Learning Environments Research (2022) 25:75–95
https://doi.org/10.1007/s10984-021-09351-4

ORIGINAL PAPER

Constructivist learning environments and forms of learning in Ethiopian public universities: testing factor structures and prediction models

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Received: 29 October 2020 / Accepted: 19 January 2021 / Published online: 9 February 2021

Abstract
While most quality debates about undergraduate education center on topics such as test scores, learning standards, and teacher quality and retention, the environment in which students learn is often neglected. We examined the dimensions of constructivist learning environments and further tested their linkages with student learning experiences across the forms of formal, non-formal, and informal episodes. To this end, the involved a cross-sectional survey design with relevant data from samples ($N = 1121$, Female = 454 and Male = 663) of volunteer undergraduate students enrolled in three public universities in Ethiopia. Both exploratory factor analysis and confirmatory factor analysis supported the validity of 4-factor learning forms and 5-factor constructivist learning environment scales. Structural equation modeling analysis indicated good fit for these models. Moreover, results of multiple regression analyses illustrated that the domains of constructivist learning environments significantly predicted the different forms of learning, $0.22 \leq R^2 \geq 0.38$, with personal relevance accounting for most of the variation ($0.11 \leq \beta \geq 0.38$). It was concluded that undergraduate students learn in diverse ways within a constructivist learning environment, but that non-formal learning episodes were relatively rare. This could be attributed to the minimal opportunities that students have had for non-formal learning during the undergraduate years in the studied context. Implications of the findings, limitations in the existing research and suggested improvements are discussed.

Keywords Constructivist learning environment · Ethiopia · Factor structures · Forms of learning · Prediction models · Public universities

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Introduction

In this 21 century, preparing undergraduates requires a broad range of learning opportunities that go beyond the classroom and laboratory. Therefore, scholars recommend that undergraduate education integrates theory with practice, making use of real-work contexts and authentic learning environments (Arum et al. 2016; Duderstadt 2010; Lee-Post 2019). The fundamental assertion is that students can learn in a wide variety of ways, including formal, non-formal, or informal platforms, either via face-to-face or virtually (Brooks et al. 2012; Rosenfeld 2015). Beginning from the original conceptualization of the forms of learning as formal, non-formal, and informal episodes, as coined by Ahmed and Coombs (1974), there has been a broader understanding of these forms of learning in education (Aruştei et al. 2018).

The central elements in different forms of learning student learning experiences, which refer to any interactions in which learning takes place (Børgesen et al. 2016). Therefore, the learning environment denotes the diverse physical locations, contexts, and cultures in which students learn. Because students can learn in a wide variety of settings, including both within and outside school, the term 'learning environment' is much preferred as a more-accurate representation than the alternative term 'classroom environment'. This later conception has more limited and traditional connotations.

In terms of its physical set-up and social dynamics, a constructivist learning environment is very different from the classroom environment where traditional teaching methods are predominantly implemented (Akar and Yildirim 2009). While the concept of learning environment is still emerging, a consensus has been formed around best practices, which include a commitment to student-centered learning (Wright 2011). This implies that an effective tertiary learning environment requires more than just investments in physical assets (Khine et al. 2018).

Against this backdrop, establishing a more holistic learning environment for students in a particular course or program is probably very demanding for most higher-education (HE) teachers (Ebrahimi 2015). Indeed, learning environments are broader than just the physical components per se, but there is a tendency to focus on either physical institutional set-ups like classrooms, lecture theatres, and laboratories or the technologies in terms of creating online personal learning environments. Learning environments are critically important in determining the kinds of learning experiences and outcomes achieved, yet little research attention has been directed towards investigating the learning environment as a key factor affecting students learning experiences in universities and colleges (Alt 2015).

Taken as a whole, student learning experiences and the associated learning environments are complex and socially situated in the HE contexts (Edo et al. 2019; Ellis and Goodyear 2010; Huang 2012). However, there is minimal empirical evidence to justify the role of the learning environment in undergraduate student learning. Therefore, we know little about the relationships between constructivist learning environments and forms of learning. Hence, what remains unclear is how and why some domains of learning environment promote student learning, whereas others do not. In this study, we tried to address these gaps and answer the following research questions:

1. What do undergraduate Business and Engineering majors perceive about their constructivist learning environments and learning experiences in Ethiopian public universities?
2. What individual factors and university experiences correlate with student learning in the Ethiopian public university context?

3. Are higher scores for perceived constructivist learning environment associated with the degree to which students report a better learning experience across the different forms of learning?

The study context

At the College of Business and Economics and College of Engineering in Ethiopian public universities, students are supposed to be disciplinary experts who also embody humanistic and lifelong learning skills. While mastery of the technical aspects of their major disciplines must remain at the center of the curriculum, new dimensions are needed to better prepare students for the world of work. They also need 'soft' skills, such as the ability to communicate their technical ideas and concepts with a wide array of people.

In the Ethiopian higher education (HE) system, universities have been mushroomed in the last decade and the number of public HE institutions has exponentially multiplied within this period. As a universal policy, every undergraduate program consisted of a modular approach for instruction, with the intent to maintain uniformity across the programs (MOE 2013a). Despite having similarity in using a nationally-harmonized curriculum, which every university needs to strictly follow for the most part, there is a difference in the volume of academic programs to be covered across the different colleges and universities. Business major fields have a three-year undergraduate education program, while Engineering majors have five-year programs (MOE 2013b).

Conceptual model for the study

In this study, we used a conceptual framework to capture relevant variables and examined relationships between them (see Fig. 1).

