

Digital capabilities and coffee cooperative productivity in Uganda: the mediating role of action learning

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Abstract

Purpose – This study aims to examine the mediating role of action learning in the relationship between digital capabilities and the productivity of coffee cooperatives in Uganda.

Design/methodology/approach – A cross-sectional survey design, using predominantly quantitative methods, was used. Data were collected from 222 managing directors of coffee cooperatives using structured questionnaires based on a five-point Likert scale. The data were analyzed using correlation, regression and mediation techniques to test the hypothesized relationships.

Findings – Correlation results indicate that digital capabilities are positively and significantly associated with both action learning ($r = 0.262, p < 0.01$) and cooperative productivity ($r = 0.503, p < 0.01$). Action learning is also positively related to productivity ($r = 0.353, p < 0.01$). Regression analysis reveals that digital capabilities significantly predict productivity ($\beta = 0.503, p < 0.01$) and action learning ($\beta = 0.262, p < 0.01$), while action learning also significantly predicts productivity ($\beta = 0.353, p < 0.01$). Mediation analysis confirms a significant indirect effect ($a \times b = 0.092, p < 0.01$), with the direct effect remaining significant ($\beta = 0.287, p < 0.01$), indicating partial mediation.

Research limitations/implications – The findings suggest that productivity gains from digital capabilities depend on action-oriented learning processes that translate digital knowledge into practice, thereby extending dynamic capabilities theory in agricultural contexts.

Originality/value – This study advances an integrative framework linking digital capabilities, action learning and productivity, demonstrating that digital investments yield outcomes when embedded within experiential learning processes in resource-constrained cooperative environments.

Keywords Digital capabilities, Action learning, Cooperatives, Productivity, Uganda

Paper type Research paper



Introduction

Uganda's coffee cooperatives constitute a foundational pillar of the nation's agricultural production system and export economy. With over 1,600 organized producer groups and cooperative societies, the coffee sub-sector has evolved into a dominant economic activity that underpins production, processing and export functions across the value chain [Mbabazi \(2025\)](#). As of 2023, approximately 1.74 million households were engaged in coffee farming, translating to over 10 million individuals directly or indirectly dependent on the coffee value chain. It is this workforce that has been behind the production of over 8 million 60-kg bags that were exported by 2025, fetching an estimated \$2bn and making coffee the largest export earner, constituting 30% of the country's foreign exports and accounting for over 85% of the national coffee-farming population ([Uganda Investment Authority Report, 2025](#)). This level of production and export performance is supported by 1,736 cooperative societies with an extensive processing infrastructure, including approximately 578 coffee-processing plants, 22–30 washing stations and 36 export-processing factories. This performance has positioned Uganda as the leading coffee producer on the African continent, surpassing Ethiopia with an estimated 190,000 60-kg bags and ranking eighth globally. Furthermore, Ugandan coffee has attained international recognition for its quality, with its taste ranked third worldwide ([Kora et al., 2025](#); [Ecel et al., 2025](#)).

To maintain this position within the global coffee market, scholars such as [Davis et al. \(2023\)](#) and [Tomashuk et al. \(2025\)](#) contend that the country must double its productive capacity by leveraging digital tools such as mobile-based extension services to deliver real-time agricultural information, technical advice and market data directly to farmers via mobile applications, SMS and voice calls. These tools allow farmers to diagnose pests using photos and videos, access and accurately predict weather patterns and connect with market experts, thereby bringing services closer to farmers, improving crop health and leading to greater yields. Countries such as Brazil, Vietnam, Colombia and Costa Rica have sustained large-scale coffee production through the strategic adoption of advanced digital innovations, characterized by automation, precision agriculture, drones for monitoring and spraying, underground soil sensors, satellite tracking systems for environmental compliance, autonomous robotic harvesters and advanced processing techniques ([Bento et al., 2023](#)). These technologies have significantly enhanced production by improving yield efficiency, optimizing input utilization, reducing labor constraints and enabling data-driven decision-making, thereby increasing both the scale and consistency of coffee output while ensuring compliance with evolving global standards.

In Uganda, however, the use of high-tech digital tools in the coffee value chain is not well known. What is known is that the digital penetration rate is estimated at 28%, social media usage at about 4.7%, smartphone advanced feature adoption at 25%, and internet penetration at 46% ([Kuteesa et al., 2021](#)). This challenge is exacerbated by prevailing illiteracy rates of 25%–30% among segments of farming communities who cannot read, interpret, analyze, and apply basic farming technology. This situation, although shaped by a range of historically embedded activity domains, is further exacerbated by the limited use of active, experiential learning approaches, leaving stakeholders within the coffee value chain unable to effectively internalize, adapt, and operationalize digital knowledge for productive purposes. Consequently, many actors lack the capacity to critically engage with digital tools, translate abstract information into context-specific agricultural practices and iteratively refine their use of technology to enhance decision-making, efficiency and overall productivity within the sector. These figures point to persistent and structural capability deficits that constrain the use of digital tools in providing extension services, spraying, surveillance, administration of fertilizers, and market information systems, potentially constraining crop yields, hence

affecting the current productivity levels, which are even projected to grow to 20 million 60-kg bags by the year 2030 (Obulei *et al.*, 2024).

