LEARNING MODELS FOR EFFECTIVE PROPAGATION OF SUSTAINABLE CONSTRUCTION PRACTICES IN THE BUILT ENVIRONMENT

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Received: 15 February 2018
Accepted: 23 April 2018
Published: 30 September 2018

ABSTRACT

The drive to achieve sustainable built environment has made learning new skills relating to Sustainable Construction Practices (SCP) imperative. This study investigated whether learning method can improve uptake of SCP through knowledge enhancement. Using survey research strategy, data from 206 construction professionals in Nigeria were collected and analysed. The results revealed that Andragogy and Experiential learning models strongly correlated SCP transfer requirements, and are therefore, appropriate models to embed SCP within existing ethos in the built environment. The study espoused the critical roles of experience and hands-on-project as prerequisite reinforcements for effective learning of SCP.

Keywords: *andragogy, experiential learning, sustainable construction, and symbolic interactionism.*

INTRODUCTION

The United Nation's decade for sustainability education has since elapsed, but the global understanding of applied mechanisms to achieve Sustainable Construction (SC) is yet, not vastly disseminated (Magaji, 2015; Heffernan, Pan & Liang 2012). As a result, the quest to have sustainable construction knowledge embedded within the fabrics of the built environment subsists across pan construction industry domain. Knowledge of Sustainable Construction Practices (SCP) is needed to tackle construction related problems in the society (Cartlidge, 2011). Dahiru, Dania and Adejoh (2014) however, found that, current level of response in promoting learning across stakeholder groups in the built environment is inadequate. The depth of SC knowledge among built environment professionals is therefore in doubt, and various researchers tend to differ on the depth of the existing gap.

Nduka and Ogunsanmi (2015) reported that a certain level of awareness exist, while Dahiru, Dania, and Adejoh (2014) and Ewuga and Moluwus (2015) obtained a low level of awareness in the Nigerian context. Sustainability skills are also less prioritised among construction manager's training (Bejide & Iyagba, 2015). This shows a lack of interest by construction organisations in learning sustainable construction practices (Opoku, 2011). In the UK, low level of awareness also overarch despite efforts to improve learning in that region (Mlecnik, 2010; Heffernan, Pan, & Liang 2012). Glass, Dainty, and Gibb (2008) confirmed that, knowledge dearth contributed to poor standard in newly built UK sustainable homes. Similarly, Mile-Shenton, Wingfield, Sutton, and Bell (2010) attributed excess use of energy in sustainable homes to low post-occupancy sustainability awareness. Pan and Gramston (2012) also had only 35% of their study sample compiled with planning regulation dealing with energy efficiency in the UK.

The above lapses portray that extensive learning is needed to ensure diffused uptake of SCP. The enabling method to achieve this learning goal is however not apparent, based on limited research within construction literature. Human resources - training literature also tend to ignore the niche created by SCP by failing to develop appropriate learning pedagogies

to address its peculiar learning needs. Moreover, organisational learning methods applied in the construction industry are not widely applied due to prevalence of non-collaborative procurement framework (Dada, 2012). These methods also require robust academic-industry collaboration, but construction research in developing countries lack corporate sponsorship. This suggests that certain approaches such as research collaborations cannot gain industry-wide adoption. The expansive infrastructure needs of other organisational learning methods also suggest enormous financing barriers. Based on these limitations, the search for an approach that will promote learning across stakeholder groups beckons. This study therefore finds it incumbent to explore effective method(s) to improve learning of SCP in the built environment. The aim of the study is to investigate whether a learning model can improve the uptake of SCP among built environment professionals through knowledge enhancement. Consequently, attempts to proffering solutions to the research problem are relevant to identifying effective learning protocols that will lead to improved application of SCP in the tropics. The knowledge about the efficacies of these methods among inferred stakeholders is also crucial to achieve a healthy built environment.

LITERATURE REVIEW

Learning Methods in the Construction Industry

Learning methods are broadly studied using two main categories namely: Organisational and Individual approaches. Organisational-based approaches involve multi-parties and sometimes multi-organisation collaborations (Opoku, 2011). These methods are also fundamentally structured to address specific needs of the organisations (Bower, 2014). Individual learning methods on the other hand, are not structured and principally enlist the learner conditioning of his/her perception to learn new things (Curtin, 2016). Approaches applied to each category are presented in Table 1. Vast numbers of these approaches under the organisational learning methods are however, a product of proactive response to resolve skills-related barriers to sustainable construction uptake. Actual deployment of related approaches in real-life scenario is limitedly reported.