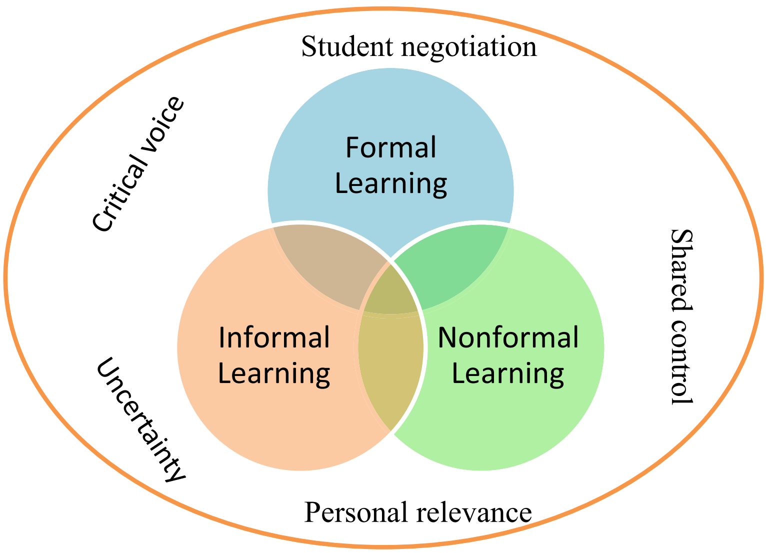

Fig. 1 A holistic conceptualization of forms of learning and constructivist learning environment

As shown in Fig. 1, learning environment is hypothesized to consist of five inter-related dimensions: students' critical voice, personal relevance, negotiation with one another, uncertainty, and shared control. Hence, learning environment is operationalized by these five variables. Similarly, the forms of learning were depicted by three distinctive but interrelated three domains such as formal, non-formal, and informal learning. Emphasizing the interconnected nature of the three forms of learning within constructivist learning environments, we tested factor structures and prediction models by which undergraduate students' learning experiences and constructivist learning environment can be promoted simultaneously.

Research methodology

Research design

We used a cross-sectional survey design involving quantitative data from a large sample of volunteered undergraduate students ($N = 1121$). Accordingly, a questionnaire was prepared for distribution to the selected sample of undergraduate students in the College of Business and Economics and College of Engineering at three public universities in Ethiopia.

Study participants and sampling

The study population included undergraduate students in the College of Business and Economics and College of Engineering and study participants were selected based on multi-stage cluster sampling techniques. First, the different public universities were classified into 6 clusters as proposed by the Higher Education Relevance and Quality Agency's (HERQA's) classification. From this, one cluster was elected using simple random sampling. After that, three universities (namely Jimma, Mizan Tepie and Metu) were selected using a stratified sampling method so that one university from each generation was included. Then, using simple random sampling, Band 1 and 5 (College of Business and Economics and College of Engineering) were selected to represent participants from the social and natural science streams because these colleges are commonly found in the selected universities. Moreover, all programs that are common to the three universities were considered (Business and Economics College: Management, Accounting and Finance and Economics departments and Engineering College: Civil, Mechanical, Electrical, Water resource departments).

Measures (study variables)

Analysis of recent literature guided the construction of two survey tools to measure forms of learning as the dependent variables and constructivist learning environment scales (CLES) as independent variables. In this study, Ahmed and Coombs's (1974) formal, nonformal, and informal learning served as the theoretical basis for the identification of items for the forms of learning measure. Also, we used the version of the CLES which was developed from the perspective of critical constructivism (Taylor 1996) and thereby alleviates weaknesses in the original version. This version of the CLES was designed to obtain measures of five key elements of a critical constructivist learning environment from the students' perspectives (Taylor et al. 1995, 1997).

With the aim of maintaining the validity of the scales, two measurement and evaluation experts and another two educational planning and management experts checked the face validity of the scales. Their reviews led to modifications of the survey to enhance comprehensibility by omitting contextually-inappropriate items and items considered conceptually complex. In the final analysis, we used a 25-item Constructivist Learning Environment Scale and an 18-items forms of learning scales. Table 7 presents the conceptualization of each variable as well as brief descriptions.

Reliability and validity of instruments

After preparing the instruments for data collection, validating them involved expert review and discussion. Some irrelevant items were discarded and some ambiguous items were modified based on comments given by the expert. Then reliability was addressed by pilot testing the instruments in the College of Education and Behavioural Sciences, Jimma University (and this college was excluded from the main data collection). Estimates of internal consistency reliability for the total scale and each subscale were calculated for a pilot sample consisting of volunteer undergraduate 2nd year English Language and Literature students in the College of Social Sciences at Jimma University ($n = 45$). Based on preliminary analysis, 3 weak items from the different scales were dropped. Estimates of internal consistency for the total scale scores exceeded $\alpha > 0.70$, with subscale reliabilities ranging from 0.76 to 0.89. These alpha coefficients are acceptable according to psychological research literature (e.g. Nunally and Bernstein 1994). Then the final instrument was administered to the whole sample students by teachers and the researchers, with sufficient time being given to complete and return responses.

Data analysis

The survey data collected from students were organized and analysed using Stata15 Statistical Analysis and Software Package. Descriptive statistics (mainly frequency, percentages, means and standard deviations) were used to identify the types of learning environment and forms of learning. SEM analysis was used to identify the factors representing each construct and test the prediction models of forms of learning.

A model adequacy test was conducted to examine the goodness-of-fit of each scale. As chi square statistics usually favour large sample sizes in testing model fitness, we used other additional practical indices to find adequate evidence of model fit. We gauged model fit through the comparative fit index (CFI; Bentler 1990), Tucker-Lewis index, root mean squared error of approximation (RMSEA; Browne and Cudeck 1992), Standardized Mean Square Residual (SRMR), Coefficient of Determination (CD), and chi-square divided by degrees of freedom (χ^2/df). CFI and TLI values > 0.90 and RMSEA and SRMR values less than 0.08 are all considered indications of good model fit (Schreiber et al. 2006; Yu 2002).

To examine whether relationships exist between undergraduate students' perceptions of the learning experiences (dependent variable) and their perceptions of the constructivist learning environment (independent variable), data were analyzed using 2-step hierarchical multiple regression analyses. The multiple regression analysis determined the strength of multivariate relationships and reduced the risk of Type 1 errors (Field 2009). To provide information about the unique and significant contribution of CLES to forms of learning, the standardized regression coefficients (βs) were interpreted.

