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Guest Contribution

The paper below was given as an invited address by Prof Roode at the July 1992 Conference of the South African Computer Lectures' Association. (Editor)

The Ideology, Struggle and Liberation of Information Systems

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In 1989, Denning *et al* presented the final report of the Task Force on the Core of Computer Science in an article entitled "Computing as a Discipline" [3]. This was said to present a new intellectual framework for the discipline of computing and proposed a new basis for computing curricula.

In the words of the authors, "an image of a technology-based discipline is projected whose fundamentals are in mathematics and engineering." Algorithms are represented as the most basic objects of concern and programming and hardware design as the primary activities. Although there is wide consensus that computer science encompasses far more than programming, the persistent emphasis on programming "arises from the long-standing belief that programming languages are excellent vehicles for gaining access to the rest of the field" [3].

The new framework sets out to present the intellectual substance of the field in a new way, and uses three paradigms to provide a context for the discipline of computing. These paradigms are *theory*, rooted in mathematics; *abstraction*, rooted in the experimental scientific method and *design*, with its roots in engineering.

Programming, the report recommends, should still be a part of the core curriculum and programming languages should be seen and used as vehicles for gaining access to important aspects of computing.

The following short definition is offered of the discipline of computing [3]:

> The discipline of computing is the systematic study of algorithmic processes that describe and transform information: their theory, analysis, design, efficiency, implementation, and application. The fundamental question underlying all of computing is, *"What can be (efficiently) automated?"*

In the same issue of Communications, tucked away towards the end of the journal, an article by Banville and Landry asked the innocent question "Can the Field of MIS be disciplined?" [1]. It is not clear whether the use of the word "discipline" in both articles was purely coincidental – however, the implications were quite clear: computer science was able to talk about "computing as a discipline," and indeed, could present a report which, in a sense, was a culmination of more than twenty years' efforts. Yet, its sister discipline was still asking questions of a very introvertive nature about itself.

It has become quite clear that the fields (leaving aside for the moment the questions of "disciplines") of computer science and information systems (or MIS, informatics, or whatever other name we want to attach to it) have different aims and objectives, different problems that confront it, and, yes, if we want to be truly scientific, different paradigms. To support the latter statement, it is sufficient to contrast the three paradigms of computing with the four paradigms of information systems development described by Hirschheim and Klein [5]. It can be said that a central activity in information systems is the development of information systems, and that therefore, these paradigms have implications for the field of information systems. The four paradigms can be characterized briefly, as follows:

- The analyst as systems expert
- The analyst as facilitator
- The analyst as labour partisan
- The analyst as emancipator or social therapist.

In the same spirit, Lyytinen sees the "systems development process as an instrument in organizational change" [6] and remarks that analysts' principal problems are "in understanding the goals and contents of such change instead of solving technical problems." Already in 1987 Boland [2] observed that: "designing an information system is a moral problem because it puts one party, the designer, in the position of imposing an order on the world of another."

This is clearly a far cry from Denning *et al*'s statement that the fundamental question is "what can be automated?" At the same time, within the context of the field of computing, there is nothing wrong with this question, and it is probably the right question for practitioners of computing to continually ask themselves. But it is a disastrous question for a practitioner of informatics to ask. And it has taken us quite a long time to realise this – that the two disciplines have fundamentally different roles to play. These roles are complementary and supportive, and not destructively opposed.

The liberation of information systems lies in realising this elemental truth: that information systems are man-made objects designed to effect organisational change and that, as such, they can ill be studied using the paradigms of abstraction and engineering mentioned above.

What then is needed? Banville and Landry offer the consolation that we need not concern ourselves too much about the lack of discipline, and that we can indeed even pride ourselves in being a fragmented adhocracy. It is, in fact, even healthy to continue in all sorts of directions. During this process of finding itself, a discipline should be allowed a considerable degree of latitude, and many avenues should be explored. This obviously makes the field of information systems extremely exciting: it is in the process of discovering remarkable truths, discovering that there are in reality people out there using the systems which analysts design and build, and that the most intriguing problems centre around the role of people in all of this: the analyst, the user, their interaction, the impact of sytems on the work lives of workers on all levels, the impact on organizations. These are questions which have mostly been ignored or lightly treated over the years, but which have emerged as *the* problems to be solved. We do not have the tools to solve them – not yet; but a good starting point would certainly be to first understand more about our field and its research tools, for the empirical, positivist approach so often employed will not suffice to solve the above problems.

In the spirit of contributing to the liberation movement of information systems, we have embarked on a study of research on research in Information Systems, and will report on the results more fully in the near future. We define Information Systems as follows [4]:

> Information Systems is an inter-disciplinary field of scholarly inquiry, where information, information systems and the integration thereof with the organisation is studied in order to increase the effectiveness and efficiency of the total system (of technology, people, organisation and society).

In Information Systems then, we see the fundamental question underlying the entire discipline, to be the problem of balancing the need to contribute, through information systems, to the achievement of the mission of the organisation with the moral responsibility to develop and implement socially accepted information systems.

Each of the fields, computer science and information systems, benefits enormously from the activities of the other. Nonetheless, we must recognize the different approaches used by the two disciplines and allow them to complement each other. It should not be our business to convince one another that the universal truth is that which we use in our discipline – whether that be computer science or information systems. Instead, we should seek out the opportunities for synergy, and for complementing each other. If we succeed in doing this at SACLA, then we could indeed do ourselves proud.

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Editor's Notes: To Compete or Collaborate

Human interaction invariably brings with it a blend of competition and collaboration. Competition means that one enjoys the exhilaration of winning while the other endures the shame of loosing. Because of this reward/punishment mechanism, it is a widely assumed that competition enhances performance and efficiency. This dogma pervades not only commerce, sport and politics, but is found in practically all areas of human endeavour, including research.

The competitive spirit in research is found in the well-known saga of Watson and Crick racing to unravel the double helix structure of DNA. Not so well-known, though equally illustrative, is the intensity of Newton's stratagems to oust Leibnitz from receiving any credit for differentiation. Recently there have been reports of scientists who have either tolerated or manufactured fraudulent results in order to win some or other scientific race. The space race, the arms race, the race for an AIDS cure, the scurry for faster smaller hardware, the race for awards, the drive for publications, Nobel prizes: all of this attests to a profoundly competitive international research culture.