Table 1: Learning Methods

Sources	Learning Methods	
	Organisational Methods	**Individual methods**
Dada (2012)	Seminars, workshop and continuous professional development	
Glass, Dainty, and Gibb (2008), Green and Bazley (2016)	Regional exemplar demonstration projects, and establishment of educational think-tank, training, and research networks	
Callcutt (2007);	Co-ordinated training programme	
Gleeson and Thomson (2012) and Dada (2012)	Involuntary approach: educational, experiences of large firms developmental and individual	
Loosemore, Dainty and Lingard (2003); Bower (2014); and Curtin (2016)		Andragogy; experiential learning, symbolic interactionism, and action learning.

In order to satisfy the learning needs of individuals in the built environment, the concept of involuntary learning approach is advanced (Loosemore, Dainty & Lingard, 2003). Cheetham and Chivers (2001) found three approaches most veritable namely: Andragogy; Experiential learning and Symbolic interactionism. Experiential learning is based on the perception that, an individual's ideas are constantly formed and modified by life experiences. The underlying philosophy of experiential learning states that people learn by involvement, and learners are not importantly inclined to think and talk of learning materials, but are also concerned with application of lessons learnt (Merriam, Caffarella, & Baumgartner, 2012; Torres & Augusto, 2017).

Symbolic interactionism is based on the theory that adults are motivated not by object set by others but their own willingness to adapt self-perception. The self-perception is not also fixed but varies by the role of the learner, and the emphasis is on incorporating self-awareness and

self-image in learning (Aksan, Kisac, Aydin & Demirbuken, 2009). This implies that learning performance is a reciprocal result of the learners or social actors. Andragogy on the other hand, is defined by five major characteristics. These include: independent self-concept to direct learning; accumulated resources from experience qualify for learning resources, learning needs is linked with changing social roles, problem-centred learning interested in immediate application of knowledge, and motivation to learn by internal factors (Abdulsalam, 2015; Henschke & Henschke, 2016). The ideologies of these learning methods are further conceptualised in Table 2. Andragogy (AN) and Experiential learning (EL) involve six measurement variables each (AN1-6; EL1-16,) while symbolic interactionism involves three variables (SI1-3.)

Table 2: Measurement Variables for Learning Methods

Authors	Learning Ideologies
Loosemore, Dainty and Lingard (2003); Abdulsalam (2015); and Bower (2014)	Andragogy (AN1) - self-directed learning; (AN2) - learning by shared experience; (AN3) - focus on knowledge needing improvement; (AN4) - job needing knowledge application; (AN5) - learning by partnership (tutor and learner); and (AN6) - learning resource formed by learner's experience).
Cheetam and Chivers (2001); Gleeson and Thomson (2012); Henschke and Henschke (2016); and Curtin (2016)	Experiential (EL1) - learning as a process than outcome; (EL2) - learning is continuous and anchored on experience; (EL3) - ability to balance learner's view with others; (EL4) - ability to acclimatise real-life cases; (EL5) - interaction between people and environment; and (EL6) - Learning as knowledge generating process.
Wu (2014) and Torres and Augusto (2017)	Symbolic interactionism (SI1) - (learning by perception; (SI2) - self-esteem in learning; and (SI3) - self-awareness and self-image vital in learning

Sustainable Construction Knowledge Transfer

Sustainable construction is defined as the 'creation of a healthy and responsible management of the built environment using resource efficient and ecological principles' (Kibert, 2008). The measurement of sustainability performance is generally compelling and there is no agreement on what data is needed and measurement criteria to be adopted. Fiksel (2015) recognised two perspectives to sustainability performance evaluation namely: Quantitative; and Qualitative metrics. The quantitative metrics relies on

empirical evidence and evaluate practice performance using countable data. Qualitative metrics on the other hand, utilises semantic particularity based on subjective judgment of the individual expert. The metrics in both approaches are either 'lagging' or 'leading'. Lagging consists of product oriented indicators which measures outputs of the end result and leading is concerned with the process and internal organisational endeavours aimed at ensuring that sustainable built environment is achieved. This study however, conducted qualitative evaluation and used leading metrics in evaluating the role of learning method in sustainable construction knowledge transfer. The rational is that, effective learning pedagogy facilitates practice embedding within a professional discipline, which also benefits project implementation towards a healthy built environment. Table 3 presents measurement variables of Sustainable Construction Practices (SCT.) Three hypotheses developed from three individual learning methods are postulated. However, all three methods are unitised (as 'learning methods') to obtain a generic hypothesis. Those hypotheses state that there is no significant correlation between learning methods efficacies and learning and transfer of sustainable construction practices.