Results

Demographic information about the student participants

In this study, demographic items included the generation of university establishment, class year, gender, and whether the student is in his/her first, second, third, fourth or fifth year at university. Fourth- and fifth-year were combined because the number of fourth year students was minimal due to leaving the universities for industrial attachment to attend their internships. In addition, student majors were divided into two and included as demographic variables (Business and Engineering). Table 1 shows demographic information (percentages) for student participants in the study (1121).

As shown in Table 1, our sample had more male than female undergraduate students. In terms major area discipline, the majority (66%) of the sampled undergraduate students were engineering majors whereas the other 34% were Business majors. Also, of the total sample of undergraduate students involved in this study, only 20% were first-year students, 30% were second-year, another 32% were third-year, and the remaining 18% were fourth- and fifth-year students. Almost all the fourth- and fifth-year students were Engineering majors. Also, descriptive analyses were conducted for the independent variables and dependent variables of interest for the whole sample to portray the average score for each dimension in the study. Table 2 presents descriptive statistics for the whole sample. (Note that, based on exploratory factor analysis reported below for the learning forms questionnaire, a 4-factor rather than the original 3-factor model is used.)

As shown in Table 2, students' perceptions of 5 factors of constructivist learning environment and 4 factors of forms of learning were similar, with the mean values ranging

Table 1 Demographic information: percentages of student participants in the study ($N = 1121$)

Demographic variable	Frequency	Percentage
University		
1st Generation	543	48.44
2nd and 3rd	578	51.56
College attended		
Engineering	744	66.37
BECO	377	33.63
Gender		
Female	454	40.64
Male	663	59.36
Class year		
First year	223	19.91
Second year	330	29.46
Third year	362	32.32
Fourth and fifth year	205	18.30

Achievement measure	Minimum	Maximum	Mean	SD
Ethiopian preparatory school certificate examination score	220	698	374.39	53.19
Cumulative GPA	1.98	4.00	3.00	0.48

Table 2 Descriptive statistics for the major predictor (independent) variables, the variables controlled in the data analysis and the five outcomes (dependent) variables

Variable	*N*	Minimum	Maximum	Mean	SD	Cronbach Alpha
Perceived learning environment						
Critical Voice	1118	1.00	4.00	2.78	0.95	0.89
Student Negotiation	1118	1.00	4.00	2.78	0.91	0.86
Uncertainty	1120	1.00	4.00	2.61	0.92	0.83
Personal Relevance	1120	1.00	4.00	2.73	0.95	0.81
Shared Control	1120	1.00	4.00	2.63	0.95	0.81
Forms of learning						
Informal Learning	1119	1.00	4.00	2.64	0.93	0.83
Non-formal Learning	1118	1.00	4.00	2.30	0.98	0.82
Formal Learning 2	1120	1.00	4.00	2.45	0.96	0.82
Formal Learning 1	1121	1.00	4.00	2.51	0.92	0.76

between 2.30 and 2.78. Relatively speaking, scores for students' perceptions of the non-formal learning experience were lower than others. In contrast, students' perception of scores for critical voice and student negotiation were relatively higher than for the other domains of the constructivist environment and forms of learning.

In terms of factor or sub-scale reliability, Cronbach alpha coefficients ranged between 0.81 and 0.89 for learning environment scales and from 0.76 to 0.83 for forms of learning scales (see Table 2). Alpha coefficients for the subscales were informal learning = 0.83, non-formal learning = 0.82, formal learning 2 = 0.82, formal learning 1 = 0.76, critical voice = 0.89, student negotiation = 0.86, uncertainty = 0.83, personal relevance = 0.81, and shared control = 0.81.

Also, we checked the number of factors retained from each model and the inter-correlations between the factors of each model separately. For this, we used both exploratory factor analysis (EFA) using principal component factor analysis and confirmatory factor analysis (CFA) using structural equation modeling. Given the dearth of literature documenting the construct validity and reliability of the instruments used in the HE context, utilizing both EFA and CFA is a useful starting point to ensure the psychometric quality of the instrument. Principal-component analysis for the 4 factors of learning forms accounted for 61.08% of the variance. The Kaiser–Meyer–Olkin (KMO) measure of sampling adequacy value was high at 0.90, meaning that overall the variables warrant a factor analysis (Kaiser 1974). Table 3 presents the factor loading of each item accounting for its corresponding factor of the forms of learning construct.

As can be seen from Table 3 for forms of learning, a 4-factor model emerged rather than the original 3-factor model, with formal learning breaking into two factors (labelled formal learning 1 and formal learning 2). Each factor has 4–6 items for each factor and factor loadings are spread from 0.59 to 0.83. The breaking point of the scree-plot was at 4 factors.

Similarly, principal component factor analysis for the 5 factors of constructivist learning environments accounted for 63.11% of the variance. The Kaiser–Meyer–Olkin (KMO) measure of sampling adequacy for CLES items was high at 0.92, warranting a factor analysis (Kaiser 1974). Table 4 shows that a 5-factor model for learning environment has 4–6 items for each factor with loadings spread from 0.61 to 0.80. The breaking point of the scree-plot was at 5 factors.

Table 3 Factor loadings for each item on factors of learning forms

Item	Factor loadings			
	Informal	Nonformal	Formal 2	Formal 1
IL17	0.60	0.21	0.23	0.03
IL19	0.72	0.20	0.18	0.06
IL20	0.81	0.13	0.10	0.16
IL21	0.81	0.09	0.10	0.13
IL22	0.73	0.14	0.14	0.10
nf10	0.08	0.69	0.14	0.18
nf13	0.19	0.76	0.15	0.07
nf14	0.16	0.83	0.14	0.10
nf15	0.12	0.81	0.14	0.11
fl5	0.10	0.16	0.59	0.34
fl6	0.18	0.18	0.73	0.20
fl7	0.14	0.09	0.78	0.19
fl8	0.20	0.13	0.72	0.13
fl9	0.10	0.33	0.66	0.13
fl1	0.07	0.13	0.06	0.77
fl2	0.15	0.23	0.29	0.66
fl3	0.15	0.13	0.23	0.73
fl4	0.18	0.02	0.29	0.65

The factor structure and correlations between the factors of each construct are presented separately in Figs. 2 and 3.