But while competition might be the handmaiden of commerce and sport, it is the harlot of research – an unfortunate concomitant of the silly side of human nature. The archetypal researcher not only rises above the incidentals of human accolades; he disdains them. By tradition, the definitive research qualification is a PhD – a Doctor of Philosophy – a lover of thought. Discovery and thought are not only by their very nature rewarding, they are also humbling. When the archetypal researcher moves outside his interior thought-world, it is to share his discoveries. If he is childish, it is not the little boy flexing his biceps and saying: "I'm stronger than you" but the child rushing to tell everyone: "Wow – look at this!" He is forgetful of self: Pythagoras, oblivious of the invading enemy and his impending death while he researches in the sand; Archimedes shouting "Eureka" without care for his nudity. The competitive spirit is a crass intrusion into this ancient legacy of innocence and selflessness.

By its nature, collaboration thrives in a climate of easy social intercourse. It may initially feel uncomfortable for researchers, who are inclined to be socially inept and are wont to bury themselves in work away from society. However, once the plunge to collaborate is taken there is ample evidence that it leads to successful research. In maximizing the use of available talent, it brings about a synergy in which two heads are better than one. All participants enjoy its rewards and no individual has to endure the full weight of its failures. In fact, the notion of collaboration is now so commonplace that significant research seems impossible without it. The tendency, however, is to encourage research collaboration within an organisation, but to emphasize competition in relation to outside organisations.

During a forum discussion at the July South African Computer Lecturers' Association (SACLA) conference, an appeal was made for greater collaboration between universities. Not surprisingly, the information technology disciplines at local universities have always had both a competitive and a collaborative relationship. The competitiveness usually takes the form of friendly rivalry, while the very existence of SACLA bears testimony to a rather unique collaborative relationship. In latter years the competitiveness seems to have intensified, while electronic mail and other developments have improved the prospects for collaboration. At issue, then, is whether there is an imbalance between these dual forces. The appeal at the SACLA forum implied that there is, and I would strongly agree. It is my view (my prejudice, if you will) that competition between universities is a self-indulgent and wasteful dissipation of energy.

Those who are inclined to compete should seriously examine what is to be gained. It is unconvincing to argue that winning makes a significant impact on the way in which students select universities: in the main, this is a matter of geography and language preference. To some extent, the same might be said about staff, although research reputation perhaps plays a more important role here. Neither are research funding agencies (e.g. the FRD) influenced by whether X is "better" in some or other sense than Y. On the contrary, it has wisely been decided to fund on the basis of criteria that are believed to be objective, without any reference whatsoever to the performance of competitors. True enough, funds are limited, but it is precisely for this reason that it is wasteful to divide the little there is between divergent research efforts.

It seems to me that there is a wealth of research talent out there, but that each researcher selects an area of interest almost as a matter of whim. There is an urgent need for well-coordinated collaboration on focussed research areas that have been carefully selected as directly relevant to the country. It is especially incumbent on those who finance, manage and lead research to identify such areas and to encourage collaboration in every possible way.

I look forward to the manifestation of such collaboration in SACJ publications authored by researchers from different university departments. To date there have been none of consequence. If we fail to collaborate, we are in danger of becoming little Don Quixotes who spend our lives attacking windmills and defending castles of xenophobia and irrelevance.

An Evaluation of the Skill Requirements of Entry-level Graduates in the Information Systems Industry

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Abstract

Information Systems (IS), although a relatively new academic discipline, is receiving considerable attention in tertiary institutions in South Africa. Despite this, there is currently no standard curricula for IS graduates or diplomates. A research project was conducted in 1991 to identify the skills of IS graduates leaving tertiary institutions and the skills required by industry. A sample of 33 IS professionals and 15 IS academics completed a questionnaire covering practical skills levels and theoretical knowledge levels. Analysis of the results showed that there were significant differences between academics and industry samples in important skills and knowledge areas. These differences relate to hardware skills and inter-personal skills. There were also significant disagreements within the groups regarding the skill requirements of entry-level graduates. An initiative to bring industry and academics closer together in curricula design and course accreditation is suggested.
Keywords: *IS skills, IS curricula, IS graduates, IS education.*
Computing Review Categories: *K.3.2*

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1 Introduction

According to Davis [9], Information Systems (IS) represents the intersection of six fields of knowledge: computer science, behavioural science, decision science, organization and management, organizational function and management accounting. He further suggested that these fields draw upon diverse disciplinary bases in mathematics, engineering and the social sciences.

Vitalari [22], in a major empirical study, concluded that without the skill requirements of these six fields of study being clearly identified, limits would be placed on the development of training programs, development of aptitude assessment instruments and staff selection procedures.

This research project was built on the hypothesis that there is a mismatch between the IS skills required by industry and those developed by the tertiary institutions. In the USA, two industry bodies (the ACM and the DPMA) have produced detailed curricula for IS courses. In addition, there is an accreditation procedure for those universities following such courses. The IS industry in South Africa still needs to develop these core courses and quality control procedures. A large number of new entrants into the IS industry come from Technikons and Universities. Graduates who have the skills and knowledge required by industry will clearly be more effective and productivity would increase as a result.

A survey was conducted to establish what commerce and industry perceive as the knowledge and skills needed at *entry-level* by a new graduate from a tertiary institution. A parallel survey was conducted to determine the knowledge and skills gained in IS courses by students prior to graduation. The results were matched and reported on with the intention of achieving a better understanding of the needs and requirements.

The research tested the following hypotheses:

H1 The required IS skills of entry-level IS graduates joining South African organizations are significantly different to the skills and knowledge gained in courses at tertiary institutions.

H2 Tertiary institutions produce IS graduates with skills that vary significantly from institution to institution.

H3 The IS industry has diverse views of the entry-level skills needed by IS graduates.

This research focussed specifically on IS and data was only collected from academic institutions where an IS syllabus was taught (these courses normally come under the title IS, BIS, BDP or CDP.). Computer Science courses were specifically excluded from the research.

2 Prior Research

The skills and knowledge of IS professionals have traditionally followed the career path from entry-level programmer to project manager [1]. A programmer required a sound technical knowledge base with communication and organizational skills [13, 4, 24]. Watson *et al* [24] specifically noted that a knowledge of application programming languages was considered to be the most essential skill for entry level programmers. Watson et al [24] also identified a high correlation between the skill requirements of a programmer and a systems analyst.

