# Reflecting on the balance between theory and practical grades of engineering students – A case study

James Swart, Lienie Olwagen, Cameron Greyling, Nicolaas Luwes
Faculty of Engineering and Information Technology
Central University of Technology
Park Road, Willow
Free State
Tel: +27 51 507 3907
Email: aswart@cut.ac.za

***Abstract*— Universities of Technology must enable students to acquire the necessary knowledge (theory), workplace skills (practice), and graduate attributes (theory and practice) needed to meet the needs of industry, business and community. Reflective practice may involve the thoughtful consideration of an academics own experiences in enhancing the fusion of theory and practice in an engineering curriculum. This fusion is currently an important criterion for Universities of Technology who may face increased pressure to improve their throughput rates. This paper aims to answer the following research question: "What balance currently exists between the practical and theoretical success of undergraduate students in a number of different engineering disciplines at a University of Technology"? Reflecting on the current balance that exists and its implications may assist academics in changing their pedagogy to include more effective ways of fusing theory and practice. A post-facto study is employed along with descriptive statistics involving quantitative analysis of the collected data. Results do indicate that undergraduate engineering students are more adept at completing the practical assessments scheduled in a laboratory, suggesting that more time on practice should be scheduled along with practical experiments that promote critical thinking and problem solving skills.**

***Keywords*— laboratory; classroom; attributes; fusing**

## I. Introduction

"The primary mission of a University of Technology (UoT) is to give students the workplace skills and knowledge to meet the needs of industry, business and community" [1]. Workplace skills and knowledge require that students acquire both practice and theory during their academic career at a UoT. Students therefore need to be exposed to both practice and theory in an engineering curriculum, especially if they are to develop the right graduate attributes such as problem solving, investigation skills and engineering professionalism [2-4]. Universities, such as the Central University of Technology (CUT), have furthermore implemented policies that are aimed at developing specific graduate attributes among their students, attributes such as sustainability, innovation, communication and entrepreneurship [5].

These attributes are important to many authoritative organizations, such as the Engineering Council of South Africa (ECSA) who is very much concerned with what a person knows and with what that person can do [6]. ECSA needs to ensure that South Africa (SA) has an appropriate supply of competent engineering personnel, with the appropriate levels of education, training and experience, for the right application, at the right time [7]. Again, the words education, training and experience conjure up the idea of fusing and balancing practical and theoretical instruction.

Fusing practice and theory in any engineering curriculum has been advocated for many years [6, 8] while reflective practice may involve the thoughtful consideration of one's own experiences in applying theory to practice [9]. Reflective practice has also been used by expert teachers who continually reflect on how they might teach even better [10]. Dewey [11] further argues that reflective activity should include some form of testing and that reflective thinking includes suspending any judgments until we have carried out some sort of systematic enquiry.

Reflective practice is currently especially important to a UoT who faces increased pressure to improve its throughput rates. The Council on Higher Education [12] in SA published a VitalStats document in 2013 in which they listed the student enrolments (141 108 in 2006 and 152 212 in 2011) versus student graduations (27 071 for 2006 and 32 244 for 2011) for UoTs. These statistics highlight an average low throughput rate of only 20% within regulation time; being 3 years in the case of a 360 credit National Diploma (regulation time is viewed as the acceptable time period in which to complete the qualification). The practical and theoretical success of engineering students contributes to this current throughput rate.

Previous research indicates that engineering students really enjoy their practical work scheduled in a laboratory, with their practical grades often outweighing their theoretical grades [6, 13, 14]. However, this was reported on only for students in an electronic communications course at a UoT, with little results published for students in other engineering disciplines. The research question therefore arises: What balance currently exists



978-1-5386-2774-7/17/$31.00 ©2017 IEEE

between the practical and theoretical success of undergraduate students in a number of different engineering disciplines at a UoT? This research question is appropriate as many seniors graduate from university without the ability to reason clearly or perform competently in analysing complex, nontechnical problems [15]. Reflecting on the current balance that exists may assist academics in changing their pedagogy to include more effective ways of fusing practice and theory in their engineering curriculums. This, in turn, has the potential to give rise to higher throughput rates for universities and improved graduate attributes for industry.

The purpose of this paper is to highlight the current balance which exists, and its implications, between the practical and theoretical success of undergraduate students in a number of different engineering disciplines. These disciplines include construction technology, electrical, electronic and computer engineering and mechanical engineering. The importance of fusing and balancing practice and theory in engineering curriculums is firstly presented along with the case study from CUT. The research methodology involving a post-facto study is then introduced with the results presented in a number of figures and tables. Succinct conclusions follow.

