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Integration of Expert Systems in Mobile Learning

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ABSTRACT

Sequel to advances and proliferations in Information and Communication Technologies (ICTs), Education Modes have changed from Traditional Face-to-Face (F2F) to different types such as Distance Learning, Electronic Learning (E-Learning) and Mobile Learning (M-Learning). This impact of ICT on education has resulted in technological usage in education. Desktop computers are used in E-Learning while portable enabled-Wi-Fi devices such as Personal Digital Assistant (PDAs), Mobile Phones and Smartphones are used in M-Learning which allows learning/education to take place anywhere and anytime provided there is wireless network coverage in that particular area. Polytechnic Education in Ghana is practically-oriented and requires the influence of ICT due to large student numbers and reduced teacher to student ratio. The main objective of this paper is to analyze through a design-based research, the influence of M-Learning in Polytechnic Education in Ghana and how an Artificial Intelligence (AI) Expert System can be integrated in M-Learning to improve the productivity of a course entitled Computer Literacy 1 (CLT 101), which is a mandatory course for all admitted first year students of Ghanaian Polytechnics. After the research analysis, we proposed an expert system integrated in mobile learning to enhance teaching and learning of CLT 101 in Accra Polytechnic, Ghana. This study is in two folds. The first fold involves enhancing the mode of education and pedagogy in Accra Polytechnic through mobile learning and the second fold involves using the expert system to motivate and help students understand the course contents better and solve course problems with ease.

Keywords: *Mobile Learning, CLT 101, Polytechnic Education, Expert Systems, Pedagogy, Cloud Computing, ICT, mLMS*

1. INTRODUCTION

Increasing trends of ICTs have resulted in its major role within the education sector in both developing and developed nations. The impact and use of ICTs in education is accompanied with advantages and benefits as well as disadvantages and challenges. However, it can be envisaged that educational modes involving ICT such as E-Learning and M-Learning are always profitable, especially in a developing nation such as Ghana where there is a disparity or mismatch between students seeking tertiary education and the number of tertiary educational establishments available.

The deployment and implementation of M-Learning in Accra Polytechnic with integration of AI Expert Systems will help Accra Polytechnic achieve it's: **Vision**- to become a universally acknowledged centre of excellence for Teaching and Research of applied science, arts and technology and

Mission- to produce skilled career focused tertiary and middle- level manpower in the areas of manufacturing, commence, science, technology, applied social science and applied arts [1].

This paper principally focuses on Expert system and M-Learning proposed systems for HND Furniture Design Students of Accra Polytechnic, who are not many and are eight (8) in number. Positive results of the system will allow its full deployment and migration to classes with higher numbers. This paper is formulated as follows: Problem Formulation and Research Questions in Section 2, followed by Related Work and Research Methodology in Sections 3 and 4 respectively. Proposed System Design and Implementation Strategies are discussed in Section 5 and Challenges, Results and Discussions are presented in Section 6. Finally, Conclusion and Future Work of the paper are elaborated in Section 7.

2. PROBLEM FORMULATION AND RESEARCH QUESTIONS

Presently in Accra Polytechnic, teaching in most forms and types of education, consists of a teacher/lecturer providing material to students, which is then presented in the classroom for the teacher/lecturer to discuss with students.

The material is provided to students in print format or written format, where students can then annotate their notes to assist their learning. The lecturer/student ratio is high in most institutions especially public ones, and this makes it difficult for most students to have a clear understanding during a classroom lesson. In Ghana, there are ten (10) public polytechnics and seven (7) public universities. This is grossly inadequate to absorb the large number of applicants that seek tertiary education and has led to the proliferation of private universities that charge exorbitant fees which only the rich can afford. In Accra Polytechnic [1] for instance, some class sizes are as large

as five hundred (500) students. This makes traditional learning and teaching very difficult resulting in low academic and pedagogical quality. Interactivity is low and feedbacks between teachers and students is diminished. Even if divisions of class sizes are made, the numbers are still too large for one lecturer to handle. In such situations, academic quality is also not assured because of the large class size and there is likely to be disparity in the marking of student's quizzes, assignments and examination scripts. It can be realized that the problems regarding education in terms of quality teaching and learning are many. M-Learning through its advantages such as enhancement of interaction between teachers and students as well as learning taking place anywhere, anytime just to mention a few, will solve these problems enumerated above. Effective Pedagogy and Academic Quality Assurance is a major issue facing Accra Polytechnic and other academic institutions in Ghana. A teacher handling five hundred students or even more, makes effective pedagogy more difficult, interactivity between teachers and students is also very much lessened, assignment and quizzes cannot be facilitated often due to large numbers and there is likely to be disparity in marking of student examination scripts, assignments and quizzes.

Disparity in evaluation/marking, results in students who are supposed to pass examinations, failing and vice versa. The limited time frame teachers are given to mark scripts and submit results of students with large numbers will likely result in marking disparity. If quizzes and assignments are also not conducted often, students tend to relax and will not learn diligently enough. This will reduce their academic standards and will affect the institution eventually. Learner success, especially through examinations, is a natural success indicator of a training institution [2] and this also translates to the effectiveness of a particular teacher, class and course as well.