Table 3: Indicators of SCP at Organisation and Project Levels

Authors	Indicators of Sustainable Practice Development
Laing (2015)	Environmental responsibility (SCT1)
Gajdzk (2010); GEC (2015)	Commitment towards employee's well-being (SCT2)
Kolleck (2010)	Use of locally sourced materials (SCT3)
Flanagan (2007); Laing (2012) and Fiksel (2015)	Sustainability integration (SPD4), and risk minimisation (SCT5), Transparency and accountability (SCT6).
Katon (2008)	Level of efficiency, effectiveness and innovation (SCT7)
Liang (2015)	Level of productivity (SCT8)

METHODOLOGY

The study employed survey research design using structured questionnaire as data gathering instrument. Questionnaire administration was carried-out using Google Form and person-to-person contact because of the need to consult widely, and to enhance the response rate. The choice of these

approaches was predicated guide to using research in sustainability programs or studies which observed that research in sustainability programs falls into three major types namely basic research, applied research, and action and participatory based research (Department of Environment and Climate Change NSW[DECC], 2009). Further, DECC (2009) noted that out of all research methods and their attendant data collection tools, the survey research method involving the use of questionnaire and interview was the most commonly used approach. In addition, previous related studies on sustainability issues have adopted this research method and data collection instrument (Niroumand, Zain & Jamil, 2013; Chin-Shan, Kuo-Chung & Chi-Chang, 2016). The respondents were subdivided into two groups based on questionnaire administration medium namely: the online group and those reached through self-administration. The online group were contacted using information obtained from various databases of professional bodies. The second group was reached using the directory of registered professionals (architecture, building, engineering, and quantity surveying) with Green Building Council of Nigeria (GBCN.) The study was conducted in six cities across three geo-political zones, including the Federal Capital Territory-Abuja, Nigeria. The determination of population sample engaged purposive sampling, and the sample size of 206 was applied in the study. The choice of purposive sampling was informed by the need to engage professionals with specific 'purpose' that is, those with 'vested interests' in sustainable construction. To determine professionals with vested interests, registration with GBCN was used. Across the regions and Federal Capital Territory covered in this study, feedback was obtained from 206 professionals only.

The questionnaire consists of nine questions (both demography and objective of the study.) Five-point Likert scale where, 5 being most preferred or effective and 1 least preferred or not-effective was adopted to construct the questionnaire. The Likert scale was used to determine stakeholders' preference of learning method for embedding SCP, and efficacies of learning methods on knowledge transfer. Construct reliability was determined by conducting Cronbach alpha test (see result Table 4.) Because each variable group contained less than ten items; inter-correlation treatment was applied, and this ensured that some variables and learning methods obtained alpha values greater than 0.6 (Pallant, 2010). Canonical correlation analysis tool was applied to determine the hypotheses of the study. The efficacy of

learning method was determined using Mean Item Score (MIS). Canonical correlation analysis was selected to measure the relationship between learning methods and SCP knowledge transfer, because, the tool has the ability to compare multivariate using several dependent variables. Canonical models were interpreted using multivariate test of significance, Eigen values and correlations co-efficient; and dimension reduction analysis (Abeysekera, 2014; Chaghooshi, Soltani-Neshan & Moradi-Moghadam, 2015.) The validity of hypotheses was determined using critical p-value. The result of the null hypothesis was rejected where p is less than 0.05; and accepted, if p is greater than 0.05.

The limitation posed by the use of purposive sampling technique is acknowledged. The sample frame was however, well defined and the administration was carried out at random. The established procedure is reproducible using its clearly defined research strategy and valid statistical conclusion. Lack of clarity of the direction or meaning of sustainable development practices reported in previous studies (Tomkiewicz, 2011; Hakkinen & Belloni, 2011) which could result in low response rate portend a notable limitation to the study.

