0.60	0.41	0.59					0.63		
STRNGTH - Scientific concepts								0.53		
STRNGTH - Time Mgmt		0.44				0.63	0.53			
STRNGTH - Practical examples					0.41					
STRGL - Time Mgmt										
STRGL - Level of knowledge										0.74
STRGL - Language issues										
STRGL - Student Engagement - Guidance		0.60		0.41		0.41				
STRGL - Tuition			0.46							
STRGL - Technical, technology issues										
STRGL - COVID, travel restricition										0.51
STRGL - Information Design										0.46
STRGL - Material Relevance										
COURSE - Beef Quality										
COURSE - Global Beef Production					0.74				0.42	
COURSE - Welfare										
COURSE - Nutrition									0.47	
COURSE - Reproduction		0.65								
COURSE - Forage			0.45							
COURSE - Genetics	0.47	0.51				0.57	0.44	0.44		
COURSE - Health and Immunology	0.44					0.39				0.43
GEO - Developing countries										
GEO - Europe										
GEO - North America				0.41						
GEO - Australia	0.47					0.48				0.44

	STRGL - Level of knowledge	STRGL - Language issues	STRGL - Student Engagement - Guidan	STRGL - Tuition	STRGL - Technical, technology issues	STRGL - COVID, travel restricition	STRGL - Information Design	STRGL - Material Relevance	COURSE - Beef Quality	COURSE - Global Beef Production
STRNGTH - Connections										
STRNGTH - Application			0.60							
STRGNTH - Prestige				0.46						
STRNGTH - Fair Investment			0.41							
STRNGTH - Information Design										0.74
STRNGTH - Instructor Experience			0.41							
STRNGTH - Scientific concepts										
STRNGTH - Time Mgmt										
STRNGTH - Practical examples										0.42
STRGL - Time Mgmt	0.74					0.51	0.46			
STRGL - Level of knowledge						0.74				
STRGL - Language issues								0.44		0.39
STRGL - Student Engagement - Guidance									0.83	
STRGL - Tuition										
STRGL - Technical, technology issues										
STRGL - COVID, travel restricition	0.74									
STRGL - Information Design								0.45		
STRGL - Material Relevance		0.44					0.45			
COURSE - Beef Quality			0.83							
COURSE - Global Beef Production		0.39								
COURSE - Welfare										
COURSE - Nutrition										
COURSE - Reproduction			0.65						0.44	
COURSE - Forage										
COURSE - Genetics			0.66						0.51	
COURSE - Health and Immunology		0.61								0.44
GEO - Developing countries				0.40						
GEO - Europe								0.57		
GEO - North America			0.56		0.58				0.45	
GEO - Australia	0.59					0.59				

	COURSE - Welfare	COURSE - Nutrition	COURSE - Reproduction	COURSE - Forage	COURSE - Genetics	COURSE - Health and Immunology	GEO - Developing countries	GEO - Europe	GEO - North America	GEO - Australia
STRNGTH - Connections					0.47	0.44				0.47
STRNGTH - Application			0.65		0.51					
STRGNTH - Prestige				0.45						
STRNGTH - Fair Investment									0.41	
STRNGTH - Information Design										
STRNGTH - Instructor Experience					0.57	0.39				0.48
STRNGTH - Scientific concepts					0.44					
STRNGTH - Time Mgmt					0.44					
STRNGTH - Practical examples		0.47								
STRGL - Time Mgmt						0.43				0.44
STRGL - Level of knowledge										0.59
STRGL - Language issues						0.61				
STRGL - Student Engagement - Guidance			0.65		0.66				0.56	
STRGL - Tuition							0.40			
STRGL - Technical, technology issues									0.58	
STRGL - COVID, travel restricition										0.59
STRGL - Information Design										
STRGL - Material Relevance								0.57		
COURSE - Beef Quality			0.44		0.51				0.45	
COURSE - Global Beef Production						0.44				
COURSE - Welfare										
COURSE - Nutrition										
COURSE - Reproduction					0.56					
COURSE - Forage										
COURSE - Genetics			0.56							
COURSE - Health and Immunology										0.41
GEO - Developing countries										
GEO - Europe										
GEO - North America										
GEO - Australia						0.41				

Figure 1. Illustration of the matrix feeding the network analysis. All correlations displayed on the table were statistically significant ($P \leq 0.05$). Values in each cell represent r value of correlation between horizontal and vertical cross sections. Top row and first column represent codes within each category. Category codes are represented by the first capitalized word. Codes which did not correlate to any others were excluded from the figure.

