Constructivist Approach for E-Learning Effectiveness in African Higher Education Contexts

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Authors’ contributions
This work was carried out in collaboration between both authors. Author MEAAI designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Author TGS managed the analyses of the study, and the literature searches. Both authors read and approved the final manuscript.

ABSTRACT

There is a spurt in online learning worldwide, particularly in Asian and African countries, after the COVID-19 pandemic. Outcomes Based Education (OBE), the new paradigm in Africa, India and elsewhere in the world promotes e-Learning as part of its Lifelong learning attribute. Design of such e-Learning system should incorporate features of autonomous learner’s characteristics (like African higher education students) for their preparedness and progression phases of e-Learning. This is due to the fact that the learning environment and learner characteristics, may differ from place to place and cultures. As per literature, principles of constructivist theory have been successfully adapted for e-Learning. Meta-cognition is a new addition to the OBE paradigm besides cognitive, affective and psychomotor domains, that plays important role in e-Learning. This paper attempts to construct metrics for meta-cognition using constructivist’s learning parameters, for analyzing three phases of e-Learning. Literatures are limited on meta-cognitive studies of e-Learner characteristics. The novelty of the paper is the adaptation of certain principles of ecological system on meta-cognition with literature support. Inductive research with appropriate methodology is applied for

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studying the effectiveness of e-Learning. Ecological factors in the meta-cognition aspects of the constructivist's theory have been considered. Two parts are treated by the paper: i. Comparative study between Indian and African scenario; ii. Detailed study of selective African countries on the preparedness and progression phases of e-Learning. Survey methods have been chosen for obtaining feedbacks on scientifically designed questionnaire. Three hypotheses on the meta-cognitive aspects of self-regulation and a null hypothesis for the comparative study, have been constructed. Observations on the three phases of e-Learning have been documented and inferences drawn. Conclusions made out our research study along with the results presented will be of immense use to e-Learning system designers, particularly for the African scenario.

**Keywords:** E-Learning; constructivism; meta-cognition; self-regulated learning; phases of e-Learning; e-Learner characteristics.

**1. INTRODUCTION AND BACKGROUND**

Universities in Africa, during 2020-21, have been called upon to implement technology enabled education in the wake of COVID-19 (University World News) [1]. It is generally believed that Information Technology (IT) enabled instructions require expertise (more specifically for adaptive e-Learning). Besides, IT personnel technical supports are also needed. More than these issues, the ones related to e-Learning environment for self-regulation in learning and the preparedness of the learners for the e-environment is very important. African students and teachers may require extensive training, both in the usage of IT and, on subject specific e-learning pedagogy, particularly on the preparedness and learning processes of e-Learning. The scope of this paper lies in these areas of e-Learning effectiveness, focusing on scientific principles, particularly on the readiness for e-Learning; its causes and effects.

Constructivism is an educational theory, which insists learners to construct their own knowledge through their experiences and beliefs. Such construction is processed through/ by their mental structures [2]. Learners, especially under Self-Regulated Learning (SRL), during any e-Learning instance, gradually construct or build their subject specific knowledge. For e.g., learning/studying a Computer Science (CS) e-content, slowly develop and progress in acquiring their knowledge of the chosen subject area, by themselves. According to the author, five principles could be identified in regard to constructivists' learning theory. They are: i. Learners construct meaning of knowledge with what they actively learn. Further, they need to do something with the learnt material, because they are engaging with the real world. The e-Learners are not merely asked to ‘do’ something for the sake of it [3], ii. Learning involves both constructed meaning as well as constructed system of meaning. iii. Learning is happening in the minds of human beings, as it is a mental process. iv. Know that (‘Constructivism’ of Vygotsky), learning and the language of learning are intertwined. v. Learning is associated with many situations, like family, teachers, peers etc., as it is a social activity. vi. Finally, learning is contextual, as learning is active and social in the real world. These principles reveal that SRL with e-contents, is a complex mental activity which involves self-motivation and willingness for autonomous learning. Only then SRL will be fruitful and lead to educational developmental of the e-Learner. This clearly indicates that several factors must be considered and researched upon for effective e-Learning process. This is important for specific contexts like African conditions. Otherwise, inappropriate e-contents might become futile and would consequently lead to failure of effective e-Learning.

