The guru and the wizard: psychological issues in the development and use of intelligent interfaces

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Abstract

This paper describes a study that examined some psychological factors involved in the development and use of intelligent systems in Nigeria. The study explored the interaction between the factors to gain deeper understanding of the relationship between human experts and their use of intelligent systems. A questionnaire was administered to 402 developers and users of intelligent systems such as games (e.g. chess), wizards, graphical user interfaces, and Internet search engines. The results suggest: that although software developers and users appreciate interface intelligence, they tend to prefer a moderate level of intelligence; that software developers and skilled users tend to dislike systems' domination and control; and that there is a growing tendency towards more and more intelligent applications software. The paper concludes that psychological issues are crucial to the effective design of intelligent systems.
Keywords: intelligent interfaces, preference for high interface intelligence, psychological factors, knowledge agents, systems users, expert users, wizards, guru.

1 Introduction

Knowledge and intelligence had, until the emergence of the computer, been considered the exclusive preserve of human beings. With the development of computing power from simple numerical processing through data processing to database management and eventually to knowledge processing, the computer has moved closer and closer to the human mind in knowledge and intelligence manipulation. Following the success of the Fifth Generation Computer project being spear-headed by Japan since 1980, Artificial Intelligence (AI) has gained

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prominence. Then the field of expert systems design and construction started to play a more significant role in knowledge processing and creation of knowledge agents.

An event of great significance was demonstrated on the chessboard in November 1997 when the expert system computer "IBM Deep Blue" defeated the world chess champion Gary Kasparov. For the first time in history, an artificial intelligent system became the world chess champion! Blanchard [1]. This is significant because chess has been traditionally regarded as the de-facto intellectual game, used by cognitive psychology as a measure of intelligence [2]. How Gary Kasparov and others might have felt? Probably shaken! And there is every reason to suspect that such feelings may spread from the chessboard to the workplace as more and more intelligent systems replace human experts.

This paper presents an attempt to study the interaction between human users and intelligent computer systems in Nigeria. It introduces some new concepts such as: Cognitive Sufficiency; Preference for High Interface Intelligence; System Control Resentment; Status Denigration Anxiety; System Adoption Anxiety; and Sibling Rivalry. The paper is divided into five parts. This section one covers the introduction, section two presents the background to the study, section three presents the methodology, section four covers the results, and section five concludes the paper.

2 Background to the study

The use of the computer has become a veritable world culture, making information systems an integral part of the society. Normally, an information system is composed of: (1) the hardware component (the electro-mechanical aspect), (2) the software component (the set of instruction or code to guide the activities of the hardware component), and (3) the "humanware" component (the human element - designers, operators, programmers, analysts, users, etc.). All these components must interact perfectly and smoothly through the various interfaces within the system. The use of intelligent interfaces is actually insulating human beings from the need to learn more extensively before being able to interact with the hardware and software.

Hayes-Roth and Jacobstein [3] show that intelligent systems have attained a permanent place in the industry and have been deployed for the purpose of increasing industrial productivity in roles such as assistants to human operators and as autonomous decision-making components of complex systems. They envision a world filled with millions of knowledge agents where "the boundary between human knowledge agents and machine agents is invisible". Similarly, Sugumaran and Bose [4] observe that expert systems technology has been successfully used in many areas such as aerospace, communications, robotics, process control, and finance. They state that intelligent systems have surpassed human beings in the roles of watchdogs or daemons (specialised systems which alert users when certain conditions arise - often used in server-client environments), and that they offer opportunity for improved techniques - e.g. the object-oriented approach and computer-aided projects.

