Distance Learning Engineering Students Languish Under Project-Based Learning, But Thrive in Case Studies and Practical Workshops

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***Abstract*—The International Engineering Alliance lists 12 important graduate attributes that students must demonstrate during their higher educational career. One of these important graduate attributes is the ability to solve problems, which can be demonstrated by the use of project-based learning, case studies, and practical workshops. The purpose of this paper is to highlight student academic results of practical work done in an electrical engineering qualification that feature these three pedagogies. These three pedagogies are used in an open-distance learning environment to assess engineering students in an electrical engineering qualification involving three separate electronic communication modules. A time-lag study using a nonexperimental descriptive design is employed. Results show that the most frequent student grade for practical workshop assignments was 80%, while the most frequent student grade for case study assignments was 70%. However, the most frequent student grade for project-based learning assignments was 50%. The results show that distance learning engineering students languish under project-based learning, while they thrive in case studies and practical workshops. Possible reasons are given for this, based on the challenges faced by students engaging with these three pedagogies.**

***Index Terms*—Assessment, challenges, electronic communications, graduate attributes, open distance learning (ODL), problem solving.**

I. Introduction

"THE ONLY difference between a problem and a solution is that people understand the solution" [1]. These words by Charles Kettering, an American inventor and social philosopher, well convey the conundrum often facing academics in higher education today, namely that some students cannot competently understand or explain engineering related problems. For example, Bok [2] stated that many seniors graduate from university without the ability to reason clearly or perform competently in analyzing complex, nontechnical problems. Swart and Toolo [3] furthermore concluded, based on a study where student dissertations of an industrial project capstone module were analyzed, that not all engineering students successfully master problem-solving skills. In 2013, however, the International Engineering Alliance released a document titled "Graduate Attributes and Professional Competencies" [4] that highlighted the importance of 12 graduate attributes, including problem analysis. In fact, it is commonly accepted that engineers solve problems. Academics therefore need to seek out and implement new assessments [5] and pedagogies that can be used to help engineering students master problem-solving skills. Moreover, these pedagogies must enable students to fuse practice with theory, which for many years has been advocated as a key requirement of any engineering curriculum [6]–[8].

This fusing of practice and theory in engineering curricula is currently receiving much attention in South Africa (SA) because of a skills shortage of qualified professionals, especially engineers, technologists, and technicians [9]–[14]. One factor contributing to this skills shortage may be the current low throughput rates of engineering students in SA. Throughput rates are defined as the ratio of the number of students registering for a specific module or course, compared to the number of students successfully completing that same module or course [15]; in SA, the rate has been around 15% in recent years [16]. Thus, for every 100 students who register for a specific qualification, only 15 graduate within the recommended time. This has a negative impact on government subsidies received from SA's Department of Higher Education and Training (DHET), and subsequently on the approved budget for new equipment within the various departments in faculties or colleges [17]. These current low throughput rates are also of concern to official accreditation bodies, such as the Engineering Council of South Africa (ECSA).

ECSA is a statutory body responsible for promoting a high level of education and training of practitioners in the engineering profession [18], being responsible for the accreditation of many engineering programs in SA. ECSA visits, on a three-year cycle, all universities in SA offering engineering programs to review their theoretical content, assessments, and practical laboratories. ECSA prefers that all engineering students write a final venue-based summative examination set by their respective universities covering the theoretical content, to validate the following:

- authenticity (the person registered for the module is the person completing the module);
- sufficiency (the evidence collected must establish that all criteria have been met and that performance to the required standard can be repeated consistently);

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- criterion-referenced assessment (student work is measured against predetermined outcomes and related assessment criteria).

However, when it comes to practical instruction, ECSA approves a number of pedagogies, including project-based learning (PBL), case studies (CS), and practical workshops (PW). In engineering education, one of the responses to the societal demand for new skills has been to incorporate problem- and project-based learning [19]. PBL has the potential to assist students to acquire the necessary knowledge and skills required in industry today. In terms of CS, some researchers argue that they cannot give students exactly the same experiences as can years of real-world practice, but they can nevertheless close the gap between education and real-world needs [20] having the potential to fuse theory and practice within specific engineering fields. Finally, PW are a key environment in which students can acquire both engineering knowledge [21], patent reasoning, and critical thinking skills [22]. PW also have the potential to equip students with a key graduate attribute, namely the ability to *apply* newly acquired engineering knowledge.