Meta-cognition, a learning domain, refers to one's own self-awareness of learning. It is a new paradigm, which is treated as the fourth domain of Outcome Based Education (OBE). OBE is the latest educational standard in Africa, India and elsewhere in the world. This fourth domain is an addition to OBE, apart from Cognitive, Affective and Psychomotor domains [4,5,6]. While cognition refers to the faculty of the brain and mind, affective, the emotional aspects or willingness in learning and psychomotor refers to the motor skill which complements learning. Constructivism and meta-cognition, therefore are closely related, particularly in the realm of e-Learning or SRL. Meta-cognition is a domain that plays an important role in SRL and vice versa. General models of self-regulation with regard to these domains have been discussed at length by [7]. The SRL process can broadly be divided into three knowledge categories (or dimensions of learning). They are: strategic knowledge, e.g.,
choosing an apt and relevant e-content and the ability for arriving at strategies for e-Learning processes; conditional knowledge, e.g., choosing the e-content and determining whether it deals with descriptive or mathematical or logical instructions, such as CS subject content; and self-knowledge, e.g., awareness of one’s own strengths and weaknesses in undergoing SRL. Detailed treatment of these domains is beyond the scope of this paper. However, measurable parameters, as variables, are constructed for the proposed experiments, which are elaborated in this paper. The design of meta-cognition and constructivists parameters are in the form of questionnaires that are administered for the proposed experiments. This research is carried out through inductive methodology. How to design and validate the variables or metrics for the experiments? A scientific approach is needed, with a researched validity.

Bronfenbrenner, U, [8] had applied certain fundamental principles of ecological system, while proposing his theory for educational practices. In his theory, he has treated intellectual development of an individual as highly subjective and complex. Various phases of development could be logically considered in the educational process, especially for e-Learning environment. This learning environment, for instance, could affect the developmental process of learning, according to Bronfenbrenner. The term ‘environment’, here, includes the e-Learner’s family settings, customs and practices of the society, Govt. policies and cultural values. For e.g., in the case of an African or an Indian e-Learner (of this current IT era), most of these factors would influence/affect the learning-effectiveness. As the e-Learner is most likely to learn in isolation, however still, within the environmental parameters such as the family surroundings (mostly in cramped houses of India or Africa facing disturbances of fellow residents etc.) and other listed components. These factors could divert the learners’ concentration during e-Learning. How to determine the causes of these parameters? Bronfenbrenner has suggested variables (metrics) which are analogous to ecological parameters, that could be measured in phases/stages during an e-Learning event.

If ecological parameters could be used for measuring e-Learning effectiveness, how to imbibe them in the process of e-Learning? How to validate them, particularly in African contexts? Under this background, the paper elaborates experimental procedures under inductive research method, to try out applying the principles of constructivism and meta-cognition. The paper presents experimental results of Indian as well as African contexts. However, the recommendations are made for African contexts, even though comparisons between the two scenarios are presented. Yet again, country wise study within the African continent’s chosen countries, is beyond the scope of this paper. The results and discussions have helped in drawing conclusions, which will be of immense use to e-Learning designers for African students and also for further research.

2. LITERATURE SUPPORT

Literature that discusses on the preparedness and progression of effective e-Learning is rather limited, particularly that elaborates on African contexts. Some of the distinctions between classroom face-to-face learning and online learning are becoming blurred and slowly collapsing [3]. Far from pure SRL, e-Learning will be effective, when learning designs are judiciously done with proper guidance of a thoughtful practitioner, according to the author. The design choices should include how the learners would engage with various elements in constructing their knowledge (aspects of ‘constructivism’). The second hypothesis of our research is derived from this assumption. Depending upon the learner’s educational needs, the dispositions and tendencies affect the way they learn, and might decide their strategies for e-Learning. Our first hypothesis is constructed from this assumption. In addition, African e-Learner’s nature and characteristics may or may not be different from that of Indian e-Learners (our Null hypothesis is therefore constructed from this assumption).