Thus, in the context of limited digital penetration (Obulei *et al.*, 2024), persistent high levels of illiteracy, and the passive, instructor-led pedagogy that is known to produce surface-level learners (Brosseau, 2024), limited critical thinking (Ang *et al.*, 2021) and reduced adaptability (Clement *et al.*, 2021), it is arguably unlikely that Ugandan coffee cooperatives can achieve the desired productivity levels, as these structural constraints hinder the diffusion of digital innovations, which limit the capacity of farmers and cooperative actors to effectively leverage available technologies for productivity enhancement. Against this backdrop, this study seeks to examine the role that action learning plays in shaping the relationship between digital capabilities and the productive capacity of coffee cooperatives. Specifically, the study advances the proposition that the influence of digital capabilities on productivity is neither direct nor automatic, but is mediated through iterative, experiential learning processes that enable actors to internalize, adapt and apply digital knowledge within their operational contexts (Hidalgo *et al.*, 2024).

Related literature

Action learning theory (Revans, 1982b)

Action Learning Theory provides a structured process for solving complex, real-world problems by taking actions and reflecting on the results. It is anchored in the principle of learning through action, whereby small, diverse groups – commonly referred to as “sets” – collaboratively address real-world and complex organizational challenges. Through iterative cycles of action and critical reflection, participants generate contextually grounded insights, develop practical competencies and implement informed, adaptive solutions that respond effectively to dynamic organizational environments. Understanding this theory is tantamount to appreciating the inherent complexities involved in acquiring digital capabilities such as technological literacy, data interpretation, platform navigation, digital communication and the integration of decision-support tools, all of which require iterative learning, contextual adaptation and continuous experiential engagement rather than mere access to digital technologies.

In the present context – where coffee cooperatives are under increasing pressure to sustain continental leadership in production and meet the national target of 20 million bags by 2030 – actors across the value chain, from farm-level producers to cooperative-level processors and exporters, remain inadequately equipped with the digital capabilities needed to drive productivity improvements (Uganda Coffee Development Authority [UCDA], 2003). This limitation is partly due to the prevailing formal education systems and subsequent training interventions, which are predominantly instructor-led, decontextualized, and insufficiently oriented toward experiential, reflective, and problem-based learning (Strang, 2015). As a result, these approaches have not effectively empowered actors with the practical competencies required to internalize, adapt, and apply digital technologies in ways that meaningfully enhance production outcomes.

Therefore, while digital technologies present significant potential to transform agricultural production systems, as proposed by dynamic capabilities theory (Teece *et al.*, 1997), their effectiveness, given the structural, systemic, and historical reasons outlined earlier, is highly doubtful in bringing about the desired change in the near future. However, as illuminated by the Action Learning Theory, the translation of digital access into tangible productivity gains is mediated by action-oriented learning processes that enable actors to experiment, reflect and adapt technologies to their specific contexts (Knaus, 2022).

Digital capabilities and action learning

Digital capabilities are increasingly recognized as critical enablers of productivity and competitiveness within agricultural systems; however, their development extends beyond mere access to digital tools and infrastructure. Rather, digital capabilities comprise a composite of skills, practices and cognitive competencies that enable actors to effectively access, interpret and apply digital information in context-specific production environments. Scholars drawing on Dynamic Capabilities Theory argue that such capabilities are cultivated through learning, adaptation, and the reconfiguration of knowledge in response to changing environmental demands (Helfat and Peteraf, 2015). However, while the Dynamic Capabilities Theorists agree that these capabilities can be attained through training, they do not emphasize the action-oriented pedagogy which is relevant in the effective understanding and practical application of digital technologies such as mobile-based extension services, market information systems and precision agriculture tools which are increasingly available and their effective utilization remains constrained by limited practical, reflective competencies and weak learning ecosystems (Klerkx *et al.*, 2012). This suggests that the development of digital capabilities is fundamentally an intensive, active learning process that requires mechanisms to translate abstract digital knowledge into actionable agricultural practices.

In this regard, Experiential Learning Theory, defined by iterative cycles of problem-solving, reflection and peer-based knowledge exchange, through which individuals engage with real-world challenges and co-create contextually relevant solutions, becomes relevant (Revans, 1982a). Empirical evidence from agricultural innovation systems indicates that participatory and experiential learning approaches – such as farmer field schools and cooperative-based learning platforms – significantly enhance farmers' ability to adopt and adapt new technologies, including digital tools (Davis and Neitzel, 2012). By embedding digital capability development within action-oriented learning processes, farmers are better positioned to internalize digital knowledge, experiment with its application and iteratively refine its use to improve productivity outcomes. Thus, action learning serves as a critical mediating mechanism that bridges the gap between digital access and effective utilization in smallholder agricultural contexts, including cooperatives.