## II. The Importance of Fusing and Balancing Practice and Theory

The importance of fusing and balancing practice and theory may be discerned when considering Table 1, which is adapted from Swart [16]. Bloom's taxonomy describes different categories of learning, which are often used to distinguish lower and higher levels of understanding [17]. Knowledge is considered the lowest level of learning as it focuses on the recall of information while evaluation is considered the highest level of learning as it requires a person to judge the worth or quality of a given system or process. Engineering students engage in the lowest level of learning when they acquire theoretical instruction and then engage in the higher level of learning when called on to apply or evaluate their newly acquired theoretical knowledge in new practical situations.

Gagné [18] devised an alternative framework for developing performance objectives which include cognitive strategies and intellectual skills. Cognitive strategies facilitate learning and remembering while intellectual skills require decision-making and problem-solving with the application of existing knowledge.

Piaget's cognitive-development theory is based on the assumption that knowledge is an interaction between the learner and the environment [19]. Assimilation and accommodation must exit together in balance in order to ensure operative intelligence which may be achieved by providing opportunities for laboratory experimentation with physical objects.

Marton and Säljö [20] were among the first researchers to suggest the constructs of deep and surface approaches to learning. Surface learning is characterized by students who try to memorize individual details from a lecture or text while deep learning is characterized by students who attempt to relate ideas together and who construct their own meaning [21]. Critical thinking is linked to deep learning [22]. Surface learning arises when students simply recite facts straight from a textbook while deep learning emerges when students put these facts into practice, using them actively to solve a given problem [16] by employing a number of skills, including critical thinking.

The four levels proposed by Haring et al. [23] in their hierarchy of learning include acquisition, fluency, generalization and finally adaptation. The acquisition level emphasizes accuracy of information while the adaptation level emphasizes the need for students to modify or adapt any theoretical knowledge to new practical environments.

TABLE 1: FUSING AND BALANCING PRACTICE WITH THEORY

| Educationalist | Basic theory acquisition | Advanced practice |
|---|---|---|
| Bloom (1954) | Knowledge and Comprehension | Synthesis and Evaluation |
| Gagné (1962) | Cognitive strategies | Intellectual skills |
| Piaget (1972) | Assimilation | Accommodation |
| Marton and Säljö (1976) | Surface approach to learning | Deep approach to learning |
| Haring et al. (1978) | Acquisition and Fluency | Generalization and Adaptation |
| Biggs and Collis (1982) | Unistructural and Multistructural (Quantitative stage) | Relational and Extended abstract (Qualitative stage) |
| Kolb (1984) | Abstract conceptualisation | Active experimentation |

The SOLO (Structure of the Observed Learning Outcomes) taxonomy provides a systematic way of describing how a student's performance grows in complexity when mastering many academic tasks [24, 25]. Five levels of learning are stipulated where levels two and three (Unistructural and Multistructural, termed the quantitative stage) require students to demonstrate an understanding of knowledge (theory assimilation) while the fourth and fifth levels (Relational and Extended abstract, termed the qualitative stage) call on students to orchestrate action (practical involvement). Biggs [24] further states that the quantitative stages of learning occur first, after which learning changes qualitatively. This implies that students must first obtain a sufficient base of theoretical knowledge before they can start to apply it in a practical environment. Garside [26] further reports that critical thinking is dependent on a sufficient base of knowledge. This implies balancing practice with theory as students obtain more theory, they must subsequently engage more in practice where they can develop their critical thinking skills.

Kolb [27] distinguishes between four stages in a learning cycle that he calls "experiential learning". A "converger" is the term given to learners who combine the learning steps of abstract conceptualisation and active experimentation. A learner with this style is best at finalising practical projects based on fundamental theories. The importance of fusing practice and theory in any engineering curriculum may further be derived from the views of authoritative organizations listed in Table 2.

One of the main objectives of SADC (refer to Table 2 for the full name) is to enhance the standard and quality of life of the peoples of Southern Africa, and support the socially disadvantaged through regional integration, built on democratic principles and equitable and sustainable development [28]. This impresses upon the mind the need for lifelong learning while sustainable development relates to applying theory in practice for the socio-economic benefit of our communities. Practice and knowledge theory must therefore continue to be intertwined through the educational career of professional technologists and technicians.