A need for customized e-content development, particularly for the African requirements and challenges have been stressed [9]. Electronic learning models (for e-content development) are infrastructure dependent. This may also be influenced by the quality of technical supports in addition to the implementation policies of the African Governments. The authors have further called for curriculum reorientation and evaluation procedures for e-content development. The authors have proposed a modified Roger’s model for African contexts. The need for examining the existing pedagogical strategies has been pointed out, although no pedagogical procedure has been suggested in this work. The authors have indicated that heuristic strategy needs to be
promoted with which the e-Learners might find out new ways of thinking and learning without much role-play of the teachers. It is an important statement; however, no scientific support for the design of such a system is not elaborated. Hence, our third hypothesis is constructed based on this assumption. It is warned here, that the technology for implementation should fit to a particular pedagogy. In another study, some of the challenges in implementing e-Learning in Kenya have been addressed [10]. Negative impact has been noticed in the effective utilization of e-Learning by Kenyan public Universities in the recent times. This was realised before their successful implementation. Survey was conducted and administered with 148 staff respondents of three Kenyan Universities by this work. The challenges included: ICT infrastructure inadequacy, financial constraints, lack of policies and skill levels, and, lack of interests with developers of e-content. The authors have clearly indicated that despite these challenges and issues, e-Learning holds (promising) opportunities for Kenyan Universities. The study however did not focus on particular aspects for effective e-Learning preparedness and progression (for the recipient student communities). In relation with the above two findings, in yet another study, the status of e-Learning in Kenyan public Universities, from the points of view of both students and teachers have been reported [11]. These studies were carried out through inductive methods using questionnaires. It is reported that majority of the e-content modules (87%) were nothing but copies of classroom lecture notes. Further, this study too, did not indicate application of any learning theories for effective progression of e-Learning.

One of the attributes of Outcome Based Education (OBE), namely the e-Learning practice is encouraged under its ‘lifelong learning’ component. In one of the studies on OBE in Indian context, the effectiveness of continuous assessment techniques [12] have been indicated. The report elaborated with responses of CS students of India, who have been classified as those that were inclined to SRL (kinaesthetic learners). It has been concluded these kinaesthetic students performed well. It has also been reported that proper avenues in continuous assessments are possible to measure the behaviour and skill components (of the principles of OBE), even for SRL. It is further concluded that these students would be ready for effective learning within the OBE context. It is found that the (experimental) Indian students’ sample have attained ‘critical thinking’ competencies better than the traditional classroom students. But there is no explanation what made the students to progress well (in SRL). In another study, again on the Indian contexts [13], experiments were conducted with Indian higher education students (to study the influence of SRL). Comparative study results have been documented between autonomous and non-autonomous Lab. practices of Electronics and Communication Engineering experiments. The inferences drawn by the authors clearly indicated the supremacy of autonomous Lab. practices, particularly in promoting critical thinking abilities over the non-autonomous conventional learning.

On the principles of constructivism, Ernst Glasersfeld, [14] has stressed that, student’s understanding can only be a matter of compatibility and not a matter of identity of ideas with that of the teacher. This means, from an applied CS education stand-point, the knowledge acquired by the student may be compatible with that of the teacher, provided the subject content satisfies logical and mathematical sense, which can then be acceptable. At the same time, according to the author, if a student merely repeats what the teacher has said (in classroom), then there is no indication that the student has understood. If this is true even in classroom environment, it could then be more affective in e-Learning environment. In another literature on SRL, much empirical and theoretical work on SRL in classroom learning has been reported by [7]. The author has expressed the need for models of SRL that should include both motivational and cognitive processes. Eriksson, M, et al. [15] have successfully adapted certain selective systems of (8), which was adapted in early 1970s) theory for mental health education and research. Several components have been tried out in a broader sense. From their validated approach, e-content developer could select the required ecological system parameters for deciding the influencing factors for e-learning, particularly in different stages like pre-preparedness and during the progression of e-Learning. From these literature supports; three hypotheses and a Null hypothesis have been constructed by us. The methodology for research has been then selected for the proposed experiments.

