End User Computing and End User Development: Exploring Definitions for the 21st Century

Sandra Barker, University of South Australia, Australia; E-mail: sandra.barker@unisa.edu.au

ABSTRACT
As end user computing continues to impact on businesses around the world, students in the fields of business and management need to be aware of how EUC and EUD impact on their future careers. This paper examines the plethora of definitions from the last 25 years of literature from a student and academic perspective and looks at how students have made attempts towards the development of clearer definitions for the future.

INTRODUCTION
End user computing (EUC) is a theoretical issue which came to prominence in the early 1980s with the introduction of personal computers (PCs) and has now become prolific throughout business due to the decreased cost of the available PCs and the introduction of "easy-to-use" software application generators such as the Microsoft ® Office Suite and the more freely available Open Source software. End user computing has been defined in many ways however the most often used definition is one which incorporates the facts that end user computing involves the interaction of managers, professionals and operational level users with application software within their own working departments (Torkzadeh & Doll, 1993).

A review of the literature has identified that much research over the past 25 years has been particularly in the areas of end-user satisfaction with information systems (not necessarily end-user developed), end-user computing in terms of the general use of computers, the development of spreadsheet applications by end-users, and the identification of who end-users are and the organisational areas which are affected by end-users (Rockart & Flannery, 1983; Brancheau & Brown, 1993; Powell & Moore, 2002). There has also been significant research published on the issues that impact on end-user development but little regarding how this can be addressed in the current technological environment.

Over this 25 year period there has been a significant change in the available technology (hardware and software), the introduction of technology into education increasing the computer literacy of the users and a change in the information technology culture within organisations (Rockart & Flannery, 1983; Brancheau & Brown, 1993; McBride & Wood-Harper, 2002). However, the changes in technology and use of technology do not appear to have been reflected in the ways that end user computing and end user development are defined. This paper explores the definitions developed in the past literature and works towards the development of a more concise and relevant definition for the future which reflects these changes.

BACKGROUND
The first papers relating to End-user Computing (EUC) were published in the late 1970s (McLean, 1979 and Codasyl report, 1979, as cited in Cotterman & Kumar, 1989). In the 1970s computing was identified with mainframe computers and end-user computing appeared to relate to one of three types of computer use: indirect use (where computing tasks were undertaken for the requester), intermediate use (where instructions were given by the person requesting the information as to the format the information would take) and direct use (where information was retrieved by the user using a terminal).

The introduction of PCs in the early 1980s lead to EUC being reported as '…a rapidly growing and irreversible phenomenon' (Alavi & Weiss, 1985, p6). The research into EUC has lead to a number of differing definitions being developed dependent upon the researcher's experience and how they classified end-users.

DEFINING END USERS
Rockart and Flannery (1983) identified that in order to understand EUC it is necessary to know who the users are, where they work and what they do. As part of this they developed six classifications of end-users dependent upon their function within the organisation. These classifications were:

- Non-programming end-user: have access to computerised data through simple menus or structured instructions
- Command level end-user: access data on their own terms. They are classified as being willing to learn just enough about the software to obtain the data required
- End-user programmers: develop applications for use by themselves and others in their department. They are able to undertake some programming using command and procedural languages.
- Functional support personnel: actively support end-users from within their own department. These persons have a sophisticated understanding of the software being used in the organisation.
- End-user computing support personnel: most commonly a formal support centre who have good general knowledge of most programming techniques.
- Data processing programmers: uses who are the most knowledgeable within an organisation of the end-user programming tools being utilised. (Rockart & Flannery, 1983)

The first three of these classifications relate primarily to non-information systems specialists who either: (1) use computers in their daily business to obtain information; (2) can use more complicated commands to filter information to obtain relevant and complex results and (3) use computer language (coding) to develop software applications for their own use (or for the use of others in their department). The remaining classifications relate to the classification of support personnel who are available to develop applications for users or to assist the users in their development and/or use of software applications. These classifications expanded upon those defined by the Codasyl report (1979, as cited in Cotterman & Kumar, 1979) by being more prescriptive with their definition of how the end-users interacted with the technology. Early researchers (eg Rockart & Flannery, 1983) reported on a producer/consumer dichotomy when it came to describing end-users whilst other researchers (Leithseier & Wetherbe, 1985 as cited in Cotterman & Kumar, 1989) reported on the comparison between the end-user operator and the end-user developer.