Bamitale [5] indicates that because of the increasing reliance on the computer for the performance of tasks hitherto regarded as humans, especially in the areas of control systems, robotics, object-oriented programming, etc, and following from the benefits that have accrued therefrom, more and more efforts are being directed towards the development of more intelligent or "smart" systems There are abundant reasons to assert that intelligent and knowledge-based systems will proliferate in the future. Some of the reasons for the proliferation of intelligent systems are as follows:

i) Knowledge, experience and expertise are strategic factors in securing long term competitiveness by organisations and countries. Hence knowledge is highly valued and much more efforts will be made to further domesticate knowledge through advanced technologies.

ii) Experts are scarce because it takes long to make human beings expert in any specific domain. Much more efforts would thus be made to multiply the knowledge of existing experts through artificial intelligence system technology.

iii) There is a globally recognised need to reduce dependence upon external sources of human domain knowledge - e.g. consultants. Preference is and will be given to internal knowledge agents who will be under the control of the management and the organisation. If non-human knowledge agents could be procured then most of the human-based problems of experts might be solved.

iv) The growth in robotics and use of robots require correspondingly sophisticated software that could simulate highly intelligent behaviours. The leap to intelligent software is necessary if existing robotics systems are to have sufficient independence to cover wider range of influence

v) The use of computer assistants - as in computer aided design (CAD), computer aided manufacturing (CAM) computer aided software engineering (CASE), Wizards, etc - only serve to show that knowledge-based or intelligent systems are already a part of our lives. Omodorion [6] shows that the productivity of engineering firms is significantly increased through the use of Computer Assistants - CAD, CAM and Robots.

In spite of the role that knowledge plays in knowledge-based systems, and considering that knowledge can be sourced ultimately only in human beings, much emphasis in knowledge elicitation and knowledge acquisition in expert systems development has been placed on the translation to the knowledge-base and less on the human beings who form the pool from which the knowledge built into the intelligent systems are acquired. Studies, such as Sugumaran and Bose [4], Mpako et al. [7] among others, have shown that knowledge acquisition is a major activity in building intelligent systems and that the cost of knowledge acquisition increases dramatically if the system development process requires a great deal of "valuable experts' time". Apart from being valuable in monetary term, the contribution of the human element is a key factor in the quality of the development as well as use of intelligent system.

Because of the vital roles that the human element must play in the development and use of information systems, studies in information science cannot afford to ignore the study of the human element. More [8] hinges the success of information technology on people. Human beings have certain psychological, mental, emotional and physiological assets and liabilities that could either hinder or else promote the development and use of any other components of an information system. According to Rheingold [9] the maintenance of human civilization for the foreseeable future will require both minds and computers. And the challenge will be to shift focus of attention from the way computers work to the way computers are designed to be used by people - *human computer interface*.

A recognition of the vital relationship between human beings and their tools led to the emergence of human factors engineering, and the man-machine model. The Man-Machine model posits that man-machine interaction is in four parts: (1) machine display (or machine output), (2) data processing (or human mental activities), (3) machine control (or human directive action), and (4) the environment (or factors surrounding the man and the machine). This model posits that after a machine has initiated communication by displaying information, the human being must think on the information displayed, take a decision and communicate back in directive action or machine control - and all the activities take place within an environment. The most important activity of man in this interaction is to think and take decision. This is the primary area of psychological research in man-machine interaction.

Human thoughts, feelings, attitudes and actions can affect the quality of the interaction between man and system. Artificial intelligence (AI) systems by their very nature seek to take over certain aspects of the work hitherto reserved for human beings - thinking, taking decisions and controlling activities. Consequently, one should expect some positive and negative fallout from the interaction. As AI systems gradually erode the monitoring and decision-making roles of human beings, the attitude of human beings must be affected one way or another. It thus becomes necessary for studies in information technology to examine the reaction of human beings (systems developers, users and knowledge agents) to the erosion of human influences in the information system domain by AI systems and to see how the man-machine interface compatibility could be affected by this situation.

Consequently, sufficient attention needs to be paid to the thought, feeling and behaviour of the users and developers of the intelligent systems. Although the broad discipline of psychology focuses on the study of human behaviours and experience, cognitive psychology handles human knowledge and thought, while ergonomics deals with the application of psychology and physiology to engineering designs and implementation. These broad disciplines leave a gap which must be filled - cognitive psychology needs to be directly related to knowledge engineering studies. Knowledge engineers need to be conversant with the principles and practice of cognitive psychology while psychologists need to be aware of knowledge engineering constructs.