While the foregoing arguments compellingly link digital capabilities to action learning, they are not without limitations. First, much of the extant literature remains conceptually assertive but empirically underdeveloped, often assuming that experiential and action-oriented learning mechanisms will naturally translate into enhanced utilization of digital capabilities without adequately accounting for structural constraints such as infrastructure deficits, institutional weaknesses and resource limitations prevalent in developing contexts (Figueiredo and Zahra, 2025). Although these systemic and structural constraints have in part been attributed to a lack of action-oriented training, a historical fact that cuts across sub-Saharan Africa (Gielnik *et al.*, 2025), there has been little transformative effort among key institutional and policy actors to fundamentally reorient learning systems toward more experiential, reflective and practice-based models (Mugabirwe *et al.*, 2025). Consequently, this inertia has perpetuated a cycle in which individuals are insufficiently equipped with the analytical, creative and practical competencies required to harness digital technologies effectively, thereby constraining the evolution of institutions into dynamic, action-oriented entities capable of driving meaningful productivity gains, especially in areas such as coffee farming and its productivity (Shorey and Rodriguez, 2025). Finally, existing studies tend to generalize findings from participatory agricultural interventions (e.g. farmer field schools) without adequately interrogating their scalability, sustainability and effectiveness in digitally mediated environments. Consequently, there remains a critical gap in rigorously establishing the causal pathways and contextual contingencies through which action learning concretely

mediates the relationship between digital capabilities and productivity outcomes, particularly within low-literacy, resource-constrained settings such as Uganda's coffee value chain.

Therefore, it is evident that the development and effective utilization of digital capabilities are intrinsically linked to learning processes that are experiential, reflective and contextually embedded. Given that digital capabilities are not merely acquired through access to technology but are cultivated through iterative engagement, problem-solving and knowledge reconfiguration, action learning emerges as a critical mechanism for developing and operationalizing these capabilities. Accordingly, and consistent with the propositions of Action Learning Theory, this study advances the following hypothesis:

- H1.* Digital capabilities have a positive and significant effect on action learning among actors in coffee cooperatives.

Digital capabilities and productivity of coffee cooperatives

Scholars and practitioners have consistently recognized that digital capabilities, such as digital literacy, access to information systems and the ability to deploy data-driven technologies, as critical drivers of productivity in cooperative-based agricultural systems, particularly in high-value commodity chains such as coffee. They enable cooperatives to enhance coordination through effective communication, optimize resource allocation, improve production planning and reach out to farmers with targeted production-related information (Lestari and Magfiroh, 2025). This is in line with the Dynamic Capabilities scholars who argue that such capabilities facilitate the sensing, seizing and reconfiguration of opportunities in dynamic environments, thereby enhancing organizational performance (Helfat and Peteraf, 2015). In agricultural contexts, empirical studies demonstrate that digital tools such as mobile-based extension services, market information platforms and traceability systems significantly improve productivity by reducing information asymmetries, strengthening decision-making and enhancing input-output efficiency. Within coffee cooperatives, these technologies further support collective marketing, quality control and compliance with international standards, thereby enabling cooperatives to achieve economies of scale and improved production outcomes (Aker and Mbiti, 2010).

Although digital capabilities may directly influence productivity, their effectiveness is often contingent upon learning processes that enable actors to interpret, adapt and apply digital knowledge. Recent studies emphasize that access to digital tools alone is insufficient to drive productivity gains unless accompanied by the requisite skills, organizational support and learning mechanisms necessary for effective application (Rotz et al., 2019). In many developing contexts, including Uganda, infrastructural limitations, low levels of digital literacy and weak extension systems continue to constrain the effective deployment of digital innovations in agriculture. Although a number of factors remain a stumbling block in the effective digital utilization for cooperative productivity, available evidence suggests that cooperatives with stronger internal governance structures and knowledge-sharing mechanisms are more likely to translate digital investments into tangible productivity gains by facilitating collective learning, coordination and technology adoption among members (Hidalgo et al., 2024).

We therefore hypothesize that:

- H2.* Digital capabilities have a positive and significant effect on the productivity of coffee cooperatives.

Action learning as a mediator in the relationship between digital competencies and productivity of coffee cooperatives

The mediating role of action learning in the relationship between digital capabilities and productivity has attracted growing scholarly attention, particularly in digitally transforming agricultural systems. While digital capabilities enable access to data, information and advanced decision-support tools, their impact on productivity is often indirect and contingent upon the mechanisms through which such knowledge is internalized and applied. Recent studies emphasize that digital technologies enhance agricultural productivity by improving access to information, optimizing input use and enabling data-driven decision-making (Oyeboade and Olagoke-Komolafe, 2023); however, these outcomes depend significantly on users' ability to learn, adapt and contextualize digital knowledge (Hidalgo *et al.*, 2024). In this regard, action learning provides a critical explanatory pathway by facilitating iterative engagement with real-world problems, enabling cooperative actors to experiment with digital tools, reflect on outcomes and refine practices over time (Hasan *et al.*, 2025). This aligns with emerging evidence that digital transformation in agriculture requires not only access to technology but also continuous learning processes that convert digital inputs into actionable, productivity-enhancing practices (Jacob and Umoh, 2025). Consequently, action learning serves as a vital mechanism for translating digital capabilities into improved operational efficiency and productive capacity within coffee cooperatives (Handiyanto *et al.*, 2024).