Three major skills areas have been identified for programmers and analysts: technical, business and inter- personal skills [22, 4]

The development of IS curricula received considerable attention in the 1980's in the USA and the UK. Many early curricula in information systems, data processing or computer science, however, focussed mainly on the computer. The aims of any IS course should be to educate and train students to be competent, professional developers and managers of information systems [14]. The student needs an understanding of the limits of the computer; an understanding of the purposes and values of the information system's end user, and to be able to understand the behavioural aspects of organisations [20]. IS professionals also need to be able to thinking critically; to have strong communication skills; to have an understanding of the nature of knowledge, and a sensitivity to the social, political, economic and ethical issues raised by the IS industry [20, 5].

Controlling bodies in the IS industry in the USA have developed curriculum guide-lines to provide academics with core curricula for IS courses. The Association for Computing Machinery (ACM) curriculum recommendations for IS were first published in 1972 and updated in 1982. The major changes to the curriculum during that decade included: the integration of management skills, the inclusion of data management and data communications, the inclusion of a common body of knowledge as a major component of the curriculum, and the inclusion of an MIS policy course as a capstone to the program. These changes reflected the changing requirements of the IS industry [4].

The DPMA curriculum defined the skills and education required in entry level data processing employees using an interaction process between educators and practitioners [10]. The courses included: Introduction to Computer-Based Systems, Applications program development I, Applications program development II, Systems Analysis methods, Structured Systems Analysis and design, Database Program development, Application Software development project, Software and Hardware development, Office Automation, Decision Support systems, Advanced Database Processing, Distributed Data Processing, EDP Audit controls, Information Systems planning, and Information Resource management.

The IFIP/BCS curriculum, developed for the European IS industry, recommended that entry level graduates should understand the process to be carried out in appraising, analysing, designing, and implementing a system; should understand the techniques and tools available to make the processes efficient and effective; should understand the environment in which computer systems could be effectively used; and should understand the functions to be carried out by other IS specialists [3]

The model curricula produced by these professional bodies identifies the industry requirements of entry- level IS employees (mainly graduates and diplomates). South Africa has a relatively small number of IS professionals and tertiary institutions. Currently there is no set curricula for IS undergraduate or postgraduate courses although the Computer Users Council has completed several related projects in 1991 on training, career development and job descriptions. The Public Accoutants and Auditors Board (PAAB) in South Africa published an IS core course for universities teaching Commerce students wishing to take the Final Qualifying Exam (FQE) leading to the professional qualification of Chartered Accountant. The syllabus, covering computer literacy, IS Development, IS Applications and IS Controls, is currently under review.

3 Research Methodology

A list of IS skills was extracted from the literature and compiled into a questionnaire using factor analysis. Cheney et al [4] identified that jobs require knowledge, skills and abilities (KSAs). *Knowledge* being technical information from a formal education required to perform adequately in a job, *skill* being the ability to select the required action from the knowledge possessed, and *ability* being cognitive factors that represent capabilities or actions. They argued that a person's productive potential depends on that person's knowledge, skill, and ability. Using this differentiation the questionnaire requested information concerning theoretical knowledge and practical skills. The items in the questionnaire were grouped into 16 major sections as in Appendix A and a 7-point Lickert scale was used for each question. Three academics validated the questionnaire.

Forty six questionnaires were sent to a random selection of IS departments in South African companies. Thirty three responses were received – a 72% response rate). As this research was considered to be exploratory, the sample was considered large enough. Nineteen questionnaires were sent to academic institutions and fifteen responded (a 79% response rate).

The nature of the first hypothesis was such that comparison of the two samples was made to establish if there were significant differences. The *U-test* of Wilcoxon, Mann, and Whitney was used to establish if there were significance differences between the samples. According to Sachs [19] the test is sensitive to differences in medians, less sensitive to differences in skewness, and insensitive to differences in variance. For this reason the test was assumed to be appropriate owing to the possibility of disagreement within the two samples. For the second and third hypotheses the standard deviation to one decimal place was used to establish the level of agreement within each sample.

4 Analysis of Results

The results of the research are documented in Appendix A. A sample of the results is duplicated in Table 1 for explanation.

The first column lists the skills areas. The next two columns separate theoretical knowledge and practical skills for academic and industry respondents.

Total represents the total of all the rankings for each item based on the 7-point Lickert-type scale. **Mean** is the average ranking. **Var.** (variance) and **S.Dev** (standard deviation) approximates the population variance and standard deviation and indicate the spread of the rankings. Where the standard deviation is 1.5 or greater, there is a wide spread of responses and a likely disagreement between responses. Items ranked by academics that appear to have

Table 1. Headings used in Appendix A

				Total	Mean	Var.	S.Dev	U	Z	Signif.
1.4)	Job control language	- Theoretical	- Academic	21	1.4	3.31	1.8	88.5	3.61	1%
			- Industry	128	3.9	2.53	1.6			
		- Practical	- Academic	19	1.3	2.73	1.7	134.5	2.56	2%
			- Industry	85	2.6	2.79	1.7			

internal agreement (ie. standard deviations of less than 1.5) have their standard deviation underlined. Where industry appear to have internal agreement, the standard deviation has been double undelined.

Thus for Job Control Language (above) there was disagreement within both academic and industry circles regarding the level of theoretical knowledge and practical skills required. The significance levels for Job Control Language are 1% and 2% indicating a strong difference of opinion between academics and industry regarding the degree of JCL taught.

The test statistic of the Wilcoxon, Mann, and Whitney test (U) was compared with the critical value (Z) to determine any difference of opinion between the two samples [19]. **Signif.** indicated the significance level of this difference. A significance of >10% indicated no difference was found whereas 5% (or 10%) indicated that the two samples were not strongly different, and 1% (or 2%) indicated a strong difference of opinion. These strong differences of opinion were highlighted by putting them in in a box ($\boxed{2\%}$) in Appendix A.

Hypothesis 1 stated that the IS skills required by organisations were different to those developed by academic institutions. An analysis of the results (identifying where the Significance value is either >10%, 5%, 1% or 2%) indicated general agreement between academics and industry, apart from the nine areas discussed below. Industry required increased skills in JCL (indicated by the higher mean). Significant differences were also found regarding the practical ability to use PC DOS, as academics perceived the need for this skill to be greater than industry.

Academics taught more PC skills than industry required, while industry required more mainframe skills than that being taught by academics.