Leithseier and Wetherbe (1986) amended their research to include a third component, that of the amount of control that the manager or user has over the computer resources. According to Amoroso (1988) end users are defined as those that develop applications according to their needs in an environment where they have access to personal computers, data and support resources. This definition did not take into account the research of Leithseier and Wetherbe (1985, 1986) or Rockart and Flannery (1983) which outlined specific categories of end users and the tasks that they performed.

Cotterman and Kumar (1989) developed a taxonomy of end-users based upon this research. It was already apparent at this early stage in the research into end-user

computing that some end-users (ie non-Information Systems trained users) were undertaking some application development. It was identified in their paper that it is imperative to understand who the users are to ensure that each class of user is treated appropriately and that the relevant training, education and management approaches are used to assist them in their daily tasks. The development of the user cube taxonomy was undertaken using a morphological analysis technique, identifying known variables and parameters from current literature, developing an orthogonal structure and then testing the taxonomy by using the previous classifications of end users to see if they fit in the new structure (Cotterman & Kumar, 1989).

The User Cube has been recently reviewed in an attempt to operationalise the taxonomy and assist in the classification of todays, more knowledgeable, end users (Govindarajulu, 2003). This review determined that the User Cube was an excellent starting point for the classification of users by using the dimensions of operator, developer and controller. It also highlighted that the users did not necessarily fall neatly into one of the three dimensions but that there could be much overlap between the dimensions leading to the inevitable 'power user' who is conversant in all of the dimensions.

DEFINING END USER COMPUTING

Davis and Olson (1985, cited in Amoroso, 1988, p50) defined EUC 'as the capability of users to directly control their own applications and computing needs.' Amoroso (1988, p50) identified that 'end-user computing has further been described as an alternative development approach in which the user can avoid the traditional development complexities, time delays, and communication problems'.

In the early 1990s, Brancheau and Brown (1993, p439) reviewed the previous 10 years of research into end-user computing. They commenced their paper by defining end-user computing as the 'adoption and use of information technology by personnel outside the information systems department to develop software applications in support of organisational tasks'. This paper concentrated on the research into the management issues related to end-user computing and used the Rockart and Flannery (1983) classification of users as a basis for the research. Brancheau and Brown (1993, p 477) concluded that 'failure to build on prior EUC research and failure to rely on theoretical knowledge accumulated in key reference disciplines have been major obstacles to furthering our understanding of EUC management'.

At the same time as Brancheau and Brown were espousing their thoughts a broader definition of EUC was introduced. Rainer and Harrison (1993, cited in Downey & Bartczak, 2005, p3) defined EUC 'as the direct, individual use of computers encompassing all the computer-related activities required or necessary to accomplish one's job'.

According to Garavan and McCracken (1993) EUC is defined as the managerial and professional use of computer power as compared with clerical tasks which use the same computer hardware.

A more refined and succinct definition of end-user computing was then proposed by Chan and Storey (1996, p119) where they stated that 'end-user computing was the autonomous use of information technology by knowledge workers outside the IS department' and that EUC is an 'important part of organizational computing today'.

Powell and Moore (2002) picked up where Brancheau and Brown left off using similar research criteria. Since their study followed the same parameters it seems logical that they used the same definition of EUC as Brancheau and Brown however this definition is solely targeted at the "development of applications" and does not look at the use of applications developed for end users. This makes the focus of the research limited to management issues related to end user application development rather than an overall view of the organizational issues being experienced due to the general usage of computers in business.

Martin, Brown, DeHayes, Hoffer and Perkins (2005) define end user computing as an activity which involves implementing all the applications for different levels, such as supportive applications, personal applications and organizational systems. Downey and Bartczak (2005, p4) researched previous definitions and concluded that the most appropriate definition, for their study, was to define EUC as 'the use and/or development of computing technology and software applications by end users to solve organizational problems and assist in decision making'.