Furthermore, the integration of action learning within digitally enabled agricultural systems enhances collective competence, coordination and adaptive capacity at the cooperative level. Contemporary literature highlights that digital agriculture reshapes knowledge systems, necessitating new skills, continuous reskilling and active participation in learning ecosystems rather than passive technology adoption (Daum, 2025). Action learning, characterized by reflection, peer interaction and experiential problem-solving, strengthens these competencies by embedding learning within organizational routines and cooperative practices (Zhou *et al.*, 2025). This is particularly critical in contexts where structural constraints – such as low digital literacy and weak extension systems – limit the effective utilization of digital technologies. Evidence suggests that training and capacity-building initiatives that incorporate participatory and experiential approaches significantly enhance agricultural actors' ability to adopt and apply digital innovations, thereby improving productivity outcomes (Prajaapati *et al.*, 2025). Therefore, action learning not only bridges the gap between digital access and utilization but also serves as a dynamic capability that enables coffee cooperatives to continuously adapt, innovate and sustain productivity improvements in increasingly complex and technology-driven agricultural environments (Kaurav, 2025).

Although the preceding paragraphs present a persuasive case for a linkage among digital capabilities, action learning and productivity, the role of action learning within this relationship may be overstated, particularly in contexts such as Uganda, where historically entrenched pedagogical traditions continue to shape contemporary learning practices. Since the introduction of formal education in the late 19th century, instructional approaches have been predominantly teacher-centered, reflecting colonial imperatives that prioritized the training of administrators, clerks and local functionaries to serve bureaucratic and governance structures (Abudetse *et al.*, 2025). Such an orientation was not designed to cultivate creativity, critical thinking or practical problem-solving competencies, but rather to transmit standardized knowledge aligned with colonial administrative objectives. This pedagogical legacy, sustained over several decades, has continued to exert a profound influence on curriculum design and instructional methods, thereby constraining the transition toward more experiential, reflective and action-oriented learning paradigms (Tiberondwa, 1998). Consequently, despite the theoretical appeal of action learning as a mechanism for enhancing

the utilization of digital capabilities and productivity, its effectiveness may be significantly moderated by these deeply embedded educational and institutional path dependencies.

Building on the foregoing critique, it becomes evident that the effectiveness of action learning is not uniform but contingent on the extent to which entrenched pedagogical legacies permit its meaningful adoption and practice within cooperative settings. In contexts where historically embedded, instructor-led learning paradigms remain dominant, the capacity of action learning to translate digital capabilities into tangible productivity gains may be constrained, yet it still represents a critical pathway for such translation:

H3. We therefore hypothesize that action learning mediates the relationship between digital capabilities and the productivity of coffee cooperatives.

Conceptual framework

Figure 1 presents the conceptual framework, which posits that digital capabilities are a critical foundation for enhancing the productivity of coffee cooperatives. However, its productivity capabilities are not automatic; they operate through action learning as a mediating mechanism. In this regard, action learning, which is defined by problem-centered engagement, collaborative learning sets, critical questioning and reflection and both individual and collective learning, facilitates the translation of digital knowledge into contextually cooperative productivity practices such as effective extension services, access to finance, information technology integration and access to market information. Thus, the framework suggests that while digital capabilities provide the necessary technological potential, action learning enables their meaningful conversion into tangible productivity outcomes.

Methodology

The context

According to the Ministry of Trade, Industry and Cooperatives, Uganda’s cooperative movement has expanded remarkably from only 273 registered cooperatives at Independence

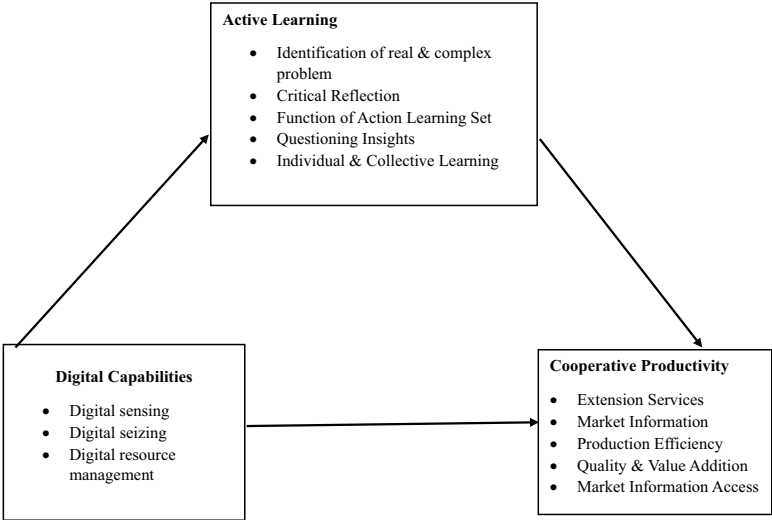


Figure 1. Conceptual framework

Source: Developed from Revans (1982), Marquardt and Waddill (2004) and Kolb (2014)

in 1962 to more than 46,000 by 2025 ([The Daily Monitor, 2015](#)). This growth reflects increasing recognition of cooperative enterprises as important vehicles for collective action, financial inclusion, agricultural commercialization, employment creation and community-based economic development. The sector comprises approximately 10,850 Savings and Credit Cooperative Organizations (SACCOs), 10,329 agricultural marketing cooperatives, 6,394 constituency-based Emyooga SACCOs, 1,051 transport cooperatives, 340 dairy cooperatives and 140 cooperative unions, demonstrating its broad presence across virtually all sectors of the Ugandan economy. Despite this impressive expansion, an estimated 40% of registered cooperatives remain inactive or only partially operational, raising concerns about their governance, sustainability and organizational effectiveness. Nevertheless, the cooperative movement continues to represent one of Uganda's largest socioeconomic institutions, with an estimated membership of approximately 15 million people as of February 2025, a substantial increase from earlier years. This sustained growth underscores the increasingly important role of cooperatives in mobilizing savings, enhancing market access, generating employment, strengthening household livelihoods and promoting inclusive economic participation across the country ([Uganda Cooperative Alliance Report, 2025](#)).