RESULTS AND DISCUSSION

Descriptive Statistics of Variables and Respondents' Demographic Information

A total of 64 valid questionnaires were retrieved and analysed to obtain 31% response rate. Received questionnaires were screened for completeness of response to determine fitness for analysis. This response rate is valid, and is within acceptable threshold, established for construction management researches (Hoxley, 2008).The response rate is attributed to the nature of the study, which primarily requires respondents' understanding of their learning needs, and in-depth knowledge of Sustainable Construction Practices (SCP). The sample comprises built environment professionals with quantity surveyors and architect constituting 56%, Engineers and Builders 44% (see Table 4.)Averagely, 25% of the respondents participated from each category of practice (contracting, academic, public sector and

consultancy.)The combined proportion of public and contracting sector participants is 51%. Over 83% of the study samples are registered members of the respective professional bodies, while 70% had averaged 8 years' practice experience. The high proportion of registered professionals with relevant years of experience portrays that, the data collected are suitable to make valid inference regarding the research problems examined.

Table 4: The Respondents Characteristics

Respondents		**Practice**	
Engineers	22%	Consultancy	17%
Architects	28%	Contracting	26%
Q. surveyors	28%	Academic	22%
		Public sector	35%
Builders	22%	**Experience**	
Registration		0-5%	24%
Registered	83%	6-10 years	70%
Probationers	17%	Above 10 years	6%

Cronbach Alpha was computed to measure reliability of measurement variables. The objectives were to evaluate the level of absolute agreement in respondents' rating and to determine the extent in which selected ideologies represent the construct measured. The result presented in Table 5 indicates that experiential and andragogy learning methods have high external and internal reliability with Cronbach Alpha values approximated as 0.7. These alpha values lie within acceptable thresholds for accepting the reliability of research instrument (0.60; Pallant, 2010). However, the averaged alpha value for symbolic interactionism is below the acceptable benchmark ($0.471 < 0.70$). The implication is that, the ideologies of symbolic interactionism lack coherence to measure the efficacies and performance of SCP knowledge transfer. The mean item scores of each learning ideologies are also significantly high (3.167 – 4.667). The standard deviation also indicates two trends similar to reliability/validity test. The standard deviation for symbolism interactionism portrays homogeneity, and this indicates tremendous variation from the population mean, and discrepancies in respondents' perception. Experiential learning and Andragogy however, show heterogeneity with no significant deviation in perception of respondents and deviation from population mean (0.890; 0.880). Similarly,

measurement variables for SCP knowledge transfer (SCT1-8) also obtained high Cronbach values and an averaged standard deviation of 0.916. The meaning also portrays insignificant variance in perception.

Table 5: Descriptive Statistics of Variables in the Study

Code	Learning Ideologies	C. Alpha	MIS	Std. D
	Andragogy			
AN1	Self-directed learning		3.167	1.339
AN2	Learning by shared experience	0.640	4.667	0.594
AN3	Focus on knowledge needing improvement		4.280	0.826
AN4	Job needing knowledge application and urgent		3.611	0.978
AN5	Learning by partnership (tutor and learner)		4.556	0.616
AN6	Learning resource formed by learner's experience		4.222	1.060
	Experiential Learning			
EL1	Learning as a process than outcome		4.167	0.985
EL2	Learning is continuous and anchored on experience	0.694	4.444	0.856
EL3	Ability to balance learner's view with others		3.833	1.150
EL4	Ability to acclimatize real-life cases		4.278	0.894
EL5	Interaction between people and environment		4.500	0.857
EL6	Learning as knowledge generating process		4.556	0.616
	Symbolic Interactionism			
SI1	Learning by perception	0.471	3.667	0.840
SI2	Self-esteem in learning		3.500	1.339
SI3	Self-awareness and self-image vital in learning		3.833	0.985

	Sustainable Practice Development			
SCT1	Efficiency in practice		4.330	0.686
SCT2	Effectiveness in practice		3.500	1.339
SCT3	Level of practice development	0.740	3.720	1.127
SCT4	Level of integration		4.060	0.998
SCT5	Environmental responsibility		3.940	0.872
SCT6	Practice economy		4.110	0.832
SCT7	Level of innovation		4.220	0.646
SCT8	Practice risk minimisation		4.110	0.832

