INTERNATIONAL SUSTAINABILITY UNIVERSITY EDUCATION FOR ARCHITECTURE, ENGINEERING AND CONSTRUCTION (AEC) COURSES: A CASE FOR GLOBAL CLASSROOM.

Allu-Kangkum, Evelyn Lami Ashelo., Katyen, Ann Muopwun. and Chong, Jonathan David.
Department of Architecture, University of Jos, Jos – Nigeria.
Email: evelynallu28@yahoo.com

ABSTRACT

Sustainability university education is targeted at social-environmental local problems to provide contextual solutions that have positive global impacts. As such, it is important for educational experiences of university students to be ascertain to close the gap between knowledge and skills for globalized sustainability education. However, not much has been pursuit in the novelty of globalization of sustainability education, particularly in Nigeria. Yet, The Global Classroom for the globalization of sustainable education provides many opportunities for the global sustainability concerns. These opportunities include; global outlook to sustainable solutions, virtual educational technologies enhancement, established international standards and quality of students, promotes cross-cultural fluency, multiple and diverse partnerships and integration of sustainability practices into university educational experiences. A two sections questionnaire survey was conducted amongst 120 academic staff of Architecture, Engineering and Construction (AEC) professionals in a Nigerian University. The theoretical underpins were validated and the contextual challenges for a Global Classroom perceived includes; lack of constant electricity and internet, differences in time zones, language barriers, lack of virtual learning technology, lack of adequate sustainability knowledge and absent of regulations to support Global Classroom. This study concludes with deduced reflections on the necessary requirements for promoting Global Classroom as its recommendations, one of which is the promotion of institutionalized regulations to support Global Classroom.

Keywords: *AEC, Education, Global Classroom, Sustainability, University*

INTRODUCTION

Integrating sustainability has many local contextual challenges which include; climatic changes, poverty, loss of biodiversity, epidemics, and violent conflicts among communities. However, the underpinning causes do have a link with other communities both locally and globally, as such collaborative proactive actions are necessary for a global coordination and standards (Van der Leeuw et al., 2012; Wiek et al., 2013). As such, the future practices for a Sustainable Development (SD) by professionals in the Architecture, Engineering and Construction (AEC) are required to practice and collaborate across regions which have some challenges and prospects (Allu & Emuze, 2017). Furthermore, the expectations for global solutions through collaborative efforts have turned the search light to teaching and education (Brundiers & Wiek, 2011; Wiek et al., 2013). The study of Wiek et al. (2013, p.19) capsulate this position as follows:

"With these new teaching challenges, educators must determine how to best equip students with these trans-boundary competencies. Classroom exercises that present sustainability problems and solution options are an important part of such a competency-focused approach".

In this study, the main concern is the university education of the AEC future professionals who are the actors in the built environment. The reasons being two-fold; firstly, sustainability research suggests that it is a problem which is social-environmental-technical in nature (Wiek et al., 2013; von Blottnitz et al., 2015; Sammalisto et al., 2015; Allu, 2018a). Secondly, it has been argued that the role of universities is significant for advancing sustainable development (Barth and Rieckmann, 2012; Allu, 2018b). According to Rieckmann (2012, p. 130)

"successfully integrated the application of the sustainable concept can develop into SD intelligence where the ESD knowledge has develop into systemic, anticipatory and critical thinking and actions for students to follow."

Following up on the quotation by Rieckmann (2012), other studies also suggested that universities drive and motivate the transformational direction of their students and society at large (Barth & Rieckmann, 2012; Tilbury, 2013; Allu, 2018b). Despite the emphasis on integration of sustainability into socio-environmental and technical university education, there is still limited research on the perception of university staff on the subject (Karatzoglou, 2013 von Blottnitz et al., 2015; Allu, 2018b) and also in the Nigerian context (Allu, 2018a & b). Yet, it is expected that future professional competences of today's students are the result of teaching received in higher education (Ludwikowska, 2019) and especially where sustainability is concerned (Sady, 2019). The global

classroom approach has a huge to impact the sustainable knowledge and future sustainable practices of today's students.