Research design, population and sample

This study used a cross-sectional, correlational survey design to examine the relationships among the study variables. The study population comprised 1,452 coffee cooperatives that were fully registered, operational and regulated by the Uganda Cooperative Alliance ([Canelas et al., 2024](#)). To determine the most appropriate sample size, we used the Krejcie and Morgan Table (Morgan and Krejcie, 1970). Based on a population of 1,452, a sample of 304 cooperatives was selected. From this sample, we conveniently selected the Managing Directors of each cooperative to respond to our questionnaires. This was done because they are considered knowledgeable about cooperatives' digital capabilities, training and productivity. Thus, a total of 304 questionnaires were sent out, of which 222 were useful responses, yielding a response rate of 73%. Given the stringent regulations that restrict cooperative employees from providing useful information regarding the operations of the cooperatives, getting 73% response rate from managing directors of these cooperatives was sufficient ([Baruch, 1999](#)).

Data collection instrument and procedure

Self-administered questionnaires, anchored on a five-point Likert scale and composed of items such as "Our business actively monitors digital trends that could impact our industry," "We have systems in place to capture and analyze information about emerging digital technologies," "What have you learned about the issue you addressed" and "What specific actions have you taken to address this problem," were administered to respondents by well-trained research assistants who reached out to the managing directors of different coffee cooperative societies in various parts of the country.

A five-point Likert scale was adopted because it provides an appropriate balance between measurement precision and respondent comprehension, enables respondents to express varying degrees of agreement or disagreement, remains simple and intuitive to complete, thereby reducing response burden and minimizing measurement error ([Joshi et al., 2015](#)). This consideration was particularly important in the present study, which involved managing directors of coffee cooperatives operating in diverse contexts characterized by varying levels of digital literacy, educational attainment and experience in understanding and managing cooperatives. Data collection was done from November 1, 2025, to December 5, 2025, after

which the collected data were finally entered into the Statistical Package for the Social Sciences (SPSS) for further analysis.

Measurement of variables

Digital capabilities were measured by the firm's ability to sense, seize and manage digital resources, as suggested by dynamic capabilities theory (Warner and Wäger, 2019). Action learning was measured using a multidimensional scale that captured its core experiential and reflective components, including problem identification, the functioning of action learning sets, questioning, insight and reflection and individual and collective learning (Revans, 1982a; Marquardt and Waddill, 2004). They emphasize iterative cycles of action, reflection and collaborative learning as central to effective action learning processes. Coffee cooperative productivity was measured as a multidimensional construct reflecting the effectiveness and efficiency of cooperative operations in offering effective extension services, access to finance, integration of information technology and access to market information. See Table 1 for the measurement and operationalization of variables.

Reliability and validity analysis

Reliability tests were conducted to assess the extent to which the measurement instrument produces stable, consistent results across varying conditions (Vilagut, 2024). Internal consistency of the questionnaire items was evaluated using Cronbach's alpha coefficient. The results indicate that all study variables achieved acceptable levels of reliability, with alpha coefficients exceeding the recommended threshold of 0.70. This suggests that the measurement items exhibit satisfactory internal consistency and are therefore suitable for subsequent analysis, in line with the criteria advanced by Nunnally (1978). See Table 2 for reliability and validity analysis.

Data processing and analysis

Data analysis was analyzed using SPSS version 25, following a systematic, sequential procedure. This software was considered more useful than other software packages because the current study focused on observed variables and hypothesis testing through correlation, regression, and mediation analyses rather than on latent variable modeling or complex structural equation modeling. SPSS provided all the statistical procedures necessary to adequately address the study objectives without requiring more advanced analytical software (Abu-Bader, 2021). The process involved preliminary data screening, which included missing-value analysis, outlier detection and assessment of normality to ensure the data set's suitability for subsequent statistical analyses. Upon confirming data integrity, descriptive statistics were generated, including frequencies, means, and standard deviations, to summarize the characteristics of the study variables.

Subsequently, inferential statistical techniques were used to examine the relationships among the variables. Pearson correlation analysis was used to determine the strength and direction of associations, while regression analysis was conducted to assess the predictive capacity of the independent variables on the dependent variable. Finally, mediation analysis was performed to examine whether the relationship between the independent and dependent variables operates through an intervening (mediating) variable, thereby providing deeper insight into the underlying causal mechanisms.

