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RESEARCH ARTICLE

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Effectiveness of a competence-based planting support training programme for development agents in Ethiopia

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Abstract

Competence-based education and training (CBE/T) has been implemented in Ethiopia to develop the competences of (future) professionals and to improve their performance. However, empirical evidence that demonstrates the effectiveness of CBE/T is scarce. Positioning the study within the theory of strategic alignment and comprehensive competence-based training, we used the authentic core job task 'On-Site Helping of Farmers during the Planting of Maize', of Development Agents as problem context and conducted an experimental-longitudinal research study including multirater performance assessment. The study compared competence development of the Development Agents who received training that could be characterized as 'High-CBT' ($N = 33$) and 'Low-CBT' ($N = 32$). 'High-CBT' means that in these training programmes, principles of competence-based training were used more completely than in the 'Low-CBT' programmes. Experts rated the competence levels of the Development Agents and Development Agents rated their own competence levels. Both groups did that before and

after the training. Individual Development Agent performance was also rated by Trained Assessors. Longitudinally, Development Agent performance data was collected during one production year at three points in time. Development Agent's competence development in the 'High-CBT' training condition was higher than in the 'Low-CBT' condition. Observations made on each Development Agent's performance by Trained Assessors both in the Farmer Training Centres and in the authentic job situations, generally confirmed better performance of the 'High-CBT' group compared with the 'Low-CBT' group. The finding contributes to the state of research on the relationship between competence development and performance improvement, which is theoretically postulated although less empirically tested.

INTRODUCTION

Competence-based training (CBT) is defined as a type of education that focuses on: (a) requirements of the work field; (b) competencies as integrated knowledge, skills and attitudes; and, (c) stimulating competency development in trainees (Mulder, 2001). The framework of this study is based on the revised Biggs Theory of Strategic Alignment (Mulder, 2017a). This framework aligns the competence framework, educational philosophy, learning outcomes, learning arrangement and assessment of educational achievement. It is operationalized by the comprehensive CBT model (Sturing et al., 2011) and integrated conceptualization of competencies (Mulder, 2001) to enhance Development Agents' competence development and improve their performance in actual job situations, since Ethiopia's public extension services are accused of poor links between theory and practice (Deneke & Gulti, 2016). Competencies are clusters of knowledge, skills and attitudes that are necessary to perform core job tasks or solve core job problems in professional practice (Mulder, 2001). Implementing CBT is assumed to have added value on the development of competence of (future) professionals and the improvement of their performances (Rothwell & Lindholm, 1999).

Fundamentally, three underlying reasons can be mentioned for CBT (Mulder, 2012, p. 319): (i) the necessity to align education with the needs in society, a sector, a region, a community, or a company; (ii) its intention to give trainees access to the world of work; and, (iii) it helps trainees contribute to the economy through being competent performers in any organization or as being self-employed. This has stimulated organizations to devote huge amounts of resources to design and implement CBT (Ellström & Kock, 2008). However, there are few studies reporting actual competence gain by direct measurement of performance improvement (Kock et al., 2007). Evidence on the effectiveness of CBT and the evaluation of actual performance improvement based on observable activities demonstrated by trainees is limited (Lassnigg,

2017; Wesselink et al., 2017). This is due to the challenging demands of aligning the world of education with the world of work, which necessitate the empirical study of CBT with longitudinal comparative designs and allocation of sufficient funding and lengthy years (Mulder, 2017b) in addition to the involvement of practitioner multiple assessors to measure actual performance (cf. Gulikers et al., 2009).

Although the public agricultural extension services of Ethiopia are surrounded by many problems, the problems at hand are less yield in quintal/hectare gains and weak performance of professionals in actual job situations which urged the importance of reforming it (Berhane et al., 2020). Moreover, the public extension services are not provided to: (a) smallholder farmers in a way that empowers them to manage complexity (Nason, 2017); (b) stimulate innovation which is able to address the complexity and foster the emergence of flexible support instruments that enable adaptive management (Klerkx et al., 2010); (c) enhance innovative (best practices) sustainably (Silva & Figueiredo, 2017; Tarekegne, 2021b). Implementing intervention studies with educational innovations such as CBT is important to fill these gaps. This study is a continuation of an earlier study which identified competence gaps of Development Agents in Ethiopia (Tarekegne et al., 2017) who are professionals that provide agricultural extension services to smallholder farmers.

It aims to tackle the problems using CBT in the Ethiopian context, particularly in the West Gojjam Zone, which is composed of 13 districts. A representative district is selected as a case since it fulfils principal features that are also relevant for other districts in the zone: (a) it produces crop dominantly; (b) it has a dense population with an urgent need of sustainable intensification of agriculture to increase yield/hectare, and; (c) farmers are still provided with more theoretical than hands-on practical training.

Ethiopia was chosen as the context of this study since CBT was introduced in 2004 in the Technical and Vocational Education and Training system based on the requirements of the world of work (Ministry of Education, 2008). The Agricultural Technical and Vocational Education and Training colleges were supposed to adopt this educational innovation. Their training programmes were designed to provide professional training to extension workers called Development Agents in Ethiopia, who are also expected to provide extension training and advisory services to smallholder farmers. The total training time was divided into two parts for which a percentage of time was allocated: 30 per cent for the theoretical part and 70 per cent for the practical part (Kassa & Alemu, 2016). Development Agents took 3 years of training in different fields such as crop science, natural resource management and plant science at government expense and earned a diploma (10 + 3) from the colleges followed by assignment in local administrations to provide extension services to farmers. However, the training programmes provided to Development Agents in the Agricultural Technical and Vocational Education and Trainings have limitations in establishing links between theory and practice (Deneke & Gulti, 2016). Development Agents are challenged by constraints of competence gaps such as relation building and communication, entrepreneurial and problem-solving skills (Davis et al., 2010; Tarekegne et al., 2017) and they are still applying conventional methods of training and advisory support services to farmers (Berhane et al., 2020; Tarekegne, 2021b). This made the extension system less effective in achieving large-scale adoption of improved technologies and knowledge (Kassa & Alemu, 2016), and agricultural productivity is still below expectations (Kassie et al., 2018). Within such background, we conducted task analysis on the current core job tasks of Development Agents with the purpose of uncovering the: (a) characteristics of the tasks to be trained; and, (b) the learning outcomes to be constructed (cf. Goldstein, 1993). Job/task description, task specification and determination of task

requirements (competencies) that are needed by trainees to complete the job have been identified to align content, instruction and assessment in CBT (Biggs, 1999; Pellegrino, 2004). The core Development Agent job task 'On-Site Helping of Farmers during the Planting of Maize' is the focus of this study. This particular task is chosen since maximizing yield needs preliminary performance of tasks that address interactions among water, seed and soil-related factors (Fageria, 1992) and combat abiotic stress, pathogens and pests to intensify agricultural production in a sustainable manner (Timmusk et al., 2017). It is decomposed into four tasks and 14 specific activities like 'recognizing the total plant population' and 'computing the total plant population per hectare'.

As stated above, Development Agents have their own previous experiences. They are not novices who need training in 'well-structured' learning environments (cf. Kirschner et al., 2006). They possess basic skills related to applying proper row-spacing and recognizing total plant population. These are indicators of their potential to learn the newly defined job tasks and performance improvement possibilities (cf. Tannenbaum & Yukl, 1992). This makes them learn better in work-related CBT assignments and meaningful contexts (Jonnaert et al., 2007). The intervention implemented in this study could contribute to increasing the productivity (yield in quintal/hectare) gains of smallholder farmers. It is aimed at conducting a field experiment and measuring the impact of CBT on competence development and performance improvement of Development Agents while training and supporting farmers respectively in the: (1) farmer training centres; and, (2) authentic job situation during the planting of maize.