This study presents Global Classroom as a means for global addressing the sustainability concerns deriving from the opportunities it provides to the educational systems and contextualizing it to the Nigerian university system.

LITERATURE REVIEW

Global Classroom and Education for Sustainable Development (ESD)

The Global Classroom (GC) deals with the internationalization of local solutions for educational programmes in sustainability. Thus, the university as a system is critical and change agent to any Sustainable Development (SD) transformation (Barth & Rieckmann, 2012). More particularly, for the environmental dimension of sustainability the onus lies with the architectural, engineering and construction (AEC) education (Watson et al., 2013; Altomonte, 2014), where and institutional and social aspects are also encouraged (Segal et al., 2012). It is expected that, when these are successfully integrated, the future sustainable application would provide SD intelligence through the ESD knowledge which guides the systemic and individual development, anticipatory, critical thinking and actions students to follow naturally (Rieckmann, 2012). Hence, the more SD studies through ESD for capacity building are encouraged and called for (Tilbury, 2013; von Blottnitz et al., 2015 & Robert, 2016).

Global Classroom started at the Earth Institute, Columbia University, since 2008. Initially, the first GC addressed wide areas that includes; agriculture, economics, education, ethics, health and policy. Currently, it is specifically used to drive sustainable development practices through cross-disciplinary collaboration for sustainable solutions by many universities across the globe (Wiek et al., 2013; Tobal, 2019). This has been adopted by the universities because the sense of global citizenship in the approach for solutions promotes the students' ability to overcome sustainability challenges holistically (Allu, 2018a and Tobal, 2019). Furthermore, sustainability education within the AEC promotes social-environmental-technical local problems and manifestations to have global solutions (Barkemeyer et al., 2014; Allu, 2019). The study by Wiek et al. (2013) further suggests that it important for educational experiences of students to confront challenges of crossing cultural, national, and international boundaries in a globalized world for easy understanding and uncovering the benefit the knowledge of the historical, epistemological and ethical underpinnings of these diversities (Homles et al., 2014 and von Blottnitz et al., 2015).

Following the discourse in the preceding paragraphs, the demand for ESD into the university system has over the years increased (Wiek et al., 2013; Robert, 2016; Allu, 2018a; Allu, 2019). As well as the expectations for universities across the globe to prepare students to develop their capacity to integrate sustainable options for every economic, socio-cultural and environmental challenges with a global applicable solution (Wiek et al., 2013; Allu, 2019).

Furthermore, the current Covid -19 pandemic has further given a push towards the option for virtual learning platforms and for sustainable actions by all human developmental processes. This is particularly so for betterment of skills, the education and supporting policy framework for AEC or the built environment professions (Oborn & Walters 2020). Integrating sustainability would enhance and contribute positively to the attainment of sustainable development goals which is certain to remain even the pandemic has been abated (Muse, 2020). According to Saxena (2020) integrating sustainability in the training of AEC places the future practitioners at an advantage in international placement.

Consequently, the onus is for the educators be to be knowledgeable on how best to guide their students with trans-boundary competencies are best achieved through the GC initiative as is the case in many developed economies (Wiek et al., 2013; Khandakar et al., 2020). According to Azeiteiro et al. (2015) sustainable education in higher learning through e-learning as GC is capable of sustainable transforming for the learner and transits into reforming the sustainable societal patterns. Yet, there is no certainty of the knowledge and understanding of the educators to position the future AEC professionals, in the Sub-Saharan African region and particular in the Nigerian context (Allu, 2018 and 2019).

The Global Classroom Challenges and Potentials

For every developmental initiative as much there may abound many potentials, there could also be some challenges, which may double as disadvantages. The challenges for GC are highlighted in Table 1, whilst Table 2 outlines the potentials of GC as opportunities. The contents of the two Tables guided the questions asked and the perceptions of the arrived were discussed to validate the theoretical findings. It can be deduced also from the

two Tables, that the potentials of GC far outweigh the challenges as postulated by earlier researcher who carried out similar research in this regard.