Table 1. Measurement of study variables

Construct	Dimensions	Sample measurement items (five-point Likert scale)	Sources
Digital capabilities	Digital sensing	Our cooperative regularly scans for new digital technologies relevant to coffee production and marketing	Teece <i>et al.</i> (1997); Teece (2007); Warner and Wäger (2019); Li <i>et al.</i> (2018)
	Digital seizing	Our cooperative effectively adopts and uses digital tools to improve operations	
	Digital resource management	Our cooperative efficiently manages and integrates digital resources into its activities	
Action learning	Problem identification	Members of our cooperative actively identify and define real operational challenges	Revans (1982); Kolb (2014); Marquardt and Waddill (2004)
	Action learning sets	Our cooperative promotes teamwork in solving practical problems	
	Questioning, insight and reflection	Members critically reflect on their actions to improve future performance	
	Individual and collective learning	Learning is shared among members to improve collective performance	
Coffee cooperative productivity	Extension services	Our cooperative provides timely and relevant advisory services to farmers	Abate <i>et al.</i> (2018); Verhofstadt and Maertens (2015); Barrett <i>et al.</i> (2022)
	Access to finance	Members of our cooperative have improved access to financial services and credit	
	IT integration	Our cooperative effectively uses digital technologies in its operations	
	Market information access	Our cooperative provides accurate and timely market information to members	

Note(s): All items were measured on a five-point Likert scale ranging from 1 = strongly disagree to 5 = strongly agree

Table 2. Validity and reliability table

Variables	No. of items	CVI	Cronbach's alpha
Digital capabilities	15	0.800	0.792
Action learning	15	0.867	0.811
Cooperative productivity	15	0.733	0.887

Source(s): Primary data (2026)

Demographic characteristics

[Table 3](#) presents the demographic characteristics of the respondents. The findings indicate that the majority of respondents were male (59.0%), compared to 41.0% female, suggesting that males dominate coffee cooperatives with notable female participation. In terms of age, most respondents (70.7%) were between 26 and 33 years, reflecting a predominantly youthful workforce likely to be receptive to digital adoption and active participation in a productive economy. Regarding education, the majority (69.8%) had attained advanced-level education, while 16.7% possessed university degrees, indicating a moderately educated workforce capable of engaging with digital tools. Regarding work experience, most respondents (70.7%) had 6–10 years of experience, suggesting sufficient practical exposure to organizational processes. The results further show that the majority of respondents (70.3%) never received any specialized training on digitalization for coffee productivity, suggesting limited digital capabilities among stakeholders. Finally, most cooperatives (61.7%) had been operating for 6–10 years, suggesting relative organizational maturity that may facilitate the adoption of digital transformation initiatives for greater productivity.

Table 3. Demographic characteristics of respondents (*n* = 222)

Variable	Category	<i>n</i>	%
Gender	Male	131	59.0
	Female	91	41.0
Age	18–25	22	9.9
	26–33	157	70.7
	34–40	8	3.6
	41 and above	35	15.8
	Ordinary level	14	6.3
Education level	Advanced level	155	69.8
	Degree	37	16.7
	Others	16	7.2
	1–5 years	22	9.9
Work experience	6–10 years	157	70.7
	11 and above	43	19.4
	Active workshops	24	10.8
Special training	No training at all	156	70.3
	Instructor-led	42	18.9
	Less than 5 years	2	0.9
Period in operation	6–10 years	137	61.7
	11 and above	83	37.4

Source(s): Primary data

Correlation analysis

A Pearson's product-moment correlation coefficient was computed to establish the relationship between variables. This statistical technique was used to assess the extent to which the variables are linearly related, providing both the direction (positive or negative) and the strength of the associations (Kurtz and Mayo, 1979). The results indicate that digital capabilities are positively and significantly associated with productivity of coffee cooperatives ($r = 0.503, p < 0.01$), suggesting that firms with stronger digital capabilities tend to sense, seize and reconfigure digital resources to achieve higher productivity. At the dimensional level, all components of digital capabilities – sensing ($r = 0.45, p < 0.01$), seizing ($r = 0.47, p < 0.01$) and reconfiguring ($r = 0.49, p < 0.01$) – exhibited moderate and significant relationships with coffee cooperative productivity with reconfiguring capability demonstrating the strongest association, underscoring the importance of resource transformation and organizational adaptability in enhancing productivity. Action learning was also positively related to the productivity of coffee cooperatives ($r = 0.461, p < 0.01$), indicating that experiential and collaborative learning processes play a critical role in improving cooperative productivity. Collective learning showed the strongest relationship with the productivity of cooperatives ($r = 0.48, p < 0.01$), followed by questioning and insight ($r = 0.46, p < 0.01$) and reflection ($r = 0.45, p < 0.01$). Problem identification ($r = 0.43, p < 0.01$) and participation in action learning sets ($r = 0.44, p < 0.01$) also demonstrated significant, albeit slightly weaker, associations. Furthermore, digital capabilities were positively associated with action learning ($r = 0.262, p < 0.01$), suggesting that firms with stronger digital competencies are more likely to engage in structured learning processes. The moderate magnitude of this relationship implies that while digital capabilities and action learning are related, they remain conceptually distinct constructs (see Table 4 for correlation matrix).