From an academic standpoint, the term end-user computing has traditionally been used to refer to the study of the management issues involved with providing services for non-specialist users of information systems. That is essentially anyone who is not an IT specialist who may be involved in developing or supporting systems (Chaffey & Wood 2005, p.558).

As can be seen the definitions of the past have been specifically designed to match the research being undertaken. It is the belief of the author that this is leading to serious confusion not only within the academic community but also with practitioners and managers as to what actually constitutes end user computing and consequently what actually needs to be managed.

DEFINING END USER DEVELOPMENT

Harrison stated that 'EUD is an activity that has been around almost as long as computers' (cited in Pickard 2005, p. 1). Many of the definitions of end user computing within the literature refer to development as part of the definition (Brancheau & Brown, 1993; Downey & Bartczak, 2005; Shah & Lawrence, 1996; Shayo, Guthrie & Igbaria, 1999). However, 'the actual term of end user development would refer however to a non-IT specialist creating their own applications to support their work' (Chaffey & Wood 2005, p.559). McGill (2005) takes the definition a little further by identifying that the development could not only support the end-user developer's work but also the work of other end users in the department or organisation.

From a software engineering perspective, EUD is said to mean, in general, the 'active participation of end users in the software development process' (Costabile et al 2005, p.1). End-user development activities are said to vary from "customization to component configuration" as well as programming, with Office software providing customization facilities and Web scripting said to provide interactivity tools for end-users of Web sites (Fischer et al, 2004)

Jawahar and Elango (cited in McGill 2005, p. 21-22) explicate that EUD of applications form a significant part of organisational systems development 'with the ability to develop small applications forming part of the job requirements for many positions.'

Sutcliffe and Mehandjiev (2004) state that EUD is about taking control, not only of personalizing computer applications (EUC) and writing programs, but of designing new computer-based application without ever seeing the underlying program code.

What can be gleaned from these literature definitions is that end user development is an important part of end user computing and that it can support not only the end user developer in their daily duties but also the duties of other end users in the department.

STUDENT PERCEPTIONS AND DEFINITIONS

Students undertaking a Master of Business (Administrative Management) degree program are required to study a course in Data Management which concentrates on the role of the end user (particularly at an administrative or middle management level) in the data and information management within the organisation. As part of the course the twenty two students were required to research the past definition of end user computing and end user development and then, using the research, propose a new set of definitions which brought the area of research into the 21st century.

To provide a definition of EUC requires an understanding of who the end-users of today are and how they interact with technology. The only difference between the eighties and now is that end user computing is no longer a unique concept confined to the office or a narrow field of study, but has reached the point where practically every task performed in the business environment has a connection to an information system and can therefore be potentially be classified as EUC. As long as technology is used in the workplace and people are expected to use information systems or technology to perform their job, then the final definition in this paper is the most contemporary and applicable. An attempt to narrow the definition denies the fact that technology has become so integrated in both the personal and professional lives of people in developed countries that we are practically all engaged in end user computing on some level. (Student C)

Table 1. Number of student referrals to particular literature definitions (where total referrals >2) * - references given as part of the course reading materials; ** - course text book

Reference	End User Computing Definition	End User Development Definition
Amoroso (1988)		3
Bocij et al (2003) *	5	2
Brancheau & Brown (1993)*	7	1
Chaffey & Wood (2005) **	6	5
Costabile et al (2005)		3
Cotterman & Kumar (1989)*	6	
Downey (2004)*	7	
Govindarajulu (2003)*	3	
Jawahar & Elango (2001)		4
McGill (2004)*		7
Powell & Moore (2002)*	4	
Rainer & Harrison (1993)	3	
Rockart & Flannery (1983)	3	
Sutcliffe & Mehandjiev (2004)*		6
Other	47 (from 37 different sources)	14 (from 11 different sources)

Students investigated a plethora of literature to inform their understanding of past definitions of the terms being investigated. Overall fifty eight resources (journal articles, textbooks and internet articles) were used in the development of this understanding. The most common sources are listed in Table 1.