Application Software package selection, drawing DFD's, spreadsheeting and word processing are significantly different. Academic institutions appear to teach more of these skills than industry required.

Large differences occurred in the area of Interpersonal skills. All items were ranked consistently higher by industry. This indicates that industry required more interpersonal skills than are possessed by, or taught to, IS graduates.

These results disproved hypothesis 1 as there were no significant differences for the majority of skills analysed. The most significant difference being interpersonal skills.

Hypothesis 2 stated that the skills of IS graduates varied dramatically between academic institutions. In the academic sample, there was agreement in 53 out of the 158 items (a 33% agreement). Areas of agreement included file design and systems development (a disagreement is identified by a standard deviation of 1.5 or greater). So, for example, the standard deviations for theoretical and practical skills of COBOL for the academic sample are both 2.1 indicating that there is disagreement between academics as to whether these should be taught. Hypothesis 2 was proved true as the academic sample disagrees on the skills required for 67% of the items.

Hypothesis 3 stated that industry has diverse views of the skills required by an entry level graduate. Representatives of industry appear to have a higher level of disagreement (only 34 out of 158 cases of agreement or 21%) than the academic sample. The area of interpersonal skills showed the highest level of agreement. In all other areas, industry representatives, in general, disagree with each other. Based on the explanation in hypothesis 2, hypothesis 3 is also proved true.

Provision was made for participants to comment on skills areas which they felt had been omitted from the questionnaire. Industry respondents mentioned skills in third generation languages like C and Pascal; fourth- generation languages like Clipper, dBASE and SQL; operating systems like UNIX and MVS; and graphics packages. Some academics also mentioned third generation languages like Basic, C and Pascal; fourth-generation languages like Clipper, dBASE and SQL; and operating systems like UNIX as being important. As some of these subjects are only taught in Computer Science courses, the authors conclude that industry has problems differentiating between IS and Computer Science.

5 Conclusions

The curricula of IS courses received considerable attention in the USA and Europe in the 1970's. This resulted in professional IS bodies working with academics to ensure the skills of graduates match the requirements of industry. In South Africa, academics and industry have not, as yet developed formal links.

This research project was initiated to identify differences between the skills of new IS graduates and the skills required by IS industry. Based on an analysis of the academic and industry samples, there is reasonable agreement between academics and industry regarding the knowledge and skills required of graduates entering the IS industry. However, academics perceived a greater need for PC skills than industry and industry perceived a need for more mainframe skills than academics. Academics also perceived a greater need for business skills than industry – particularly in the areas of accounting and law. Industry required considerably more inter-personal skills than are currently offered in academic courses.

There is no indication of agreement between academics as to the skills possessed by IS graduates. There was also disagreement in the industry sample about the skill requirements of entry-level graduates.

Based on these results, there is a strong and urgent need for academics and industry to co-operate more closely in South Africa and develop IS curricula which will encompass the needs and requirements of both parties. These curricula should take into account the American and European models that have existed for some time. The project could be driven by the Computer Users' Council (CUC), which represents the IS industry at the corporate level.

Methods of accreditation of academic courses should also be investigated to ensure the IS industrys' quality requirements are met.

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Appendix A Research Results

				Total	Mean	Var.	S.Dev	U	Z	Signif.
1)	**Programming:**									
1.1)	Program design	- Theoretical	- Academic	81	5.4	0.64	0.8	238.5	0.21	>10%
			- Industry	173	5.2	2.24	1.5			
		- Practical	- Academic	70	4.7	1.69	1.3	206.5	0.93	>10%
			- Industry	141	4.3	2.68	1.6			
1.2)	COBOL	- Theoretical	- Academic	63	4.2	4.43	2.1	225.5	0.5	>10%
			- Industry	153	4.6	3.44	1.9			
		- Practical	- Academic	55	3.7	4.36	2.1	229	0.42	>10%
			- Industry	131	4.0	3.73	1.9			
1.4)	Job control language	- Theoretical	- Academic	21	1.4	3.31	1.8	88.5	3.61	$\boxed{1\%}$
			- Industry	128	3.9	2.53	1.6			
		- Practical	- Academic	19	1.3	2.73	1.7	134.5	2.56	$\boxed{2\%}$
			- Industry	85	2.6	2.79	1.7			
2)	**Files:**									
2.1)	File organization & access methods	- Theoretical	- Academic	77	5.1	1.45	1.2	247	0.01	>10%
			- Industry	165	5.0	2.73	1.7			
		- Practical	- Academic	62	4.1	1.45	1.2	197.5	1.13	>10%
			- Industry	114	3.5	2.91	1.7			
2.2)	Database files	- Theoretical	- Academic	80	5.3	1.16	1.1	201.5	1.05	>10%
			- Industry	157	4.8	2.67	1.6			
		- Practical	- Academic	61	4.1	1.40	1.2	198.5	1.11	>10%
			- Industry	112	3.4	2.72	1.7			
2.3)	File design	- Theoretical	- Academic	73	4.9	1.85	1.4	245	0.06	>10%
			- Industry	155	4.7	3.00	1.7			
		- Practical	- Academic	58	3.9	2.25	1.5	183	1.46	>10%
			- Industry	100	3.0	2.57	1.6			
3)	**Operating systems:**									
3.1)	PC Dos	- Theoretical	- Academic	57	3.8	4.56	2.1	198	1.13	>10%
			- Industry	112	3.4	2.97	1.7			
		- Practical	- Academic	65	4.3	4.09	2.0	139	2.46	$\boxed{2\%}$
			- Industry	102	3.1	2.51	1.6			
4)	**Hardware:**									
4.1)	Micro computer	- Theoretical	- Academic	73	4.9	1.72	1.3	133	2.6	$\boxed{1\%}$
			- Industry	116	3.5	2.61	1.6			
		- Practical	- Academic	69	4.6	2.77	1.7	97.5	3.39	$\boxed{1\%}$
			- Industry	90	2.7	2.50	1.6			
4.2)	Mini computer	- Theoretical	- Academic	39	2.6	4.51	2.1	212	0.81	>10%
			- Industry	68	2.1	3.63	1.9			
		- Practical	- Academic	32	2.1	5.18	2.3	195.5	1.23	>10%
			- Industry	39	1.2	2.15	1.5			
4.3)	Mainframe	- Theoretical	- Academic	38	2.5	2.92	1.7	154	2.12	5%
			- Industry	122	3.7	1.97	1.4			
		- Practical	- Academic	14	0.9	2.06	1.4	120.5	2.89	$\boxed{1\%}$
			- Industry	82	2.5	2.98	1.7			
5)	**Data comms and networks:**									
5.1)	Data comm. concepts	- Theoretical	- Academic	72	4.8	1.09	1.0	190	1.31	>10%
			- Industry	138	4.2	2.33	1.5			
		- Practical	- Academic	39	2.6	3.71	1.9	216.5	0.7	>10%
			- Industry	74	2.2	2.67	1.6			