THEORETICAL FRAMEWORK

Many authors emphasize the importance of education since it enhances competence development (Brown et al., 2001). However, current educational systems are often accused of producing 'nonrelevant' graduates (Mulder, 2017a). Complaints articulated by employers demanded the need of undertaking educational reforms that align the world of education with the world of work (Mulder, 2014). There is a need to improve the connectivity between learning in school and learning in the workplace and to secure a balance between them to produce graduates who can effectively manage the emerging multitude of challenges in authentic job situations (Wesselink et al., 2017). To ensure a strong connection between educational programmes and the world of work, competencies should be directly derived from professional practice in relation to job-specific core tasks and should be used as a starting point for the development of the curriculum (Biemans et al., 2004).

According to the principle of 'constructive alignment' (Biggs, 1999), intended learning outcomes derived from competencies as specified by the curriculum should be aligned with teaching and learning activities and assessment tasks. However, Biggs's (1999) model is proposed to be revised since: (a) it does not elaborate on how intended learning outcomes are developed which can be done by considering the different inputs against the educational philosophy; and, (b) it is deterministic which is used to state the content of intended learning outcomes and assessments. However, the competence framework model involves deliberation among concerned stakeholders about the educational programmes, the learning of students and the assessment of their achievements where dynamic interactions among these factors and emerging state of the world of work leading to innovation and transformation is possible (Mulder, 2017a).

This framework acknowledges the necessity of an educational philosophy that deals with the *nature of learning* and *knowing* around which the curriculum, instruction and assessment

functions are organized (cf. Mulder, 2017a; cf. Pellegrino, 2004). This urged experts to favour internal alignment between learning activities and assessment and linkages between the curriculum and the world of work (Figure 1). In addition, they advocated the use of CBT which is rooted in social constructivist philosophy, according to which learners construct their own knowledge through interaction with others (Simon et al., 2000). This educational philosophy serves as a unifying paradigm so that the three functions are directed toward the same ends and reinforce each other (cf. Pellegrino, 2004). According to Loyens and Gijbels (2008), characteristics of constructivist learning arrangements include: knowledge construction, cooperative learning, self-regulated learning and engaging trainees in meaningful and authentic problem contexts, among others. Essentially, learning requires self-regulation and the building of conceptual structures through reflection and abstraction (Von Glasersfeld, 1995). The training and support programmes provided by Development Agents to farmers are expected to be based on these theoretical notions since they have the potential to enhance alignment between the two worlds. However, Development Agents persist in delivering conventional instructional (e.g., lecturing, not flexible) and assessment (e.g., asking to recite information) methods (Davis et al., 2010) instead of promoting meaningful learning of farmers via: (a) engaging them in solving real-world problems, (b) activating existing knowledge of them as a foundation for new knowledge gain, (c) demonstrating new knowledge to them, (d) encouraging them to apply the new knowledge and (e) integrating the new knowledge to their world (cf. Merrill, 2002, pp. 44–45). In addition, the expectations that they could bridge the differences between the two worlds are not realized.

Conventional instructional and assessment methods, although supportive, are less suitable to competence-based curricula (Biemans et al., 2009). Because, competence is inferred from observable performance outcomes on a set of tasks (Shavelson, 2013) and assessment of professional competencies necessitate incorporation of actual observation of the trainee's performance in real professional practice (Biemans et al., 2009). It needs to correspond to what is expected from trainees in the world of work (Gulikers et al., 2004). To comply with professional requirements, there is a need to develop and apply competence-based assessments that are performance-based and require trainees to perform professional tasks in the workplace (Gulikers et al., 2006). The quality of the assessment also desires to be strengthened through inclusion of stakeholders perspectives and qualitative argumentations (Gulikers et al., 2009). Based on the insights discussed above, Mulder (2017a) revised Biggs's (1999) model within the

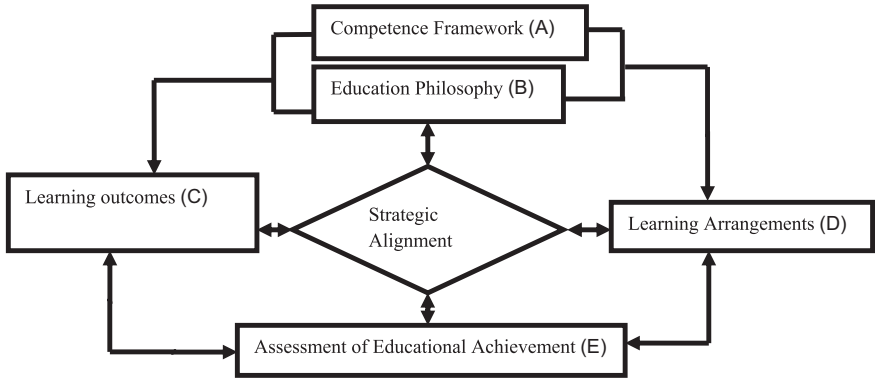

FIGURE 1 Theoretical framework based on Biggs's Theory of Strategic Alignment (Mulder, 2017a)

conceptualization of the Comprehensive Competence-Based Training (CCBT) model to enhance better alignment between the worlds of education and work as illustrated above.

In the present study, the revised model (Figure 1) and CBT are used as theoretical and conceptual frameworks, respectively to provide the fundamental bonding principle around which the strategic alignment functions would revolve to examine the effects of CBT activities. To operationalize the alignment of the components (*a*–*e*) (Figure 1), the CCBT model (Sturing et al., 2011) was used to design the training programme as intervention. This model was selected since it: (a) uses content, job and task analysis as a starting point to make decisions regarding education and training curriculum; (b) combines information from the job and task analysis with content analysis based on the current state of disciplinary knowledge (Mulder, 2012); and (c) uses the social constructivist philosophy of teaching and learning as a unifying paradigm (Simons et al., 2000). In the CCBT model applied in this study, the conceptualization of 'competence', 'competency' and 'competencies' is defined as follows: competence is the generic, integrated and internalized capability to deliver sustainable effective performance in a certain professional domain, job, role, organizational context or task situation while competency is a part of generic competence, that is, a coherent cluster of knowledge, skills and attitudes which can be utilized in real performance contexts; and, competencies are the plural of competency (Mulder, 2014; Mulder & Winterton, 2017).

When organizing CBT training, 10 CBT principles of the model were taken into consideration (Sturing et al., 2011, p. 203). These basic CBT characteristics were central in the training and can be enlisted as: (1) the training programme is based on core tasks, working processes and competences (the qualification profile); (2) complex vocational core problems are central; (3) learning activities take place in different concrete, meaningful vocational situations; (4) knowledge, skills and attitudes are integrated; (5) trainees are regularly assessed; (6) trainees are challenged to reflect on their own learning; (7) the training programme is structured in such a way that the trainees increasingly self-steer their learning; (8) the training programme is flexible; (9) the guidance is adjusted to the learning needs of the trainees; and, (10) in the training programme, attention is paid to learning, career and citizenship competences. This combination of characteristics makes CBT unique, compared with other training approaches. In addition, the CBT training approach had five implementation levels which were described correspondingly to the 10 principles (Sturing et al., 2011). They were enlisted as: 'not competence-based', 'starting to be competence-based', 'partially competence-based', 'largely competence-based' and 'completely competence-based'. From these levels, the 'not competence-based' and 'completely competence-based' were adapted into 'Low-CBT' (L-CBT) and 'High-CBT' (H-CBT) training methods in our study (*see Supporting Information A*). The training is provided to 'L-CBT'-conventional ($N = 32$) and 'H-CBT'-innovative ($N = 33$) trainee DAs, respectively, each group for 5 days in the farmer training centres and 10 days placement in an authentic job situations. The basis for fixing the time gap of 5 days (33 per cent) and 10 days (67 per cent) in every assessment stage is made based on the training programmes of the agricultural and technical and vocational education and training colleges principle which used to allocate 30 per cent for the theoretical part and 70 per cent for the practical part (Kassa & Alemu, 2016).

