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Evaluation of Cognitive Learning in an Academic Webinar in Agriculture

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ABSTRACT: The paper mapped the webinar content to evaluate its influence on participants' progress in cognitive learning on synchronous online platforms that facilitated a multidimensional structural learning process. A quasi-experimental research design was followed in analyzing the transcripts recorded from the three-day academic webinar attended by 630 participants, which was coded into significant themes and the frequency of codes recorded to validate the content coverage using MAXQDA software. The cognitive learning of the participants was calculated as the difference between post- and pre-evaluation test scores. Pre- and post-evaluation knowledge test scores of participants conducted on selected themes showed webinars to be effective in enhancing the knowledge level of participants across age, professional status and gender, with the most significant improvement in students and young professionals related to hybrid breeding correlating the content coverage. It has aided pedagogical characterisation and progress in the effectiveness of online learning environments. Contributes to the metacognition domain of cognitive learning theory in the emerging context of online learning, specifically to the information process theory. Address the research gap on effective planning and design of e-learning content in agricultural education.

Keywords: Academic webinar, Content analysis, Cognitive learning, tropical vegetables, Knowledge test.

INTRODUCTION

The COVID-19 pandemic has disrupted the lives and livelihoods of humankind globally. In the adaptation process, lockdowns and social distances became the norm, with all institutions, including schools and colleges, remaining closed indefinitely since March 2020. Soon, most of them adopted online educational methods using ICT tools and resumed academic programmes virtually. This made the education sector witness unprecedented transformation with seamless technology integration to build a unified learning system, especially in countries like India. The developments have altered the educational environment of schools and universities mostly into virtual learning mode. This has resulted in a distinctive rise in innovative instructional technologies such as e-learning platforms, flipped classrooms and e-resources in education (Bhati *et al.,* 2020). Webinars have emerged as one of the most common formats, especially in higher education systems (Ulyanishcheva and Zakharova 2020). It represented the digital version of seminars, which use video-conferencing software to transmit the learning content digitally across the globe in real-time and work in a Multi-Media (MM) learning format. The significance of webinars in academic forums has been that they enabled in retaining the much-needed human interface by facilitating synchronous learning wherein the participants could interact ubiquitously in MM formats of text, video or audio chat. However, some reports suggest issues related to the digital divide, digital illiteracy and unequal distribution of ICT infrastructure, especially from developing countries like India, impede the effective use of webinars (Mohalik and Poddar 2021). These mixed results of the impact of webinars on learning called for more validation studies that assess its impact on learning effectiveness.

Theoretically, learning focuses more on cognitive psychological processes related to knowledge gain and understanding through the senses, experiences, and thoughts. As such, cognitive psychology also formed one of the core dimensions of virtual learning.

However, though many educational studies in cognitive psychology are available, its application in virtual learning systems has been limited. According to Wang and Hsu (2018), the advantages attributed to the use of webinars are a multitude and include low cost, unlimited participants, collaborative and discussion-based learning, access to web resources and the ability to save for future use. However, it provided limited opportunities to promote the emotional connection between participants that could influence interactions in learning contexts and dissemination of practical skills in webinars was found difficult (Pan and Sullivan 2005). A meta-analysis study on webinars found them to be more effective than asynchronous learning management systems and classroom instruction equally for learners in higher education and professional training (Gegenfurtner and Ebner 2019). They also found webinars to focus on declarative knowledge or procedural skills, when learning was assessed with knowledge tests or performance ratings, and when webinar events were sequenced over multiple occasions or cast as single events. The Cisco WebEx platform was positively associated with participants' gain scores compared to other learning platforms studied. Gegenfurtner *et al*. (2019) also evaluated participants' reactions to webinar-based training. They reported that the trainees preferred webinars for their ability to deepen their content knowledge, virtual consultation with the facilitators and high levels of geographical flexibility. The results of Compenab *et al*. (2021) indicated that the impact of webinars, in terms of long-term knowledge retention, was on the increase. This was observed in knowledge scores obtained for both the post-test and the follow-up test conducted concerning modern high-quality knowledge among students, young scientists and interested specialists. Research findings confirm the effect of both the mindsets and learners' content and situational contexts on transforming information into knowledge in virtual interactive learning (Sharit *et al*., 2008). These suggest that the diversity of content of sessions in these virtual learning significantly influences the knowledge and cognition-building processes. These called for comprehensive studies assessing the inclusiveness of the content delivered in webinars and its relationship with the attributes of participants' affective and cognitive learning domains.