Although the students predominantly cited definitions from literature that had already been sourced for them (either their textbook or required readings), many students were able to locate many other sources of literature which contained definitions of the terms under investigation.

Student B reflected the thoughts of the many of the students by commentingd that 'in the 21st century, EUC should consider as a group or an individual non-technical EU adopting any kind of information technology applications, including information generation and processing, web applications and multimedia approaches under a secure computing environment' While a few of the students were broader in their comments. These comments are best summed up by student C who stated that 'EUC in the twenty first century includes, everyone who uses information systems to deliver a service or develop solutions that provide an information output within an organisation.' Many of the students did not directly develop new definitions but chose to make comment on the definition that they believe best fit the requirements of the assignment. These students chose to reflect on the definitions from Chaffey and Wood (2005), Suttcliffe and Mehandjiev (2004) and Powell and Moore (2002).

Student D made some interesting observations by identifying that 'end user computing and development was now in the hands of the end users themselves, which arose from many reasons including wider use of cheaper and more powerful computers and more user friendly applications for example. Now end users have developed the skills to benefit from information technology much more than they had previously been exposed to during the early years.'

End-user computing and development is a widespread phenomenon; many organisations, despite their size and activity integrate it in their information strategy. The terminology has been subject to fundamental change resulted from technology advancements, change, organisational structures and the way we look at information and knowledge. The technology-based view has replaced by the humanised knowledge management focus. It has moved from being a tactical issue to be a major ingredient in organisation's information strategy. End-users now can respond quicker and more effective to problems due to the given control and responsibility. This can place the organisation on a leading edge, however,

lack of training in the strategy and consequently poor development of applications can leave the organisation on a bleeding edge. (Student J)

Student G defined EUC in the 21st century as 'the resultant processing of data obtained and recorded by end users in conjunction with company objectives and overseen with company control.' This definition is quite interesting as it includes the end user as a primary part of the process rather than an outcome as found in the predominate literature of the past. However, in the opinion of the author, the most interesting definition of EUC offered by the students for the 21st century stated that 'end user computing is defined as the management of information technology systems and development, incorporating different levels of personnel to best pursue strategic objectives by facilitating organizational functional requirements' (Student V).

Very few of the students were able to determine a new definition for EUD which reflected the changes in technology and user expertise that have occurred over the past 25 years. Student B determined that '...a modified definition of the term EUD in the 21st century could define as a non-technical EU modified, generated or created customised application using existing IS and advancing technology, providing solutions to personal needs and demands'. On the other hand Student G postulated that 'EUD in the 21st century: the development of complex, server-based processing applications structured in conjunction with company objectives and designed for ease of use for the end users.' This is an interesting definition as it considers end user development as the development of applications for end users, not necessarily by end users. It is this definition that reflects the confusion being purported in previous literature and shows the need for a more definite, clear focus on the definitions of EUC and EUD.

Reflecting on the students' thoughts and attempts at defining the terms the author has developed new definitions for each of the terms. End User Computing (EUC) can now be defined as the use of computing technology and/or software applications, together with the enhancement and/or development of information systems by end users. On the other hand end user development (EUD) is, more specifically, the development, modification and/or enhancement of information systems applications by end users for individual, departmental or organisational use.

FUTURE RESEARCH

The literature of the past 25 years has given us plenty of definitions of end user computing and, to a lesser extent, end user development. The problem with this plethora of definitions is the confusion that can be caused when researching the topic. Researchers need to be aware of the exact context of each of the definitions and then attempt to relate the definition chosen to the context of their new research. Making an incorrect choice of definition could be disastrous as it could completely change the focus of the research being undertaken.

Students trying to understand the concepts of end user computing and end user development are also confused by the mass of slightly different definitions as can be seen in their attempts to redefine the terms given all of the background research.

Thus it is time for a more meaningful and direct definition of each term which will take us through the 21st century and all the possible changes in technology, user ability and technology use. The definitions proposed by the students are a good starting point however the time is now ripe for more in-depth studies of the perceptions and understandings of EUC and EUD in the practical arena with the opportunity to use these studies to finally propose serious 21st century definitions.