Model fit for 4-factor learning forms scale

Factor loadings for each variable in the 4-factor model were moderate to high with a range between 0.58 and 0.83, and there were moderate correlations between the four latent variables with correlations ranging from 0.45 to 0.71 (Fig. 2). Considering the four-dimensional nature of the construct based on exploratory factor analysis result, we estimated a four-factor model, with formal learning 1, formal learning 2, non-formal learning, and informal learning items loading onto their respective latent variables, which could intercorrelate with one another. The fit indices for the hypothesized model were χ^2 (df, $n=1113$) of 594.02 ($p<0.001$), TLI (0.93), CFI (0.94), CD (0.99), RMSEA (0.057), and SRMR (0.043). These results suggest that the hypothesized model is an adequate fit to the data because the goodness-of-fit statistics, practical indices and model residuals are within acceptable ranges. Both at the structural and item levels, this study provides evidence supporting the adequacy of the 4-factor model of learning forms.

Model fit for 5-factor constructivist learning environment scale (CLES)

The factor loading for each variable in the model was moderate to high with a range between 0.54 and 0.82. Similarly, the correlations between the five latent variables were between low and high, ranging from 0.35 to 0.74 (Fig. 3). Considering the five-dimensional nature of the construct, we estimated a five-factor model, with the critical voice,

Table 4 Factor loadings for each item on factors of constructivist learning environment

Item	Factor loadings				
	Cv	Unc	Sn	Pr	Sc
cv17	0.70	0.05	0.15	0.21	0.21
cv18	0.80	0.12	0.19	0.15	0.05
cv19	0.74	0.08	0.26	0.13	0.20
cv20	0.73	0.03	0.27	0.15	0.17
cv21	0.72	0.10	0.30	0.14	0.24
cv22	0.61	0.10	0.27	0.19	0.22
unc5	− 0.13	0.69	0.10	0.03	0.08
unc6	0.13	0.78	0.07	0.10	− 0.04
unc7	0.06	0.75	0.08	0.09	0.17
unc8	0.11	0.66	0.01	0.28	0.19
unc9	0.19	0.62	0.05	0.31	0.11
unc10	0.13	0.70	0.15	0.18	0.08
SN24	0.36	0.04	0.64	0.19	0.14
SN25	0.29	0.01	0.73	0.16	0.12
SN26	0.23	0.04	0.79	0.13	0.20
SN27	0.19	0.12	0.75	0.08	0.25
SN28	0.22	0.26	0.67	0.04	0.04
pr1	0.02	0.09	0.16	0.67	0.32
pr2	0.20	0.22	0.14	0.74	0.12
pr3	0.26	0.12	0.11	0.80	0.09
pr4	0.20	0.23	0.11	0.73	− 0.01
sc11	0.37	0.09	0.13	0.28	0.61
sc12	0.36	0.10	0.15	0.23	0.65
sc13	0.17	0.14	0.20	0.10	0.78
sc14	0.16	0.10	0.27	0.00	0.71

student negotiation, uncertainty of science, personal relevance, and shared control items loading onto their respective latent variables, which could intercorrelate to one another. The fit indices for the hypothesized model were χ^2 (df, $n = 1110$) of 1701.92 ($p < 0.001$), TLI (0.88), CFI (0.90), CD (0.99), RMSEA (0.070), and SRMR (0.049). These results suggest that the hypothesized model is an adequate fit to the data as the goodness-of-fit statistics, practical indices and model residuals are within acceptable ranges. Both at the structural and item levels, this study provided ample evidence for the adequacy of the 5-factor model.

Regression models

We used four separate multiple regression models for testing the predictions of the controlling and constructivist learning environment variables at two phases. Figure 4 is a visual representation of the two-step hierarchical multiple regression models for predicting the 4 factors of learning forms.

As shown in Fig. 4, in the first step, the controling variables, including university attended, college enrolled, student gender, class year, and previous academic ability as