				Total	Mean	Var.	S.Dev	U	Z	Signif.
5.2)	WAN's	- Theoretical	- Academic	51	3.4	2.64	1.6	239.5	0.18	>10%
			- Industry	108	3.3	3.29	1.8			
		- Practical	- Academic	23	1.5	3.05	1.7	231.5	0.37	>10%
			- Industry	50	1.5	1.46	1.2			
5.3)	LAN's	- Theoretical	- Academic	66	4.4	1.97	1.4	178.5	1.57	>10%
			- Industry	121	3.7	1.98	1.4			
		- Practical	- Academic	47	3.1	4.25	2.1	177.5	1.58	>10%
			- Industry	69	2.1	1.78	1.3			
6)	**Databases:**									
6.1)	Database concepts	- Theoretical	- Academic	80	5.3	1.29	1.1	240.5	0.16	>10%
			- Industry	175	5.3	1.06	1.0			
		- Practical	- Academic	52	3.5	2.65	1.6	216	0.72	>10%
			- Industry	107	3.2	2.30	1.5			
6.2)	Data dictionaries	- Theoretical	- Academic	69	4.6	1.31	1.1	226	0.49	>10%
			- Industry	156	4.7	1.47	1.2			
		- Practical	- Academic	46	3.1	2.06	1.4	242.5	0.11	>10%
			- Industry	100	3.0	2.15	1.5			
6.3)	DBMS	- Theoretical	- Academic	66	4.4	3.97	2.0			
			- Industry	120	4.4	2.54	1.6			
		- Practical	- Academic	45	3.0	2.40	1.5			
			- Industry	68	2.5	2.18	1.5			
6.3.1)	ADABAS	- Theoretical	- Academic	20	1.3	3.69	1.9	229.5	0.46	>10%
			- Industry	46	1.4	4.48	2.1			
		- Practical	- Academic	18	1.2	3.89	2.0	230	0.49	>10%
			- Industry	29	0.9	2.41	1.6			
6.3.2)	DB2	- Theoretical	- Academic	31	2.1	6.20	2.5	226.5	0.49	>10%
			- Industry	81	2.5	5.82	2.4			
		- Practical	- Academic	22	1.5	4.78	2.2	227.5	0.49	>10%
			- Industry	51	1.5	3.58	1.9			
6.4)	Database design	- Theoretical	- Academic	75	5.0	0.80	0.9	191	1.29	>10%
			- Industry	137	4.2	3.34	1.8			
		- Practical	- Academic	55	3.7	1.16	1.1	160.5	1.97	5%
			- Industry	84	2.5	2.79	1.7			
6.5)	Database admin	- Theoretical	- Academic	53	3.5	3.18	1.8	235.5	0.27	>10%
			- Industry	112	3.4	3.45	1.9			
		- Practical	- Academic	26	1.7	1.93	1.4	239.5	0.18	>10%
			- Industry	60	1.8	2.21	1.5			
7)	**Software Tools:**									
7.1)	CASE	- Theoretical	- Academic	56	3.7	2.06	1.4	225	0.52	>10%
			- Industry	115	3.5	3.40	1.8			
		- Practical	- Academic	33	2.2	2.69	1.6	242.5	0.11	>10%
			- Industry	78	2.4	3.44	1.9			
7.2)	JAD	- Theoretical	- Academic	40	2.7	3.82	2.0	188	1.35	>10%
			- Industry	114	3.5	3.58	1.9			
		- Practical	- Academic	21	1.4	3.04	1.7	204	1	>10%
			- Industry	60	1.8	2.27	1.5			
7.3)	Prototyping	- Theoretical	- Academic	57	3.8	2.03	1.4	243	0.1	>10%
			- Industry	126	3.8	2.39	1.5			
		- Practical	- Academic	38	2.5	3.18	1.8	235	0.28	>10%
			- Industry	91	2.8	2.43	1.6			