The paper presents the results of a study to evaluate the overall effectiveness of an academic webinar in agricultural higher education. The study was based on the hypothesis that synchronous learning through webinars significantly enhanced participants' cognitive learning levels across disciplines, professional levels and genders. Also, an attempt to interpret the results in the theoretical framework of the cognitive theories of Multi-Media (MM) learning (Mayer, 1997). This helped to explore how the MM learning environment of webinars supported the cognitive learning of participants.

METHODOLOGY

Research context and the agricultural webinar programme. The study followed mixed method research design using both qualitative and quantitative tools which enabled better contextualization and triangulation of results (Cresswell and Cresswell 2018; Janssens *et al.*, 2017). The study was based on the proceedings of a three-day national academic webinar on *Challenges and opportunities of vegetable production in warm humid tropics* organized from the 11th to 13th of November, 2020. The webinar was hosted following the presenter with multiple participants from multiple locations format in the CISCO WEBEX platform. The programme content was designed by leading experts in collaboration with the research team that provided insights into advances in vegetable production in the warm humid tropics.

Data collection. Coverage of the topic was assessed using the content analysis software tool MAXQDA version 2020. The content analysis sample consisted of 146 pages of the webinar transcript document prepared on the 15 topics covered in five sessions over three days and validated by the session experts. The analysis procedures involved creating a code system concerning the significant themes described in the webinar and calculating code frequencies which were supplemented by MAXmap visualizations. Three rounds of line-by-line data-driven inductive coding were used to cover the content of the webinar transcript which was documented from the presentations of 21 expert speakers including particular addresses and messages (Pradeepkumar, 2021).

Gain analysis considered one of the most relevant methods in determining the effectiveness of webinars was adopted in the study. It measured participants' knowledge at baseline, then estimated their relative gains within three days after the webinar (Harned *et al.*, 2014). An online survey using Google Forms were administered to collect pre and post-webinar responses of selected participants to the knowledge test. The empirical analysis was based on the data collected from a sample of 235 participants randomly selected from the 630 participants registered in the webinar from different parts of India. Both the pre and post-evaluation responses were collected on items of a knowledge test based on the webinar content devised for the purpose. Results of content analysis were used to ensure that the items of knowledge test covered all themes and subthemes of the webinar. The selection of items in the knowledge test was further validated using a pilot study conducted on 20 randomly selected students and researchers in vegetable science and related fields that formed a non-sampling population. Item difficulty analysis using the pilot test data enabled the selection of the final test items. The questions on which all the participants either answered correctly or failed to answer correctly were excluded so as to ensure variability. The knowledge test's maximum and minimum possible scores ranged from 20 – 0 respectively.

The overall cognitive learning score of the webinar was calculated as the difference between post and pre-test scores and estimated as the aggregate score on all knowledge test items. The attributes of participants such as gender, designation, qualification and discipline relevant for determining the effectiveness of webinars were also derived from the online registration schedule.

Statistical tools. Descriptive statistical parameters such as per cent, mean, and standard deviation were used to categorise the samples. The observed and experimental values of test scores were verified by Pearson's chi square test at 0.01 and 0.05per cent levels of significance. Paired t test was used to compare the mean values of both pre and post-tests cores (Hsu and Lachenbruch 2005).

RESULTS

Participant profile. Participant profiles on selected attributes such as gender, designation, qualification and discipline were used to interpret the results of cognitive learning. The description of participants based on selected profile attributes is presented as Table 1. The results from the table indicated that on gender, males had a slight advantage with participation at 52.77 per cent over the 47.23 per cent of female participation. Designation-based categorization of the participants showed maximum participation from PG students (29.36 %) followed by Assistant Professors (28.94%).

Table 1: Profile of the webinar participants on selected attributes (N=235).