This case study is timely and relevant since it tries to empirically test the theory of strategic alignment as operationalized in the comprehensive and conceptualization of the CBT model in the public extension services context of Ethiopia since the extension services lack linkage between world of education and world of work or theory and practice (Kassa & Alemu, 2016), fail to meet the needs of smallholder farmers (Tarekegne, 2021b), and Development Agents are accused of being less competent (Davis et al., 2010), which resulted in poor performance in the

actual job situation and less yield/hectare gains (Kassie et al., 2018). It examines a specific CBT training operationalized by the 10 comprehensive CBT principles and two implementation levels.

To illustrate aligned teaching; therefore, an authentic problem experienced by Development Agents during delivery of extension services to farmers is used for three reasons: (a) its objective is to help trainees solve emergent problems they will meet in the actual job situation; (b) its instructional method is problem-solving; and (c) the assessment is made based on the capability of trainees to solve the problem (cf. Biggs, 1999, p. 71). Hence, the study is positioned within the revised theory of strategic alignment (Figure 1) and CCBT model and in an authentic problem context experienced by Development Agents in their current delivery of extension services to farmers.

RESEARCH QUESTIONS

This study aimed to examine competence development and performance improvement of Development Agents in 'H-CBT' and 'L-CBT' training situations as observed by Development Agent's self-assessment, experts' perceptions of Development Agents competence levels, and Trained Assessors' observations of Development Agent's performance while training farmers in the farmer training centres and supporting them in an authentic job situation. Research questions (RQs) were:

(RQ1): *To what extent are CBT principles applied by both groups of trainee Development Agents during their training of farmers in the farmer training centres? (As measured by Trained Assessors)*

(RQ2): *To what extent the 'H-CBT' training is effective in improving performance of Development Agents in the authentic job situations in the study context as compared with the 'L-CBT' training. (As measured by Trained Assessors)*

(RQ3): *What are the differences between the effects of 'H-CBT" and 'L-CBT" training on the competence level of Development Agent's as measured by*:

RQ3A: *Development Agents themselves (self-assessments based on their experiences)*;

RQ3B: *Experts (assessment by the experts)*; *and*

(RQ4): *To what extent there is a difference in competence gain between Development Agents trained via 'H-CBT" and Development Agents trained via 'L-CBT"?*

METHODS

Participants

All 65 Development Agents (females = 22, males = 43) who were assigned in local administrations to train farmers participated. Their ages and work experience range from 23

to 43 years (mean age = 28.5, SD = 5.51) and from 2 to 18 years (mean work experience = 6.3, SD = 4.43). Experts ($N = 21$) who were subject matter specialists with demonstrated work experience and lived in the agriculture district-level department also participated. Trained Assessors ($N = 42$) who were Development Agent teachers and selected from three Agricultural Technical and Vocational Education and Training colleges participated after receiving training on the CCBT model. Smallholder farmers (440; females = 39 and males = 401) participated in the training programmes provided by Development Agents in: (1) the farmer training centres; and, (2) authentic job situations of their own farms. We obtained the consent of all participants.

Procedures

(a) Identification of the core problem:

The problem context was low yield (Kassie et al., 2018) and a baseline study was conducted for 440 smallholder farmers producing maize. The average yield in gains of 22 quintal/hectare was obtained. Maximizing yield/hectare gains requires preliminary performance of tasks that address interactions among water-, seed- and soil-related factors (Fageria, 1992). From the six job fields identified for successful Development Agent performance (Tarekegne et al., 2021a), the Job Profile for the field of 'During-Planting Crop Management' was chosen to run the field experiment since it addresses the interactions among those factors. Multistage discussions on the job profile with key stakeholder groups identified two types of training for farmers: (1) theoretical part in the farmer training centres; and, (2) hands-on practical part on farmers' own farm, that is, 'On-Site Helping of Farmers during the Planting of Maize' as the core job problem. It consisted of four tasks: (a) applying innovative farming methods; (b) capturing the complex and dynamic interactions among systems and subsystems; (c) implementing nature-friendly and sustainable farming practices; and, (d) managing human and nonhuman resources. These tasks were composed of 14 activities (e.g., recognizing the total plant population and operating uniform planting). For successful performance of the tasks, stakeholder groups selected seven competences from Tarekegne et al. (2017) through multistage discussions and judgement of their relevance to solve the particular core job problem. These competences belonged to the four competence domains (cognitive, functional, social and meta) and they took a central position in the training provided to Development Agents.

(b) Content of the training:

Key stakeholder groups and participants (see section Participants above) took part during CBT module development (cf. Wenger, 1998). The seven competences were made up of five modules. Each module consists of its descriptions, target competences and competencies to be developed, learning outcomes, time and duration of the training module, pre- and post-self-assessment of competencies as requirement, and instructional methods. Each module was also divided into subunits, including tasks that could be further practiced in authentic job situations individually. The first module belonged to cognitive competence domain while the second and third modules belonged to functional competence domain. The fourth module belonged to social-competence domain while the fifth module belonged to meta-competence domain (Le Deist & Winterton, 2005; Tarekegne et al., 2017). Within meta-competence domain, stakeholders selected three competences; that did need split treatment during the training programme.

TABLE 1 Levels of CCBT, number of Development Agents/training centres and total number of smallholder farmer trainees

CCBT levels	Number of development agents/ training centres	Number of smallholder trainees	Total trainee smallholders	Total trainee smallholders
'L-CBT' (conventional)	28	7	$28 \times 7 = 196$	220
	4	6	$4 \times 6 = 24$	
'H-CBT' (innovative)	22	7	$22 \times 7 = 154$	220
	11	6	$11 \times 6 = 66$	
Total trainee smallholder farmers in the 'L-CBT' and 'H-CBT' groups				440

Abbreviations: CBT, competence-based training; CCBT, comprehensive competence-based training.

Module 1: Understanding agroecological farming practices;
Module 2: Agricultural extension management competence;
Module 3: Programme Planning and Objective Preparation Competence;
Module 4: Realizing Extension Communication and Relation-Building Processes,
Module 5: Applying Affective Attributes, Extension Advisory-Facilitative Personal Characteristics and Acting Ethically in a during-extension advising context

(c) CCBT learning environment and instructional methods:

Development Agents are supposed to provide their training services based on the main characteristics of CBT. They are provided with the same curriculum framework to train farmers in the farmer training centres. We randomly divided local administrations called *Kebeles* into 'Innovative' and 'Conventional' groups followed by labelling the Development Agents randomly into ('H-CBT'; $N = 33$) and ('L-CBT'; $N = 32$) implementers of extension services, respectively. The operational guideline prepared for farmer training centres (Ministry of Agriculture, 2009) recommended that 15–20 smallholder farmers be included in a single session and recommended a training period ranging from 3 to 15 days or sometimes to 20 days for short-term training. However, in the training programme organized by each Development Agent, the size of the farmer-participants was limited to 6–7 individuals and a total of 440 smallholder farmers participated (Table 1).

During the development and conduct of competence assessments, the participation of practitioners with different educational backgrounds was suggested (Gulikers et al., 2009). We provided a training to Agricultural Technical and Vocational Education and Training teachers ($N = 42$) on the 10 CCBT principles, levels, descriptors; target competences and competencies; tasks and activities; and performance indicators in advance to serve as Trained Assessors. This was designed to observe individual Development Agent performance while s/he is training farmers in the farmer training centres and supporting them in authentic job situations. The intervention was conducted based on the 10 CCBT principles and serving as guiding tools in the training programme (e.g., centrality of complex problem, integration of knowledge, skills and attitude, flexibility, self-directed learning, student-centeredness, reflection and learning to learn) (Sturing et al., 2011; Wesselink et al., 2010). For the list of the 10 CBT principles, see the theoretical section and *Supporting Information A*.