3. RESEARCH METHODOLOGY

Survey method under inductive research has been adapted by us. For constructing the hypotheses in three chosen dimensions of the
survey, Bronfenbrenner’s ecological theory has been applied [15]. One to three dependent variables are considered for each dimension. 9 independent variables have been finally arrived at, which are categorised in three learning phases (or stages) of e-Learning, as detailed latter. One null hypothesis is assumed for the comparative study and five dependent variables are constructed for the comparative studies between African and Indian scenarios. The hypotheses are:

Null hypothesis: There is no significant difference between the e-Learners of African and Indian origins, preferring for SRL.

Hypothesis 1: Self-strategic knowledge is strongly signified in the preparatory phase of self-regulated e-Learning of African e-Learners.

Hypothesis 2: Conditional knowledge is strongly signified during the performance of self-regulated e-Learning by African e-Learners.

Hypothesis 3: Self-knowledge of e-Learners of Africa is strongly reflected on self-regulated e-Learning.

Albert Bandura, one of the pioneers who formulated social learning theory, stressed [16] that students’ beliefs on their capabilities in controlling their own learning habits are important (for effective SRL). On the other hand, Learners’ cognitions can influence the instigation, direction, and persistence of (SRL) achievement-related behaviours [17]. When e-Learners are systematically orient themselves towards attaining their learning goals, then e-Learners are likely to achieve effective e-Learning. The initiation for SRL, progress of SRL and the determination in achieving finally, can be treated in three phases/stages, as per the findings/recommendations of these authors. They are: planning phase, monitoring phase and evaluating phase [17]. Accordingly, three stages (or phases) of SRL of e-Learning is considered for our studies.

3.1 Formulation of Variables

The construction of variables (metrics) for the proposed experiments in these three phases, have been done in accordance with the principles and practices recommended by various literature on SRL (presented in our literature support), in addition to constructivists approaches [16,17,7]. The variables have been grouped under meta-cognition aspects [15]. Meta-cognition is awareness of learner’s own SRL in e-Learning. The questionnaire consisting the variables under Phase 1, are intended to determine: Interested in SRL? Organized & Self-disciplined? Enjoy working alone? Confident in contacting teachers? Voracious reader? Skilled in using WEB? Can spend 3-4 hours per week? Phase 2: Know weaknesses; Remove temptations; Set clear goals/plan for situations; Create new strategies; Change perception about willpower. Phase 3: Group collaboration; Provoke questions; Self-assessments; Summarize learning experiences; Real world activities. Validated questions have been arrived at before administering in our proposed surveys. All questions are designed for feedbacks in a 5 point Likert’s scale values for each question.

3.2 Questionnaire for Determining e-Learning Effectiveness

The questionnaire aims at qualitatively measuring meta-cognitive abilities that are possessed by the samples (respondents), which will indicate their preferences for e-Learning contents. However, quantitative scores are needed for measuring qualitative metrics. Hence the questionnaire needs validation from experts. The opinions given by respondents must be arrived at through concrete facts, and not directly from opinions. The analyses of the responses would then help in designing efficient and reliable e-Learning facility. The questionnaires are designed to be scored on a continuous, linear 5-point scale. The validity of the questionnaire is obtained on the representation of discrete parameters (facts) but arranged in a linear fashion. For e.g., the strategy for obtaining information for the learner from various sources, are arranged in a scale which is from less ‘freedom of choosing’ to more ‘freedom of choosing’ (e.g., only from prescribed text books to a combined resource like textbooks, unspecified reference books, classroom notes, and the Web etc.). Depending upon the freedom of choices, the respondent may select appropriate scale value within 1 to 5. It should be noted that the choices are not only based on the personal preferences of the user; but also depends upon the restrictions confined by the learner’s environmental parameters. For the conditional knowledge, the discrete parameters are: referring only class notes; discussing with peers (including mobile phones); searching for information in the internet; combinations of all the above etc., for working on assignments/projects/presentations.
etc. Thus, the questionnaire is designed to obtain scale values for such linearly organised qualitative parameters; from transformed quantitative/discrete parameters. Based on this idea, the essence of the validated questionnaire is presented below.