Sr. No.	Selected attribute	Category	Frequency		Category total*
			Male	Female	
1.	Designation	Assistant Professor	30	38	68 (28.94)
		Associate Professor	06	04	10 (04.26)
		PG student	41	28	69 (29.36)
		PhD / Research student	17	23	40 (17.02)
		Professor	06	05	11 (4.68)
		Scientist	15	07	22 (9.36)
		Others (Teaching Assistant/ Technical Assistant/ Project Fellow)	09	06	15 (6.38)
2.	Qualification	UG degree	41	28	69 (29.36)
		PG degree	44	55	99 (42.13)
		PhD	39	28	67 (28.51)
3.	Discipline	Vegetable Science	61	54	115 (48.93)
		Horticulture (other than vegetable Science)	14	20	34 (14.47)
		Other disciplines	49	37	86 (36.60)
Gender wise total			**124 (52.77)**	**111 (47.23)**	**235 (100)**

*Figures in parenthesis represent the percentage

Least participation was from higher designation categories *viz*., Professors and Associate Professors which was only around four per cent each. Similar was the trend of participation concerning qualification as well, with the PG students leading at 42.13 per cent, followed by PhD (28.51%) and UG students (29.36 %). Moreover, the maximum 48.93 per cent participation was from the Vegetable Science discipline followed by participants from non-horticultural disciplines (36%). The results could be interpreted in terms of perceived importance attributed to participation of webinars in career development especially at the lower end of career. This is evident from the significant participation from PG, PhD and Assistant Professors in the webinar.

Content analysis of the webinar. MAXQDA's code coverage function was used in the content analysis and the results revealed that the coded text volume of the sample improved from 65 to 80 percent with each round of coding. The major topics coded from the webinar covered prospects and application of recent technologies in increasing vegetable production, breeding for biotic and abiotic stress management development of hybrids in major vegetables and prospects of underutilized vegetables as protective food. Vegetable crops are highly prone to climate change fluctuations which directly affect growth phase, flowering behaviour and productivity of crops, stress tolerance in breeding was covered in detail. Various biotic and abiotic factors *viz*., insect pests, diseases, temperature, drought, flood, salinity, acidity and alkalinity are considered the major limiting factors in vegetable production. The need to develop and adopt various strategies such as hybrid breeding resistant to abiotic and biotic stresses, and improved cultivation and management practices were iterated in the webinar. Grafting in vegetables which has emerged as a promising alternative tool for conventional breeding methods has been highlighted as a measure to increase tolerance to abiotic stress and fruit quality (Abdelmageed and Gruda 2009; Agele and Cohen 2009). Another critical technology presented was related to the protected cultivation of vegetables. It is being practised across the country for commercial vegetable production as well as seedling production. It held great potential in off-season vegetable cultivation and increasing the productivity of vegetables (Singh and Sirohi 2006). Though diverse agroclimatic conditions of India permit cultivation of more than 60 vegetable crops, systematic research and developmental efforts are confined to a few primary cultivated vegetables. The webinar discussions referenced many works that have reported the presence of around 30 lesser-known vegetables that have not received adequate attention and emphasis in research or

production (Jena *et al.*, 2018). These unexploited vegetable crops which were rich sources of micronutrients and bioactive compounds offered great opportunities as protective foods (Singh and Pandey 2005). Keeping this in view, the topics for the webinar gave due importance to these unexploited vegetables and covered its prospects for cultivation in India's warm, humid tropical conditions. The MAX map visualisation of the code matrix and the document portrait delineated with the colour code system is presented in Fig. 1.