Regression analysis

A multiple regression analysis was conducted to examine the extent to which digital capabilities and action learning predict the productivity of coffee cooperatives. The overall regression model was statistically significant, $F(2, 219) = 64.03, p < 0.001$, indicating that the predictors jointly explain a significant proportion of the variance in the productivity of coffee cooperatives. The model yielded an R of 0.607 and an R^2 of 0.369, suggesting that approximately 36.9% of the variation in coffee productivity is explained by digital capabilities and action learning. Digital capabilities emerged as a strong and statistically significant predictor of the productivity of coffee cooperatives ($\beta = 0.410, t = 7.376, p < 0.001$). This implies that improvements in firms' abilities to sense, seize and reconfigure digital resources are associated with increased productivity of cooperative outcomes. Similarly, action learning was a significant predictor ($\beta = 0.353, t = 6.350, p < 0.001$), indicating that experiential learning processes – such as problem identification, questioning, reflection and collaborative learning – contribute meaningfully to productivity enhancement of these cooperatives (see Table 5 for a regression model).

Mediation analysis of action learning in the relationship between digital capabilities and cooperative productivity

Figure 2 shows the mediation model examining the role of action learning in the relationship between digital capabilities and cooperative productivity. Following the classical mediation framework proposed by Baron and Kenny (1986), mediation is established when the independent variable is significantly associated with both the mediator and the dependent variable and the mediator is significantly associated with the dependent variable. Consistent with these conditions, the results revealed significant and positive relationships among the

Table 4. Correlation matrix of study variables and their subconstructs

Variable	1	2	3	4	5	6	7	8	9	10	11
1. Digital capabilities (overall)	1										
2. Sensing capability	0.71**	1									
3. Seizing capability	0.68**	0.65**	1								
4. Reconfiguring capability	0.74**	0.69**	0.72**	1							
5. Action learning (overall)	0.262**	0.25**	0.24**	0.27**	1						
6. Problem identification	0.24**	0.23**	0.22**	0.25**	0.68**	1					
7. Action learning sets	0.26**	0.24**	0.23**	0.25**	0.70**	0.66**	1				
8. Questioning and insight	0.27**	0.25**	0.24**	0.26**	0.72**	0.68**	0.71**	1			
9. Reflection	0.26**	0.24**	0.23**	0.25**	0.70**	0.67**	0.69**	0.72**	1		
10. Individual and collective learning	0.29**	0.27**	0.26**	0.28**	0.74**	0.70**	0.72**	0.73**	0.75**	1	
11. Coffee productivity	0.503**	0.45**	0.47**	0.49**	0.461**	0.43**	0.44**	0.46**	0.45**	0.48**	1
Note(s): * $p < 0.05$, ** $p < 0.01$											

Table 5. Regression results for digital capabilities and action learning predicting cooperative productivity

Model	R	R ²	Adjusted R ²	SE	F	Sig.
1	0.607	0.369	0.363	0.46213	64.03	0.000
Variable		B	SE	β	t	Sig.
Constant		0.350	0.327		1.070	0.286
Digital capabilities		0.528	0.072	0.410	7.376	0.000
Action learning		0.467	0.074	0.353	6.350	0.000

Note(s): Dependent variable: Cooperative Productivity. $F(2,219) = 64.03, p < 0.001$

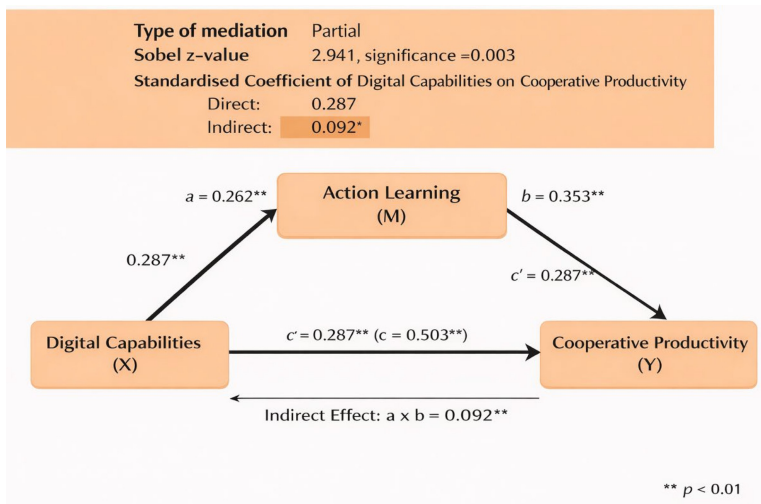


Figure 2. Mediation analysis

study variables. Digital capabilities were positively and significantly associated with action learning ($a = 0.262, p < 0.01$), and also exhibited a strong positive relationship with cooperative productivity ($c = 0.503, p < 0.01$). In addition, action learning was positively and significantly related to cooperative productivity ($b = 0.353, p < 0.01$), thereby satisfying the key prerequisites for mediation testing. Further analysis indicates that digital capabilities retained a statistically significant direct effect on cooperative productivity even after accounting for the mediating role of action learning ($c' = 0.287, p < 0.01$), while the total effect remained substantial ($c = 0.503, p < 0.01$). Importantly, the indirect effect ($a \times b = 0.092, p < 0.01$) was also statistically significant, as confirmed by the Sobel test ($z = 2.941, p = 0.003$).

Taken together, these findings provide evidence of partial mediation, suggesting that action learning is an important explanatory mechanism by which digital capabilities influence cooperative productivity. This implies that while digital capabilities directly affect productivity outcomes of cooperatives, their impact is further amplified through organizational learning processes such as problem identification, questioning, reflection, and collective learning.