3.2.1 Dependent variables

Dimension I on Strategic knowledge:

1. The choices with which I capture subject related information. In the scale of 1 to 5 (few to more choices).

Dimension II on Conditional knowledge:

2. The freedom of sourcing for executing my assignments/projects. In the scale of 1 to 5 (low to high freedom).
3. I have been regular in using the internet. From none to more than 5 years in the scale of 1 to 5 (none to heavy usage).
4. I have registered/completed online courses. From none to more than 5 courses in the scale of 1 to 5 (few to many).

Dimension III on Self-knowledge:

5. I rate myself in adapting IT skills. From very low to very high in the scale of 1 to 5.

3.2.2 Independent variable(s) for African responses

Pre SRL phase:

6. I rate myself, as self-disciplined and well organised. In the scale of 1 to 5 (low to high).
7. I enjoy working alone. In the scale of 1 to 5 (from very poor to very much).
8. I am confident in contacting my teachers. In the scale of 1 to 5 (low to high).

Performing phase of SRL:

9. My perseverance level, in the scale of 1 to 5 (low to high).
10. I am clear in setting my own goals. In the scale of 1 to 5 (low to high).
11. I am confident in creating new strategies. In the scale of 1 to 5 (low to high).

Reflection phase after SRL:

12. My strength in provoking questions. In the scale of 1 to 5 (low to high).
13. I correctly self-appraise myself. In the scale of 1 to 5 (inaccurately to accurately).
14. I can properly summarize my learning experiences. In the scale of 1 to 5 (inaccurately to accurately).

From that above questionnaire, it is possible to measure qualitative aspects that are intended for the research studies from quantitative 5-point scale.

3.3 Sampling and Demography

3.3.1 Demography of Indian samples

Total number of control group samples considered (CS students who have ‘S/w Engineering’ course for their study) is 224. The selection is based on ‘purposive sampling’. These students were undergoing CS programme in various higher educational engineering colleges in the state of Kerala, India. The higher education institutions, where they were undergoing Post Graduate programme in Computer Applications, during the survey period. The institutions were spread at various locations across the state of Kerala, India. The experimental group is selected from a pilot study, which was conducted with 27 students. Selection was based on the experimental students’ prior experience with e-Learning and also their preferences or willingness for e-Learning. Final experimental group sample size: 162 (Male 56%; Female 44%). The experimental group to control group ratio is (162:224) i.e., 0.72. The experimental group of students belong to CS programme in three different institutions located in the State of Kerala, India. The chosen sample (respondents) has prior knowledge of S/W Engineering course and liking for e-Learning experiences. They also have some knowledge about the intended study itself. The sampling is based on purposive sampling [18], which allows 5% of total universal sample size for the purpose for which the study is intended. This sampling method fits well for the intended purpose of the research, and found to be well distributed in the demography. The experimental group satisfies these requirements also. No gender-based behaviour study is intended for.

3.3.2 Demography of African samples

The first author of this paper is a native of Sudan and has wide contact with African students/teachers of CS through emails. The students/teachers and the African countries that
were contacted for the (research) survey include: Sudan (74; 55 male and 19 female), Ethiopia (52; 40 male and 12 female), Kenya (40; 35 male and 15 female) and South Africa (63; 40 male and 23 female). The above samples included 12 teacher candidates who attended various overseas teachers training programmes at the National Institute of Technical Teachers Training and Research, Chennai, India during 2009-2019. The first author himself was a trainee in one of the programmes. The second author was the course coordinator for 11 overseas teacher training programmes from 2005–2018. Out of the 11 developing countries, African trainees who attended overseas training programme in India during 2019, have also been considered. They were surveyed in another published study on ethnic conflicts [19]. A total of 170 male and 69 female samples (totalling 239 African origin students/teachers) are considered. They formed the control group for the African scenario. As with the case of Indian samples, the selection for the experimental group of African scenarios was based on the students'/teachers’ prior knowledge and liking for e-Learning. The final chosen experimental group size is 114 (male 84 and female 30). As mentioned earlier comparative studies between individual African country (and also gender-wise study) is beyond the scope of this research. However, results on comparisons between India (Kerala state) and selective African countries are documented in this paper.