The following research questions therefore arise: Which pedagogy produces the best student academic results for practical instruction at the largest open-distance learning institute in SA? What conclusion may be drawn from these results? Finally, what challenges do distance learning engineering students need to overcome in completing their practical instruction through these three pedagogies? This paper first examines the relevance of the three pedagogies and its application within the research context of this study, which focuses on the University of South Africa (UNISA). It then presents the research methodology and findings, followed by succinct conclusions.

II. Relevance of Project-Based Learning

PBL is defined as an important method used to help students acquire necessary knowledge, vital skills, and citizenship values for the 21st century; it may be demonstrated through portfolios, performance assessments, and written reports [23]. Donnelly and Fitzmaurice [23] define PBL as an "individual or group activity that goes on over a period of time, resulting in a product, presentation, or performance." PBL may bring to mind problem-based learning, where students learn content, strategies, and self-directed learning skills through collaboratively solving problems, reflecting on their own experiences, and engaging in self-directed inquiry [24]. However, problem-based learning may often occur within one module, or even within one practical experiment covered in a module over a limited period of time [25]. Hence, while there are subtle differences between PBL and problem-based learning, it may be fair to say that the one includes aspects of the other, as solving a problem does not necessarily include executing a project in the formal sense [26]. PBL is, in various aspects, a very superior educational methodology compared to other traditional ones [27], leading to an enhanced learning experience [28] as it makes the delivery of both technical content and generic professional skills in a specialized course possible [29]. However, in a distance learning environment, a problem arises in that there is limited opportunity for peer evaluation or cooperative learning [30].

III. Relevance of Case Studies

CS are evocative narrative descriptions of a specific, real-world activity, event, or problem. Their use is well established in professional education (e.g., law, business, and medicine) and is rapidly expanding in many other disciplines [31]. According to Yin [32], CS provide a systematic way of looking at events, collecting data, analyzing information, and reporting the results within a number of different categories, such as exploratory, descriptive, and explanatory CS. CS are teaching strategies that promote critical thinking [33] and have the potential to reveal rich contextual findings of a personal, social, and pedagogical nature that cannot easily be obtained by other methods [34]. CS are appropriate when "how" and "why" types of questions guide the central research inquiry [35] and are useful when there is an opportunity to investigate a phenomenon within its real-life context [36], especially when studying situations that are hard to control [37]. CS are used in teaching to illustrate particular situations and provide a framework for discussion among students [38]. Teaching cases do not necessarily include a complete or accurate description of actual events, as their details and materials may be changed to better illustrate a specific point. The criteria for developing high-quality teaching cases are very different from those for producing high-quality case study research.

IV. Relevance of Practical Workshops

PW have been used in postgraduate forensic radiography programs to prepare students for real-world scenarios [39]. However, challenges do exist in that some students fail to attend these practical-based sessions. Teaching degree programs have also featured intensive PW [40], where the use of interactive resources provided opportunities for students to revise and develop their procedural, or practical, knowledge at their own pace by using technology with which they are familiar. Kahan [41] discussed the importance of PW within the medical field in providing positive experiences for practitioners who want to transfer to newer technologies. Students' employment prospects are considerably enhanced by their having practical, "hands-on" knowledge [42], often acquired in PW. These PW significantly enhance student learning and provide a measure of practical experience required by many employers, as well as affording students the opportunity to attain skills in patent reasoning and critical thinking [22]. Further goals of PW include the transfer of theoretical and technological knowledge, the effective teaching of practical skills [43], the reinforcement of acquired theoretical knowledge through practical application [44], and the use of cooperative learning [25].