TABLE 2: STATEMENTS NECESSITATING THE FUSION OF PRACTICE AND THEORY

| Organisation | Acronym | Objectives / statements / values |
|---|---|---|
| The South African Development Community | SADC | The objective states in part that the standard and quality of life of the peoples of Southern Africa must be enhanced, built on democratic principles and equitable and sustainable development |
| The Engineering Council of South Africa | ECSA | The vision statement states in part that a strong, competent, growing, sustainable and representative Engineering profession must be provided to be able to provide all the expertise necessary for the socio-economic needs of the country |
| South African Council for the Quantity Surveying Profession | SACQSP | One of the core values is innovation which is described as the development and maintenance of best practice |
| South African Council for the Project and Construction Management Profession | SACPCMP | Mission statement states in part that an environment must be created that will encourage and facilitate world class education and training |

ECSA's vision is to ensure that SA enjoys all the benefits of a strong, competent, growing, sustainable and representative Engineering profession; able to provide all the expertise necessary for the socio-economic needs of the country, and to exert a positive influence in SA [7]. ECSA is therefore concerned about the knowledge and expertise which students attain for the benefit of their communities. Synonyms for the word expertise may include know-how, skill and capability which all point to practice which must be used to reinforce theory in any engineering curriculum.

One of the core values of SACQSP (refer to Table 2 for the full name) is innovation, described as the development and maintenance of best practice, adapting to and initiating change and being leaders in the field in updating to technology changes [29]. Best practice must be developed among engineering students based on the acquisition of new knowledge, and must therefore be fused together in an engineering curriculum.

Finally, the mission statement of SACPCMP (refer to Table 2 for the full name) states in part that an environment must be created that will encourage and facilitate access for all who are prepared to gain the necessary skills, ensuring world class education and training [30]. Another synonym for education is teaching, teaching theory to engineering students. However, a synonym for training is exercise, exercising the theory in practice to the benefit of the community. Practice and theory must go hand in hand if engineering students are to be educated and trained in their preferred professions!

A curriculum consists of the knowledge and skills in specific subject areas that are taught by academia and learned by students [31]. Articles have highlighted that electrical engineering study programmes should be designed to provide students with basic theoretical knowledge and practical skills [32, 33]. The engineering curriculum must therefore allow students to experience being an engineer, by introducing pedagogies, such as problem-based learning, project-based learning, inquiry-based learning and work-based learning, where practice and theory can be linked to ensure the development of competent technologists and technicians. Practical and theoretical instruction (skills and knowledge respectively) must therefore be fused together and balanced in a curriculum for engineering students.

However, academia should first reflect on the background and prior learning experiences of their undergraduate engineering students before attempting to design or update a curriculum that will fuse and balance practice and theory effectively. Moreover, reflecting on the current balance which exits between the practical and theoretical success of engineering students has the potential of helping academia to reflect on what they should include in the curriculum and how they may improve their teaching skills. This reflection on teaching is encouraged by Biggs and Tang [10] and by Dewey [11] who further encourages that some form of testing or inquiry be done before judgments or recommendations for change are made.

## III. Case Study – The Central University of Technology

Table 3 presents the breakdown of the different modules used in this research, which covers 4 distinct departments or disciplines within the Faculty of Engineering and Information Technology (FEIT) at CUT.

TABLE 3: DEPARTMENTS WITHIN THE FEIT AT CUT

| Module | Department | Qualification | Authoritative organizations |
|---|---|---|---|
| Construction Technology I | Built Environment (KTG10AI) | ND: Building | SACQSP SACPCMP |
| Logic Design III | Electrical, Electronic and Computer Engineering (LOG32BI) | ND: Engineering: Electrical | ECSA |
| Applied Strength of Materials III | Mechanical Engineering (MSK31AI) (MSK32AI) | ND: Engineering: Mechanical | ECSA |