Table 1. The challenges of Global Classroom

SN	Challenges	Source
1	Possible devaluation of local cultural content, knowledge and languages.	Pelech & Macpherson, 2009; Khandakar et al.2020
2	Lack collaborations across local, regional, national, geographical, and cultural boundaries**.**	Brundiers & Wiek, 2011 Wiek et al. 2013 and 2014
3	Limited knowledge and understanding of GC	Wiek et al. 2014; Khandakar et al. 2020
4	Lack of competence by educators on sustainability	Teff-Seker et al., 2019; Khandakar et al. 2020; Matsekoleng & Awshar, 2020.

Table 2. Opportunities for Global Classroom

SN	Potentials/Opportunities	Source
1	Global outlook to sustainable solutions	Wiek et al. 2014; Khandakar et al. 2020
2	Virtual educational technologies enhancement.	Wiek et al. 2014; Lock, 2015
3	Established international standards and quality of students,	Jiusto, 2013; Wiek et al. 2013 and 2014
4	Promotes cross-cultural adaptations, fluency, multiple and diverse partnerships	Wiek et al. 2013 & 2014; Lock, 2015.
5	Integrate sustainability practices into university educational learning and experiences	Sipos, et al. 2008; Teff-Seker et al., 2019; Khandakar et al. 2020
6	Closes the gap between knowledge, skills and problems for global impact for sustainable solutions	Wiek et al. 2013 & 2014; Servant-Miklos, 2018; Noordegraaf-Eelens at al. 2019
7	Promotes cross border research standards, funding and ratings	Wiek et al. 2013 & 2014; Lock, 2015.
8	Promotes flexible study/work hours and future international placement	Wiek et al. 2013 & 2014; Lock, 2015; Saxena, 2020.
9	Promotes and allows compare classroom models and ensures variable collaboration	Wiek et al. 2014; Servant-Miklos, 2018
10	Promotes participatory actions and learning amongst the university students	Rieckmann, 2012; Matsekoleng and Awshar, 2020.

METHODOLOGY

A questionnaire survey was adopted and divided into two main sections. The AEC practitioners were presented asked questions to which they had expressed their opinions based on the five points Likert options of; Strongly Agreed, Agreed, Neutral, Disagree and Strongly Disagreed. The second section forms the semi-structured survey where the respondents commented freely on their perceptions on the challenges and the opportunities for GC adaptions for sustainable internationalization of university training in the AEC courses. The respondents profile is presented in Table 3 to show the spread on the respondents' professions. Whilst views expressed are presented in Table 4. Practical Tools for International Development (2020) suggested that a minimum of 100 questionnaire survey is adequate and in this this study a total of 22 (82.96%) responses were returned out of the 270 online surveys sent out. These were from 6 universities in the 6 geopolitical regions of Nigeria. These universities have an average of 17 academics within the AEC Departments and 15 survey questionnaires were sent to each department.

The simple statistical metrics analysis was explored for easy understanding and clear presentation (Di Leonardo, 2017), with the aim of identifying the main challenges and the potentials associated with integrating GC as a tool for the internationalization of sustainability into the university educations of the AEC professions.

Table 3 Respondents Profile and Breakdown

		Department/ Professions			Total sent out	Total returned
S/N	**Regions**	**Architectural**	**Engineering**	**Construction**		
1	North Central	13	12	14	45	39
2	North East	10	8	13	45	31
3	North West	11	15	9	45	35
4	South East	13	13	12	45	38
5	South West	14	15	13	45	42
6	South-South	12	14	13	45	39
Total		73	77	74		
Grand Total					**270**	**224 (82.96%)**

FINDINGS

Table 4 presents the proposed questions and statements to which the respondents' responses are grouped into architecture, engineering, and construction regardless of geographical zone of the respondents. The views are captured in percentages for clarity and direct interpretation of views expressed by the respondents.