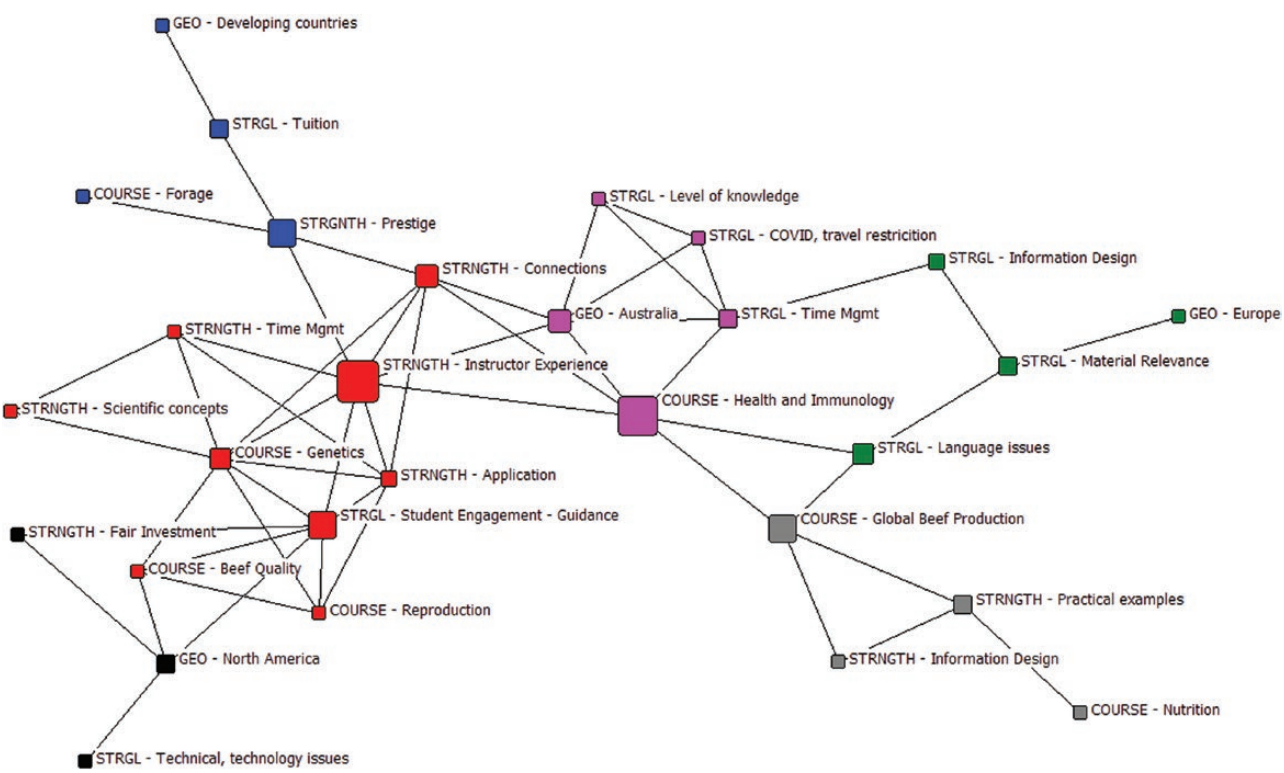


Figure 2. Network analysis map generated from the symmetrical correlation from the codes of interview transcripts ($P \leq 0.05$; $Q = 0.46$).

Experience to preserve the privacy of faculty members instructing the courses.

Network Map and Cluster Analysis

The network analysis of correlations at $P < 0.001$ and $P < 0.01$ did not yield maps with relevant interpretations, more specifically, these maps did not produce enough clusters or connections and between nodes to contribute to the elucidation of our hypothesis, so these results are not reported herein. However, the network analysis of correlations at $P \leq 0.05$ yielded a satisfactory network map, containing six different clusters with $Q = 0.468$ through Girvan–Newman analysis (Figure 2). As shown in Figure 2, node color represents different clusters and node size represents betweenness centrality, with larger nodes having higher values for this parameter. Nodes are labeled with their corresponding category and code. Isolated nodes not belonging to any of the clusters, (*STRNGTHS—Effective delivery* and *COURSE—Welfare*) were removed from the map.

In the blue cluster, it is possible to observe the close relationship between developing countries and the difficulty with the cost of tuition, which in turn is related to the perceived prestige of program, showing an interesting dynamic between monetary and epistemic value. Also, the course on Forage Production and Utilization appears as a relevant subject, which can be attributed to the predominantly pasture-based nature of cattle production in the countries represented in this cluster (Brazil, Panama, Dominican Republic, and South Africa).