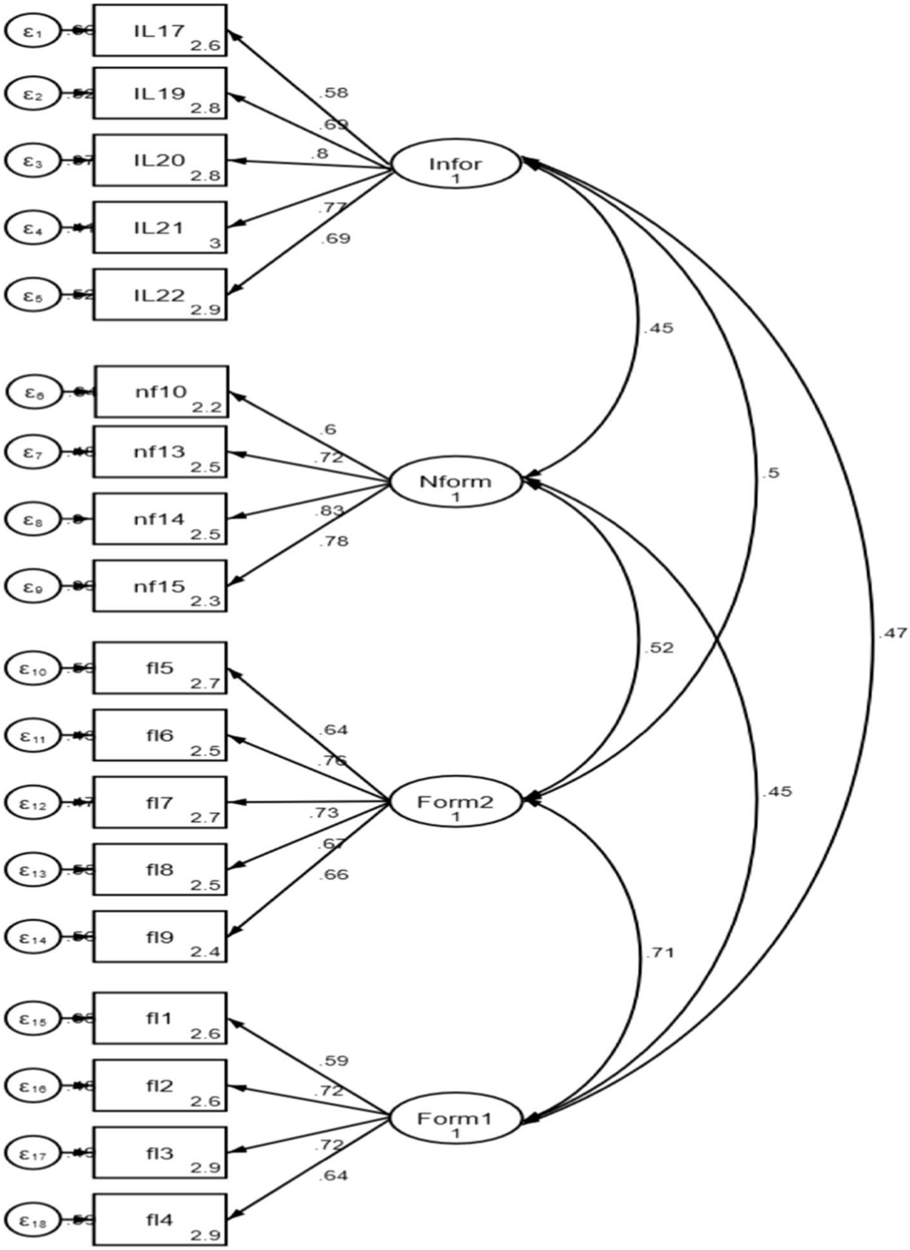

Fig. 2 Structural representation of a 4-factor learning forms scale

measured by EPSCE were used for the prediction of the four learning forms. In the second step, the 5-factor constructivist learning variables were added together with to controling variables.

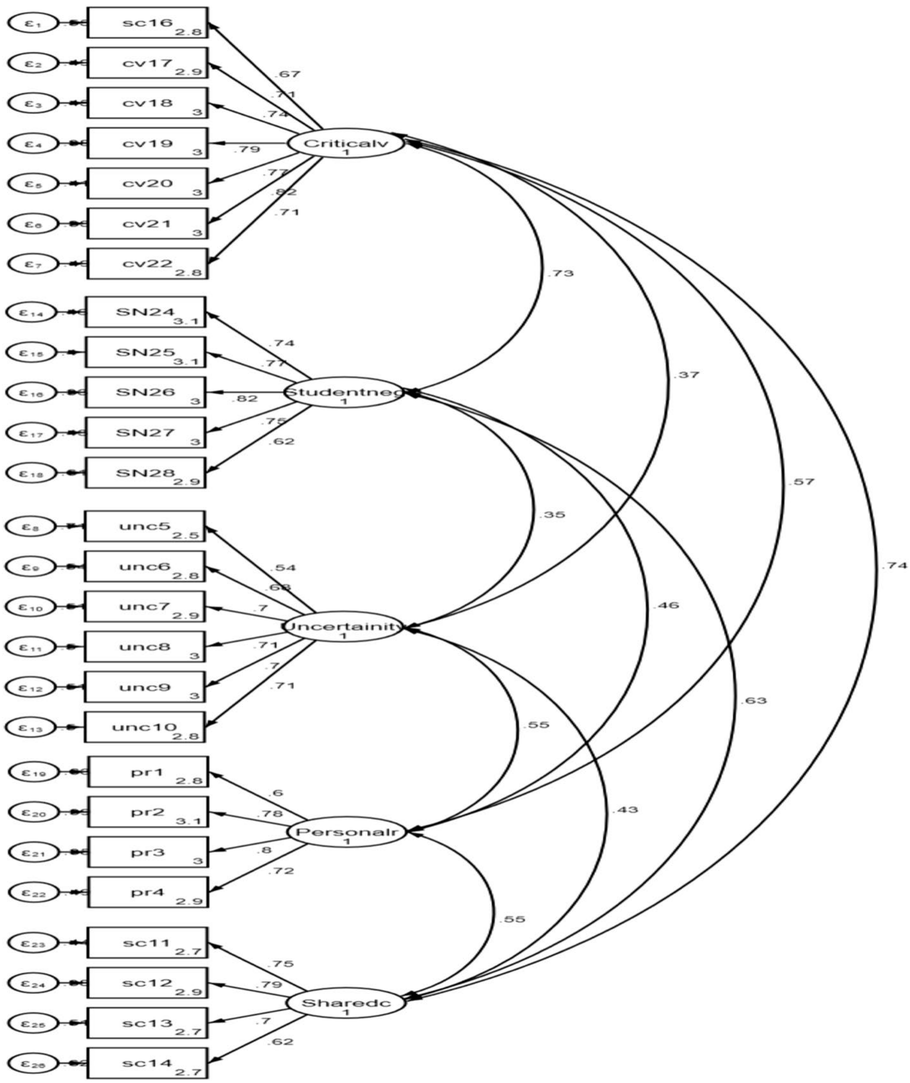

Fig. 3 Structural representation of a 5-factor constructivist learning environment scale

In the first step, the control variables statistically predicted informal learning, non-formal learning, and formal learning experiences of the total sample of undergraduate students, when entered first into the regression models (Step 1: Model 1 $R^2=0.3$, $F[5, 1109]=6.01$, $p<0.001$), (Step 1: Model 2 $R^2=0.10$, $F[5, 1109]=25.80$, $p<0.001$), (Step 1: Model 3 $R^2=0.08$, $F[5, 1109]=18.53$, $p<0.001$), and (Step 1: Model 4 $R^2=0.11$, $F[, 1109]=27.19$, $p<0.001$).