This research into the definitions of EUC and EUD forms the starting point for a more in depth look at end user computing and end user development in today's business environment being undertaken by the author. The key foci of this major project are the impacts of EUC and EUD on the business (from many perspectives) and the how management handles the plethora of end user applications being developed. By clearly defining the terms for the 21st century, the author believes that this future research will be easier to describe the terms to the participants which, in turn, will allow the results of the research project to be translatable into today's business environment.

PRACTICAL IMPLICATIONS

For the definitions to be of any practical use they must not only assist the academics in the contextualisation of their research but also allow end users and

managers alike to understand the concepts of EUC and EUD as they apply to their particular context. It will also give management the chance to develop policies and procedures in order to efficiently and effectively manage their personal who undertake end user development within their work environment.

CONCLUSION
This paper has shown that the plethora of definitions of EUC and EUD in the literature of the past has given rise to some serious confusing and misunderstanding by students and academics alike. In an attempt to dispel this confusion, students undertaking a Master of Business degree put forward their ideas and suggestions as to how these definitions could be better explained for the 21st century.

Although no one individual student was able to propose a new, more decisive description of these terms, the author has been able to use a combination of the literature with the student ideas to propose two new definitions which will be used to further the author's research in this field.

Although the author believes that these new definitions will hold in current and future business contexts the thoughts of Student V are pertinent and provide some indication of areas that need consideration when researching this area in the future.

Perhaps it is time to stop looking at the benefits of one group winning over the other and start looking more often at the benefits of both groups working collaboratively. In the end, in a society where development is most often driven by money, history tells us that the most cost effective option will probably endure. To this end the cost versus risk debate will go on until the risks on one end and the costs on the other are minimized. Once this point is reached the definition of end user computing may well look different again. (Student V)