Construction Technology 1 (KTG1) is a compulsory offering or module for the National Diploma: Building, comprising approximately 19 subjects in total. This module is offered over a year period (approximately 22 weeks in duration) within the diploma course. The aim of this module is to give a good theoretical background to what is essentially a practical module that will enable students to tackle specific real-life building construction problems with confidence by the time the course of study has reached an advanced level. Another aspect of this module is to give students a sufficient knowledge base, covering the field of construction activities, thereby enabling the graduate student to initiate and maintain discussions with other field specialists. The assessment of theory is achieved by using 8 class tests (100% of knowledge recall and understanding), 4 main tests (100% of knowledge recall and understanding) and 2 semester examinations (approximately 70% of knowledge and understanding and 30% of scaled drawings). Each of the class tests covers approximately 10% of the syllabus with the main tests covering approximately 20%. There are 8 practical assignments included in the curriculum and 22 practical based drawing assignments. These practical assignments assist students in bridging the gap between the theoretical and practical instruction so that they may be able to solve real-life problems in the construction environment. KTG1 encourages effective group work in order to mitigate the large class sizes (approximately 90-120 students annually).

Logic Design III (LOG3) is a voluntary offering or module for the National Diploma: Engineering: Electrical qualification, but compulsory for students who are enrolled for computer systems. The qualification comprises approximately 22 modules in total with between 80 and 120 student registration per semester (±50% of these students are from electronic engineering, ±30% from power engineering and ±20% from computer engineering). This module is usually offered during the final semester (approximately 14 weeks in duration) of the diploma course and builds on previously acquired knowledge of digital systems. This module is specifically designed to aid students to understand the process of design and evaluation of complex digital systems, with particular emphasis on the implementation of these systems in field-programmable gate arrays. The assessment of the theory is done using a classroom written test, one main test and one main examination. The first test covers approximately 20% of the syllabus with the main test covering 60%. The main examination features many calculations (±50% of the exam), with design (±40%) and explain (±10%) questions completing the paper. Seven practical assignments are included in the curriculum to help students to bridge the gap between theoretical and practical instruction, of which three are assessed formatively while four serve as summative tutorials. A tutorial is usually scheduled before an assignment and serves to give the student the skillset and confidence to complete the larger assignment. The curriculum for LOG3 includes two practical tests, where one is assessed on an individual basis while the other involves a group assessment.

Applied Strength of Materials 3 (MSK3) is a compulsory offering or module for the National Diploma: Engineering: Mechanical qualification, comprising approximately 24 modules in total. This module is usually offered during the final semester (approximately 14 weeks in duration) of the diploma course and builds on previously acquired knowledge in the field of strength of materials. The purpose of the module is to provide students with a general background of beam theory and to calculate and understand principle stresses and strains in engineering materials. The assessment of the theory is done using a classroom written test, (25% of the semester mark), one main test (40% of the semester mark) and one main examination (60% of the final mark). The class test covers approximately 20% of the syllabus, while the main test covers 75% of the syllabus with the main examination covering 100%. The main examination features approximately 40% of applied knowledge, 30% of analysis and 30% of evaluate and design questions. Three practical assignments (35% of the semester mark) are included in the curriculum to help students to bridge the gap between theoretical and practical instruction. These practical assignments further enable students to exercise engineering judgment and apply it to a practical problem. MSK3 encourages group work where a number of students attend practical sessions together.

## IV. RESEARCH METHODOLOGY

A post-facto study is employed along with descriptive statistics involving quantitative analysis of the collected data. Descriptive statistics, rather than inferential statistics, will be used as the results will be interpreted with regard to specific engineering students enrolled at a UoT. Quantitative analysis is important as it brings a methodical approach to the decision-making process, given that qualitative factors such as "gut feel" may make decisions biased and less than rational [34].

The target population is restricted to engineering students enrolled for the modules outlined in Table 3 during the time period of 2009 – 2013. These modules represent different engineering disciplines at CUT, focusing on both freshman and senior engineering students. The median is used in the comparison of the theory and practical grades for each semester, while the averages of all the semesters are considered when comparing the different disciplines. The median is used in preference to the mean, or some other location parameter, since it is not usually affected by the presence of outliers [35, 36].

## V. RESULTS

More undergraduate engineering students enrol for Electrical, Electronic and Computer Engineering (LOG3 with 1075 students) as compared to the Built Environment (KTG1 with 932 students) and Mechanical Engineering (MSK3 with 617 students). Furthermore, a disproportionate gender equality still exists in these engineering disciplines (4 males to 1 female), which is substantiated by previous research which indicates that engineering tends to be dominated by males [37].