As shown in Table 5, in step 1, the selected independent variables have a significant influence on the prediction of the four measured outcomes differentially. While the overall influence of the selected independent variables on informal learning was relatively minimal with $R^2=2\%$, their influence on non-formal learning, formal learning 1 and formal learning 2 was relatively higher, with $R^2=8$–11%. The F-ratio indicates whether the overall

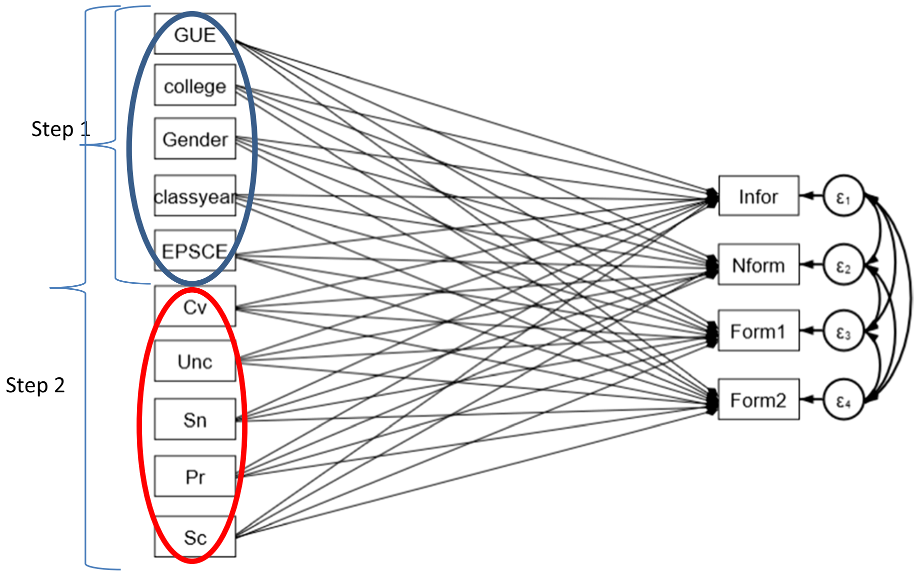

Fig. 4. 2-steps hierarchical multiple regression models for the prediction of forms of learning from learning environment and controlling variables

Table 5 Results of multiple regression analyses for control variables on forms of learning ($N = 1121$)

Step One (Control variables)	Explanatory variables							
	Informal learning		Non-formal learning		Formal learning1		Formal learning2	
	b	*β*	*b*	*β*	*b*	*β*	*b*	*β*
Constant	0.13		0.36		0.51		0.53	
GUE[1]	−0.14	−0.14***	−0.28	−0.26***	−0.27	−0.27***	−0.34	−0.31***
College/major	−0.00	−0.00	0.05	0.04	−0.07	−0.07	−0.02	−0.02
Gender	0.02	0.02	−0.02	−0.01	−0.07	0.02	−0.01	−0.01
Class year	0.05	0.09**	0.10	0.19***	0.02	0.12***	0.08	0.14***
EPSCR[2]	−0.00	−0.01	−0.00	−0.06	−0.00	−0.05	−0.00	−0.04
R^2	2%	10%	8%	11%				
F	6.01	25.80	18.53	27.19				

Significance levels ** $p < .01$, *** $p < .001$

regression model was a good fit for the data. The outputs for the four separate models show that the independent variables (GUE, College, sex, class year, and EPSCE) statistically significantly predicted the dependent variables of informal learning Model 1, $F(5, 1109) = 6.01$, $p < 0.0001$; nonformal learning Model 2, $F(5, 1109) = 25.80$, $p < 0.0001$; formal learning1 Model 3, $F(5, 1109) = 18.53$, $p < 0.0001$; and formal learning Model 4, $F(5, 1109) = 27.19$, $p < 0.0001$ (i.e., the regression models are good fit for their respective data).

Clearly, the control variables had a significant influence on the prediction of the measured learning experiences differentially.

To investigate whether the constructivist learning environment variables influenced the four outcomes, we ran four multiple regression analyses for the four forms of learning, including the 5 factors of constructivist learning environment and the control variables as independent variables. When the constructivist learning environment variables were added to the regression models, there were significant changes in the prediction of the models: (Step 2: Model 1 $R^2 = 0.38$, F for change in R^2 [10, 1104] = 67.02, $p < 0.0001$), (Step 2: Model 2 $R^2 = 0.21$, F for change in R^2 [10, 1104] = 30.09, $p < 0.0001$), (Step 2: Model 3 $R^2 = 0.25$, F for change in R^2 [10, 1104] = 37.32, $p < 0.0001$), and (Step 2: Model 4 $R^2 = 0.29$, F for change in R^2 [10, 1104] = 44.58, $p < 0.0001$). Table 6 presents a summary of a 2-step hierarchical regression analysis for variables predicting informal learning, non-formal learning, formal learning, satisfaction, and CGPA.

As shown in Table 6, in step 2, the controlling variables, along with the constructivist learning environment variables, contributed to the predictions of informal, non-formal, formal learning 1, and formal learning 2 for the sample undergraduate students. Across the different models, the addition of constructivist learning environment variables brought significant changes in the prediction of the models: (Step 2: Model 1 $R^2 = 0.38$, F for change in R^2 [10, 1110] = 70.65, $p < 0.001$), (Step 2: Model 2 $R^2 = 0.24$, F for change in R^2 [10, 1110] = 36.34, $p < 0.001$), (Step 2: Model 3 $R^2 = 0.30$, F for change in R^2 [10, 1110] = 49.06, $p < 0.001$), and (Step 2: Model 4 $R^2 = 0.30$, F for change in R^2 [10, 1110] = 49.06, $p < 0.001$). Clearly the addition of constructivist learning environment variables differentially influenced the prediction across the different models, with the highest prediction being for the informal learning prediction model ($R^2 = 38\%$).