MIS = mean item score; Std. D = standard deviation; C.Alpha = Lee Cronbach Alpha

Tests of Hypotheses

The canonical correlation analysis was applied to determine the following dimensions of the study (1) whether andragogy, experiential, and symbolic interactionism's empirical variables represent expressed individual learning improvement method for theoretical SCP (SCT1-8); (2) to evaluate the extent in which learning ideologies (variables) agree with learning methods (constructs); and (3) to determine whether individual learning methods can improve SCP. These dimensions are explored in the following sections.

Efficacy of Andragogy to Improve Learning of Sustainable Construction Practices

The test in this section determines whether Andragogy can improve learning and transfer of Sustainable Construction Practices (SCP) knowledge. The hypothesis states that, there is no significant correlation between Andragogy and SCP. The general fitness models - Wilk's multivariate test is significant ($p < 0.05$ - $F(48, 23.74) = 0.002$ – Table 6). This result is less than the critical p-value, hypothesis one is therefore rejected. The inference is that a significant correlation exists between andragogy and learning and transfer of SCP knowledge at 95% level of significance. The canonical correlation and Eigen value also show that, the canonical model for andragogy is adequate. The most significant canonical correlation co-efficient is 0.961; explained variance for AN1-6 is 60.68%, and an Eigen value of 12.323 were also obtained. The high correlation co-efficient supports the appropriateness

of the rejected hypothesis and further buttresses that, andragogy is adequate to learn and transfer SCP knowledge. The above inference is explained by 60.68% (4 out of 6) ideologies. Dimension reduction analysis result also indicates that, five out (83.33%) of six canonical roots obtained significant F-values (F = 1.316, 0.982, 0.743, 0.578, 0.220, > 0.05 and 0.042) greater than 0.05.

Table 6: Impact of Andragogy on SCP Learning and Knowledge Transfer

Andragogy					
Multivariate Tests of Significance					
Test Name	**P –value**	**Appox. F**	**Hypoth. F**	**Error DF**	**Sig. of F**
Wilks	0.002	1.316	48	23.74	0.237
Eigenvalues and Canonical Correlations					
Root No	**Eigen Value**	**Pct.**	**Cum. Pct.**	**Canon. Cor**	**Sq. Cor**
AN1	12.323	60.683	60.683	0.961	0.925
AN2	4.661	22.952	83.634	0.908	0.823
AN3	1.875	9.230	92.865	0.808	0.652
AN4	1.220	6.005	98.87	0.741	0.550
AN5	0.216	1.061	99.931	0.421	0.177
AN6	0.014	0.068	100	0.117	0.014
Dimension Reduction Analysis					
Roots	**Wilks L.**	**F-value**	**Hypoth. DF**	**Error DF**	**Sig. of F**
1 to 6	0.002	1.316	48	23.74	0.237
2 to 6	0.023	0.982	35	23.46	0.529
3 to 6	0.127	0.743	24	22.14	0.761
4 to 6	0.365	0.578	15	19.73	0.858
5 to 6	0.812	0.220	8	16.00	0.982
6 to 6	0.986	0.042	3	9.00	0.988

Wilk's L. = Wilk's Lambda; F = F-value; Hypoth DF. = hypothesis Degree of Freedom; Error DF = Error Degree of Freedom; Sig. of F = Significance of F value; Cum. Pct. = Cumulative Percentage; Pct. = Percentage; Canon. Cor. = Canonical Correlation; Sq. Cor. = Square correlation

Efficacy of Experiential Model to Improve Learning of Sustainable Construction Practices

This section determined hypothesis two, and the hypothesis states that there is no significant correlation between experiential learning and SCP knowledge transfer. The canonical model characteristics for experiential is similar to the result for andragogy. The Wilk's value is less than the critical p-value (F (48, 23.74) = 0.001 – Table 7). The analysis therefore created relevant multivariate for experiential learning, and hypothesis two is rejected. This implication is that, a significant relationship exists between experiential learning and SCP learning and knowledge transfer at 95% level of significance. The most significant canonical correlation co-efficient of roots 1 to 6 is 0.971; explained correlation is 62.14%, while the Eigen value of 16.752 was obtained. The implication is that, 62.14% (4 out of 6) experiential learning ideologies significantly support the inference that, experiential learning and SCP learning and knowledge transfer are correlated. The p-values for all ideologies of experiential learning are also greater than 0.05. This is an indication that, the strong positive correlation between experiential learning and SCP knowledge transfer is significant. The tests of correlation significance (dimension reduction analysis) provide further grounding of the canonical model adequacy for experiential adequacy. Six (100%) ideologies underlying explaining experiential learning generated six roots and all six roots are significant learning ideologies for SCP learning and knowledge transfer.