V. Research Context and Pedagogy Application

UNISA is the largest open-distance learning institute on the African continent, providing distance education to almost 400 000 nonresidential students [45]. UNISA offers a National Diploma (N.D.) and a Baccalaureus Technologiae (B.Tech.) in Electrical Engineering (EE) and is therefore mandated by the ECSA to provide quality engineering education programs that adhere to the high standards set forth in the Washington, Sydney, and Dublin Accords [46]. These Accords list a number of graduate attribute profiles that engineering students must

TABLE I
STRUCTURE OF MODULES IN THE B.TECH: ENGINEERING: ELECTRICAL QUALIFICATION

Institution	University of South Africa		
Registration deadline	End of March		
Course material posted	Middle April		
Theory part	10 credits awarded	Important dates	Weighting
Formative assessments	1 x Multiple choice assignment	20 May	2 %
	First written assignment	30 June	9 %
	Second written assignment	30 July	9 %
Summative assessment	1 x Venue-based written examination	October / November	80 %
Practical part	2 credits awarded	Important dates	Weighting
Various pedagogies	Written assignment and electronic project	30 August	100%
	Written assignment on a case study	30 August	100%
	Practical workshop on one day	30 September	100%

meet to be considered as professional engineers, technologists, and technicians; these include investigation, problem analysis, and application of knowledge [47]–[49]. Students may demonstrate these graduate attributes by fusing their newly acquired theoretical knowledge with relevant practical work.

At the start of the calendar year, engineering students register for a variety of modules offered within the B.Tech. qualification. Each module has two parts covering the theoretical content and practical work (see Table I). Engineering students need to obtain more than 50% for each part to be credited for the entire module, which takes approximately 9 months to complete. The delivery of the theoretical part is generic for all the modules, while the practical part draws on various pedagogical approaches according to what is considered most suited to the curriculum. These various pedagogical approaches further contribute to the one compulsory B.Tech. module in this qualification, Industrial Projects 4, a capstone module requiring students to draw on all their previous educational experiences to complete a mini-dissertation in preparation for further post-graduate studies.

PBL is used in the module Radio Engineering 4 (RAE4), structured as in Table I; the theoretical part involves both formative and summative assessments with numerous theoretical examples being posted on UNISA's learning management system [17]. However, the practical part requires a written assignment and an electronic project based on the design of various radio frequency (RF) circuits. Furthermore, engineering students are required to design an RF antenna to achieve a specific antenna gain required for a given meteor-based communication system. The various parameters of the antenna must be evaluated by means of simulation, but students are not required to physically build the antenna. However, registered students need to design and build three fully operational RF generation circuits. These electronic circuits (LC oscillator, crystal oscillator, and brute-force synthesizer) must be based on theoretical design principles and verified by simulation. The design principles, calculations, and simulation results must be detailed in a written assignment that must be submitted, with the circuits, via postal services to UNISA. Students are held accountable for any rough handling or transportation issues. The electronic circuits must work, as an academic will test it with an oscilloscope. Nonoperational circuits automatically result in student failure, necessitating re-registration in the following calendar year. These electronic projects are the result of hard work (design, construction, and fault finding) by engineering students over a period of time; this being defined as PBL.

CS are used in the module Satellite Communication 4 (SCM4), structured as in Table I; the theoretical part involves both formative and summative assessments involving open-book examinations [50]. However, the practical part requires a written assignment based on a CS involving the OSCAR-13 satellite. Although OSCAR-13 is redundant and no longer in service, its principles of operation remain relevant, especially the telemetry data used to assess students' ability in data decoding and interpretation. Students cannot be required to manipulate or control actual satellite systems, but they can use CS to answer questions of "how" and "why" a specific design, component, or orbit was chosen for a given satellite. In this module, students are asked to calculate the percentage difference in Doppler shift for perigee and apogee heights, interpret and analyze a given table of telemetry data, evaluate the operation of the satellite for a given table of current and temperature values, evaluate why the design team chose this specific photovoltaic (PV) module layout, and sketch the orientation of the satellite with regard to the sun based on a given set of data.