Practical success of undergraduate engineering students in the Built Environment overshadowed their theoretical success on average by 10% (see Figure 1 right hand column), while in Electrical, Electronic and Computer Engineering the average difference was only 4% (see Figure 2 right hand column). Mechanical Engineering students also performed much better with their practical assessments, which outweighed their theoretical assessments on average by 18% (see Figure 3 right hand column). Noteworthy too is the fact that the smallest percentage difference between theory and practice resulted in the highest average throughput rate (compare the final three columns of Figures 1 through 3 with each other).

Two recommendations may be derived from these results (Figures 1 – 3). Firstly, the time spent on practice should increase and secondly the quality of the practice should increase. This agrees with published literature by Jun *et al.* [38] who stated that academics must increase the time spent on practice and enhance students understand ability by doing experiments. Moreover, Li *et al.* [39] found that students achieved higher scores on their theoretical tests when they spent more time on practice. The longer the time on practice becomes, the more experience is acquired and the more individual expertise develops [40]. Indeed, the level of the students within higher education depends more on the level and quality of the practical teaching [41].

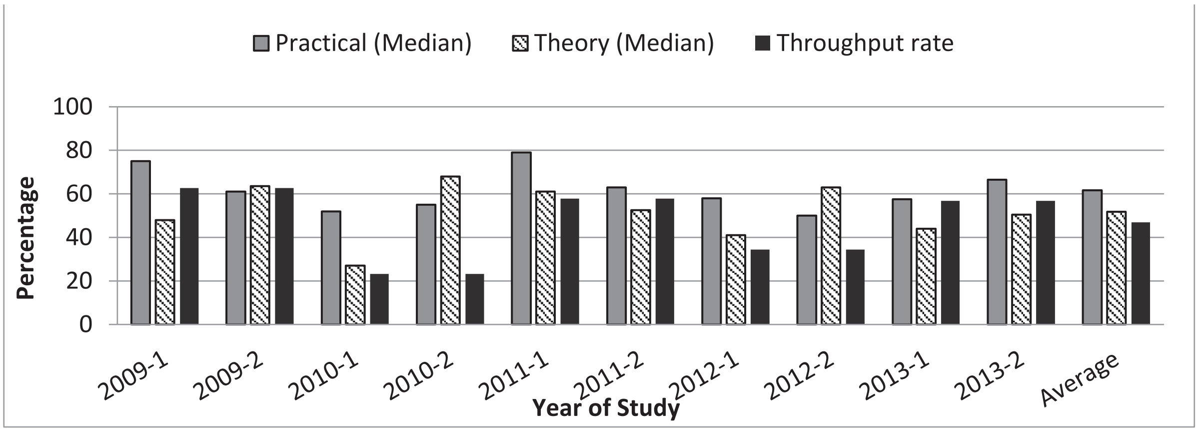


Fig. 1: Construction Technology I practical, theoretical and throughput results (KTG1)

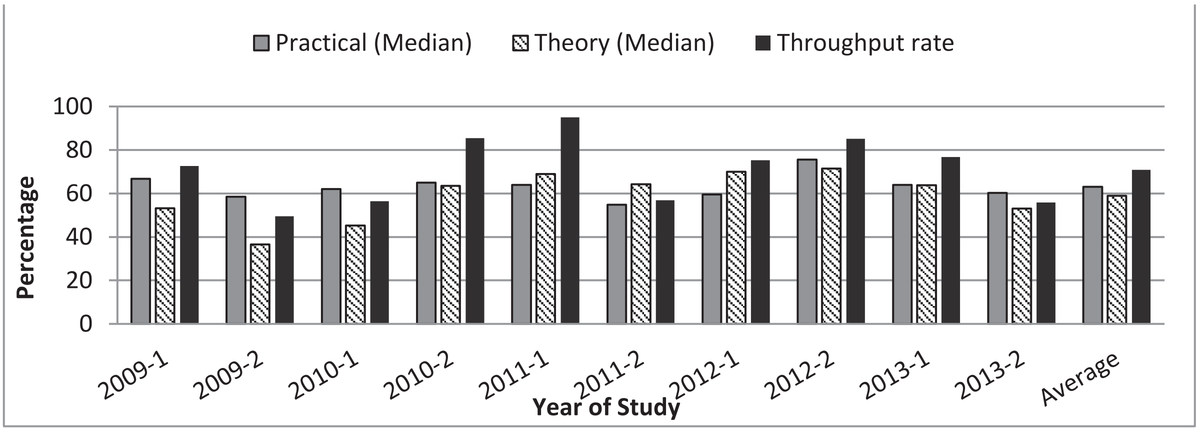


Fig. 2: Logic Design III combined results (LOG3)