REFERENCES
Alavi, M., & Weiss, I.R. (1985). Managing the Risks Associated with End-User Computing, *Journal of Management Information Systems, 2*(3), 5-20
Amoroso, D.L. (1988). Organizational Issues of End User Computing, *ACM SIGMIS Database, 19*(3-4), 49-58
Bocij, P., Chaffey, D., Greasley, A., & Hickie, S. (2003). *Business Information Systems: Technology, Development and Management for the e-business*, Prentice Hall, Harlow, England.
Brancheau, J.C., & Brown, C.V. (1993). The Management of End User Computing: Status and Directions, *ACM Computing Surveys, 26*(4), 437-482
Chaffey, D., & Wood, S. (2005). *Business Information Management Improving Performance Using Information Systems*, Pearson Education Limited, Essex, England.
Chan, Y.E. & Storey, V.C. (1996). The use of spreadsheets in organizations: Determinants and consequences, *Information & Management, 31*(3), 119-134
Costabile, M.F., Fogli, D., Mussio, P. & Piccinno, A. (2005). A meta-design approach to End-user development, in *Proceedings of the 2005 IEEE Symposium on Visual Languages and Human-Centric Computing*, IEEE Computer Society, 308-310
Cotterman, W.W. & Kumar, K. (1989). User Cube: A Taxonomy of End-users, *Communications of the ACM, 32*(11), 1313-1320
Downey, J.P. (2004). End User Computing Research Issues and Trends (1990-2000), *Journal of Organizational and End User Computing, 16*(4), 1-16
Downey, J.P. & Bartczak, C.A. (2005). End User Computing Research Issues and Trends (1990-2000) in *Advanced Topics in End User Computing, Volume 4,* (pp1-20) ed MA Mahmood, Idea Group Publishing, Hershey, PA, USA,
Fischer, G., Giaccardi, E., Ye, Y., Sutcliffe, A.G., & Mehandjiev, N. (2004). End-user development: meta-design a manifesto for end-user development, *Communications of the ACM, 47*(9), 33-37
Garavan, T.N. & McCracken, C. (1993). Introducing End-user Computing: The Implications for Training and Development-Part 1, *Industrial & Commercial Training, 25*(7), 8-14.
Govindarajulu, C. (2003). End Users: Who Are They?, *Communications of the ACM, 46*(9), 152-159
Jawahar, I.M. & Elango, B. (2001). The effects of attitude, goal setting and self-efficacy on end user performance, *Journal of End User Computing, 13*(2), 40-45
Leithseier, R.L. & Wetherbe, J.C. (1985). The successful information centre: what does it take? in the *Proceedings of the Twenty-first annual conference on Computer personnel research*, ACM Press, 56-65.
Leithseier, R.L. & Wetherbe, J.C. (1986). Service Support Levels: An Organized Approach to End User Computing, *MIS Quarterly, 10*(4), 337-349
Martin, E., Brown, C., DeHayes, D., Hoffer, J., & Perkins, W. (2005). *Managing Information Technology*, Pearson Education.
McBride, N. & Wood-Harper, A.T. (2002). Towards User-Oriented Control of End-User Computing in Large Organizations, *Journal of End User Computing, 14*(1), 33-42
McGill, T. (2004). The Effect of End User Development on End User Success, *Journal of Organizational and End User Computing, 16*(1), 41-58
McGill, T. (2005). The Effect of End User Development on End User Success in *Advanced Topics in End User Computing, Volume 4,* (pp21-41) ed MA Mahmood, Idea Group Publishing, Hershey, PA, USA
Pickard, M.M. (2005). Old issues, new eyes, in *Proceedings of the first workshop on End-user software engineering, 30*(4), 1-3
Powell, A. & Moore, J.E. (2002). The focus of research in end user computing: where have we come since the 1980s?, *Journal of End User Computing, 14*(1), 5-22
Rainer, R.K. & Harrison, A.W. (1993). Toward development of the end user computing construct in a university setting, *Decision Sciences, 24*(6), 1187-1202
Rockart, J.F. & Flannery, L.S. (1983). The Management of End User Computing, *Communications of the ACM, 26*(10), 776-784
Shah, H. & Lawrence, D. (1996). A study of end-user computing and the provision of tool support to advance end-user empowerment, *Journal of End User Computing, 8*(1), 13-21
Shayo, C., Guthrie, R. & Igbaria, M. (1999). Exploring the Measurement of End User Computing Success, *Journal of End User Computing, 11*(1), 5-14.
Sutcliffe, A. & Mehandjiev, N. (2004). End-user development: introduction, *Communications of the ACM, 47*(9), 31-32
Torkzadeh, G. & Doll, W.J. (1993). The place and value of documentation in end-user computing, *Information & Management, 24*(3), 147-158.

Related Content

Efficient Cryptographic Protocol Design for Secure Sharing of Personal Health Records in the Cloud
Chudaman Devidasrao Sukte, Emmanuel Markand Ratnadeep R. Deshmukh (2022). *International Journal of Information Technologies and Systems Approach (pp. 1-16).*
www.irma-international.org/article/efficient-cryptographic-protocol-design-for-secure-sharing-of-personal-health-records-in-the-cloud/304810

BitTrace: A Data-Driven Framework for Traceability of Blockchain Forming in Bitcoin System
Jian Wu, Jianhui Zhangand Li Pan (2024). *International Journal of Information Technologies and Systems Approach (pp. 1-21).*
www.irma-international.org/article/bittrace/339003

NLS: A Reflection Support System for Increased Inter-Regional Security
V. Asproth, K. Ekker, S. C. Holmbergand A. Håkansson (2014). *International Journal of Information Technologies and Systems Approach (pp. 61-82).*
www.irma-international.org/article/nls/117868

Quality Online Learning in Higher Education
Deborah G. Wooldridge, Sandra Poirierand Julia M. Matuga (2018). *Encyclopedia of Information Science and Technology, Fourth Edition (pp. 3930-3944).*
www.irma-international.org/chapter/quality-online-learning-in-higher-education/184101

Cognitive and Psychological Factors in Cross-Language Information Retrieval
Rowena Li (2018). *Encyclopedia of Information Science and Technology, Fourth Edition (pp. 4490-4501).*
www.irma-international.org/chapter/cognitive-and-psychological-factors-in-cross-language-information-retrieval/184157