(d) Measurements, instruments, participants (sample size) and sampling method (Table 2)

TABLE 2 Timeline of measurements during data gathering

Date	Measurements	Instruments	Participants	Sampling method
June 2018 (4–8; 18–22; 25–29)	(a) Assessing the competency level of individual Development Agent three times: Right before and after training in 5 days workshop (one module/day) and at the end of 10 working days placement in an 'On-Site Helping of Farmers during the Planting of Maize'; self-assessment and expert assessment (one expert assessed 3–4 Development Agents)	Five-point Likert-type scale	Experts ($N = 21$) and Development Agents ($N = 65$)	Cluster
June 2018 (28–29)	(b) Assessing competence gain of Development Agents in the innovative ('H-CBT') and conventional ('L-CBT') groups at the end of 10 working days placement in an 'On-Site Helping of Farmers during the Planting of Maize' (self-assessment)	Ditto	'H-CBT' ($N = 33$); 'L-CBT' ($N = 32$) group of Development Agents	Simple random (lottery)
June 2018 (11–15)	(c) Assessing application of CCBT principles at individual level of Development Agents in the 'innovative' and 'conventional' groups while each individual Development Agent is providing 5 days training to target farmers using 'H-CBT' ($N = 220$) and 'L-CBT' ($N = 220$) levels in the farmer training centres	Ditto	Trained Assessors selected from three Agricultural Technical and Vocational Education and Training colleges ('H-CBT'; $N = 22$); ('L-CBT'; $N = 20$)	Cluster and simple random (lottery)

TABLE 2 (Continued)

Date	Measurements	Instruments	Participants	Sampling method
June 2018 (18–22; 25–29)	(d) Assessing performance improvement using sampled tasks at individual level of Development Agent in each group during 10 days' parallel placement where Development Agents provided 'On-Site Helping of Farmers during the Planting of Maize'	Ditto	Ditto	Simple random (lottery)
July 2018 (2–6)	(e) Assessing the perspectives of trainee farmers on *previous* and *current* training and support services provided by Development Agents in farmer training centres and authentic job situations	Interview until data saturation using: Kirkpatrick's (1996) four-level model	Farmers ($N = 21$) per training centre	Random selection of trainee farmers in 'H-CBT' & 'L-CBT' conditions
July 2018 (9–10)	(f) Assessing the perspectives of Trained Assessors and experts on performance improvement and problem-solving capability of individual Development Agents in each group using Focus Group Discussions	3-h Reflective sessions with each group of Experts and Trained Assessors	Experts: 'L-CBT'; $N = 10$ and 'H-CBT'; $N = 11$ TAs ($N = 22$) in 'H-CBT'; (TAs = 20) in 'L-CBT'	Cluster
June 15–30/2019; 15–30/2020; 15–30/2021	(g) Assessing sustainability of CCBT practices in the 'Innovative' and 'Conventional' group of trainee Development Agents and farmers using checklists	Semi-structured and participant observation	The researcher	Random selection of trainee Development Agents and farmers

Note: The researcher developed the questionnaires and tested their reliability. Cronbach's α coefficients ranged from 0.71 to 0.92, which is from respectable to very good (DeVellis, 1991, p. 85).

Abbreviations: CBT, competence-based training; CCBT, comprehensive competence-based training; H-CBT, high-CBT; L-CBT, low-CBT.

(e) The research design:

The intervention was field experiment with *Randomized Pretest Posttest Control-Group Design* since it maximizes internal validity (Ross & Morrison, 2004). We defined the condition with the 'H-CBT' and L-CBT levels as *independent variable* and 'competence development' of the seven competences and 'performance improvement' of Development Agents as *dependent variables*. We applied the random assignment and mixed-method approach to collect both quantitative and qualitative data.

(f) Data analysis:

First, to analyse the data collected for research questions (RQ1) and (RQ2), the independent samples *t*-test was used. Before the analysis, the following assumptions were tested (Pallant, 2010): (a) independence of observations (each person is independent of every other person's scores); (b) normality (populations from which the samples are taken are normally distributed); and (c) equality of variances (variability of scores for each of the groups is similar). These assumptions were met. Second, to analyse the data collected for the research questions (RQ3A) and (RQ3B), a mixed between-within-subjects analysis of variance was applied. Before the analysis, the following assumptions were tested: (a) independence of observations; (b) normality; and (c) sphericity (the variance of the population difference scores for any two conditions is the same as the variance of the population difference scores for any other two conditions). For RQ3A, independence of observations and normality were met. However, the assumption of sphericity was violated, and the Greenhouse–Geisser epsilon was used to correct degrees of freedom. For RQ3B, all three assumptions were met. Third, to analyse the data collected for the research question (RQ4), a mixed multivariate analysis of variance (mixed MANOVA) was used. Before the analysis, the following assumptions were tested: (a) independent observations, (b) multivariate normality, (c) homogeneity of variance–covariance matrixes between groups, (d) sample size (the sample sizes were approximately equal across the groups; therefore, the assumptions were considered to be met), (e) outliers, (f) linearity of relations among the dependent variables, (g) multicollinearity; and (h) missing data. Finally, qualitative data were analysed using content analysis method.

FINDINGS

The following section presents the results of the intervention.

RQ1: *To what extent are CBT principles applied by both groups of trainee Development Agents during their training of farmers in the farmer training centres*? (*As measured by Trained Assessors*)

The independent samples *t*-test was conducted to compare the extent of application of CBT principles by the 'H-CBT' and 'L-CBT' group of Development Agents while training farmers in the farmer training centres as measured by Trained Assessors. There was a statistically significant difference in the scores of extent of application of CBT principles between the 'H-CBT' ($M = 143.09$, $SD = 12.44$) and 'L-CBT' ($M = 134.90$, $SD = 10.25$); $t(40) = -2.32$, $p = 0.026$, two-tailed) groups. The magnitude of the differences in the means (mean difference = −8.19, 95 per cent confidence interval [CI]: −15.34 to −1.04) was a moderate effect ($\eta^2 = 0.12$) (cf. Pallant, 2010).

RQ2: *To what extent the 'H-CBT' training is effective in improving performance of Development Agents in the authentic job situations in the study context as compared with the 'L-CBT' training*? (*As measured by Trained Assessors*)

Independent samples *t*-test was conducted to compare the extent of performance improvement of Development Agents in the 'H-CBT' and 'L-CBT' groups as measured by Trained Assessors, while the Development Agents support farmers in authentic job situations. There was statistically significant difference in the scores of performance improvement between the 'H-CBT' ($M = 86.41$, $SD = 6.65$) and 'L-CBT' ($M = 74.00$, $SD = 7.96$); $t(40) = -5.50$, $p = 0.0005$, two-tailed) groups. The magnitude of the differences in the means (mean difference = −12.41, 95 per cent confidence interval [CI]: −16.97 to −7.85) was large effect ($\eta^2 = 0.43$) (cf. Pallant, 2010).

We also used Kirkpatrick's (1996) four-level model (*Reaction, Learning, Behaviour* and *Results)* to evaluate the training and on the job support services provided by Development Agents to farmers. We held interviews with both 'L-CBT' and 'H-CBT' trainee farmers (Table 3).

From the commentary of trainee farmers, we learned that both the 'L-CBT' and 'H-CBT' approaches have added value. We understood that the 'L-CBT' group of farmers perceived the training as a refresher to improve their usual practice, while the 'H-CBT' group perceived it as a good opportunity to substantially change their earlier practice. Farmers in the 'L-CBT' group observed the instructional change of the Development Agent from lecturing to giving some practical examples. However, farmers in the 'H-CBT' group were more motivated and interested because of their involvement in narrative cases and role-play exercises presented frequently. Farmer's views illustrate the visibility of 'L-CBT' and 'H-CBT' levels of training. We organized 3-h focus group discussion sessions with each group of experts and Trained Assessors and synthesized their observations. Comparison of their views demonstrated better problem-solving capability of Development Agents in the 'H-CBT' level. We conducted random observation for three consecutive production years (June 2019/2020/2021) to assess the sustainable practice of CBT principles. We used a checklist developed from these principles and conducted semi-structure interview and participant observation. We found relatively better implementation of the principles in the 'H-CBT' level trainee Development Agents and farmers. However, Development Agents reported poor coordination and commitment among key stakeholder groups and less budgetary support to enhance such intensive training and improve farmer performance.