PW are used in the module Electronics 4 (ECT4), which again has the same structure shown in Table I, with the theoretical part having both formative and summative assessments. However, the practical part requires registered students to attend a one-day PW at a contracted residential university. These PW, scheduled on a Saturday between May and August of each calendar year, are limited to 20 students per workshop, with the total number of workshops usually depending on the number of registered students. All final student grades are due by September 30. The module focuses primarily on renewable energy in the form of PV systems. Students are exposed to the orientation and operation of the PV modules, calculation of specific PV system parameters, and the limitations of PV systems. The number of student registrations are usually higher than for the previous two modules [17], thereby necessitating the use of cooperative learning in the PW.

VI. RESEARCH METHODOLOGY USED IN THIS RESEARCH

The research on which this paper is based incorporates a time-lag study using a nonexperimental descriptive design.

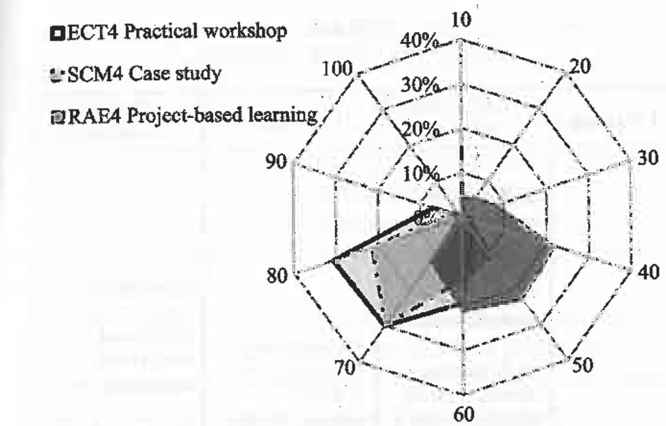

Fig. 1. Radial chart of the normalized data for student grade distributions.

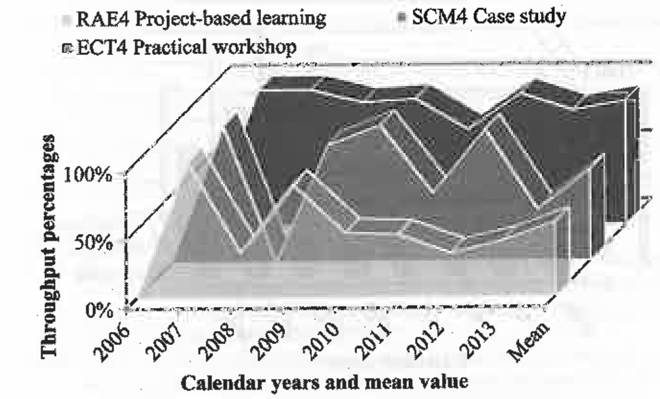

Fig. 2. Calendar year results of the throughput rate with the final mean values.

Descriptive research occurs where a specific situation is studied to see if it gives rise to any general theories, and a time-lag study determines the impact of a particular event on a group of students over a specific period of time [51]. The period of interest is from 2007 to 2013, with the results of all registered students ($n = 680$) being considered, therefore obviating the need to use a sampling technique. During this period, the principal researcher was the official external examiner for RAE4 and SCM4, and a colleague was the official external examiner for ECT4; this provided consistency in marking of the practical assignments, thus ensuring a degree of validity and reliability for the students' results during the research period. Student registration and completion numbers (number of students achieving 50% or more for the practical part of the modules) are contrasted for each calendar year. All student grades for this period are analyzed using a histogram analysis, with the results being presented as normalized data in a radial chart.

VII. FINDINGS AND INTERPRETATIONS

Fig. 1 presents a radial chart showing normalized data of student grade distributions for ECT4, SCM4, and RAE4. This radial chart is obtained by first obtaining histogram data of all student grades for the entire 7-year period for specific bin values (10–100 in 10-point intervals). To construct a histogram, the data space is partitioned into many small ranges, with each range corresponding to a bin [52]. The height of a bin is determined by the percentage of data points that fall within the corresponding range. These histograms prove difficult to compare in their present state, as each module has a different number of registered students. This is overcome by dividing each bin value by the total number of registered students to obtain normalized values. The radial chart shows the number of students as a percentage from 0% to 40% (inner circles) who obtained specific grades (values outside the final circle from 10 to 100).