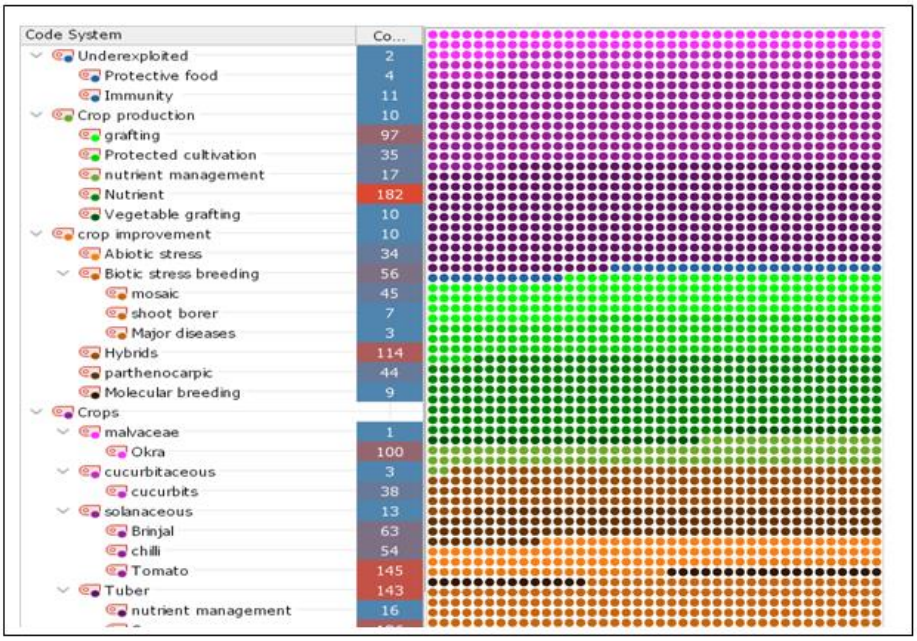
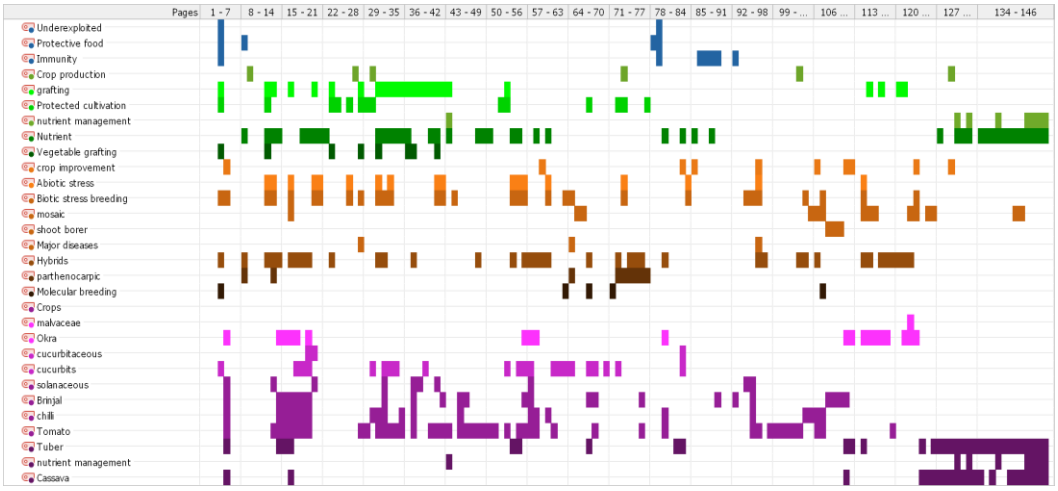


Fig. 1. MAX map showing the code matrix and the document portrait (with 900 tiles) sorted by colour frequencies of themes and subthemes.

Fig. 1 shows four major topics covered by the code system *viz*., underexploited vegetables, crop production, crop improvement and crop type with subcodes and graded colour for each theme and subthemes. The frequency of occurrence of codes in the webinar transcript document is also shown in the figure which made the analysis more objective by enabling the quantitative articulation of the content characteristics. The frequency of occurrence of coded themes and subthemes in the transcript document shown in the figure suggested that among the vegetable crops covered tomato (145) had the maximum representation, followed by tubers (143) with cassava having a maximum coverage of 136. Another vegetable crop that showed significant coverage in the webinar sessions was okra with a frequency score of 100. The crop improvement theme showed hybrid production to have the greatest extent of coverage with a frequency representation of 144 and in crop management, nutrients had a significant presence of 182. The document portrait also showed the distribution of codes in the analysed document (Fig. 1) and represented the number of times the coded categories were discussed in various sessions. This information indicated the number of times a category was reintroduced into the discussion during the webinar. The page-wise content coverage of coded themes with respective colour codes is presented in the code line MAXmap as depicted in Fig. 2.