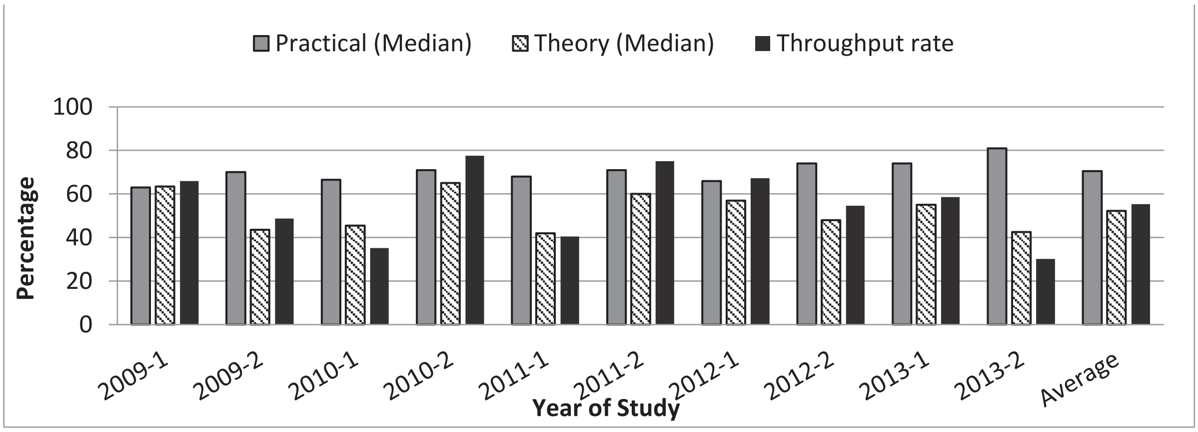


Fig. 3: Applied Strength of Materials III combined results (MSK3)

Figure 4 shows the fluctuation in the numerical gap (difference between the practical and theoretical results) for the 2009 through 2013-time period. No difference is observed in the first semester of 2013 for LOG3, while a large difference is observed for the second semester of 2013 for MSK3.

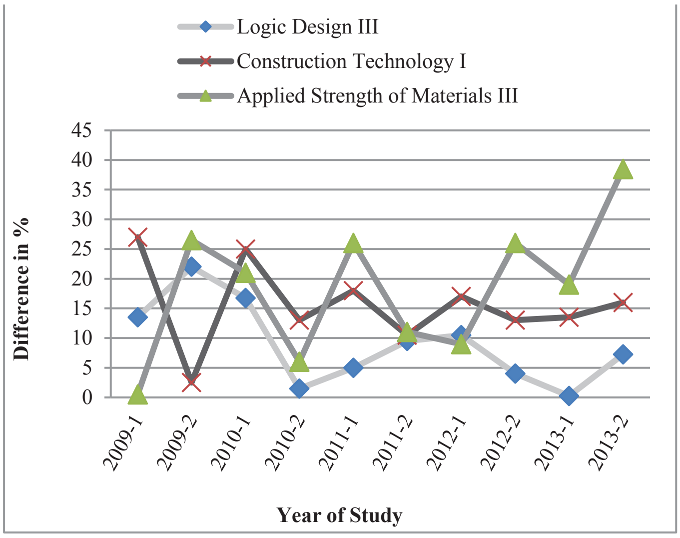


Fig. 4: Numerical gap between the practical and theoretical results

A negative correlation is furthermore calculated between the throughput rates and the numerical gap that exists between the practical and theoretical results (see Table 4). This indicates that as the numerical gap decreases, the throughput rate increases (the negative sign under the Pearson column indicates this). Furthermore, the correlation is stronger for third year level modules, which tends to suggest that final year students are more aware of the benefits of completing the practical instruction in a laboratory with the view to better understanding the theory presented in the classroom. Pearson correlations can be used to provide information about consistency agreements [42] and is useful for assessing linear relationships between pairs of variables [43].