An effective comparison can now be made between the academic achievements of registered students, in terms of the frequency of student grades, for these three modules with their different pedagogical approaches. This comparison shows that the most frequent student grade for ECT4 was 80% (30% of the students achieved this grade in the PW), while the most frequent student grade for SCM4 was 70% (30% of the students achieved this grade for the CS assignment). However, the most frequent student grade for RAE4 was 50% (22% of students achieved this grade for the PBL assignment). This comparison also shows that the second most frequent student grade is around 40% for RAE4, thereby indicating that students are languishing under PBL. The second most frequent student grade for ECT4 is around 70%, while that for SCM4 is around 80%. This suggests that students are more adept at completing practical work involving PW or CS. A comparison of the throughput rate between the three modules is shown in Fig. 2.

Fig. 2 highlights that ECT4 has the highest throughput rate of the three modules (mean value of 91% shown on the right-hand side of the graph). This indicates that distance learning engineering students do very well in the PW, which may be attributed to cooperative learning and face-to-face academic facilitation. SCM4 (using CS) enjoys the next highest throughput rate (67% mean value), while RAE4 (using PBL) has the lowest throughput rate (mean value of 55%). This comparison again highlights that distance learning students are thriving in the modules using CS and PW, while those in the module using PBL are languishing. It must be reiterated that the same students who are exposed to PBL are exposed to CS and to PW, as these modules all form part of the electronic communication field within this B.Tech. qualification.

Individual calendar year student registrations for the practical part of each module, and the number of students who successfully completed the practical work, are shown in Figs. 3–5. These figures highlight that the number of registered students has grown steadily over the 7-year period, with ECT4 having the largest contingent of students. Students registering for SCM4 will also register for RAE4 and for ECT4. The same students are therefore exposed to CS in SCM4, to PBL in RAE4, and to PW in ECT4. What is further evident from these figures is that the number of registered students never equals the number of students attending the PW or submitting the written assignments; this is because many of these students are employed full-time and often experience an increased workload as the year progresses. As their workload increases, their academic studies often tend to be neglected or sidelined.

Students encounter a number of challenges in completing their practical assignments involving the three pedagogies. These challenges, identified by the principal researcher who

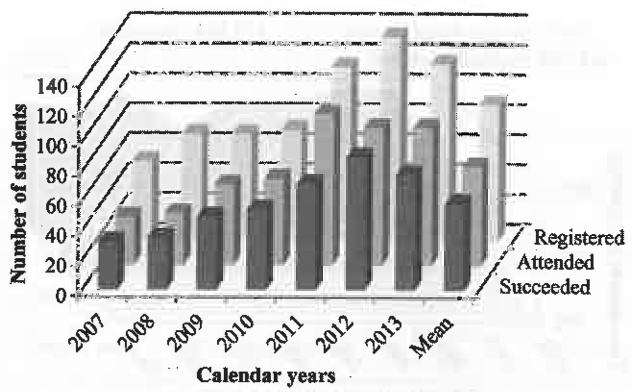

Fig. 3. Calendar year results for ECT4 using practical workshops.

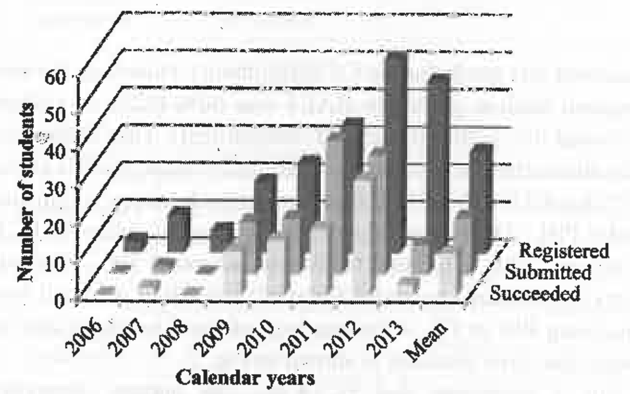

Fig. 4. Calendar year results for SCM4 using case studies.