Discussion

The findings of this study provide robust evidence that digital capabilities constitute a critical driver of productivity within coffee cooperatives. Empirical evidence from leading coffee-producing countries such as Brazil and Vietnam, where the strategic adoption of digital technologies at both farm and cooperative levels has been associated with productivity gains of approximately 20%–30% ([Vietnam News, 2025](#)), further reinforces this position. Consistent with extant literature, the results indicate that cooperatives with higher levels of digital sensing, seizing, and resource management are better positioned to access and use critical information, coordinate value chain activities, strengthen extension service delivery, and integrate digital technologies into their operational processes, thereby enhancing their overall productivity potential.

However, the findings also reveal that the productivity benefits of digital capabilities are not automatically realized. In the absence of mechanisms that facilitate the comprehension, interpretation and contextual application of digital knowledge, these capabilities remain underused. This underscores the necessity for cooperatives to develop action-based knowledge and practical competencies in using digital tools, which are best cultivated through action-oriented learning processes.

Accordingly, these findings challenge technology-centric assumptions prevalent in the literature which demonstrate that access to digital technologies alone is sufficient to drive meaningful transformation in agricultural systems in the absence of complementary learning and capability-building mechanisms. This is particularly salient in contexts where learning has been shaped by epistemic injustices associated with passive, transmission-oriented pedagogies, which constrain the development of critical, practical and adaptive competencies required for effective technology utilization ([Origgi and Ciranna, 2017](#)).

Although this assertion has often been downplayed by colonial apologists on the grounds that such societies have failed to effectively use their resources for social and economic advancement, the enduring problem of epistemic injustice – which has systematically deprived individuals of action-oriented knowledge and practical competence – remains a critical constraint ([Fernández, 2021](#)). This legacy continues to undermine the development of digital capabilities and, consequently, limits the realization of higher levels of farm and organizational productivity. The present findings, which establish that action learning plays a pivotal mediating role in translating digital capabilities into tangible productivity outcomes, lend renewed credence to the critique of colonial pedagogical legacies. This is particularly evident in contemporary digital environments that demand practical, action-oriented understanding, problem-based learning, collaborative knowledge exchange, and reflective practice. In such contexts, the absence of these learning modalities constrains the effective utilization of digital tools, whereas their presence enhances key performance outcomes, including improved extension service delivery, greater access to market information, enhanced financial inclusion and increased operational efficiency within coffee cooperatives.

Conclusion

This study set out to examine the mediating role of action learning in the relationship between digital competencies and cooperatives' productivity. The findings provide compelling evidence that both constructs are critical drivers of productivity in the sector. Specifically, the results reveal that digital capabilities significantly influence cooperative productivity, while action learning plays a pivotal mediating role by translating digital potential into actionable, contextually relevant practices. These findings contribute to the growing body of literature by demonstrating that productivity gains in agricultural

cooperatives are not merely a function of access to technology but are fundamentally shaped by experiential and reflective learning processes.

Practical implication

The study underscores the imperative for policymakers and cooperative leaders to move beyond merely providing digital technologies toward the deliberate design and institutionalization of action-oriented learning ecosystems that enable meaningful use of technology. For meaningful utilization of tools such as precision agriculture (drones and sensors), Artificial Intelligence Sorting/Grading, Traceability Software and data-driven roasters, policymakers and practitioners must invest in experiential, problem-based training models – such as farmer field schools and cooperative learning platforms – that integrate digital tools into real-world agricultural practices.

Theoretical implications

The findings of this study yield several important theoretical implications. First, they extend Dynamic Capabilities Theory by demonstrating that digital capabilities alone are insufficient to drive organizational performance; rather, their effectiveness is contingent upon learning mechanisms that enable their enactment in practice. In this regard, the study introduces action learning as a critical micro-foundational process through which sensing, seizing, and resource reconfiguration are operationalized within cooperative contexts, especially in countries such as Uganda, where farmers lack sufficient modern, technology-oriented knowledge to improve productivity. Second, the study contributes to Experiential Learning Theory by empirically positioning action learning not merely as a pedagogical approach, but as a strategic capability that mediates the relationship between technological resources and productivity outcomes.

Limitations and future studies

First, this study used a cross-sectional design and purely quantitative methods, which limited the ability to draw definitive causal inferences about the relationships among the study variables. The quantitative nature of the study also limited the ability to capture respondents' qualitative aspects, such as their feelings, perceptions and other subjective elements regarding action learning and the cooperatives' digital capabilities in the coffee sector. Future research should therefore adopt longitudinal or experimental designs to better capture causal dynamics, incorporate objective productivity measures, and extend the model to other agricultural value chains or comparative contexts.

Acknowledgements

The authors have no affiliations or involvement with any organization or entity with a financial or nonfinancial interest in the subject matter or materials discussed in this manuscript.

Funding

This research did not receive any funding from any individual or organization.

Research involving human participants and/or animals

This study did not require ethical approval, as it involved no foreseeable risk of harm or discomfort to participants. Informed consent from the respondents was considered sufficient.

Data availability

The authors will make available data supporting this manuscript's results when deemed necessary.

Informed consent

The authors obtained verbal consent from cooperatives and the individual respondents.

Author contributions

The corresponding author is entirely responsible for this manuscript. All efforts in conceptualization, methodology, statistical analyses and discussion are attributed to the corresponding author.

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