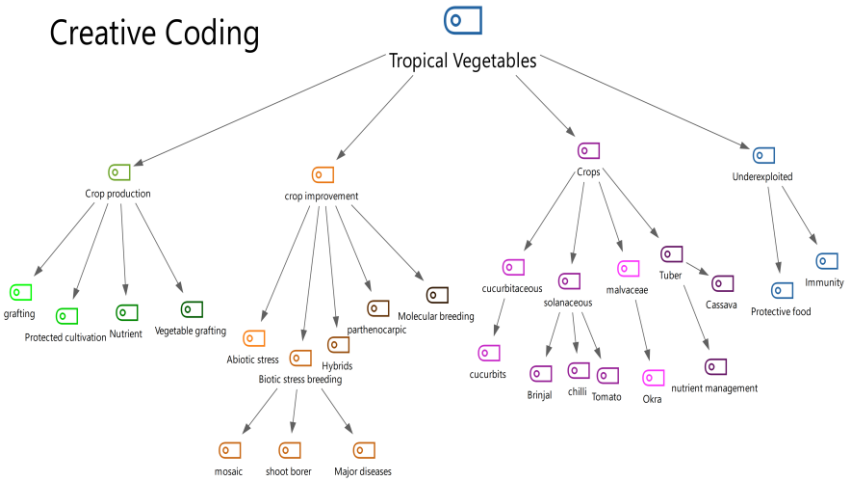


Fig. 2. Code line Maxmap with Hierarchical codes and sub-codes depicting page-wise distribution of the coded content.

Evaluation of change in cognitive learning. Change in knowledge attributable to experience is termed as cognitive learning (Mayer, 2011). Accordingly, cognitive Learning Theories (CLT) use metacognition ("thinking about thinking") as the primary process concerned with learning. It implied that the different learning processes could be explained by analysing the mental processes and are often estimated in terms of changes in knowledge. It posits that with an effective learning environment, learning is more accessible and new information would be memorized for longer. Based on this postulation the evaluation of the impact of the webinar on the knowledge of the participants in terms of cognitive learning was attempted. Cognitive learning was measured in terms of improvement in knowledge test scores on the webinar content related to protected cultivation, advanced breeding techniques, crop nutrition, under-exploited crops and biotechnology themes delineated in content analysis. Items of knowledge test covered the content of all sessions in the webinar as delineated using code frequencies in content analysis to ensure comprehensive coverage.

Pre-test score was observed in the range of 2-15, while post-test score ranged from 2-20. An estimate of the overall cognitive learning score and percentage difference (P diff) was also used in the analysis. The overall mean of pre-evaluation and post-evaluation scores from the knowledge tests were 9.10 and 11.74 respectively as depicted in Table 2. It could be inferred from the results in the table that the webinar was effective in bringing an overall improvement in the mean learning score by a value of 2.64. Mean and standard deviation were used to categorize the pre-evaluation scores into low (<6), medium (6-12) and high (>12) groups. Similarly, the post-evaluation scores were also categorized into low (<8), medium (8-12) and high (>15) categories and the distribution of participants under each category was recorded. Estimation of paired two-sample t-test for means between the pre-and post-evaluation scores indicated a significant increase in overall scores. The results indicated webinar technology's ability to serve as a powerful functionality for the implementation of distance learning. It showed significant interactive capabilities that effectively deepened the content knowledge of higher education learners from agriculture.

An illustration of the improvement in the overall cognitive learning score among different designation categories is also presented in Table 2. The results of changes in cognitive learning from the table showed that all the designation categories recorded an overall improvement in knowledge score of around 20 per cent.

Table 2: Distribution of different categories of participants on knowledge test scores.