Knowledge engineering is the arrow-head of man-machine interface, and human factor is a dominant aspect of that interface. Human beings can and do affect the state and quality of intelligent systems while the systems may also affect the behaviour of users. The nature of this bi-directional effect needs to be subjected to empirical study. Hence this study which was designed to generate non-trivial information promoting understanding regarding the planning, design and utilization of Artificial Intelligence systems in Nigeria.

Artificial Intelligence applications are characterized as those programs, which are designed principally to emulate intelligent behaviour. They include game-playing systems such as chess, natural language understanding programs, computer vision, robotics and expert systems. In expert systems, the computer is programmed to play the role of an expert such as medical diagnostician, systems developer, etc, in carrying out one of the expert's tasks. It is argued that one can potentially call any entity that plays chess intelligent. Alan Turing, a researcher in computation classed as being one of the most influential figures in AI, developed the "black box " test of intelligence in 1950. It involves putting the machine behind a curtain and letting it speak to judges. If the system can convince the judges that it is human, it passes the test [10]. Obviously, if most of the intelligent systems in the market today were to be subjected to this test they would pass and be considered, at least narrowly, intelligent.

3 Methodology

In order to implement this study, the survey research design involving four stages was used. The four stages involved were: (a) Observation of systems developers and users, (b) Interview, (c) Questionnaire design and testing, and (d) Survey. The multi-stage data collection work started with the observation of programmers and users in the process of actual use and development of specific software systems - e.g. games - which formed the background for the design of the interview schedule which, in turn, snowballed into the survey instrument, the questionnaire.

3.1 Study population

This study focused on the population of intelligent systems developers, users and knowledge agents in Nigeria. In Nigeria, IT professionals are concentrated in urban centres like Lagos, Port Harcourt, Ibadan, Abuja, Kaduna, Enugu, and the information technology-related departments of the higher institutions. To contact this class of professionals deliberate effort was made to reach out to them in the information technology companies in urban areas and the related departments in higher institutions.

Following from the nature of the population described above, the stratified random strategy was employed. This method of sampling involved dividing of the population into more homogeneous subgroups or strata from which random samples were then taken Vaughan [13]. The key subgroups targeted by this study were: (a) Systems designers/developers, (b) Intelligent systems users, and (c) Knowledge agents (human experts).

3.2 Research Instruments

In accordance with the survey research design proposed for the study, the principle research instrument was the questionnaire. This was a collection of

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questions printed out to elicit information from respondents. The items on the questionnaire were arranged in eight parts. Each part elicited information on variables that were considered important to the study. The eight parts were as follows:

Section A: Personal Data: this sought to capture demographic variables. Variables captured included gender and age.

Section B: Cognitive Sufficiency scale: covers academic qualifications and computing experience, etc.

Section C: Preference for High Interface Intelligence Scale: covers interface intelligence as well as whether it is preferred or not.

Section D: System Control Resentment Scale: measures degree of resentment of systems control.

Section E: Status Denigration Anxiety Scale: measures degree of anxiety related to the effect of systems on professional status.

Section F: System Adoption Anxiety Scale: measures level of anxiety about systems adoption.

Section G: Sibling Rivalry Scale: measures degree of love-hate relationship with intelligent systems.

Section H: Computer Attitude Scale: measures degree of negativeness of attitude to the computer.

To measure the internal validity of the scale, an alpha coefficient or Cronbach's reliability index was calculated for each scale, using the Statistical Package for Social Sciences (SPSS). This score shows the extent to which the items in each scale share a common factor Table 1.

Table 1: Result of reliability analysis.

	Mean	**Number of Items**	**Variance**	**Alpha**	**Standard Alpha**
Cognitive Sufficiency	0.2588	9	0.0840	0.7176	0.7586
Preference for High Interface Intelligence	0.2682	6	0.0621	0.6947	0.6874
System Control Resentment	0.3164	8	0.0346	0.7254	0.7873
Status Denigration Anxiety	0.2489	6	0.0924	0.6978	0.6654
System Adoption Anxiety	0.3739	6	0.0834	0.7517	0.7818
Sibling Rivalry	0.4288	6	0.0408	0.7622	0.8183
Computer Attitude	0.2625	8	0.0776	0.7241	0.7401

3.3 Data analysis

Using the SPSS, the data collected from the questionnaires administered in the fourth stage was subjected to both descriptive and inferential statistical analysis.