4. RESULTS AND DISCUSSIONS

Feedback instruments were administered through interview schedules for the Indian experimental group. The feedbacks for African respondents were administered through Google forms, which were supplied to various respondents by emails. A few African trainees who attended the overseas training programmes in India were personally contacted through interview schedules. The results obtained for dimensions I, II and III on strategic, conditional and self-knowledge are scheduled for comparative studies between African and Indian scenarios. The statistical computations included mean, median, standard deviations, minimum and maximum scores and One-way ANOVA results along with Cronbach’s alpha, were carried out by SPSS 20.0 [20]. The validity of the questions was done through expert opinions on pilot study as mentioned earlier. The final results of the 5 variables (Dimensions I, II and III) were subjected to One-way ANOVA for comparisons at 95% significant levels.

Box and whisker plots are preferred for observing pairs of results to draw inferences, as box and whisker plots give better picture for comparing relative positions among two scenarios [21]. Fig. 1. shows comparisons between Africa and India on strategic knowledge (variable 1). Fig. 2. is for the conditional, and Fig. 3. for the self-knowledge.

![Comparisons on 'Strategic Knowledge'](image1.png)

![Comparisons on 'Conditional Knowledge'](image2.png)

Fig. 1. Comparing Strategic Knowledge  
Fig. 2. Comparing Conditional Knowledge
4.1 Comparative Studies between African and Indian Responses

4.1.1 Observations on the strategic knowledge (Fig. 1)

Even though the minimum/maximum extremes are scored by the African respondents, the mean and median are much lower than that of Indian responses. In fact, the average score is on the lower score (2.0) for the Africans than that of the Indians (3.0). Another important observation is that the first quartile median is 1.0 for the Africans, while it is 2.0 for the Indians.

This shows that the African learners mostly have limited freedom in strategically sourcing for e-Learning than their Indian counterparts. Cronbach’s alpha for reliability, tested on Indian responses is found to be 0.614. The distribution for consistency-measure of the responses is acceptable, as Cronbach’s alpha value is more than 0.5. The mean of Indian score is found to be 2.981481 which is slightly lower than its own median (3.0). The dot is lower to hyphen in the Indian box-whisker plot of Fig. 1. But the mean score of the African responses is 2.421053 which is more than its median of 2.0 (see Fig. 1., where the dot is upper to hyphen). Besides, there is no upper whisker for the Indian scores, which indicates the responses are more consistent. The standard deviation is 1.036431 (162 responses) for the Indians, while it is 1.240145 (114 responses) for the Africans; which shows that the Indian responses are more consistently distributed. In the case of Africa, the mean is more than median, while in the case of Indian respondents, it is the other way. This shows that the responses are more narrowed kurtosis in the respected quartiles. It is hence inferred that there is a significant difference between African and Indian scenarios in strategic knowledge of e-Learning.

4.1.2 Observations on the conditional and self knowledge (Figs. 2.0 and 3.0)

There are three questions in Dimension II (conditional knowledge). While the strategic knowledge (question 1) in Dimension I, was meant for general usage of the internet, question 2 of Dimension II (conditional knowledge) is for specific applications like assignments or student’s project works. The learner’s own strategic ability is mostly revealed in the question 1, while in question 2, it included the influencing factors of the learner’s other environmental factors (conditioned). The first two box-whisker plots of Fig. 2. reveal African and Indian responses respectively for the question 2. It is observed that the distributions are almost similar to that of the strategic knowledge (Fig. 1). The mean value of the African responses is 2.491228 (median 2), while for the Indian responses it is 3.209877 (median 4). The median of the third quartile of the Indian responses is same as that of the median of the entire responses (4). Although both results (questions 1 and 2) show similar distributions, the results of one-way ANOVA (Table 1.0) show correct results. There is a significant difference between Africa and India in strategic knowledge ($F_{critical}$ being 2.766 while its own significant factor value is 0.031). But for the question 2, the $F_{critical}$ is 0.770 and its significant factor is 0.513. In both these cases, differences are seen between the African and Indian scenarios (in $F_{critical}$ and significant values).