Contrarily, in the green cluster on the opposite side of map, participants from Europe showed difficulty with finding relevance on some aspects of the material. We interpret this result as due to many environmental, socioeconomic, and cultural differences between the beef industry in these countries (Romania, Germany, and Kazakhstan) and the practices in United States, which were the foundation for most of the materials. Other difficulties related to the material relevance are the informational design and issues with the English language, which are, in their essential nature, related amongst themselves, as they impact complete mastery of materials, which may prevent learners to appreciate its relevance.

The grey cluster presents two courses (Global Beef Production and Nutritional Management and Requirements) which were successful in providing both practical examples and informational design appreciated by the participants. Such results are insightful for future program development, as they indicate that practical examples are an important component of constructing relevant learning experiences in extension settings.

The pink cluster is predominantly represented by difficulties more closely related to individuals in Australia. High complexity of materials, differences in time zone, and feelings of isolation due to the COVID-19 pandemic are some of the interpretations from the emerging themes identified in this cluster. These difficulties probably affected the learning experiences of these participants in a negative way. However, the node referent to the Health and Immunology course is also present in this cluster and, as denoted by its enlarged size, it has an important linking role between different clusters. While the Health and Immunology course is directly related to challenges with time management and language comprehension, it is also related to the core strengths of positive experiences with the instructors and the networking and interpersonal connections gained from the program. These findings are curious, as their dual nature is an illustration of the complexity of learning experiences studied through network and cluster analysis, corroborating previous findings (Ohsaki and Oshima, 2021).

On the bottom left corner of the figure, the black cluster is represented by nodes with low linking relevancy between other clusters, denoted by their small size. Interestingly, in this cluster it is possible to observe that the perception of an educational initiative as an investment is more strongly expressed by participants in North America, where the concept of tuition is more common and well accepted. Also, this node (*STRNGTH—Fair Investment*) is distant from the ideas of prestige and difficulties with tuition costs, which indicates that, according to the data, these are perceived differently by the participants.

Finally, located on the center-left portion of the map, between the black, blue, and pink clusters, is the red cluster containing the core node for the main hypothesis of this study, relating to application of research-based technologies (*STRNGTH—Application*). The largest node in this cluster is referent to positive experiences, or more specifically, when the relationship and expertise of the different instructors were perceived as a strength by the participants. Not surprisingly, this node was also connected to other aspects of the program perceived positively, such as networking and interpersonal connections (*STRNGTH—Connections*) and flexibility in the time management.

Another interesting finding in this cluster includes the positive perception towards scientific concepts and research details leading to practical recommendations shared in the program (*STRNGTH—Scientific concepts*). These results corroborate literature in the learning sciences, which has demonstrated that learners enabled to construct their own knowledge have overall better learning experiences (Narayan et al., 2013; Mann and MacLeod, 2015). More specifically, in this study, when instructors shared with participants the scientific principles and reasoning supporting practices adopted by the beef industry, there is a solidification of a functional learning community in which participants can exchange and relate their experiences to the material (Vescio et al., 2008). As previously described, the comprehensive and personal design of this program was chosen to better serve the target audience of non-traditional students (Tilley, 2014). However, according to the data, this environment was also inducive of constructivist learning, in which construction of knowledge by these learners is evidenced through real-life application of the taught research-based principles.

Summary and Conclusion

The code frequency and the further network and cluster analysis of this data demonstrate the importance of interpersonal relationships in the construction of knowledge within an agricultural extension scenario. Participants perceived connections with peers and instructors as highly positive to their overall learning experience, which translated as increased application of technology into their own realities.

Socioeconomic, environmental, and cultural backgrounds of participants had a great influence on how strengths and weaknesses of the program were experienced. Regarding evaluation of extension initiatives, these results are novel and relevant, especially considering that educational efforts to increase efficiency of animal agriculture may become more globalized in upcoming years.

Collectively, these results support our hypothesis that relevant learning experiences have a positive impact on construction of knowledge, here translated as application of research-based principles by the participants. This study also corroborates with findings of others on the complexity of learning (Donaldson and Allen-Handy, 2023) translated herein in the duality of aspects which were perceived as both strengths and weaknesses of the program depending on learner view and context (i.e., informational design and time management). More research is warranted to investigate how other aspects not evaluated herein may influence learning experiences and relate to application and to compare these findings with those of programs based, for example, in other institutions or on different subjects.

Conflict of Interest Statement

The authors Alice P. Brandão, Reinaldo F. Cooke, G. Cliff. Lamb, and Ky G. Pohler were involved in the ideation, design, and development of the extension program object of this study (44 Farms International Beef Cattle Academy, IBCA). At the time of this publication, the authors Alice P. Brandão, Reinaldo F. Cooke, and Ky G. Pohler served as coordinators of the program.

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