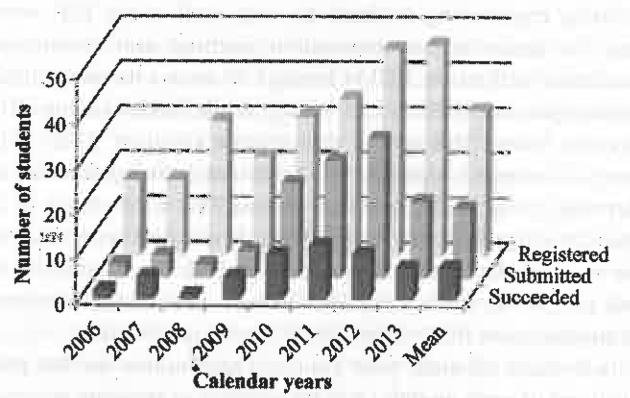

Fig. 5. Calendar year results for RAE4 using project-based learning.

worked closely with many of the registered students during the 7-year period, are summarized in Table II, along with possible reasons for students' success.

One of the key challenges in PBL is obtaining the electronic components required for the circuit, due to the fact that some of the students reside in rural areas. Some who manage to source the components struggle to produce a working electronic circuit, while others simply package the circuit in an envelope with no protective material, not realizing that rough handling by the postal services can render the electronic circuit inoperable. Students who are more likely to succeed with PBL live near established electronic suppliers or work for research and development companies.

TABLE II
CHALLENGES FACED BY STUDENTS

Pedagogy	Project-based learning	Case studies	Practical workshops
Challenges	Difficulty in sourcing electronic components in rural environments Skill shortage among students in constructing a working electronic circuit Postal service delays and lost packages Inadequate packaging and protection for the electronic circuit in transit	Downloading the simulation software required for the assignment due to limited Internet connectivity	Significant travel to the contracted residential university Overcrowded facilities if students attend workshops to which they had not been assigned
Reasons for success	Being located near established electronic suppliers Working in a research and development environment	All material supplied except for the simulation software Internet availability to obtain more data relevant to the case study	Cooperative learning between peers Academic face-face support All materials or equipment supplied

A key challenge faced by students with regard to PW is traveling to the contracted residential university where the laboratories are located. However, once they reach the laboratories, they enjoy cooperative learning in terms of peer support and face-to-face contact with the academic facilitating the workshop.

With regard to CS, some students struggle to download the required simulation software due to limited Internet connectivity in their rural areas. Once past that barrier, however, they have all the necessary material in terms of data and information and just need to analyze and interpret it, and draw conclusions, to successfully complete the practical work.

VIII. CONCLUSION

This paper has highlighted student academic results of practical work done in an electrical engineering qualification that includes three pedagogical approaches: PBL, CS, and PW. Results indicate that ECT4 (using PW) has the highest throughput rate (mean value of 91% of students successfully completing the practical work), SCM4 (using CS) has the second highest throughput rate (mean value of 67%), while RAE4 (using PBL) has the lowest throughput rate (mean value of 55%).

Key challenges to completing the PBL assignment include sourcing the components, constructing a working circuit, and packaging the circuit correctly for postal delivery. A key challenge to attending the PW is traveling to the contracted residential university, while some students experience difficulties in downloading the required simulation software for the CS. Including all required components and simulation software in the course package sent to distance learning student may overcome these specific challenges.

A very important graduate attribute for qualified professionals in engineering is the ability to solve problems, which can be developed by the use of PBL, CS, and PW. Many distance learning students in engineering are demonstrating this ability. However, the ability to solve problems with specific reference to designing and constructing a working electronic circuit to address a particular need or problem remains a large challenge which academics need to address. Engineering students need to be assisted in not only understanding the solution, but also in understanding and formulating the problem.