4 Results

4.1 Demographic Statistics

As indicated above, the respondents for this study were drawn from the following towns and cities in Nigeria where the questionnaire was administered: Lagos, Ibadan, Port Harcourt, Abuja, Kano, Kaduna, Enugu, and Akure. Detail analysis of the respondents from the various towns and cities in Nigeria are presented in Table 2.

Table 2: Analysis of respondents by town.

Town	**Number of Respondents**	**Percentage (%)**	**Cumulative Percentage (%)**
Lagos	103	25.6	25.6
Ibadan	97	24.1	49.8
Portharcourt	82	20.4	70.1
Abuja	47	11.7	81.8
Kano	21	5.2	87.1
Kaduna	16	4.0	91.0
Enugu	22	5.5	96.5
Akure	14	3.5	100.0
Total	**402**	**100.0**	

The respondents were made up of sixty-five (65) females (16.2%) and three hundred and thirty-seven (337) males (83.8%). The maximum age was 52 years, the minimum age was 20 years while the mean age was 30.86 (Standard Deviation: 6.80)

Two hundred and twenty (54.7%) had their academic qualification in Computer and Information Technology, 38 (9.5%) from Law and Social Sciences, 34 (8.5%) from Electrical and Electronics Engineering, 32 (8.0%) from Pure and Applied Sciences, eight (2.0%) were from the Medical and Health Sciences while 70 (17.4%) were from other academic areas.

In terms of their contribution to the field of intelligent systems, the respondents were grouped into three major categories: (a) Designers and Developers, (b) User of AI Systems and (c) Knowledge Agents. Table 3 gives an analysis of the classification of the respondents in term of their position as stakeholders in AI development and use. To arrive at the classification presented in Table 3 respondents were actually asked to indicate the role they play in AI development and use.

Table 3: Classification of respondents by role in AI development and use.

	Number of respondents	**Percentage (%)**	**Cumulative Percentage (%)**
Designers/Developers	120	29.9	29.9
Users of AI Systems	196	48.8	78.6
Knowledge Agents	86	21.4	100.0
Total	**402**	**100.0**	

Concerning computing experience, that is the years of experience in using the computer, 72 respondents (17.9%) reported having at least ten years experience, 97 (24.1%) had six to nine years experience; 102 (25.4%) had 3-5 years experience while 30 (7.5%) had no computing experience.

4.2 Artificial Intelligence systems developers and development

From Table 3.3, the total number of Designer/Developers in the sample was presented as 120. This section describes the developers in more detailed to give a clearer picture of intelligent systems developers and development in Nigeria.
Age: The minimum age is 20 years, maximum age is 45 years while the mean age is 29.46 years.
Sex: There were 14 (11.7%) females and 105 (88.3%) males.
Disciplines: Eighty eight designers/developers (73.3%) were from Computer/Information Technology; fifteen (12.5%) were from Electrical / Electronic engineering, eight (6.7%) were from Medical and Health Sciences, and nine (7.5%) were from other disciplines.

4.3 Computing experiences of developers

One hundred designer/developers (83.3%) had at least one year computing experience while 39 (32.5%) reported having more than ten years experience. When asked to define their knowledge level, 22 (18.3%) of the designers/ developers reported having excellent knowledge of intelligent systems, 62 (51.7%) claimed higher than average knowledge and 27 (22.5%) average knowledge, in all 92.5% of the developers rated themselves as having at least average knowledge of intelligent systems development.

4.4 Use of MS Wizards by designers/developers

Ninety one designer/developers (75.8%) had used MS wizards before. And considering the frequency of Wizards' usage, 66 (55.0%) were always using Wizards, 32 (26.7%) used wizards occasionally, while 22 (18.3%) reported that they never used wizards.