RQ3: *What are the differences between the effects of 'H-CBT' and 'L-CBT' training methods on the competence level of Development Agents*?

(RQ3A): *As measured by the Development Agents themselves*?

(RQ3B): *As measured by the experts*?

A mixed between-within-subjects analysis of variance was conducted to assess the effects of the interventions on Development Agents competence scores as measured by the Development Agents themselves and the experts. Their competences were measured across three time periods: pretest (t0), posttest immediately after 5 days training (t1) and posttest after 10 working days of field support and follow-up (t2). Self-assessment results indicated a statistically significant main effect for time, $F(1.166, 73.468) = 53.266$, $p < 0.0005$, partial $\eta^2 = 0.458$, with

TABLE 3 Sample quotes taken from trainee farmers

Levels	Trainee farmers in the...	
	'L-CBT' level	'H-CBT' level
Reaction	I was happy about the training. It refreshed me. The Development Agent trained us better than previous times. After instructing us, s/he tried to show us some practical examples.	I was more motivated in this training. I learned a lot from the narrative cases, role-play exercises and practical examples presented regularly by the Development Agent.
Learning	We acquired knowledge in the role-play exercises and were able to demonstrate it during the planting of maize (e.g., understanding soil features).	We acquired knowledge and skills in the role-play exercises and were able to demonstrate them during the planting of maize (e.g., understanding soil features and applying uniform planting).
Behaviour	TAs and experts measured and judged my ability related to my use of the newly learned knowledge and skills during the planting of maize and witnessed that my performance is improved.	TAs and experts measured and judged my ability on my use of the newly learned knowledge and skills during the planting of maize and witnessed that my performance improved substantially.
Results	I evaluated myself that my morale increased. I improved my interactions with Development Agents, reduced my resistance, and followed the training seriously. My yield/hectare of maize has increased from 22 quintal/hectare to 31 quintal/hectare.	I evaluated myself that my morale increased. I improved my interactions with Development Agents, reduced my resistance, and followed the training seriously. My yield/hectare of maize has increased from 22 quintal/hectare to 41 quintal/hectare. The Amhara Regional State has targeted to harvest 15.8 million quintals of maize in maize farming that covers 253,380 hectares of land which is 62.4 quintal/hectare in early December of 2021 through utilizing the Agricultural Commercialization Clustering package while the Agricultural Transformation Agency targeted 40–60 quintals/hectare in the same package (The Ethiopian Herald, 24 November, 2021).

Abbreviations: H-CBT, high-CBT; L-CBT, low-CBT.

both groups of Development Agents showing an increase in the scores of competence development as measured by themselves across the three time periods (see Table 4 below). There was also a substantial main effect for the type of intervention, $F(1, 63) = 17.193$, $p < 0.0005$, partial $\eta^2 = 0.214$, suggesting that there is a statistically significant difference in the effectiveness of the two types of intervention. The interaction between time and type of intervention was also statistically significant, $F(1.166, 73.468) = 5.940$, $p = 0.013$, partial $\eta^2 = 0.086$, indicating that the way in which the 'H-CBT' and 'L-CBT' group of Development Agents reported the growth of perceived competency levels over time was different for the two groups.

The means, standard deviations and sample sizes for these groups are presented (Table 4). As the table shows, the means of the two groups (the 'L-CBT' and 'H-CBT' intervention types)

are close to each other in the pre-test but they have large mean differences in the posttest 1 and posttest 2. This is also more evident in Figure 2 below. This figure shows that in the pretest (t0), both groups have very close means but in the posttests (t1) and (t2) the mean of the innovative training ('H-CBT') group increases substantially.

Similarly, the results from assessments made by experts indicated that there was a substantial main effect for time, Wilks' $\lambda = 0.096$, $F(2, 18) = 84.461$, $p < 0.0005$, partial $\eta^2 = 0.904$, with both groups of Development Agents showing an increase in the scores of competence development as measured by the experts across the three time periods (Table 4). The main effect comparing the two types of intervention was also statistically significant,

TABLE 4 Development Agents competence development mean scores for the 'L-CBT' and the 'H-CBT' levels across three time periods as measured by themselves and experts

	Self-assessment				Assessment by experts			
	'L-CBT' level ($N = 32$)		'H-CBT' level ($N = 33$)		'L-CBT' level ($N = 10$)		'H-CBT' level ($N = 11$)	
Time period	***M***	**SD**	***M***	**SD**	***M***	**SD**	***M***	**SD**
Pretest (t0)	110.31	17.40	113.24	13.52	110.90	4.12	113.91	5.22
Posttest 1 (t1)	118.56	15.91	132.73	13.45	123.70	4.17	127.18	5.78
Posttest 2 (t2)	124.19	11.83	139.61	11.21	129.00	6.39	135.36	7.93

Abbreviations: H-CBT, high-CBT; L-CBT, low-CBT; *M*, mean.

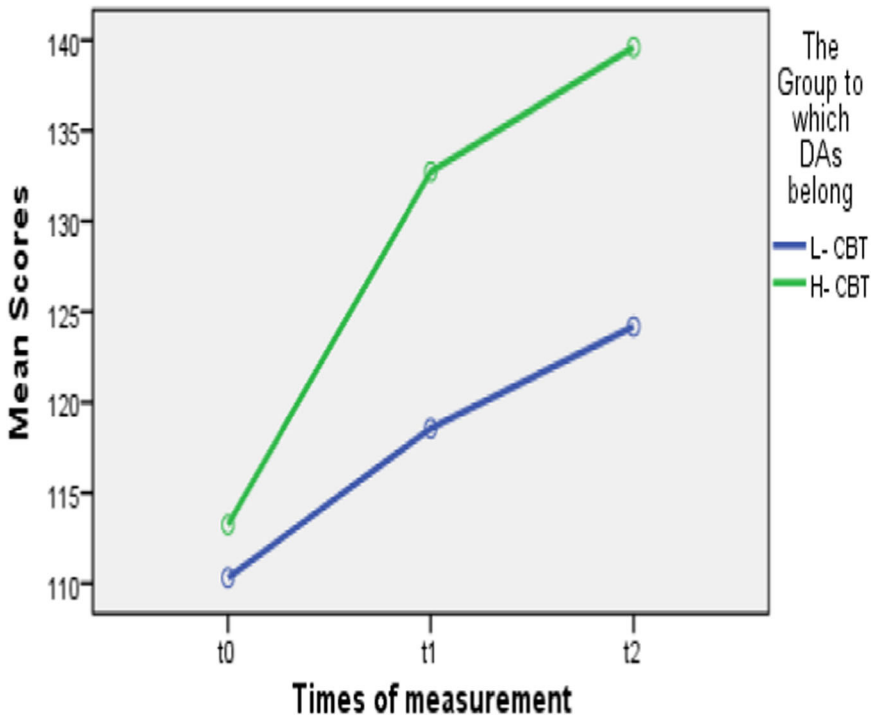

FIGURE 2 Development patterns of DA's competences between H-CBT and L-CBT groups across three time periods as measured by DAs themselves. H-CBT, high-CBT; L-CBT, low-CBT

$F(1, 19) = 6.279$, $p = 0.021$, partial $\eta^2 = 0.248$, suggesting that there is a statistically significant difference in the effectiveness of the two training methods. However, there was no significant interaction between intervention type and time, Wilks' $\lambda = 0.944$, $F(2, 18) = 0.537$, $p = 0.594$, partial $\eta^2 = 0.056$, indicating that the way in which the 'H-CBT' and 'L-CBT' group experts reported the growth of Development Agent's perceived competency levels over time was not different for the two groups. This may be because of their assumption that growth of competency is influenced by the extent of integration of theory and practice.