Regarding the statistical significance and direction of relationships for the five constructivist learning environment predictors, perceived critical voice was not significant except for the prediction of the informal learning (Cv, $\beta = -2.34$, $p < 0.05$). The coefficient is

Table 6 Hierarchical regression models CLES scales on forms of learning ($N = 1121$)

Step Two (Control CLES Variables)	Forms of learning							
	Informal learning		Non – formal learning		Formal learning1		Formal learning2	
	b	*β*	*b*	*β*	*b*	*β*	*b*	*β*
Constant	− 0.16		0.16		0.29		0.30	
GUE	− 0.05	− 0.05	− 0.22	− 0.20***	− 0.19	− 0.20***	− 0.27	− 0.24***
College/major	0.06	0.06*	0.09	0.07**	− 0.02	− 0.02	0.03	0.03
Gender	0.01	0.01	− 0.02	− 0.02	0.01	0.01	− 0.02	− 0.02
Class year	0.04	0.07**	0.10	0.18***	0.05	0.11***	0.07	0.13***
EPSCR	0.00	0.01	− 0.00	− 0.03	− 0.00	− 0.03	− 0.00	− 0.02
Critical voice	− 0.09	− 0.11*	− 0.07	− 0.08*	− 0.05	− 0.06	− 0.06	− 0.07
Uncertainty	0.13	0.12***	0.27	0.23***	0.16	0.15***	0.23	0.20***
Student negotiation	0.12	0.15***	0.10	0.11*	0.11	0.14**	0.07	0.08**
Personal Relevance	0.37	0.38***	0.11	0.11**	0.17	0.18***	0.20	0.20***
Shared control	0.13	0.17***	0.01	0.01	0.07	0.10*	0.08	0.10*
R^2	38%	21%	25%		29%			
F	67.02	30.09	37.32		44.58			

Significance levels * $p < .05$, ** $p < .01$, *** $p < .001$

negative which indicates that more critical voice was related to lower informal learning experiences, which is not what we expected.

The influence of uncertainty across the four measures (Unc, $0.12 \leq \beta \geq 0.23$, $p = 0.000$) was significant and its coefficient was positive, indicating that student perceptions of higher uncertainty was associated with better learning experiences across the four domains of learning. The influence of student negotiation across the three measures (informal, non-formal, and formal 1) (Sn, $0.11 \leq \beta \geq 0.15$, $p = 0.000$) was significant and its coefficient was positive, indicating that greater perceived student negotiation was linked to better learning experiences across the informal, non-formal, and formal learning1 domains. The influence of perceived shared control on formal learning 2 (Sc, $\beta = -0.08$) was not statistically significant at the 0.05 level ($p = 0.067$).

The influence of perceived relevance across the four measures ($0.11 \leq \beta \geq 0.38$, $p < 0.000$) was significant and its coefficient was positive, suggesting that higher perceived relevance was linked to better learning experiences across the four domains of learning. Finally, the influence of shared control across the three measures (informal, formal 1 and formal 2) (Sc, $0.10 \leq \beta \geq 0.17$, $p = 0.000$) was significant and its coefficient was positive, indicating that perceptions of more student negotiation was related to better learning experiences across the three domains of learning. Shared control (Sc, $\beta = -0.01$) was not statistically significant at the 0.05 level ($p = 0.841$).

Discussion

Several studies have shown that the learning environment is associated with student learning (Fraser 2007, 2012; Wolf and Fraser 2008). In fact, investigating relationships between students' learning and their perceptions of the learning environment has been the predominant focus in learning environment research (Fraser 1998, 2014; Wong et al. 1997). However, the factor structure and influence of constructivist learning environment on forms of learning have received little attention. The results of the current study demonstrate the multidimensional nature of forms of learning and constructivist learning environments in universities, thus supporting previous research in this field (Aruştei et al. 2018). This suggests that learning in university is blended across formal, non-formal and informal activities. The findings corroborate that learning is holistic and engages the whole person, so that the intellect, emotions, values and practical activities are blended within the constructivist learning environment (Ellis and Goodyear 2010).

The current study revealed that undergraduate students learn in a diverse ways within a constructivist learning environment, but that non-formal learning episodes were relatively infrequent (M = 2.30, SD = 0.98). This could be attributed to students' minimal experience with non-formal learning during undergraduate years in the studied context.

In this study, analysis of data from 1121 student respondents confirmed the fit of the two proposed models (forms of learning and CLES) to the data. Based on both EFA and CFA, the structural representation of each scale showed positive and high factor loadings for the items within each factor. A closer examination revealed that each item had a factor loading well above the recommended minimum of 0.40 (Kline 1998).

The models presented in this study represent an initial attempt to describe and evaluate the dimensionalities and relationships of the constructivist learning environment and forms of learning. The minimal number of items used to measure informal learning and non-formal learning activities might need attention, as does decomposition of formal learning into two separate domains.

The four measures of learning forms revealed significant intercorrelations between them (r ranging from 0.45 to 0.71 and $p < 0.001$) for the total group (Fig. 2). Furthermore, as expected, modest to moderate and high intercorrelations were revealed among the five constructivist learning environment scales (r ranging from 0.35 to 0.63, and 0.74 and $p < 0.001$) (Fig. 3).

Existing studies of undergraduate student learning are primarily quantitative and a focus on learning outcomes in terms of academic achievement measured by grade point average (GPA) (Richardson et al. 2012; Rugutt and Chemosit 2005). However, as the findings of this study and others confirm, learning in undergraduate education happens in many different ways (Aruştei et al. 2018), which is represented by a variety of activities (Soyyilmaz et al. 2017) far beyond academic achievement (Hung et al. 2009; Virtanen and Tynjälä 2019). This has implications for widening the scope of efforts in quality improvement and curriculum revision to holistically viewing learning as a multidimensional concept beyond the formal learning (Davis 2011).