Category of participants	Pre-evaluation knowledge score			Post-evaluation knowledge score			Overall changes in cognitive learning (%)
	Low (< 06)	Medium (06 – 12)	High (>12)	Low (<08)	Medium (08 – 14)	High (>15)	
PG student (69)	20 (28.99)	44 (63.77)	5 (7.25)	29 (42.03)	23 (33.33)	17 (24.64)	20.56
PhD student/ Researcher (40)	02 (5.00)	28 (70.00)	10 (25.00)	05 (12.50)	23 (57.50)	12 (30.00)	18.80
Assistant Professor (68)	04 (5.88)	45 (66.18)	19 (27.94)	01 (1.47)	41 (60.29)	26 (38.24)	21.50
Associate Professor (10)	01 (10.00)	09 (90.00)	00 (0.00)	00 (0.00)	08 (80.00)	02 (20.00)	
Professor (11)	00 (0.00)	09 (81.82)	02 (18.18)	02 (18.18)	05 (45.45)	04 (36.36)	
Scientist (22)	03 (13.64)	18 (81.82)	01 (4.54)	02 (9.09)	13 (59.09)	07 (31.82)	
Teaching Assistant / Technical Assistant/ Project Fellow (15)	01 (6.67)	10 (66.67)	04 (26.67)	01 (6.67)	08 (53.33)	06 (40.00)	
Overall mean knowledge score (n=235)	09.10			11.74			20.00
Standard Deviation	3.27			3.60			

*In parenthesis, corresponding percentage values are listed

However, the highest increase in the overall scores from the webinar was for the group comprising Assistant Professor, Associate Professor, Professor, Scientist and Teaching Assistant/Technical Assistant/Project Fellow from vegetable Science, who recorded an improvement of 21.5 per cent. The results implied that the webinar was more effective in improving the cognitive learning of the scientific community involved in vegetable research. Observations on theme-wise comparison revealed a maximum score in post-evaluation recorded for topics related to tomato hybrid breeding, which correlated well with the content coverage results.

In order to understand how the selected variables influenced the knowledge scores in the pre-and post-evaluation stages, Pearson's Chi-square test was attempted and the results are presented in Table 3.

The results from Table 3 indicated that all four variables viz. gender, designation, qualification and discipline influenced the knowledge score positively at 0.01 level of significance except for the evaluation gender score, which was significant at 0.05 level. The graphical representation of the overall change in cognitive learning expressed as a percentage difference of pre and post-knowledge scores for participants with different professional qualifications in vegetable sciences is given in Fig. 3. It could be observed from Fig. 3 that the majority in all the three groups of PG, PhD and research professionals from vegetable sciences recorded improvement in their overall knowledge, suggesting the webinar's overall effectiveness. However, there was a minority that recorded no improvement and a few that showed a negative change in the score. This could be attributed to the unfamiliarity with the learning environment and even issues related to uninterrupted connectivity. In fact, further research is needed to ascertain the probable reasons involved.

Table 3: Influence of selected variables on knowledge scores of the participants.

Associate variables	Pearson's Chi-square value	
	Pre-test	Post-test
Gender	09.88***	05.93**
Designation	35.93***	49.48***
Qualification	27.13***	43.81***
Discipline	20.76***	17.47***