				Total	Mean	Var.	S.Dev	U	Z	Signif.
8)	**System development:**									
8.1)	Business analysis	- Theoretical	- Academic	71	4.7	1.00	1.0	234.5	0.3	>10%
			- Industry	153	4.6	2.72	1.6			
		- Practical	- Academic	52	3.5	0.78	0.9	226	0.5	>10%
			- Industry	104	3.2	2.61	1.6			
8.2)	Development methodology procedures	- Theoretical	- Academic	75	5.0	1.33	1.2	198	1.13	>10%
			- Industry	145	4.4	2.60	1.6			
		- Practical	- Academic	56	3.7	0.86	0.9	178.5	1.59	>10%
			- Industry	96	2.9	2.45	1.6			
8.3)	Systems analysis	- Theoretical	- Academic	78	5.6	0.53	0.7			
			- Industry	148	4.6	3.36	1.8			
		- Practical	- Academic	63	4.5	0.68	0.8			
			- Industry	102	3.2	2.71	1.6			
8.3.1)	Information gathering techniques	- Theoretical	- Academic	76	5.1	0.86	0.9	196.5	1.16	>10%
			- Industry	142	4.3	3.67	1.9			
		- Practical	- Academic	59	3.9	0.60	0.8	178.5	1.6	>10%
			- Industry	104	3.2	2.25	1.5			
8.3.2)	User requirements	- Theoretical	- Academic	76	5.1	1.00	1.0	212	0.81	>10%
			- Industry	146	4.4	3.58	1.9			
		- Practical	- Academic	59	3.9	1.00	1.0	190	1.31	>10%
			- Industry	105	3.2	3.00	1.7			
8.3.3)	Cost benefit analysis	- Theoretical	- Academic	65	4.3	2.49	1.6	222	0.58	>10%
			- Industry	129	3.9	3.60	1.9			
		- Practical	- Academic	48	3.2	0.96	1.0	175	1.65	>10%
			- Industry	82	2.5	2.31	1.5			
8.3.4)	Feasibility assessment	- Theoretical	- Academic	70	4.7	1.29	1.1	192.5	1.25	>10%
			- Industry	128	3.9	3.68	1.9			
		- Practical	- Academic	50	3.3	0.49	0.7	158.5	2.02	5%
			- Industry	81	2.5	2.43	1.6			
8.3.5)	Develop functional requirements	- Theoretical	- Academic	73	4.9	2.38	1.5	198.5	1.13	>10%
			- Industry	143	4.3	3.13	1.8			
		- Practical	- Academic	52	3.5	1.58	1.3	234.5	0.3	>10%
			- Industry	108	3.3	2.02	1.4			
8.3.6)	System flowcharts	- Theoretical	- Academic	71	4.7	2.73	1.7	212.5	0.8	>10%
			- Industry	146	4.4	2.30	1.5			
		- Practical	- Academic	56	3.7	2.46	1.6	215.5	0.73	>10%
			- Industry	111	3.4	2.47	1.6			
8.3.7)	Data flow diagrams	- Theoretical	- Academic	81	5.4	0.77	0.9	179	1.59	>10%
			- Industry	156	4.7	1.90	1.4			
		- Practical	- Academic	69	4.6	1.57	1.3	164.5	1.9	10%
			- Industry	122	3.7	2.21	1.5			
8.3.8)	Hardware & software selection	- Theoretical	- Academic	65	4.3	1.96	1.4	148.5	2.23	5%
			- Industry	100	3.0	3.48	1.9			
		- Practical	- Academic	45	3.0	2.80	1.7	138.5	2.49	$\boxed{2\%}$
			- Industry	53	1.6	2.48	1.6			
8.4)	Data analysis	- Theoretical	- Academic	74	4.9	1.80	1.3	241	0.15	>10%
			- Industry	162	4.9	2.02	1.4			
		- Practical	- Academic	54	3.6	3.17	1.8	239	0.19	>10%
			- Industry	125	3.8	2.65	1.6			

				Total	Mean	Var.	S.Dev	U	Z	Signif.
8.5)	Application software package selection	- Theoretical	- Academic	59	3.9	2.60	1.6	159.5	2	5%
			- Industry	96	2.9	2.57	1.6			
		- Practical	- Academic	39	2.6	2.77	1.7	155	2.11	5%
			- Industry	49	1.5	2.13	1.5			
8.6)	Systems design	- Theoretical	- Academic	75	5.0	1.07	1.0	208	0.91	>10%
			- Industry	145	4.4	2.72	1.7			
		- Practical	- Academic	58	3.9	3.05	1.7	182	1.49	>10%
			- Industry	110	3.3	2.22	1.5			
8.7)	Systems testing	- Theoretical	- Academic	74	4.9	1.26	1.1	210.5	0.85	>10%
			- Industry	171	5.2	1.85	1.4			
		- Practical	- Academic	54	3.6	2.91	1.7	203	1.01	>10%
			- Industry	137	4.2	2.55	1.6			
8.8)	Quality assurance	- Theoretical	- Academic	71	4.7	1.66	1.3	209	0.89	>10%
			- Industry	165	5.0	1.88	1.4			
		- Practical	- Academic	42	2.8	2.43	1.6	197	1.14	>10%
			- Industry	111	3.4	3.08	1.8			
9)	**End user computing:**									
9.1)	End user computing concepts	- Theoretical	- Academic	72	4.8	0.96	1.0	192	1.28	>10%
			- Industry	142	4.3	1.85	1.4			
		- Practical	- Academic	48	3.2	5.49	2.3	230.5	0.38	>10%
			- Industry	98	3.0	2.33	1.5			
9.2)	Spread-sheating	- Theoretical	- Academic	75	5.0	3.07	1.8	118.5	2.93	1%
			- Industry	117	3.5	2.49	1.6			
		- Practical	- Academic	78	5.2	1.09	1.0	67	4.07	1%
			- Industry	100	3.0	2.45	1.6			
9.3)	Word processing	- Theoretical	- Academic	71	4.7	3.40	1.8	131	2.67	1%
			- Industry	112	3.4	2.24	1.5			
		- Practical	- Academic	73	4.9	1.32	1.1	87	3.63	1%
			- Industry	98	3.0	2.64	1.6			
10)	**Project management:**									
10.1)	Project management concepts	- Theoretical	- Academic	64	4.3	3.66	1.9	215.5	0.73	>10%
			- Industry	134	4.1	2.54	1.6			
		- Practical	- Academic	43	2.9	2.65	1.6	209	0.87	>10%
			- Industry	79	2.4	3.27	1.8			
10.2)	Estimating techniques	- Theoretical	- Academic	54	3.6	3.57	1.9	220.5	0.61	>10%
			- Industry	132	4.0	3.33	1.8			
		- Practical	- Academic	33	2.2	2.16	1.5	237.5	0.23	>10%
			- Industry	77	2.3	2.77	1.7			
10.3)	Planning techniques	- Theoretical	- Academic	57	3.8	3.49	1.9	231	0.38	>10%
			- Industry	130	3.9	3.57	1.9			
		- Practical	- Academic	35	2.3	2.36	1.5	229.5	0.41	>10%
			- Industry	84	2.5	2.67	1.6			
10.4)	Control techniques	- Theoretical	- Academic	57	3.8	3.49	1.9	246.5	0.02	>10%
			- Industry	122	3.7	3.30	1.8			
		- Practical	- Academic	32	2.1	1.85	1.4	246.5	0.02	>10%
			- Industry	72	2.2	2.94	1.7			
10.5)	Configuration management	- Theoretical	- Academic	54	3.6	2.64	1.6	225.5	0.5	>10%
			- Industry	127	3.8	2.43	1.6			
		- Practical	- Academic	31	2.1	1.93	1.4	246	0.03	>10%
			- Industry	72	2.2	3.24	1.8			