Table 4 Questions/Statements and Responses from Questionnaire Survey

Questions/Statements	Strongly Agreed	Agreed	Neutral	Disagreed	Strongly Disagreed
1. Sustainability is part of your university's curricula and practices.	2.2%	26.8%	17.9%	36.2%	16.9%
2. Global Classroom is a common educational practice in your university.	0.01%	0.4%	9.8%	87.5%	2.2%
3. I am competence to teach sustainability	5.3%	10.6%	16.5%	48.2%	19.4%
4. Do you think Global Classroom should be adopted by your university as a method for training the AEC students?	67.8%	28.1%	3.1%	0.89%	0.1%
5. Global Classroom has the potential to integrate sustainability in the education of AEC students for future employment and sustainable practices.,	89.7%	9.9%	0.4%	0.0%	0.0%
6. The AEC professional institutes, and the Nigerian Universities Commission (NUC) are important stakeholders to ensure awareness and to explore the institutionalization of sustainability in the university education of the AEC professionals	10.7%	88.3%	1.0%	0.0%	0.0%
7. Government regulatory agencies and Nigerian educational policies have adequately support the integration of sustainability education	15.9%	16.5%	0.0%	47.5%	20.1%
8. Do you think there would be some challenges/limitations for the integration of sustainability into the curricula of the Nigerian Universities? Please explain in the space provided	31.2%	67.8%	0.90%	0.0%	0.0%
9. Do you think there would be some challenges/limitations for the adaptation of GC in the Nigerian Universities? Please explain in the space provided below	81.6%	17.0%	0.0%	1.3%	0.0%

DISCUSSIONS

The theoretical discourse suggests a global awareness and interest in sustainability university education and the use of Global Classroom as tool for promoting sustainable education. However, findings from this survey revealed that there are limitations in the understanding of sustainability in itself, limitations on the application of GC and consequently in its adaptation.

In this study, the responses suggest that, 36.2% and 16.9% (53%) of the respondents are clearly not aware that, their universities are sustainable compliant and about 60% are also not confident of their ability to teach sustainability. This is an indication that the AEC students are not adequately positioned and trained to compete favourably with other AEC students across the globe in terms of job requirement and the application of sustainable applications in their future practices.

Results on the potentials for the GC is highly positive, with about 90% agreement but surprising because the respondents are not privileged to operate with GC. This is an indication that when GC is formally adopted as a tool for educating the AEC students, it will be generally acceptable by these educators. As such, it possible for the educators to seek for the adaptation of GC and invariably to further integrate and embed sustainability into their individual course curricula. This position was strongly agreed to with 67% and a further 28% also agreed for the adaptation of GC into their university system of training.

Whilst, about 99% of the respondents also agreed that the AEC professional institutes, and the Nigerian Universities Commission (NUC) are important stakeholders to ensure awareness and to explore the institutionalization of sustainability in the university education of the AEC future professionals. This again shows that the respondents have confidence on the ability of the different professional institutes and NUC to coordinate and produce a benchmark for the operations of GC in the university system in Nigeria.

On the other hand, about 68% of the respondents do not agreed that Government regulatory agencies and Nigerian educational policies have adequately supported the integration of sustainability education. This serves as further explanations as to why the respondents do not perceived their universities to be sustainability compliant.

The follow-up question on the challenges/limitations for sustainability in questions 8 on Table 4 have the following responses recorded:

• The inadequate knowledge and proper understanding sustainability integration into the curricula of the AEC courses.

- Lack of specific guidelines and framework for the integration of sustainability into AEC university education.
- Lack of coordination by professional institutions and NUC.
- The NUC set minimum standards for university education related to the AEC course requires updating.