***Significant at 1 per cent, ** Significant at 5 per cent

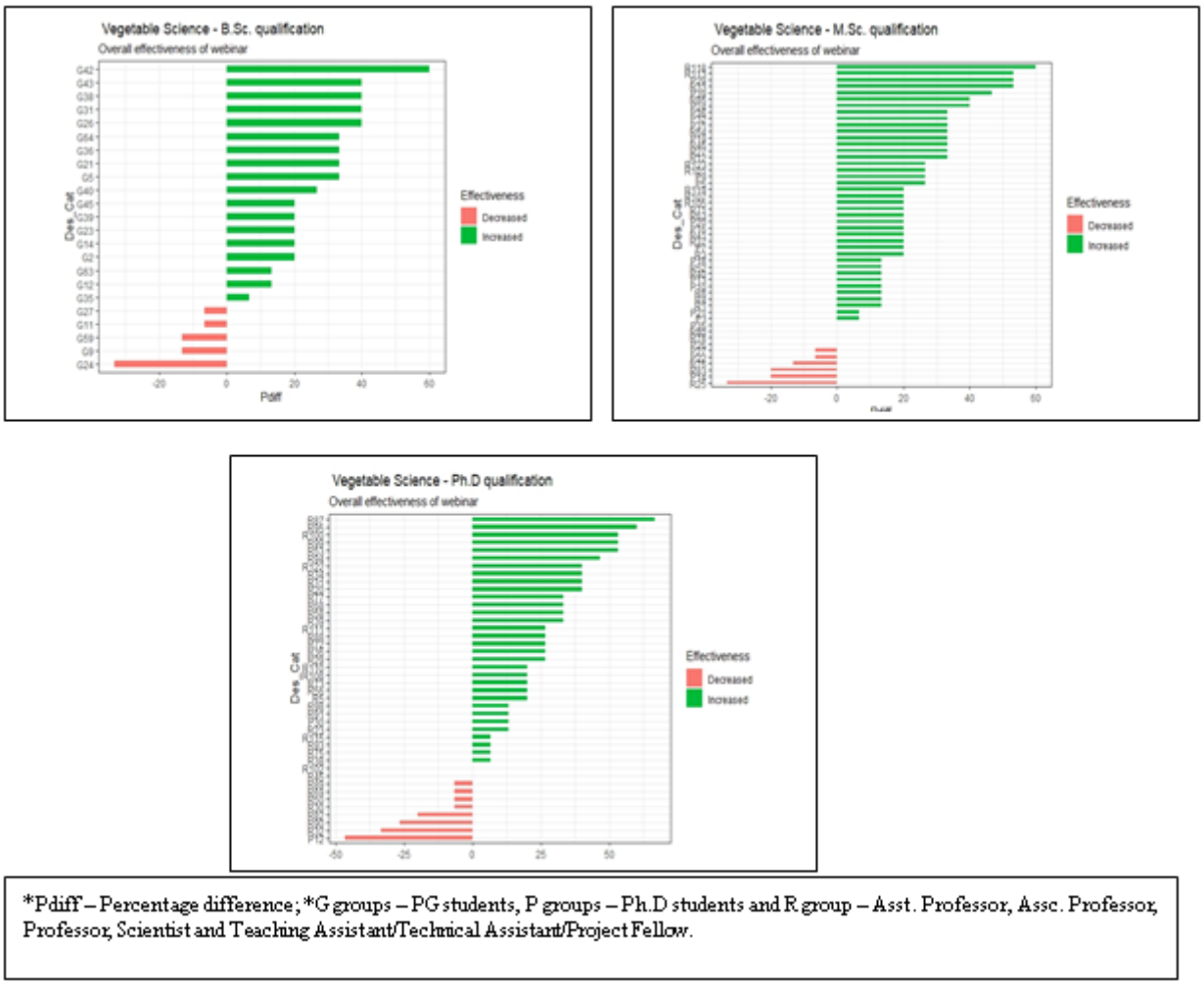
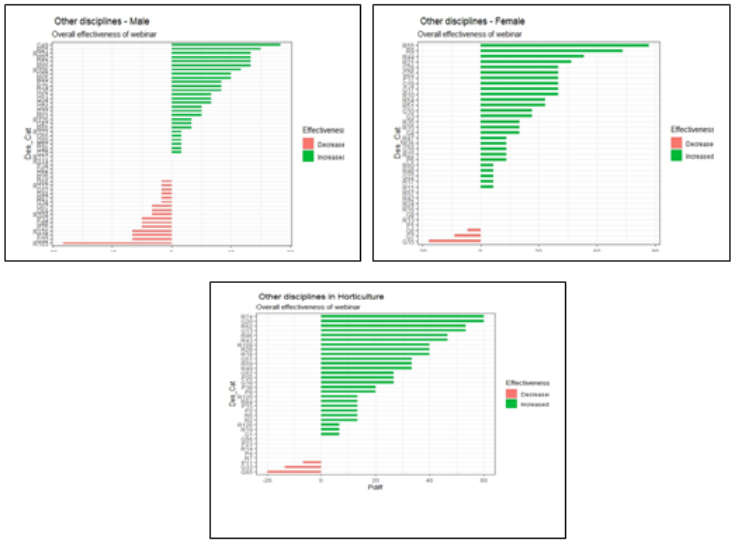


Fig. 3. Percentage difference in knowledge scores of participants with qualifications in vegetable sciences.



*Pdiff – Percentage difference; *G groups – PG students, P groups – Ph.D students and R group – Asst. Professor, Assc. Professor, Scientist and Teaching Assistant/Technical Assistant/Project Fellow.

Fig. 4. Percentage difference in knowledge scores of participants with qualifications in other disciplines of Horticulture.