REFERENCES

[1] "Brainy Quote," Jan. 9, 2015 [Online]. Available: http://www.brainyquote.com/quotes/
[2] D. Bok, *Our Underachieving Colleges*. Princeton, NJ, USA: Princeton Univ. Press, 2006.
[3] A. J. Swart and L. E. Toolo, "Fundamental problem-solving skills are found across the board in education: Are our power engineering students on-board?," presented at the ICEE, Zagreb, Croatia, 2015.
[4] International Engineering Alliance, "Graduate attributes and professional competencies," Dec. 12, 2014 [Online]. Available: http://www.ieagreements.org/GradProfiles.cfm
[5] A. J. Swart, "Evaluation of final examination papers in engineering: A case study using Bloom's taxonomy," *IEEE Trans. Educ.*, vol. 53, no. 2, pp. 257–264, May 2010.
[6] A. J. Swart, "Does it matter which comes first in a curriculum for engineering students—Theory or practice?," *Int. J. Elect. Eng. Educ.*, vol. 47, pp. 189–199, 2010.
[7] A. J. Swart, "Theory versus practical in a curriculum for engineering students—A case study," presented at the AFRICON, Nairobi, Kenya, 2009.
[8] L. Hunt *et al.*, "Assessing practical laboratory skills in undergraduate molecular biology courses," *Assess. Eval. Higher Educ.*, vol. 37, no. 7, pp. 861–874, 2012.
[9] J. Erasmus and M. Breier, *Skills Shortages in South Africa—Case Studies of Key Professions*. Pretoria, South Africa: HSRC Press, 2009.
[10] R. du Toit and J. Roodt, *Engineering Professionals: Crucial Key to Development in South Africa*. Pretoria, South Africa: HSRC Press, 2008, pp. 82–83, Department of Labour for the Sector Skills Research Project.
[11] Creamer Media Reporter, "Education and skills development remains areas of concern for engineers," Engineering News, 2012.
[12] ECSA, "The engineering skills pipeline," 2010 [Online]. Available: https://www.ecsa.co.za/default.aspx
[13] ECSA, "Submission to the Department of Higher Education and Training on the green paper on post-school education and training," 2012 [Online]. Available: https://www.ecsa.co.za/default.aspx
[14] S. Goga and C. van der Westhuizen, *Scarce Skills Information Dissemination: A Study of the SETAs in South Africa*. Pretoria, South Africa: HSRC Press, 2012, pp. 26–27, Department of Labour.
[15] A. J. Swart and T. Sutherland, "Co-operative learning versus self-directed learning in engineering: Student preferences and implications," presented at the IEEE FIE, Spain, Madrid, 2014.
[16] J. F. Strydom *et al.*, "Enhancing success in higher education by measuring student engagement in South Africa," *Acta Academica*, vol. 42, pp. 1–13, 2010.
[17] A. J. Swart, "Student usage of a learning management system at an open distance learning institute—A case study in electrical engineering," *Int. J. Elect. Eng. Educ.*, vol. 0, pp. 1–13, 2015.
[18] ECSA, "ECSA," Aug. 14, 2014 [Online]. Available: http://www.ecsa.co.za/
[19] A. Kolmos, "Problem-based and project-based learning," in *University Science and Mathematics Education in Transition*, O. Skovsmose, et al., Ed. New York, NY, USA: Springer, 2009, pp. 261–280.
[20] H. Jiang *et al.*, "Four requirements for digital case study libraries," *Educ. Inf. Technol.*, vol. 15, pp. 219–236, 2010.
[21] A. Peteris *et al.*, "Remote workshop for practical knowledge improvement in electrical engineering education: Computer control of electrical technology," in *Proc. 15th ICL*, 2012, pp. 1–4.
[22] A. J. Swart, Durban University of Technology, "Practical workshops arranged at a contracted residential university by an open distance learning institute: Evaluating the quality of teaching," presented at the ICEIM, Durban, South Africa, 2014.