TABLE 4: CORRELATIONS BETWEEN THE THROUGHPUT RATE AND THE GAP BETWEEN THE THEORY AND PRACTICAL RESULTS

| **Module** | **Department** | **Pearson** |
|---|---|---|
| Construction Technology I | Built Environment | -0.21 |
| Logic Design III | Electrical, Electronic and Computer Engineering | -0.71 |
| Applied Strength of Materials III | Mechanical Engineering | -0.84 |

## VI. Conclusions

Dewey [11] argued that reflective activity should include some form of testing and that reflective thinking includes suspending any judgments until we have carried out some sort of systematic enquiry. Testing, in the form of gathering and analysing student results for the past few years, has revealed that undergraduate engineering students are more adept at completing the practical assessments scheduled in a laboratory, than in completing the theoretical assessments scheduled in a classroom. This systematic enquiry needs to continue over the next few years, as student profiles and academic achievement are set to continue to change. However, three distinct judgements or recommendations should be made when considering the abovementioned results:

1. Academics need to increase the quantity of time they spend on their practical instruction, by increasing the time on task that students spend in a laboratory;
2. Academics need to improve the quality of their practical instruction, by promoting critical thinking and problem solving skills;
3. Academics need to ensure that their practical instruction in a laboratory fuses and balances with the theoretical instruction given in the classroom.

Implementing these three recommendations has the potential to improve current low throughput rates at a UoT, which may lead to a subsequent enhancement in student graduate attributes. This is substantiated by work done by Li *et al.* [39], by Nistor *et al.* [40] and by Ya-man [41]. Balancing the practical and theoretical instruction of undergraduate engineering students has the potential of giving students the workplace skills and knowledge they need to meet the needs of industry, business and community.

## References

1. R. H. Du Pré, A. Koorts, Q. T. Mjoli, D. Moore, and D. J. J. van Rensburg, "Report of the CTP Team on Universities of Technology," ed. Pretoria, 2001.
2. R. Martin, B. Maytham, J. Case, and D. Fraser, "Engineering graduates' perceptions of how well they were prepared for work in industry," *European Journal of Engineering Education,* vol. 30, pp. 167-180, (2005).
3. S. M. Easa, "Framework and guidelines for graduate attribute assessment in engineering education," *Canadian Journal of Civil Engineering,* vol. 40, pp. 547-556, (2013).
4. ECSA, "Qualification Standard for Diploma in Engineering: NQF Level 6," in *Standards and Procedures System*, ed, 2012.
5. Central University of Technology, "Cohort statistics - student graduation for multiple base years," 2017.
6. A. J. Swart, "Does it matter which comes first in a curriculum for engineering students – theory or practice?," *IJEEE, International Journal of Electrical Engineering Education,* vol. 47, pp. 189-199, (2010).
7. ECSA, (14 August, 2014). *Home Page*. Available: http://www.ecsa.co.za/, (2014).
8. L. E. Grinter, "Responsibility in engineering education," *The Journal of Higher Education,* vol. 25, pp. 258-261, (1954).
9. D. A. Schön, *The reflective practitioner: How professionals think in action*. London: Harpur Collins, (1983).
10. J. Biggs and C. Tang, *Teaching for quality learning at university*: McGraw-Hill International, (2011).
11. J. Dewey, *How we think*. New York: Prometheus Books (1991 edition), (1910).
12. Council on Higher Education, "VitalStats," Pretoria 2013.
13. A. J. Swart, "Enhancing students' perception of single-sideband suppressed-carrier principles by using cooperative and computer-based learning," *CAEE, Computer Applications in Engineering Education,* vol. 20, pp. 332-338, (2012).
14. A. J. Swart, "Using problem-based learning to stimulate entrepreneurial awareness among senior African undergraduate students," *EJMSTE, Eurasia Journal of Mathematics, Science and Technology Education,* vol. 10, pp. 125-134, (2014).