Table 7: Impact of Experiential Model on SCP Learning and Knowledge Transfer

Multivariate Tests of Significance					
Test Name	**P –value**	**Appox. F**	**Hypoth. F**	**Error DF**	**Sig. of F**
Wilks	0.001	1.663	48	23.74	0.09
Eigenvalues and Canonical Correlations					
Root No	**Eigen Value**	**Pct.**	**Cum. Pct.**	**Canon. Cor**	**Sq. Cor**
1	16.752	62.14	62.14	0.971	0.925
2	5.77	21.401	83. 541	0.923	0.823
3	2.973	11.028	94.57	0.865	0.652
4	1.024	3.797	98.367	0.711	0.55

5	0.400	1.483	99.85	0.535	0.177
6	0.040	0.15	100	0.197	0.014
Dimension Reduction Analysis					
Roots	**Wilks L.**	**F-values**	**Hypoth. DF**	**Error DF**	**Sig. of F**
1 to 6	0.001	1.664	48	23.74	0.090
2 to 6	0.013	1.225	35	23.46	0.307
3 to 6	0.085	0.945	24	22.14	0.556
4 to 6	0.339	0.630	15	19.73	0.817
5 to 6	0.687	0.414	8	16	0.896
6 to 6	0.981	0.121	3	9	0.945

Wilk's L. = Wilk's Lambda; F = F-value; Hypoth DF. = hypothesis Degree of Freedom; Error DF = Error Degree of Freedom; Sig. of F = Significance of F value; Cum. Pct. = Cumulative Percentage; Pct. = Percentage; Canon. Cor. = Canonical Correlation; Sq. Cor. = Square correlation.

Efficacy of Symbolic Interactionism to Improve Learning of Sustainable Construction Practices

This section determines the last hypothesis, and the hypothesis states that, there is no significant correlation between symbolic interactionism and SCP knowledge transfer. The Wilk's Lambda is greater than andragogy and experiential learning (0.076 – Table 8). Hypothesis three is accepted. The implication is that, no significant relationship exists between symbolic interactionism and SCP learning and knowledge transfer at 95% level of significance. The most significant canonical co-efficient is 0.899; explained variance of 75.52%, and an Eigen value of 4.199 were obtained. The canonical correlation co-efficient and Eigen value in this method are the overall least. The variance in this method is also significant compared to andragogy and experiential learning. Absent of correlation between both dimensions represents about 76% of the sample population views. The test of correlation significance also indicates that, the three ideologies are also significant (1.247, 0.395 & 0.729 > 0.05). Therefore, symbolic interactionism does not support sustainable construction learning and knowledge transfer.

Discussion of Findings

The canonical correlation analysis determined three dimensions in the study as reported in the tests of hypotheses. The three canonical models represent isolated perspectives of individual learning method and provide the same information about learning of sustainable construction. The performance of two- out-of three learning methods is however, sufficient to theoretically learn and propagate SCP to stakeholders in the built environment. The implication suggests that, having multiple dimensions in a study could be procedurally convenient, but do not often support theoretical paradigms. Therefore, it is imperative for variables of a study to adequately satisfy measurement conditions to qualify for adoption in theory building. Abeysekera (2014) shared this opinion, and insisted that scientific knowledge exists only where an appropriate variable concept is adopted as the pathway to theory building.