The means, standard deviations and sample sizes for these groups are presented (Table 4). As the table shows, the means of the two groups as measured by respective experts are close to each other in the pretest (t0) and posttest 1 (t1) but they have large mean differences in the posttest 2 (t2). Figure 3 makes this more evident.

RQ4: *What are the differences between the 'H-CBT' and the 'L-CBT' levels of Development Agents in the amount of competence gain that occurs over time on the seven competences*?

Mixed MANOVA tests were performed using SPSS version 20 for Windows to assess whether there was a difference between participants in the 'H-CBT' and 'L-CBT' groups in the

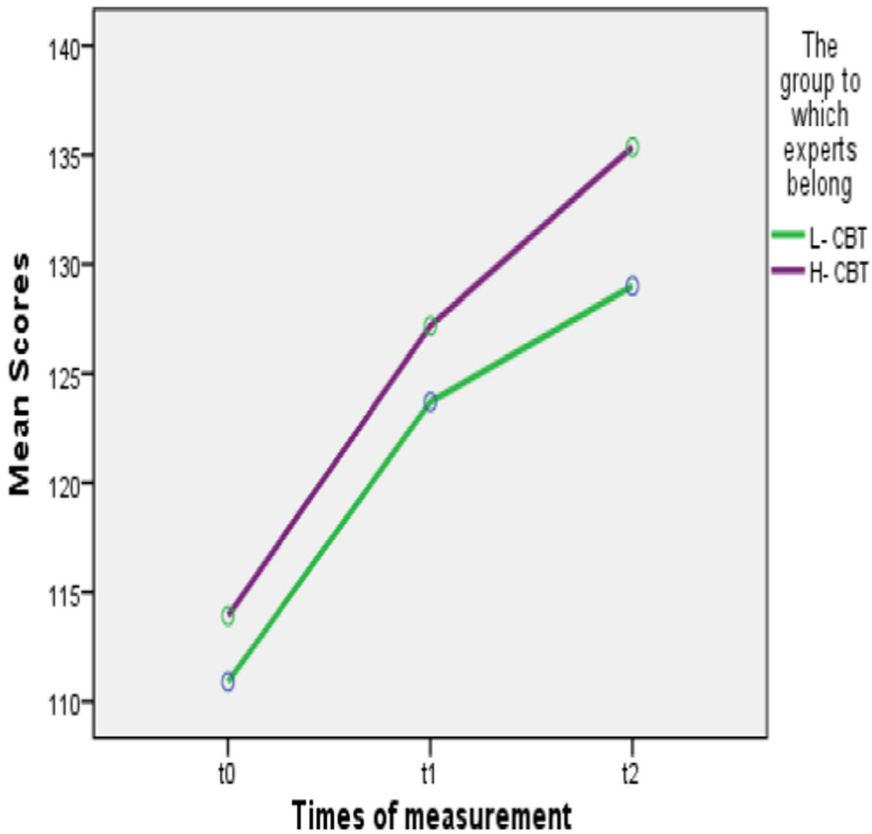

FIGURE 3 Development patterns of DA's competence in the H-CBT and L-CBT groups across three time periods as measured by experts. H-CBT, high-CBT; L-CBT, low-CBT

TABLE 5 Development Agents ratings of the seven competences in the 'H-CBT' and 'L-CBT' group across three time points

Competences	Time 0			Time 1			Time 2		
	'H-CBT'	'L-CBT'		'H-CBT'	'L-CBT'		'H-CBT'	'L-CBT'	
***N* = 65 (H-CBT = 33, L-CBT = 32)**	***M* (SD)**	***M* (SD)**	***F***	***M* (SD)**	***M* (SD)**	***F***	***M* (SD)**	***M* (SD)**	***F***
Understanding agro-ecological farming practices	12.5 (2.1)	12.7 (2.1)	0.154	13.9 (2.5)	13.8 (2.4)	0.011	14.8 (2.4)	14.4 (2.0)	0.485
Agricultural extension management	16.2 (2.6)	15.8 (2.9)	0.513	20.0 (2.5)	17.0 (2.6)	16.681[a]	20.6 (2.0)	17.8 (2.0)	33.226[a]
Programme planning and objective preparation	15.9 (2.4)	15.3 (3.1)	0.832	17.7 (2.8)	16.2 (2.3)	5.198[a]	18.7 (2.7)	16.9 (2.2)	8.719[a]
Realizing extension communication and relation-building processes	27.7 (3.3)	25.8 (5.4)	2.846	32.6 (4.5)	28.6 (4.7)	11.980[a]	33.4 (4.0)	30.2 (4.0)	10.051[a]
Applying affective attributes in a during- planting situations	9.6 (2.8)	9.0 (3.9)	2.910	11.9 (1.2)	9.9 (1.8)	27.390[a]	12.7 (1.2)	10.4 (1.5)	47.975[a]
Applying extension advisory and facilitative personality characteristics	18.6 (2.8)	18.8 (3.9)	0.030	21.2 (2.6)	19.6 (2.8)	6.170[a]	22.5 (2.6)	20.5 (2.8)	8.763[a]
Acting ethically	12.7 (2.9)	13 (2.3)	.265	15.8 (1.9)	13.4 (2.4)	20.352[a]	17.0 (1.5)	14.0 (1.9)	48.574[a]

Note: 'H-CBT' = innovative method, 'L-CBT' = conventional method.

Abbreviations: H-CBT, high-CBT; L-CBT, low-CBT.

[a]Significant difference between the 'H-CBT' and the 'L-CBT' groups at $p < 0.05$.

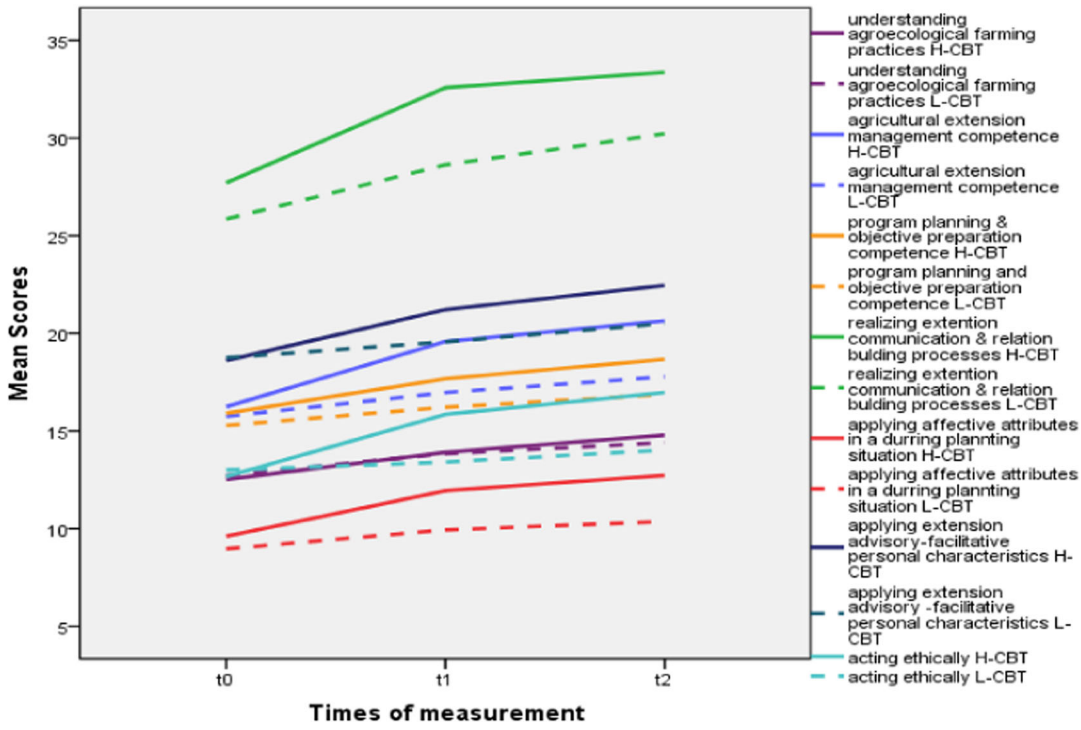

FIGURE 4 Development patterns of the seven competences in H-CBT versus L-CBT groups across three time periods. H-CBT, high-CBT; L-CBT, low-CBT