				Total	Mean	Var.	S.Dev	U	Z	Signif.
11)	**Business fundamentals:**									
11.1)	Accounting	- Theoretical	- Academic	67	4.5	2.78	1.7	165	1.88	10%
			- Industry	130	3.9	2.12	1.5			
		- Practical	- Academic	54	3.6	3.31	1.8	137	2.5	$\boxed{2\%}$
			- Industry	73	2.2	2.35	1.5			
11.2)	Finance	- Theoretical	- Academic	61	4.1	2.86	1.7	220.5	0.62	>10%
			- Industry	128	3.9	2.23	1.5			
		- Practical	- Academic	44	2.9	3.26	1.8	172.5	1.7	10%
			- Industry	66	2.0	2.30	1.5			
11.3)	Marketing	- Theoretical	- Academic	54	3.6	3.57	1.9	212	0.8	>10%
			- Industry	111	3.4	2.41	1.6			
		- Practical	- Academic	37	2.5	3.58	1.9	170	1.77	10%
			- Industry	46	1.4	1.94	1.4			
11.4)	Economics	- Theoretical	- Academic	53	3.5	3.58	1.9	180	1.52	>10%
			- Industry	91	2.8	3.27	1.8			
		- Practical	- Academic	34	2.3	4.06	2.0	186	1.41	>10%
			- Industry	44	1.3	2.10	1.4			
11.5)	Management science	- Theoretical	- Academic	48	3.2	2.16	1.5	212.5	0.79	>10%
			- Industry	91	2.8	2.91	1.7			
		- Practical	- Academic	29	1.9	2.06	1.4	191.5	1.28	>10%
			- Industry	47	1.4	2.06	1.4			
11.6)	Production management	- Theoretical	- Academic	41	2.7	3.93	2.0	215.5	0.73	>10%
			- Industry	79	2.4	3.75	1.9			
		- Practical	- Academic	17	1.1	1.85	1.4	241	0.15	>10%
			- Industry	38	1.2	1.70	1.3			
11.7)	Principles of management	- Theoretical	- Academic	53	3.5	4.25	2.1	222.5	0.57	>10%
			- Industry	113	3.4	2.73	1.7			
		- Practical	- Academic	32	2.1	2.65	1.6	191.5	1.28	>10%
			- Industry	50	1.5	2.55	1.6			
11.8)	Law	- Theoretical	- Academic	36	2.4	2.64	1.6	150	2.24	5%
			- Industry	44	1.3	2.22	1.5			
		- Practical	- Academic	20	1.3	1.29	1.1	151.5	2.35	$\boxed{2\%}$
			- Industry	18	0.5	0.67	0.8			
11.9)	Quantitative methods	- Theoretical	- Academic	51	3.4	2.24	1.5	173.5	1.68	10%
			- Industry	86	2.6	2.66	1.6			
		- Practical	- Academic	37	2.5	2.65	1.6	149.5	2.23	5%
			- Industry	44	1.3	1.56	1.2			
11.10)	Systems thinking	- Theoretical	- Academic	51	3.4	4.11	2.0	232	0.35	>10%
			- Industry	112	3.4	3.39	1.8			
		- Practical	- Academic	29	1.9	3.00	1.7	243.5	0.09	>10%
			- Industry	65	2.0	3.24	1.8			
11.11)	Organizational theory	- Theoretical	- Academic	48	3.2	3.49	1.9	200	1.07	>10%
			- Industry	93	2.8	2.88	1.7			
		- Practical	- Academic	28	1.9	3.18	1.8	204	1.01	>10%
			- Industry	40	1.2	2.11	1.5			
11.12)	Organizational behaviour	- Theoretical	- Academic	48	3.2	3.76	1.9	218.5	0.66	>10%
			- Industry	99	3.0	2.79	1.7			
		- Practical	- Academic	28	1.9	3.45	1.9	214.5	0.77	>10%
			- Industry	45	1.4	2.84	1.7			

				Total	Mean	Var.	S.Dev	U	Z	Signif.
12)	**Interpersonal:**									
12.1)	Listening skills	- Theoretical	- Academic	48	3.2	4.03	2.0	106.5	3.24	$\boxed{1\%}$
			- Industry	168	5.1	1.90	1.4			
		- Practical	- Academic	43	2.9	4.12	2.0	125	2.78	$\boxed{1\%}$
			- Industry	154	4.7	1.56	1.2			
12.2)	Writing skills	- Theoretical	- Academic	52	3.5	3.98	2.0	125.5	2.77	$\boxed{1\%}$
			- Industry	169	5.1	1.99	1.4			
		- Practical	- Academic	53	3.5	2.65	1.6	143	2.38	$\boxed{2\%}$
			- Industry	154	4.7	1.25	1.1			
12.3)	Oral skills	- Theoretical	- Academic	52	3.5	4.25	2.1	133.5	2.62	$\boxed{1\%}$
			- Industry	168	5.1	1.66	1.3			
		- Practical	- Academic	53	3.5	3.05	1.7	138	2.5	$\boxed{2\%}$
			- Industry	160	4.8	1.40	1.2			
12.4)	Negotiation & conflict handling	- Theoretical	- Academic	41	2.7	4.60	2.1	150.5	2.2	5%
			- Industry	139	4.2	3.08	1.8			
		- Practical	- Academic	36	2.4	3.57	1.9	182	1.48	>10%
			- Industry	108	3.3	3.23	1.8			
12.5)	Presentation skills	- Theoretical	- Academic	46	3.1	3.80	1.9	117	2.97	$\boxed{1\%}$
			- Industry	156	4.7	1.90	1.4			
		- Practical	- Academic	51	3.4	2.91	1.7	171	1.76	10%
			- Industry	141	4.3	1.59	1.3			
12.6)	Stress management	- Theoretical	- Academic	23	1.5	3.45	1.9	157.5	2.05	5%
			- Industry	85	2.6	2.49	1.6			
		- Practical	- Academic	21	1.4	3.97	2.0	187.5	1.38	>10%
			- Industry	60	1.8	2.51	1.6			
12.7)	Time management	- Theoretical	- Academic	38	2.5	3.98	2.0	129.5	2.66	$\boxed{1\%}$
			- Industry	138	4.2	2.39	1.5			
		- Practical	- Academic	30	2.0	3.47	1.9	148	2.24	5%
			- Industry	108	3.3	2.56	1.6			
12.8)	Problem solving skills	- Theoretical	- Academic	67	4.5	2.92	1.7	204	1	>10%
			- Industry	170	5.2	1.70	1.3			
		- Practical	- Academic	59	3.9	2.73	1.7	219	0.64	>10%
			- Industry	141	4.3	3.41	1.8			
12.9)	Interpersonal relationship skills	- Theoretical	- Academic	46	3.1	3.53	1.9	145	2.32	5%
			- Industry	145	4.4	2.91	1.7			
		- Practical	- Academic	39	2.6	4.37	2.1	172	1.71	10%
			- Industry	121	3.7	2.95	1.7			
12.10)	Motivation skills	- Theoretical	- Academic	51	3.4	3.97	2.0	245	0.06	>10%
			- Industry	118	3.6	3.21	1.8			
		- Practical	- Academic	40	2.7	4.62	2.1	227.5	0.45	>10%
			- Industry	78	2.4	4.17	2.0			
12.11)	Interviewing skills	- Theoretical	- Academic	53	3.5	2.65	1.6	208	0.89	>10%
			- Industry	103	3.1	4.71	2.2			
		- Practical	- Academic	49	3.3	2.46	1.6	179	1.55	>10%
			- Industry	75	2.3	4.44	2.1			