[23] İ. Ilter, "A study on the efficacy of project-based learning approach on social studies education: Conceptual achievement and academic motivation," *Educ. Res. Rev.*, vol. 9, pp. 487–497, 2014.
[24] C. E. Hmelo-Silver *et al.*, "Scaffolding and achievement in problem-based and inquiry learning: A response to Kirschner, Sweller, Clark (2006)," *Educ. Psychol.*, vol. 42, pp. 99–107, 2007.
[25] A. J. Swart, "Using problem-based learning to stimulate entrepreneurial awareness among senior African undergraduate students," *Eurasia J. Math., Sci. Technol. Educ.*, vol. 10, pp. 125–134, 2014.
[26] A. Jowitt, "Issues in making the transition from traditional teaching to project based learning," in *Proc. 20th Annu. Conf. Australasian Assoc. Eng. Educ.*, Dec. 6–9, 2009, p. 417.
[27] F. Martinez *et al.*, "Project-based learning and rubrics in the teaching of power supplies and photovoltaic electricity," *IEEE Trans. Educ.*, vol. 54, no. 1, pp. 87–96, Feb. 2011.
[28] D. J. Cappelleri and N. Vitoroulis, "The robotic decathlon: Project-based learning labs and curriculum design for an introductory robotics course," *IEEE Trans. Educ.*, vol. 56, no. 1, pp. 73–81, Feb. 2013.
[29] N. Hosseinzadeh and M. R. Hesamzadeh, "Application of project-based learning (PBL) to the teaching of electrical power systems engineering," *IEEE Trans. Educ.*, vol. 55, no. 4, pp. 495–501, Nov. 2012.
[30] M.-L. Dahms, "Problem-based learning methodology," presented at the Seminar at the Central University of Technology, 2014.
[31] J. M. Carroll and M. B. Rosson, "Case studies as minimalist information," *IEEE Trans. Professional Commun.*, vol. 49, no. 4, pp. 297–310, Dec. 2006.
[32] R. K. Yin, *Case study Research—Design and Methods*. Thousand Oaks, CA, USA: SAGE, 2009.
[33] I. Popil, "Promotion of critical thinking by using case studies as teaching method," *Nurse Educ. Today*, vol. 31, pp. 204–207, 2011.
[34] J. Miller, "Case study in second language teaching," *Queensland J. Educ. Res.*, vol. 13, pp. 33–53, 1997.
[35] M. Alagaraja, "Mobilizing organizational alignment through strategic human resource development," *Human Resource Dev. Int.*, vol. 16, pp. 74–93, 2013.
[36] I. Oandasan *et al.*, "Exploring and understanding academic leadership in family medicine," *Can. Family Physician*, vol. 59, pp. e162–e167, 2013.
[37] K. Lööf, "Strategy for automation and layout change in production systems," Master thesis in production, Royal Institute of Technology, Stockholm, Sweden, 2010.
[38] R. K. Yin, *Case Study Research: Design and Methods*, 2nd ed. London, U.K.: Sage, 1994.
[39] J. Vallis, "Court on the web: Courtroom simulation in distance learning," *J. Forensic Radiol. Imag.*, vol. 1, p. 86, 2013.
[40] D. Ellis, "Procedural skills and sketch-up: An example of how drawing skills can be taught over a distance," *Inst. Ind. Arts Technol. Educ.*, vol. 2, pp. 1–6, 2012.
[41] R. S. Kahan, "Summary of: A survey of adoption of endodontic nickel-titanium rotary instrumentation part 1: General dental practitioners in Wales," *Brit. Dental J.*, vol. 214, p. 114, 2013.
[42] Y. Gulatee *et al.*, "Providing remote hands on network curriculum," in *Proc. Sci., Math. Technol. Educ.: Beyond Cultural Boundaries*, Thailand, 2008, p. 168.
[43] M. Kwiatkowska and L. Matthews, "Analysis of informational and technological requirements for the respiratory therapy workshops in Peru," in *Proc. IEEE GHTC*, 2014, pp. 675–681.
[44] J. Recker and M. Rosemann, "Teaching business process modelling: Experiences and recommendations," *Commun. Assoc. Inf. Syst.*, vol. 25, p. 32, 2009.
[45] University of South Africa, "University of South Africa," Mar. 11, 2013 [Online]. Available: http://www.unisa.ac.za/default.html