15. D. Bok, *Our Underachieving Colleges*. Princeton: Princeton University Press, (2006).
16. A. J. Swart, "Evaluation of Final Examination Papers in Engineering: A Case Study Using Bloom's Taxonomy," *IEEE Transactions on Education,* vol. 53, pp. 257-264, (2010).
17. B. S. Bloom, *Taxonomy of Educational Objectives*. New York: Longman’s, Green and Company, (1954).
18. R. Gagne, "Military training and principles of learning," *American Psychologist,* vol. 17, pp. 263-276, (1962).
19. J. Piaget, "Intellectual Evolution From Adolescence to Adulthood.," *Human Development,* vol. 15, pp. 1-12, (1972).
20. F. Marton and R. Säljö, "On qualitative differences in learning. I. Outcome and process.," *British Journal of Educational Psychology,* vol. 46, pp. 4-11, (1976).
21. A. Lundberg, "Student and teacher experiences of assessing different levels of understanding," *Assessment and Evaluation in Higher Education,* vol. 29, pp. 323-333, (2004).
22. J. Elander, K. Harrington, L. Norton, H. Robinson, and P. Reddy, "Complex skills and academic writing: a review of evidence about the types of learning required to meet core assessment criteria," *Assessment and Evaluation in Higher Education,* vol. 31, pp. 71-90, (2006).
23. N. Haring, T. Lovitt, M. Eaton, and V. Hansen, *The Fourth R*. Columbus, OH: Charles Merrill, (1978).
24. J. Biggs, *Teaching for quality learning at university*, 2nd ed. Berkshire: Open University Press, (2003).
25. J. B. Biggs and K. F. Collis, *Evaluating the quality of learning: The SOLO taxonomy*. New York: Academic Press, (1982).
26. C. Garside, "Look who’s talking: a comparison of lecture and group discussion teaching strategies in developing critical thinking skills," *Communication Education,* vol. 45, pp. 212-227, (1996).
27. D. A. Kolb, *Learning Cycle and Learning Style Inventory*. London: Prentice Hall, (1984).
28. SADC, (14 August, 2014). *Home page*. Available: http://www.sadc.int/, (2014).
29. SACQSP, (14 August, 2014). *Home page*. Available: http://www.sacqsp.org.za/, (2014).
30. SACPCMP, (14 August, 2014). *Home page*. Available: http://www.sacpcmp.org.za/, (2014).
31. N. M. Seel and S. Dijkstra, *Curriculum, Plans and Processes in Instructional Design: International Perspectives*. Hillsdale, NJ: Lawrence Erlbaum Associates, (2004).
32. T. Kilić, I. Puljak, and D. Begušić, "Studying electrical engineering and information technology and the University of Split, Croatia," *International Journal of Electrical Engineering Education,* vol. 44, pp. 175-183, (2007).
33. J. B. Nisbet, N. J. Entwistle, B. McQuillin, and I. M. Robinson, "Staff and student perceptions of the teaching-learning environment: a case study," *International Journal of Electrical Engineering Education,* vol. 42, pp. 30-40, (2005).
34. W. Reddy, D. Higgins, and R. Wakefield, "An investigation of property-related decision practice of Australian fund managers," *Journal of Property Investment & Finance,* vol. 32, pp. 282-305, (2014).
35. C. Svensson and D. A. Jones, "Review of rainfall frequency estimation methods," *Journal of Flood Risk Management,* vol. 3, pp. 296-313, (2010).
36. S. Leanderson, P. Laguna, and L. Sörnmo, "Estimation of the respiratory frequency using spatial information in the VCG," *Medical engineering & physics,* vol. 25, pp. 501-507, (2003).
37. A. J. Hodges and B. Park, "Oppositional Identities: Dissimilarities in How Women and Men Experience Parent Versus Professional Roles," *Journal of Personality and Social Psychology,* vol. 105, pp. 193-216, (2013).
38. Z. Jun, C. Xiuli, and G. Fuxiang, "Research on the Practice Teaching of Assembly Language and Programming," in *Computer Science-Technology and Applications, 2009. IFCSTA'09. International Forum on*, pp. 403-405, (2009).
39. Y. Li, C. Dow, C. Lin, and P. Lin, "A transparent and ubiquitous access framework for networking and embedded system laboratories," *Computer Applications in Engineering Education,* vol. 20, pp. 321-331, (2012).
40. N. Nistor, B. Baltes, and M. Schustek, "Knowledge sharing and educational technology acceptance in online academic communities of practice," *Campus-Wide Information Systems,* vol. 29, pp. 108-116, (2012).
41. W. Ya-man, "The Construction of Practical Teaching System in Higher Vocational Colleges," *Liaoning Higher Vocational Technical Institute Journal,* vol. 12, pp. 031-035, (2007).
42. J. F. Edens, M. T. Boccaccini, and D. W. Johnson, "Inter-rater reliability of the PCL-R total and factor scores among psychopathic sex offenders: are personality features more prone to disagreement than behavioral features?," *Behavioral sciences & the law,* vol. 28, pp. 106-119, (2010).
43. F. R. Allen and M. Dickie, "Toward a formula-based model for academic library funding: Statistical significance and implications of a model based upon institutional characteristics," *College & Research Libraries,* vol. 68, pp. 170-182, (2007).