amount of change in their scores on the seven competences measures. Time was used as within-subjects variable whereas CBT was used as a between-subjects variable. Statistically significant multivariate result was found for the main effect of the CBT variable ('H-CBT', innovative vs. 'L-CBT', conventional), $F(1, 63) = 17.193$, $p = 0.0005$, partial $\eta^2 = 0.214$, which means that the Development Agents in the 'H-CBT' and 'L-CBT' group reported differences in the growth of their competences. The main effect for time was also statistically significant, $F(2, 62) = 72.552$, $p < 0.0005$, partial $\eta^2 = 0.701$, indicating that Development Agents reported growth of competences across the three time points. This growth refers to the difference score from t0 to t1 and t2. A statistically significant result was also found for the interaction between the group and time, $F(2, 62) = 4.150$, $p < 0.020$, partial $\eta^2 = 0.118$. This interaction effect indicates that the difference between the 'H-CBT' and 'L-CBT' training method groups on the linear combination of the seven dependent variables (competences) is different at posttest than it is at pretest. Table 5 presents the means and standard deviations of the seven variables (competences). Competence development (gain) here refers to the growth of competency levels as represented by mean scores of the seven competences from the first (t0), second (t1) and third (t2) measurements.

Univariate tests presented in Table 5 show that mean scores for all the seven competences in the 'H-CBT' group were higher than in the 'L-CBT', indicating that Development Agents in the 'H-CBT' group perceived themselves as more competent than Development Agents in the 'L-CBT' group for all seven competences, especially at t1 and t2 testing times. The differences are statistically significant for the six competences (agricultural extension management practices, programme planning and objective preparation, realization of extension

communication and relation-building processes, applying affective attributes in a during-planting situations, extension advisory and facilitative personality characteristics and acting ethically) at t1 and t2 (Table 5). However, their difference on 'understanding agroecological farming practices competence' between the 'H-CBT' and 'L-CBT' groups is not statistically significant at all three time periods. The growth patterns shown in Figure 4 help to make these findings more evident. Table 5 and Figure 4 shows mean scores for the seven competences at the three time periods, as well as the growth patterns in the seven competences in the 'H-CBT' and 'L-CBT' groups of Development Agents.

CONCLUSIONS AND DISCUSSIONS

Development agents in the Ethiopian agricultural context are largely receiving theory-based trainings, although the tasks they are assigned to perform need more practical training (Davis et al., 2010). On paper, the curriculum designed for development agents is largely based on the main characteristics of CBT (Ministry of Education, 2008). However, in practice, development agents are receiving more conventional training that is mainly based on theory and lacks a link between theory and practice (Kassa & Alemu, 2016). In addition, the training provided by Development Agents to smallholder farmers is more theoretical than practical. This resulted in less yield in quintal/hectare gains (Kassie et al., 2018), food insecurity (GFSI, 2019) and less sustainability (MoANR, 2017). Although some experts understand this situation and have urged the importance of reforming the training of public agricultural extension services to a truly competence-based approach (Berhane et al., 2020), there is limited research in this regard. In addition, empirical research demonstrating CBT effectiveness in improving professional performance in actual job situations and productivity (yield/hectare) gains in the developing country context is also limited.

This study; therefore, aimed to fill this gap using the revised strategic alignment theory (Figure 1) and the integrated conceptualization of competencies (Mulder, 2001) operationalized by the CCBT model (Sturing et al., 2011). They served as theoretical and conceptual frameworks and guiding tools, respectively, to design and assess the learning environments that aimed at enabling Development Agents to solve the core job problem. We found promising findings about the effectiveness of the 'H-CBT' level. The Development Agent self-reports of their competence levels are important for gaining insight into the effectiveness of CBT and for facilitating Development Agent competence development. However, investigating the success of CBT by only looking at trainee Development Agent perspectives may be deficient. This is because a trainee Development Agent self-report may lack validity and objectivity (cf. Ward et al., 2002). We tried to get the perceptions of experts since the perceptions of Development Agents and experts on the development of competence development of Development Agents may differ. However, similar findings are computed. The means of the two groups as measured by respective experts are close to each other in the pretest (t0) and posttest 1 (t1) although they have substantial mean differences in the posttest 2 (t2). Table 4 and Figure 3 make this more obvious. Development Agents and experts who belonged to the 'H-CBT' group perceived more competence development of Development Agents than the Development Agents and experts belonged to the 'L-CBT' group. This is due to the nature of 'H-CBT' learning environments which aim to encourage trainee Development Agents to largely reflect on themselves and self-steer their own learning (Sturing et al., 2011; Wesselink et al., 2010).

Competence development in this study refers to the growth of competency levels. We obtained Development Agents ratings on the target seven competences in the 'H-CBT' and 'L-CBT' groups across three time periods. The 'H-CBT' group perceived themselves as more competent than Development Agents in the 'L-CBT' group for all the seven competences especially at t1 and t2 measurement times. The effect of 'H-CBT' learning environment is more visible between postmeasurement times (t1 and t2) which could be due to: (a) the more familiarity of trainee Development Agents with the core task, specific activities and target competences and competencies and the alignment between theory and practice; (b) the centrality of complex problem during training; (c) the arrangement of learning activities in different concrete and meaningful farming situations; (d) instruction of trainee Development Agents on a single task that integrates knowledge, skills and attitudes and supporting them to see relationships and learn by abstraction and self-reflection; (e) regularly assessing and challenging them to reflect on their own learning; (f) enhancement of self-regulation and flexibility of the training; and (g) considering the learning needs of trainees. However, the differences are statistically significant for the six competences in t1 and t2 (Table 5). The difference between the two groups in 'understanding agro-ecological farming practices' is not statistically significant at all three time periods.

However, there is a slight difference in the development pattern of this competence in favour of the 'H-CBT' group (Figure 4). This has implications for those who advocate the idea that CBT negotiates knowledge development and favours the conventional approach (Koopman et al., 2011). In this study, though not a bold conclusion, we have observed the added value of the strategic alignment framework operationalized by the CCBT model as a valuable training model to promote the development of knowledge and competences in balance.

We compared the performance of each Development Agent by Trained Assessors during: (a) training farmers in the farmer training centres; and, (b) supporting farmers in the actual job situation. Trained Assessors observed a better application of CBT principles by trainee Development Agents during training and supporting farmers in the 'H-CBT' group than their counterparts. They perceived more effectiveness of the 'H-CBT' group in training and supporting farmers in the authentic job situation than the 'L-CBT' group. Development Agents in the 'H-CBT' achieved better transfer than did Development Agents in the 'L-CBT' groups. The utilization of Trained Assessors was valued by Development Agents. Development Agents argued that the presence of Trained Assessors was not only limited to assessing actual performance, but also to providing strategies to improve future performance (Gulikers et al., 2009).

Interviews held with farmers in 'L-CBT' and 'H-CBT' groups revealed improvement of yield/hectare gain of maize which is 31 and 41 quintals/hectare respectively. Compared to the baseline (22 quintal/hectare), more improvement in yield/hectare gains is seen in the 'H-CBT' group. The Amhara Regional State has targeted to harvest 62.4 quintal/hectare (see Table 3) through utilizing the agricultural commercialization cluster package in early December 2021 while the Agricultural Transformation Agency of Ethiopia targeted 40–60 quintals/hectare (The Ethiopian Herald, 2021). However, it is important to realize that such kind of targeting can be achieved by introducing an innovative training approach; for example, 'H-CBT' intensively. Successive focus group discussions held with experts and Trained Assessors disclosed that 'the H-CBT' training method has the potential to lead to achievement of such kind of regional target if it is applied with effective coordination, commitment, budgetary support and professional expertize.