Previous studies have shown positive relationships between the tertiary learning environment and students' cognitive and affective outcomes (Chiu et al. 2017; Huang 2012). Also, existing studies of different forms of learning, particularly how they are related to the learning environment, have focused mainly on either classroom-based research (Alansari and Rubie-Davies 2019) or qualitative studies (Aruştei et al. 2018; Symeonides and Childs 2015). The findings reported in this study fill an existing gap in the literature.

The results of our multiple regression analyses provide support for a number of related theoretical propositions. The current study indicates that constructivist learning environments plays a significant role in students learning across a range of domains. Moreover, our findings show that control variables have a moderate influence on students' learning experiences. Also, it was clear from the findings of the current study that students' perceived learning environment influenced their learning experiences over and above the control variables. Previous studies support this pattern and justify why predictions of students' learning (formal, non-formal, and informal) are stronger for the perceived learning environment than for personal factors (Fraser 2012).

The current study revealed that perceptions of greater critical voice were negative and nonsignificant in terms of predicting forms of learning for the participants. These findings are inconsistent with previous studies of the constructivist learning environment that demonstrated positive associations between critical voice and some aspects of students' learning. Hence, further research should pay attention to this unusual relationship and its cause.

This study has limitations and therefore caution must be exercised in generalizing its findings to undergraduate students in the other major fields than those involved in this study. Moreover, because the current study relied exclusively on self-reported measures, future research should use other direct observational methods to triangulate the data. Another potential limitation of this study is that the sample included only undergraduate students. Future research should examine the relationship between forms of learning and constructivist learning environments among teacher samples, because teachers and students can place different emphases on domains of learning activities and the constructivist learning environments.

Conclusions

This study provides a detailed portrait of the factor structure and relationships between constructivist learning environment and the forms of learning experienced by the students. The findings point to two major conclusions. First, both EFA and CFA supported the validity of 4 factors of learning forms and 5 factors of constructivist learning environments. Second, student perceived learning environment was positively related to learning forms in university. Regression analyses showed that variation in formal learning, non-formal learning, and informal learning can be attributed to constructivist learning environment variables, over and above controlling variables. Environmental variables brought significantly-higher changes in predictions of the learning forms domains.

Implications for higher education policy and practice

Exploring the undergraduate student learning experience and constructivist learning environments would enhance understanding of the contexts and processes of learning from an inner perspective, thereby promoting the quality of teaching and learning. Also, this research highlights the potential factors of constructivist learning environments that can promote student learning. It is hoped that this research stimulates discussion and further research into undergraduate student learning. It would also be helpful for policy makers at higher-education institutions to consider in their policy the role of constructivist learning environments for student learning.

Future directions for research

The incorporation of other institutions and colleges than those included in this study would help to widen the applicability generalizability of conclusions. It also could be valuable in future research designs to obtain more demographic information regarding socioeconomic status, parental occupation, language spoken at home, whether living in urban or rural areas, and social support networks. This information could provide greater clarity regarding the myriad of variables that contribute to students' academic outcomes in university.

In addition, the incorporation of qualitative research designs could help to further illuminate the unique contextual issues of implementation and the overall influences of institution-related variables. Instructors' views of student learning experiences warrant special attention in future endeavors.

Appendix

See Table 7.

Table 7 Study variables grouped by distinct research domains

Research domain	Sub-domain	Construct/indicator	Sub-scale	Description
Forms of learning	Formal learning	Self-created items	(9 items)	Takes place in a systematic, organized, and intentional way as in programmed instruction. This type of learning follows a syllabus and is intentional in the sense that learning is the goal of all the activities learners participate in
	Non-formal learning	Self-created items	(4 items)	Takes place outside formal learning environments but within some level of organization. While it is voluntary for the learners to engage in a particular activity, skill, or area of knowledge and is thus the result of intentional effort. But it need not follow a formal syllabus
	Informal learning	Self-created items	(5 items)	Informal learning is unstructured, often unintended learning that occurs outside of a conventional learning setting. This takes place while the learner involves in activities that are not undertaken with a learning purpose in mind. Hence, it is involuntary and an inescapable part of daily life
Personal characteristics	Prior academic ability	EPSCE[a]	–	Self-reported GPA during high school competition exam
	Demographic correlate	Gender	–	Self-reported gender, measured using a dichotomous item (1 = female, 2 = male)
	Enrolment experience	College attended	–	Self-reported college enrolled and measured using dichotomous item (1 = Business and Economics and 2 = Engineering
		Class year	–	Student self-reported class year for the current academic year

Table 7 (continued)

Research domain	Sub-domain	Construct/indicator	Sub-scale	Description
Constructivist learning environment	Critical voice	Critical voice scale	(6 items)	The degree to which students feel free to express concerns about their learning
	Uncertainty	Uncertainty scale	(6 items)	The extent to which science is viewed as ever-changing. This highlights the perceived quality and availability of resources in the institution attended
	Student negotiation	Student negotiation scale	(5 items)	The degree to which students can interact with each other to improve their understanding
	Personal relevance	Personal relevance scale	(4 items)	The degree of personal relevance in their studies. This deals about connectedness of university learning to students' life experiences outside the university
	Shared control	Shared control scale	(4 items)	Students' having opportunities to share control of the learning environment and their learning, including the design and management of their learning activities

[a]Ethiopian Preparatory School Completion Examination

Acknowledgements First and foremost, the authors' would like to thank the College of Education and Behavioral Sciences, Jimma University, for the full funding support of this research. Also, the authors appreciate the undergraduate students of Business and Economics Colleges and Technology Colleges at Jimma University, Mettu University, and Mizan Tape Universities for their cooperation in filling out questionnaires. Moreover, the authors' sincere thanks go to Assistant Professor Frew Amsale (Ph.D. Candidate) and Dr. Abaya Geleta (Associate Professor) for their expert reviews of the instrument used for data collection in this study.

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