Responses for challenges/limitations for GC asked in questions 9 on Table 4 suggested the following:

- Limited knowledge on the term “Global Classroom” and its aim for global standardization of university education for sustainability.
- About 82% of respondents perceived Global Classroom as a means of continuous education amidst the Covid-19 pandemic. The remaining18% are of the opinion that, GC would be limited by:
- Lack of steady electricity supply to run an online programme
- Unsteady internet service to remain connected with scheduled classes, group assignments and other interactions requiring collaborations.
- The differences in global time zones may limit GC to regional classrooms.
- Limited availability of virtual learning facilities.
- Language barriers would affect communication between students and sustainable educators.
- There is no known regulation or legislation to support GC in Nigeria.

These points enumerated above are therefore, the peculiar challenges/limitations for the Nigerian context for the adaptation of GC for the education of the AEC students.

CONCLUSION

To promote the adaptation of Global Classroom in the Nigerian system of education, its understanding, principles, processes and applications would have to enshrined into the AEC education and professional requirements and enforced by professional institutes and the National University Commission.

This study is able to identified what would constitute challenges/limitations for the integration of sustainability and GC into the education and training of the AEC students in the Nigerian context, despite the potentials enumerated in Table 2.

Consequently, the AEC educators, the AEC professional institutes, and the National University Commission NUC would be required to provide a benchmark. Additionally, the legislating arms and the Federal government should provide legislation and supporting policies for the adaptation of GC. More so, that the global pandemic of Covid-19 has further propel the use of virtual technologies for educational interventions and innovations.

Conclusively, GC has become an option being pursued elsewhere and the AEC education and training in Nigeria cannot afford to remain inactive in this regard, as potentials for engaging with GC remains a sustainable educational tool for sustainable development. Thus, promoting the solving of local socio-environmental problem sustainably with a global positive impact for replications.

REFERENCES

Adler, P.A., & Adler, P. (2011). *The Tender Cut: inside the hidden world of self-injury*. New York: New York University Press.

Allu, E. L. A., & Emuze, F. A. (2017). Towards sustainable architectural education in Nigeria: challenges and potentials - A Review. *Journal of Contemporary Research in the Built Environment (JOCREBE)*, 1(2), 115-123. ISSN: 2636-446

Allu, E. L. A. (2018a). Integrating Sustainability in Universities: Perceptions from Nigeria. *Humanities and Social Sciences Review*, 08(02):149–156. ISSN: 2165-6258. www.universitypublications.net

Allu, E. L. A. (2018b). Advancing design education and industry collaboration for sustainable development in Nigeria: A Review. Association of Architectural Educators in Nigeria (AARCHES) Conference Proceedings, Zaria, 21st -24th February, 53 - 62.

Allu, E. L. A. (2019). Lean for sustainable development in South Africa: A case study of three Universities. *Integrity Journal of Education and Training*, 3(2), 22 – 29. ISSN: 2636-5995. DOI: 10.31248/IJET http://integrityresjournals.org/journal/IJET/edition/30Jun2019

Altomonte, S., Rutherford, P., & Wilson, R. (2014). Mapping the way forward: education for sustainability in architecture and urban design. *Corporate Social Responsibility and Environmental Management*, 21(3), 143-154. ISSN 1535-3966

Azeiteiro, U. M., Bacelar-Nicolau, P., & Caetano, F. J. P. (2015). Education for sustainable development through e-learning in higher education: experiences from Portugal. *Journal of Cleaner Production*, 106 (2015), 308-319.