An attempt was also made to delineate the overall effect of the webinar on the cognitive learning of the participants with qualifications in other disciplines of Horticulture and its gender-wise representation. The results of the same are depicted in Fig. 4. It is interesting to note the results in Fig. 4 that indicated no adverse change in the overall scores which implied that all of them either gained positively or retained their original knowledge levels. However, the gender-wise presentation also indicated that the percentage difference in knowledge scores of males and females was more prominent in the high change category. Moreover, the females exhibited a significant improvement in learning when compared to males with negligible negative and no change categories.

DISCUSSIONS

The results confirmed the study hypothesis that the webinars provided effective MM learning environments that supported the cognitive learning of participants across disciplines, professions and gender. This implied that the MM learning environment provided in webinars facilitated the selection of verbal and visual sensations and the organization of these into appropriate information image models of the learning content as explained by Mayer (1997). Moreover, the development of information image models followed the principles of multiple representations of the same content as different integrated image models with the presentation of corresponding words and pictures at the same time than independently as in conventional pedagogy. This indicated the potential of MM platforms to provide a better understanding of content as captioned illustrations along with the audio used would promote the use of multiple senses. This confirmed the contiguity effect, which was theorised in cognitive learning theories, to positively influence the working memory of learner (Baddeley *et al.*, 1986, 2000; Baddeley & Hitch 1974). This could be attributed to the inferential links established between the verbal and visual images presented simultaneously but processed separately as explained by the split attention principle of the cognitive theory. Accordingly, the auditory narration of words along with the visual onscreen presentation of them as text could reduce the overload of visual information processing. This implied that the independent processing of visual and verbal sensations helped to reduce the visual information processing overload at the level of the learner. Thus, the webinar could serve as a viable online distance learning method that provides better visual-spatial learning environment, unlike the linear, auditory and sequential manner of information delivery in conventional classrooms. Moreover, as evident from the results, it provided opportunities for the participants, especially the students and young professionals to acquaint and interact with national and international experts in the subject with considerable saving in resources and time. This could be related to the highest recorded improvement among the students and young professionals.

However, the individual difference principle of cognitive learning was less evident as the study focussed on higher learning domains that involved high-knowledge learners, mainly from PG, PhD classes and early-level professionals. Gender analysis showed that anonymity in virtual platforms gave women better opportunities and learning environment. Therefore, it could also be inferred that the results from the study corroborated the research findings that reported webinars as efficient and reliable tools to deliver a near-normal interaction between the participants and the speakers (Compen *et al.*, 2020; Gegenfurtner and Ebner 2019; Wang and Hsu 2008). Moreover, the findings were indicative that the webinar facilitated the delivery of conceptual knowledge rather than skill. Provisions for a face-to-face environment enhanced participants' web presence and facilitated multi-level interactions which could be validated from the queries and responses in chats. It also reflected the gaining

popularity of virtual learning programs among the academic community, especially the higher education sector in agriculture. This could mainly be attributed to its convenience, where the participants could access the sessions irrespective of their location, time and work schedule (Chen *et al.*, 2020).

CONCLUSIONS

Thus, it could be concluded that the study's findings contributed to the meta cognition domain of cognitive learning theory in the emerging context of online learning, specifically to the information process theory. This could find application in improving the effectiveness of online learning in synchronous virtual methods like webinars. This could be attributed to webinars' role in facilitating multidimensional structural learning processes, self-regulatory activities and learner autonomy (Jenkins *et al.*, 2009). As such the results could find application in the pedagogical characterisation and improvements in the effectiveness of online learning environments of higher education in general and agricultural education specifically. These indicated its tremendous potential to be integrated into blended learning programme curricula. However, there is a need to develop criteria for evolving coding indicators that could be used in similar studies involving content analysis. This warranted a more detailed study to identify and analyse the learning effects and the associated pedagogies of synchronous learning environments to find the causes related to the dynamics of cognitive learning. Also, research on the online discussions emerging from these synchronous learning platforms will be helpful in promoting Socratic methods of discussions, as suggested in many reports (Hansen 1988; Yang *et al.*, 2005). This would facilitate guiding and interpret how learning occurred in these virtual innovations of instructional technology that have gained prominence.

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