Trainee farmers in the 'H-CBT' level informed us that Development Agents advised them better than earlier times. Similarly, farmers in the 'L-CBT' level reported better services of Development Agents than previous periods. Development Agents and farmers in the 'L-CBT' level did not underestimate the added value of the training programme. Repeatedly, they stated: 'it energized them to work harder in their farming profession'. Development Agents and farmers liked the 'H-CBT' level learning situation for its inclusion of vocational practice to improve performance on the job. They believed that this captured their experiences and helped them to conceptualize facts and develop declarative knowledge (cf. Lebow, 1993). In addition, they loved the presentation of narrative cases and role-plays based on a given character description. They purported that this helped them associate the exercises with their actual jobs and supported them to develop new patterns to convert their declarative knowledge into procedural knowledge. In particular, the narrative cases provided by the peers helped them evaluate their previous experiences compared to the new information provided in the training sessions. They reasoned that this helped them examine the relationships and reinterpret old and new experiences from a new set of expectations, which concurs with Mezirow's (1991) findings.

Development Agents in the 'H-CBT' group appreciated the practice situation on the problems encountered by farmers in an authentic job context. They acknowledged that this enhanced reflections and helped them develop the competencies to train farmers effectively. Inclusion of critical discourse in forms of communities of practice was further treasured by them, since it facilitated collaborative learning (cf. Wenger, 1998). Development Agents stated: 'it helps them to revise their belief systems' for better performance of training and supporting farmers in the authentic job context (cf. Mezirow, 2003).

Experts and Trained Assessors in the 'H-CBT' groups also appreciated the efforts made to integrate theory and practice in this study. They reported repeatedly that the main problem in the study context is the limitation to align training in the Agricultural Technical and Vocational Education and Training colleges with authentic job situations although policy documents are advocating it (Kassa & Alemu, 2016). In their opinion, this has its own influence on the growth of competencies of development agents. This may be the reason for the finding (Figure 3) in which the 'H-CBT' and 'L-CBT' group of experts reported the growth of Development Agent's perceived competency levels over time was not different for the two groups.

The process of learning through experience, on-site discussions with farmers and listening to their narrative cases from their present, past, or distant situations related to planting and yield problems helped Development Agents develop their problem-solving, critical thinking and decision-making skills. They believed that this helped them develop their ability to use knowledge, facts and evidence from authentic job situations to effectively solve problems and assess alternative views for a plan of action. The authentic job situation helped them improve their critical thinking skills, problem-solving abilities and communication skills with farmers, as it provides opportunities to work in close collaboration with them. We recognized that the complexity of the problem with ill-structured designs motivated both Development Agents and farmers to work together for a longer period of time. We also discovered that sustaining such kind of practice initiates lifelong learning in the farming context, which is confirmed by earlier studies (cf. Duch et al., 2001).

We argue that the strategic alignment framework operationalized by the holistic learning infrastructure (CCBT and its 'H-CBT' level) has significant added value in the development of Development Agents' competencies from all competence domains: *cognitive, functional, social* and *meta* (Le Deist & Winterton, 2005) and improvement of their performances (cf. Mulder, 2017a). We learned that the development of competencies from all domains has the potential to help trainees develop decision-making and problem-solving skills in the authentic

job context through situated deliberations (Brown et al., 1989). There is a need to institutionalize a learning alliance through multistakeholder coalition and innovation systems to achieve agricultural transformations like increase in yield/hectare. In particular, building an effective Development Agent-farmer connection should be done extensively to alleviate farming-related problems (cf. Fullan, 2012).

Thus, we concluded that our positioning of the study within the theory of strategic alignment and CCBT principles and use of the authentic core job task 'On-Site Helping of Farmers during the Planting of Maize' as problem context with true experimental-longitudinal design and multiassessor way of assessing performance is relevant to build effective Development Agent-farmer linkage and thus solve farm-related problems. We realized better linkages between the worlds of education and work through their use. Although it is demanding in terms of time, budget and human resources, we realized that proper applications of them have tremendous contributions to develop the competencies of professionals and improve their performance. Using CBT has added value in the development of competencies and the improvement of professional performance. The finding is informative that the current agriculture extension education implemented in the study area; namely, 'conventional' needs revision similar to the 'innovative' approach. We observed that the latter better bridges the gap between the worlds of education (e.g., training in the farmer training centres) and work (e.g., authentic job situation) and resulted in yield/hectare improvement better than its counterpart. It informed us of the importance of applying training innovations such as the CBT approach to improve yield in quintal/hectare gains, food security and implement sustainable agriculture.

IMPLICATIONS FOR PRACTICE AND THEORY

The results of the study have the following practical implications: First, training designers have to enhance deliberative curriculum decision-making (Westbury, 1994) and align theory and practice (Mulder, 2017a; Pellegrino, 2004); second, trainers have to implement the 'H-CBT' training method effectively to increase yield in quintal/hectare gains and improve professional performance in actual job situations. The performance of agricultural extension services also depends on the coordinated performance of other actors such as seed, credit, fertilizer suppliers, research institutions and civil society organizations. These actors, development agents and smallholder farmers need to work together to improve the overall performance of the sector, and this needs team competence (e.g., innovating competence-comprising the competency of creating and experimenting with new ideas) which needs constructive interplay among different actors.

Theoretically, the constructive alignment theory and the integrated view of competence operationalized by the CCBT model have added value in potentially avoiding the pitfalls observed in the behaviour-functionalist views of competence. In our view, this study is among the few to examine the relationship between competence development and performance improvement, which is theoretically postulated and is less empirically tested at the individual level.

LIMITATIONS OF THE STUDY AND SUGGESTIONS FOR FUTURE RESEARCH

Double-blind experiments are recommended to achieve a higher standard of scientific rigour than single-blind or nonblind experiments. We were unable to replace the first author and conduct a double-blind study due to the shortage of experienced experts in CCBT. This may

have unconsciously influenced the behaviour of the participants. Trained Assessors received training on the CCBT model before training starts and were provided with checklists that explain basic features of both 'L-CBT' and 'H-CBT' levels. However, they might have made errors, been biased in observation, or failed to recall the main features during observation. In addition, assessment of competence in practice is a difficult exercise, and this may affect the findings, particularly those analysed based on Trained Assessors observations in authentic job situations. Although we applied a Likert-type questionnaire with a descriptor (as criterion-referenced test), there may be inherent subjectivity. Another limitation of assessing competence may emanate from its dependence on inferences derived from limited observations of sampled tasks in authentic job situations, which potentially may affect the validity of the research.

Future research should assess in detail: (a) the importance of CBT innovation in developing the competencies of smallholder farmers and their performance improvement in yield/hectare; (b) team competences that are relevant for all actors involved in the agriculture sector. This is because; improving the overall performance of the agriculture sector is not only limited to developing the competences of Development Agents and smallholder farmers. The performance of the sector also depends on the coordinated performances made with stakeholders. These stakeholders, Development Agents and smallholder farmers need to work together to improve the performance of the sector which needs team competence (e.g., innovating competence: comprising the competency of creating and experimenting with new ideas) to enhance constructive interplay among different actors; (c) the relevance of the revised strategic alignment theory and the CCBT model in other sectors of education (e.g., engineering, health and teacher education) in a developing country context; (d) the results of double-blind experiments via increasing the number of experts in CCBT; (e) assessing competencies based on actual observations of professional performance in large number of tasks; (f) checking Trained Assessors perceptions with further evaluation of other Trained Assessors by two or three rounds; and, (g) the effect of other factors (such as opportunity and motivation) on development agent performance in a developing country context in relation to the intervention in this study.

AUTHOR CONTRIBUTIONS

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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