The standard deviation of African responses is found to be 1.169264, while that of the Indian responses it is 1.018049. This indicates that the Indian responses seem to be slightly more consistent than the African responses. Distributions are similar in question 3 too (the third and fourth box plots of Fig. 2). But for the question 3 (specific usages of internet), the distribution is more narrowed kurtosis rather than skewness’s for both the scenes. This is an important observation which reveals that there is a high level (significant) difference between African users of internet and the Indians. The mean of African responses is 2.157895 (median is 2) and the mean of Indian responses is 2.864198 (median is 3). More over a small standard deviation value of the Indian responses is also noted (0.595075). The standard deviation of the African responses is found to be 1.000698. This indicates that the Indian responses seem to be more consistent than the African responses.

In the fourth question, which is quantitative in finding the volume of e-courses undergone by the respective respondents. It is evidenced that the African countries give more preference for online courses. The last two box-whisker plots of Fig. 2. show that, both the scenarios are similar in their distributions. In both the cases, the median is 3, when the mean of African responses is 2.745614, and the Indians it is 2.598765. The standard deviation of African distribution is 1.07103 and that of the Indians it is 1.060059. These values indicate that the distributions are virtually the same for both the cases. In the case of the last study, which is on Self-knowledge, the distributions of Africans are shown in the first box-whisker plot of Fig. 3. while that of the
Indians it is shown in the second plot of the same figure. The question is purely on self-appraisals by the respondents. The distributions also indicate the same trends for both the cases (mean or dot is lower to median or hyphen), but of different intensities. The median of African responses is 3.0 (mean is 2.745614), which is in middle-upper scale value. But for the Indian responses, the median is 4.0 (mean is 3.901235), which is certainly in the upper scale region. There is no upper whisker found from the Indian responses, which indicates the distributions are more consistent (standard deviation is also 0.94711, which is less than least scale value). There is upper whisker for the African responses, which indicates that a few African users are highly competent in the usage of internet, although the distribution is not as concentrated as that of Indians (Africans' standard deviation is found to be 1.045948 which is greater than 1.0, the minimum scale value).

4.1.3 Recommendations

Contrary to the general believes on limited choices available for online courses, our results clearly show that large volume of students/teachers of Africa are registering for online courses. In fact, from our survey results, it is observed that the one area where there is a higher impact of Africa than India is on the number of registrations of online courses (mean value of Africa is 2.745614 while that of India is 2.598765). Since our sample size is scoping mostly to CS studies, further research is recommended before making concrete conclusions. More importantly, even though the number of e-course registrations in Africa is more, the strategic, conditional and self-knowledge parameters are less present/encouraged by the African systems than what is practiced in India. Yet again, while both the systems need improvements in strengthening e-Learning on strategic, conditional and self-knowledge, African countries require better promotion, particularly on the three components of the constructivist theory.

4.2 Studies on Self-regulated e-Learning Processes of African Learners

Three phases of SRL have been considered, namely the Pre-SRL, Performing SRL and Reflecting on SRL. Variables have been derived based on meta-cognitive factors using Bronfenbrenner’s ecological aspects. In the Pre-SRL phase, three meta-cognitive parameters have been constructed as three variables. They are: (6) Self-discipline and organising characteristics of the e-Learner, for seriously commencing his/her e-Learning SRL; (7) Willingness to work in isolation; and (8) Ability
and courage to contact the teacher/instructor for clarifications, even though the questions be on trivial doubts. In the Performing SRL phase, three meta-cognitive parameters have been constructed in three variables. They are: (9) Perseverance in continuing with SRL; (10) Ability to set goals in pursuing SRL and (11) Ability in changing the strategies during an SRL process. In the Reflecting on SRL phase, three meta-cognitive parameters have been constructed in three variables. They are: (12) Ability to provoke appropriate questions to himself/herself or to peers; (13) Capability in accurately self-appraising himself/herself so as to judge the e-content quality; and (14) Ability to summarize the e-Learning experience for further promotion of e-Learning. The statistical data pertaining to the feedbacks (of African respondents only) are listed in Table 2.0. The average mean and median of every phase are arranged in a linear fashion so as to get an idea of the trend of the meta-cognition factors so as to understand their significance levels of SRL. Fig. 4. shows this trend (in terms of the average scores of each stage/phase of SRL).