Table 8: Impact of Symbolic Interactionism on SCP Learning and Knowledge Transfer

Test Name	Error DF	Sig. of F
Wilks	20	0.307
Root No	Canon. Cor	Sq. Cor
1	0.899	0.807
2	0.458	0.458
3	0.271	0.271
Dimension Reduction Analysis		
Roots	Error DF	Sig. of F
1 to2		
2 to 3	16	0.767
3 to 3	9	0.754

Wilk's L. = Wilk's Lambda; F = F-value; Hypoth DF. = hypothesis Degree of Freedom; Error DF = Error Degree of Freedom; Sig. of F = Significance of F value; Cum. Pct. = Cumulative Percentage; Pct. = Percentage; Canon. Cor. = Canonical Correlation; Sq. Cor. = Square correlation

Five out of six ideologies supported the efficacy of andragogy as an effective model for learning and transfer of SCP and knowledge. The implication is that, for effective transfer of SCP learning, seeking SCP knowledge must be self-directed. Based on shared experience, and driven by the desire to improve construction practice. Other ideologies require

that, learning must be stimulated by job opportunities, and also emphasises instructor/learners' partnership. Insignificant 0.42% of the correlation variate accounts for the result of AN6. AN6 suggests that learners' experience should not form part of the learning resources. This result is a surprise, since personal involvement underscores individual learning. The implication is that 83.33% of the measurement variables (Roots 1-5) account for stakeholder acceptance of andragogy as an effective strategy to learn and embed SCP.

The six ideologies in experiential learning significantly support the learning of SCP and knowledge transfer. The inference from this result is that, learning must be perceived as a process rather than focus on the outcome, continuous but hinged on experience, not as when need arises, and must promote balance- in- view between parties (learner and instructor). Learning must also include the use of real-life practice, promote interaction between people and environment, and above all, learning must generate new knowledge (innovation). Experiential learning ideologies tend to align more with SCP knowledge embedding by directly aligning SCT8 (innovation), SCT1 (environmental responsibility), and SCT2 (commitment to employees' well-being - social sustainability). The ideology EL5 ('interaction between people and environment') clearly addresses environmental and social responsibility goals of SCP. The method also inculcates industry role in encouraging learning and the need for practical demonstration of learning in real-life projects. However, increasing penchant to the use of exemplary projects in the construction industry draws attention to possible shortcoming in the use of this learning method. This practice is widely criticised for the inability to prioritise resource constraints that clearly prohibits SCP uptake in real-life (Gleeson & Thomson, 2012).

Symbolic interactionism represents a significant departure from other methods evaluated in this study. The method exhibits no relevant efficacy to promote SCP learning. Its ideologies do not represent effective mechanics for SCP dissemination. These include freestyle learning (learning by way it is perceived), recognising self-esteem and promoting self-awareness and self-image.

The review of the outcome of the study portrays heterogeneity (67% of the learning methods and 90% of their ideologies) is effective to improve learning and transfer of SCP knowledge. The varying perception exhibited by varying level of performance of the results is also relevant. The understanding, practice, and framing of sustainability in real-life also tend to vary (Boyd & Schweber, 2012). The differing level of performance of the learning models suggests that, no learning model is a perfect fit to embed SCP. Therefore, the need to cross fertilise the underlying ideologies of the significant learning methods is identified.

CONCLUSION

The construction sector is challenged by knowledge and skills dearth. This problem is peculiar to Sustainable Construction Practice (SCP). Learning at individual and organisational level remains one of the mechanisms for improving the status quo. Although, traces of adoption of formal and informal learning models exist in related literature; empirical narratives of their performances are however sketchy. Some of the learning models also have prohibitive cost and focus mainly on large organisational settings thereby neglecting the peculiarity of individual learning needs. This study investigated whether learning methods can improve or influence the uptake of SCP. The objective was to evaluate the efficacy of three interrelated learning models (andragogy, experiential learning and symbolic interactionism) on the propagation of SCP. Two methods, andragogy and experiential learning showed significant efficacies to improve learning and propagation of SCP in the built environment. Based on the established result, the study concludes that andragogy and experiential learning methods are appropriate learning models to improve sustainable construction practices. However, to achieve optimal result in the use of these models, a combination of methods and cross fertilisation of their underpinning philosophies could generate superior performance.

Beyond the promotion of sustainable construction practices, the learning models established to be effective in the study could be explored in the uptake of sustainable designs and innovative practices in the construction industry. However, since the efficacy of learning method relies on its ability

to translate learned skills to real-life application, future research may wish to model the extent to which significant learning models can predict sustainable construction learning performance when successfully embedded within professional practice.

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