4.5 Interface generally preferred by developers

Eighteen (15.0%) designers/developers preferred low intelligent interfaces, 68 (56.7%) preferred moderately intelligent interfaces while 34 (28.3%) designers/developers preferred highly intelligent interfaces.

4.6 Participation in systems development

The degree of participation in systems development as reported by the respondents is as follows: 22 (18.3%) were almost always participating, 49 (40.8%) participated sometimes, while 102 (85.0%) reported having participated at least once in systems development.

4.7 Tools used in AI development

Concerning the tools used in AI development works, 26 (21.7%) reported using expert systems shells, 43 (35.8%) reported using traditional programming languages, 26 (21.7%) used logic programming languages, 16 (13.3%) used object oriented programming languages, while 8 (6.7%) reported using Wizards.

5 Discussion and conclusion

Development in AI has shown that much focus has been on: (i) Robots, (ii) game programs (e.g. Chess), (iii) expert system and (iv) embedded intelligent systems in common applications making AI more popular as observed by Blanchard [11]. Although not at the same pace with the four above, other AI areas being systematically developed include: neural network, speech recognition, virtual reality, fuzzy logic, genetic algorithm and data mining. The implication of these developments is that intelligent systems become so pervading that “the average man-on-the-street is no longer fascinated by the possibilities of expert systems and speech recognition software” Blanchard [1].

However, AI is still bedeviled with some problems bordering on the human component. These human-related problems include problem of non-use, problems of non-cooperation of human experts, problem of resistant to control, and problem of sabotage. Rugg and McGeorge [12] are particularly worried about the state of development of AI and Expert systems. They write:

> The future of AI is more uncertain. The success stories typically involve embedded software, where AI is a background component of a less intelligent IT application. Success stories featuring stand-alone AI systems are less common, and there is a worrying similarity in the examples cited in introductory texts… this is because the examples are classic systems, such as MYCIN, but there should be more recent success stories in routine commercial use. MYCIN was outperforming human experts in the 1970s. An entire generation of students have been born, grown up, graduated and gone on to start careers and families since then, and hardly any of them will ever have seen an expert system in routine use...”

The crux of the problem is psychological. This study posits that the relative lack of success of stand-alone intelligent systems has to do with the psychological relationship between the potential users and the systems. By relating knowledge, experience, feelings and attitudes to the adoption and use of intelligent systems, this study found that cognitive and emotional factors interact with other systems-specific variables such as systems adoption and usage implying that understanding this relationship may actually lead to better usage and system acceptance.

This study shows that although users appreciate intelligence, users tend to preferred interface intelligence only at moderate level. It could be seen that most respondents in this study prefer the windows GUI which is only moderately intelligent compared to voice activated system which is more intelligent and command based system which is less intelligent. The pattern of response shows that moderation in level of interface intelligence is vital. This preference for moderate intelligent interface is also found among systems users who may complain about systems that tend to go beyond the tolerable limit.

Integrating intelligence into applications is becoming more prevalent and consequently no longer seen as something strange or extraordinary. Even the intelligent system that defeated the World Chess Champion was not regarded by those who developed it as an AI-based system and so was not explicitly classified as an AI application. The implication of this is that most applications that were considered intelligent systems ten years ago are no longer considered so and many that are not considered as explicit intelligent systems are actually so. As intelligent systems are evolving and developing, it is necessary to consider their interface with human knowledge space.

Multidisciplinary collaborative efforts are necessary in areas like these. There is a great need for studies involving researchers from information science, electrical/electronics, cognitive psychology, computer science, physiology and knowledge engineering to more effectively cover the developments in man-machine interaction, especially in key areas such as: Personality and motivational factors; Knowledge and sensory limitation; Human relations in knowledge management; interface development; understanding psychological mechanisms that might underpin object-oriented design and programming; and so on. As can be seen, confronting the problems enumerated above requires multidisciplinary approach which is possible only through multidisciplinary collaborative efforts.

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