4.2.1 Observations on SRL of the African e-Learners

The average score mean values of the first stage is 2.8888 (Table 2.0 and Fig. 5). The average of the median is 3. The average standard deviation of this phase is 0.8931 which is less than 1.0 (the minimum scale value). This indicates that the African learners’ readiness for SRL is of the acceptable level. Fig. 5. also shows the responses of the African learners for this phase is more positively pronounced. While the second variable is more positively visible; the third variable is widely distributed, but still more in the positive side. All the three variables show positive trends. Hence the meta-cognitive factors are signified for the pre-SRL stage. Hence Hypothesis 1 is accepted.

The average score mean values of the second stage is 3.7018 (Table 2.0 and Fig. 6). While the average of the median is 4. The average standard deviation of this phase is 1.0323 which is slightly more than 1.0. The average mean and median values of the African learners’ responses show that the SRL is progressed sensibly. Fig. 6.0 also shows the responses of the African learners for this phase to be highly positive in all the three variables. Hence the meta-cognitive factors are signified during the SRL process. Hence Hypothesis 2 is accepted.

The average score mean values of the third stage is 3.5205 (Table 2.0 and Fig. 7). While the average of the median is 3.33, the average standard deviation of this phase is 0.8473 which is less than 1.0. The average mean and median values of the African learners’ responses show that the SRL which was undertaken (or completed) has a positive impact. Fig. 7. also shows the responses of the African learners for this phase is highly positive in all the three variables. Hence the meta-cognitive factors are signified for reflecting the SRL completed by the e-Learners. Hypothesis 3 is also accepted.

Table 1. Comparisons on dimensions of African and Indian scenario

| Dimensional description | Fcritical Value | Significant |
|-------------------------|-----------------|-------------|
| Strategic knowledge     | 2.766           | .031        | Significant |
| Conditional knowledge   | Variable2       | 0.770       | .513        | Mild significance |
|                         | Variable3       | 5.193       | .025        | Significant |
|                         | Variable4       | 6.017       | .003        | Significant |
| Self-knowledge          | 1.644           | .183        | Significant |

Table 2. Statistical data pertaining African responses on SRL

| Variables | (6) Valid | (7) Missing | (8) Mean | (9) Median | (10) Std. Dev. | (11) Mean | (12) Median | (13) Std. Dev. | (14) Mean | (15) Median | (16) Std. Dev. |
|-----------|-----------|-------------|----------|------------|----------------|-----------|-------------|----------------|-----------|-------------|----------------|
|           | 114       | 0           | 2.6754   | 3.0000     | .90716         | 114       | 0           | 2.8070         | 3.0000    | 1.00939     | .74036         |
|           | 114       | 114         | 2.1842   | 2.0000     | 1.00939       | 114       | 0           | 4.0000         | 4.0000    | 4.0000      | .74036         |
|           | 114       | 0           | 3.6053   | 4.0000     | .74036        | 114       | 0           | 3.5075         | 3.0000    | 4.0000      | .74365         |
Fig. 4. Significance of the meta-cognitive factors on SRL

Fig. 5. African Responses on Questions 6, 7 & 8 of Pre-SRL

Fig. 6. SRL Process of African Responses on Questions 9, 10 & 11
5. CONCLUDING REMARKS AND RECOMMENDATION

Our survey results clearly demonstrated that there is a significant difference between the responses of African and Indian e-Learners on their preferences for SRL, rejecting the Null hypothesis. Even though the African students are eager with autonomous e-Learning, there is a significant difference between the preparedness and progression phases within the African context. It is concluded that, while the preparedness phase components of the African e-Learners are promising, the progression phase components are not conducive.

Recommendation: Freedom in strategically sourcing learning materials by the African students must be ascertained by the education systems of the African countries.

Our study is limited to the African and Indian students of Computer Science discipline. It is concluded by our research work, that aspects of meta-cognition when treated with appropriate principles of constructivism, will accurately measure the performances of e-Learning. It is observed from our results that the self-system of African e-Learners are encouraging in agreement with the findings of Omwenga, E.I., et. al. [9] and of George, L, Makokha et. al., [2] (Kenyan public Universities) on the need for customization of e-content development, particularly for the African requirements.

Recommendation: African education system should promote more research in studying different subject specific areas of higher education in the e-Learning mode, through meta-cognition and constructivist theory.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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