Khandakar, A., Chowdhury, M. E. H., Gonzales Jr, A., Pedro, S., Touati, F., Emadi, N. A., & Ayari, M. A. Case study to analyze theimpact of multi-course project-based learning approach on education for sustainable development. *Sustainability*, 12(480), 1-21. doi:10.3390/su12020480 www.mdpi.com/journal/sustainability

Barkemeyer, R., Holt, D., Preuss, L., & Tsang, S. (2014). What happened to the development' in sustainable development? business guidelines two decades after brundtland. *Sustainable Development*, 22(1), 15-32. https://doi.org/10.1002/sd.521n

Di Leonardo, G., Zaccagna, G., & Crisci, R. (2017). Basic Statistics with microsoft excel: a review. *Journal of Thoracic Disease*, 9(6), 1734–1740. doi: 10.21037/jtd.2017.05.81

Holm, T., Sammalisto, K., & Vuorisalo, T. (2014). Education for sustainable development and quality assurance in universities in China and the Nordic countries: a comparative study. *J Clean Prod.* http://dx.doi.org/10.1016/j.jclepro. 2014.01.074

Global Association http://mdpglobal.org/global-mdp-program/global-classroom-overview/ (Accessed 21/2/2020)

Hüttel, H., & Gnaur, D. (2017). If PBL is the answer, then what is the problem? *Journal of Problem Based Learning in Higher Education*, 5, 1–21. https://doi.org/10.5278/ojs.jpblh e.v5i2.1491

Karatzoglou, B. (2013). An in-depth literature review of the evolving roles and contributions of universities to education for sustainable development. *Journal of Cleaner Production*. 49, 44-53.

Filho, L. W. (2011). Applied Sustainable Development: A Frankfurt (Germany): *Peter Lang Scientific Publishers*, 11–30.

Jiusto, S., McCauley, S., & Stephens, J. C. (2013). Integrating shared action learning into higher education for sustainability. *Journal of Sustainability Education*,5, 1–22.

Lock, J. (2015). Designing learning to engage students in the global classroom. *Technology Pedagogy and Education*, 24(2), DOI: 10.1080/1475939X.2014.946957

Lozano, F. J., & Lozano, R. (2014). Developing the Curriculum for a new bachelor's degree in engineering for sustainable development. *Journal of Cleaner Production*. 64, 136-146.

Ludwikowska, K. (2019). Teacher competetnce inventory: an empherical study on future-oriented competences of the teaching profession in higher education. *Education and Training*, 61(9), 1123-1137 Doi.org/10.1108/ET-12-2018-0266

Martin, J. & Samels, J. (2012). The Sustainable university: green goals and new challenges for higher education leaders. Baltimore (MD): Johns Hopkins University Press.

Matsekoleng, T. K., & Awshar, M. P. (2020). Improved attitudes towards littering through progressive action research activities in an environmental education context. Asia- Pacific *Journal of Teacher Education*, https://doi.org/10.1080/1359866X.2020.1793906 (Accessed 22/11/2020).

Muse, A. (2020). Construction *Economics is Fundamental in Responding to Coronavirus*. https://www.fig.net/fig2020/articles/FIG2020_10_Construction_Economics_and_Man agement.htm (Accessed 12/09/2020).

Noordegraaf-Eelens, L., Kloeg, J., & Noordzij, G. (2019). PBL and sustainable education: addressing the problem of isolation. *Advances in Health Sciences Education*, 24, 971– 979. https://doi.org/10.1007/s10459-019-09927-z

Oborn, P., & Walters, J. (2020). Planning for climate change and rapid urbanisation: survey of the built environment professions in the Commonwealth. file:///C:/Users/HPPAVI~1/AppData/Local/Temp/SurveyoftheBuiltEnvironmentProfe sisonsintheCommonwealthSurveyResults.pdf (Accessed 12/09/2020).

Pelech, W., & Macpherson, S. (2009). The Global Classroom: an opportunity for empowerment or exploitation? *The International Journal of Learning*, 16(8), 302-311, http://www.Learning-Journal.com, ISSN 1447-9494

Practical Tools for International Development (2020). How to choose a sample size. http://www.tools4dev.org/resources/how-to-choose-a-sample-size/ (Accessed 22/10/2020)

Rieckmann, M. (2012). Future-oriented higher education: which key competencies should be fostered through university teaching and learning? *Futures*, 44(2), 127-135.