				Total	Mean	Var.	S.Dev	U	Z	Signif.
13)	**Role of IS:**									
13.1)	Decision	- Theoretical	- Academic	61	4.1	1.80	1.3	211.5	0.82	>10%
	support		- Industry	113	3.4	2.79	1.7			
	systems	- Practical	- Academic	42	2.8	2.69	1.6	182	1.49	>10%
			- Industry	69	2.1	2.45	1.6			
13.2)	Expert systems	- Theoretical	- Academic	56	3.7	2.33	1.5	169	1.78	10%
			- Industry	92	2.8	2.17	1.5			
		- Practical	- Academic	25	1.7	3.69	1.9	237.5	0.23	>10%
			- Industry	44	1.3	2.16	1.5			
13.3)	Data security	- Theoretical	- Academic	62	4.1	1.45	1.2	198.5	1.15	>10%
			- Industry	119	3.6	2.30	1.5			
		- Practical	- Academic	37	2.5	3.05	1.7	213.5	0.77	>10%
			- Industry	67	2.0	2.51	1.6			
13.4)	Office	- Theoretical	- Academic	56	3.7	2.06	1.4	187.5	1.38	>10%
	automation		- Industry	97	2.9	1.94	1.4			
		- Practical	- Academic	33	2.2	3.76	1.9	213	0.78	>10%
			- Industry	53	1.6	1.81	1.3			
14)	**Vendor liaison**									
		- Theoretical	- Academic	47	3.1	3.05	1.7	155	2.09	5%
			- Industry	63	1.9	2.93	1.7			
		- Practical	- Academic	18	1.2	2.96	1.7	233	0.36	>10%
			- Industry	30	0.9	1.54	1.2			
15)	**Strategic planning:**									
15.1)	Information	- Theoretical	- Academic	54	3.6	2.91	1.7	246	0.03	>10%
	architecture		- Industry	117	3.5	2.91	1.7			
		- Practical	- Academic	29	1.9	3.26	1.8	216.5	0.71	>10%
			- Industry	48	1.5	1.58	1.3			
15.2)	IS planning	- Theoretical	- Academic	59	3.9	2.73	1.7	217	0.69	>10%
			- Industry	119	3.6	2.91	1.7			
		- Practical	- Academic	38	2.5	3.45	1.9	160.5	1.98	5%
			- Industry	47	1.4	1.64	1.3			
16)	**General:**									
16.1)	Ethical &	- Theoretical	- Academic	54	3.6	0.91	1.0	150	2.21	5%
	social		- Industry	79	2.4	3.63	1.9			
	implications	- Practical	- Academic	17	1.1	2.25	1.5	238	0.23	>10%
			- Industry	30	0.9	1.48	1.2			
16.2)	Ergonomics	- Theoretical	- Academic	39	2.6	1.97	1.4	193	1.24	>10%
			- Industry	68	2.1	2.78	1.7			
		- Practical	- Academic	19	1.3	2.60	1.6	236	0.28	>10%
			- Industry	32	1.0	1.91	1.4			

Notes for Contributors

The prime purpose of the journal is to publish original research papers in the fields of Computer Science and Information Systems, as well as shorter technical research papers. However, non-refereed review and exploratory articles of interest to the journal's readers will be considered for publication under sections marked as Communications or Viewpoints. While English is the preferred language of the journal, papers in Afrikaans will also be accepted. Typed manuscripts for review should be submitted in triplicate to the editor.

Form of Manuscript

Manuscripts for *review* should be prepared according to the following guidelines.

- Use wide margins and $1\frac{1}{2}$ or double spacing.
- The first page should include:
  - title (as brief as possible);
  - author's initials and surname;
  - author's affiliation and address;
  - an abstract of less than 200 words;
  - an appropriate keyword list;
  - a list of relevant Computing Review Categories.
- Tables and figures should be numbered and titled. Figures should be submitted as original line drawings/printouts, and not photocopies.
- References should be listed at the end of the text in alphabetic order of the (first) author's surname, and should be cited in the text in square brackets [1, 2, 3]. References should take the form shown at the end of these notes.

Manuscripts accepted for publication should comply with the above guidelines (except for the spacing requirements), and may be provided in one of the following formats (listed in order of preference):

1. As (a) LaTeX file(s), either on a diskette, or via e-mail/ftp – a LaTeX style file is available from the production editor;
2. As an ASCII file accompanied by a hard-copy showing formatting intentions:
   - Tables and figures should be on separate sheets of paper, clearly numbered on the back and ready for cutting and pasting. Figure titles should appear in the text where the figures are to be placed.
   - Mathematical and other symbols may be either handwritten or typed. Greek letters and unusual symbols should be identified in the margin, if they are not clear in the text.

   Further instructions on how to reduce page charges can be obtained from the production editor.
3. In camera-ready format – a detailed page specification is available from the production editor;
4. In a typed form, suitable for scanning.

Charges

Charges per final page will be levied on papers accepted for publication. They will be scaled to reflect scanning, typesetting, reproduction and other costs. Currently, the minimum rate is R20-00 per final page for LaTeX or camera-ready contributions and the maximum is R100-00 per page for contributions in typed format.

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Letters to the editor are welcomed. They should be signed, and should be limited to less than about 500 words.

Announcements and communications of interest to the readership will be considered for publication in a separate section of the journal. Communications may also reflect minor research contributions. However, such communications will not be refereed and will not be deemed as fully-fledged publications for state subsidy purposes.

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Contributions in this regard will be welcomed. Views and opinions expressed in such reviews should, however, be regarded as those of the reviewer alone.

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Contents

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