Robert, L., Nonoyama-Tarumi, Y., McKeown, R., & Hopkins, C. (2016). Contributions of Education for Sustainable Development (ESD) to quality education: a synthesis of research. *Journal of Education for Sustainable Development*, 10(2), 226–242. www.sagepublications.com DOI:10.1177/0973408216661442

Sady, M., Zak, A., & Rzepka, K. (2019). The role of universities in sustainability-oriented competences development: insights from an empherical study on Polish Universities. *Administrative Science*, 9(62), 1-20

Sammalisto, K., Sundstrom, A., & Holm, T. (2015). Implementation of sustainability in universities as perceived by faculty and staff: a model from a swedish university. *Journal of Cleaner Production*, 106(2015), 45-54

Saxena, A. (2020). Career options after intermediate in built environment sector. http://bweducation.businessworld.in/article/Career-Options-After-Intermediate-In- Built-Environment-Sector-/22-10-2020-334356/ (Accessed 12/09/2020).

Segal, J., Mulder, K.F., & Ferrer-Balas, D. (2012). What do EESD "experts" think sustainability is? which pedagogy is suitable to learn it? results from interviews and Cmaps analysis gathered at eesd 2008. *International Journal Sustainability in Higher Educ*ation, 13(3), 293-304.

Servant-Miklos, V. F. (2018). Problem solving skills versus knowledge acquisition: the historical dispute that split problem-based learning into two camps. *Advances in Health Sciences Education.* https ://doi.org/10.1007/s1045 9-018-9835-0.

Sipos, Y., Battisti, B., & Grimm, K. (2008). Achieving transformative sustainability learning: engaging head, hands and heart. *International Journal of Sustainability in Higher Education*, 9, 68-86. doi:10.1108/14676370810842193

Teff-Seker, Y., Portman, M. E., & Kaplan-Minz, K. (2019). project-based learning in education for sustainable development: a case study of graduate planning students. *Case Studies in the Environment*, 3 (1): 1–16. doi.org/10.1525/cse.2018.001537

Tilbury, D. (2013). Another world is desirable: a global rebooting of higher education for sustainable development. In: Sterling, S., Maxey, L., Luna, H. (Eds.), *The Sustainable University, Progress and Prospects*, 71-89. Routledge studies in sustainable development, UK.

Tobal, L. (2019). Teaching sustainability. www.participatelearning.com/blog/teaching- sustainability/ (21/02/2020)

Van der Leeuw, S., Wiek, A., Harlow, J., & Buizer, J. (2012). How much time do we have? urgency and rhetoric in sustainability science, *Sustainability Science*, 7, 115-120. Doi:10.1007/s11625-011-0153-1

von Blottnitz, H, Case, J. M., & Fraser, D. M. (2015). Sustainable development at the core of undergraduate engineering curriculum reform: a new introductory course in chemical engineering, *Journal of Cleaner Production*, 106, 300-307

Wals, A. E. J. (2014). Sustainability in higher education in the context of the UN DESD: a review of learning and institutionalization processes. *Journal of Cleaner Production*. 62, 8e15.

Watson, M. K., Lozano, R., Noyes, C., & Rodgers, M., (2013). Assessing curricula contribution to sustainability more holistically: experiences from the integration of curricula assessment and students' perceptions at the georgia institute of technology. *Journal of Cleaner Production,* 61, 106-116.

Wiek, A., Bernstein, M. J., Laubichler, M., Caniglia, G., Minteer, B., & Lang, D. J. (2013). A global classroom for international sustainability education, *Creative Education*, 4(4), 19-28 www.scirp.org/journal/ce

Wiek, A., Xiong, A., Brundiers, K. & van der Leeuw, S. (2014). Integrating problem- and project-based learning into sustainability programs: a case study on the school of sustainability at Arizona State University, *International Journal of Sustainability in Higher Education*, 15(4), 431-449. https://doi.org/10.1108/IJSHE-02-2013-0013