In a particular semester of an institution of higher learning, learners will usually need to complete between one to three assignments, depending on the number of registered courses. Teachers are then required to mark the assignments and provide appropriate feedback to the learners. When the class size is large, as discussed above and the number of assignments are quiet overwhelming, the number of assignments given to students is usually one (1) especially if there will be feedback to individual learners. In some institutions, there are situations in which one Lecturer is assigned over one thousand (1000) students. It is evident that in a situation like this there will be a problem of Effective Pedagogy and Academic Quality Assurance and these problems need to be solved.

These problems coupled with the varying skill, attention and experience of the teachers involved, has been known to hamper the overall quality of assessment methods. For example, in the Open Distance Learning (ODL) programme at Open University of Malaysia (OUM), Kuala Lumpur, Malaysia, disparities have been found in assignment scores and grading techniques between teachers and learners. This is because there are about 3,500 active tutors and 30,000 active learners during a single semester. The number of assignments that is handed in is also quite overwhelming, thus, there is clearly a concern of standards that needs to be addressed [3].

Randomly re-marking assignments, quizzes and examinations can be used to analyze the marking practices of teachers. Though this method can provide a general representation of the overall marking quality, another approach which is the focus of this paper could involve an application of AI specifically and expert system connected/installed to a Portable PC, whereby assignments can be electronically handed in by the mobile devices of learners within a network platform and automatically marked by Portable PC (expert system). As every assignment comes with a list of criteria or marking/evaluation scheme which the learners are expected to meet, these can be configured in the expert system. Marks, comments and even penalties for errors can be specified for each criterion, and this intelligent system can thus be used to accurately allocate scores/points and mark/evaluate answers in a learner's work [3].

Consequently, the system could even be configured to routinely send personalized feedback to each learner via e-mail. Implementing such a system in a learning environment, would be beneficial in the sense that Accra Polytechnic will have the opportunity to ensure consistency and quality in not only the marking standards, but the feedback to individual learners as well [3].

CLT 101 is an introductory IT/Computing course for all first year students of Polytechnics in Ghana and is facilitated to let students understand the fundamental application and use of computer systems. An Expert System can also be developed to aid in the teaching of CLT 101, by creating a knowledge base of the contents of the course with appropriate strategies of learning these contents as well as interfaces comprising of questions and feedbacks within the course and this has proven to be faster, according to AI research, than traditional face-to-face education.

Research Questions: The three main research questions of this paper are as follows:

1. How to implement M-Learning in Accra Polytechnic to improve productivity of education through ICT?
2. How to design and expert system for CLT 101 to enhance teaching and learning in Accra Polytechnic?
3. What will be the pedagogical implications if the above systems are implemented in Accra Polytechnic?

3. RELATED WORK

Application and integration of AI techniques in different educational modes such as traditional Face-to-Face, Distance Learning, E-Learning, M-Learning has been extensively researched studied in recent years. Among many of the researchers ideas are to enhance education through mobile learning and also to integrate mobile learning with AI in order to make learning and teaching more easier for the learner and teacher in an educational establishment.

Costano *et al*., (2008) presented a practical implementation of a multiuser technical laboratory that combines Artificial Intelligence (AI) and Bluetooth (BT) techniques. Their objective was to build an m-learning environment where students can work in a customized way. By applying BT capabilities this domain could be isolated into a classroom and used by several learners simultaneously. The student's activities can be supervised by means of AI strategies (planning, scheduling and expert systems) in order to adapt the modus operandi to the characteristics of each one. Integrating these technologies, the whole system was able to recognize each user, organize his/her work and evaluate his/her results without or with little educator intervention. Nevertheless, a report will be generated for the teacher about the student actions and the student will be advised when the situation requires an advice.

Fadzil *et al*., (2008) discussed that though the implementation of AI has not been fully realized in education, Open University of Malaysia (OUM) foresees many areas that can benefit from it, in terms of ensuring quality, improving pedagogical methods as well as enhancing the overall teaching and learning experience. They further explore several fields whereby AI could be potentially utilized in an Open Distance Learning (ODL) institution, i.e. expert system for programme advising; automated scheduling of classes; marking of assignments; plagiarism detection; retaining learners and adapting to their diverse needs and backgrounds; maintenance of property; and ensuring security. OUM also anticipates that AI could provide a significant and highly intriguing paradigm shift in the deployment of ODL and that it could greatly influence the future of all open and distance learners.

Sakala *et al*., (2010) discussed the result of the inevitable deterioration of educational standards because semi-qualified staffs are dominating throughout the whole education industry in Zimbabwe. This paved the way for them to explore the need of an expert system to create an enjoyable student learning environment that has positive impact to their learning outcome. The study was done in 2010 with students at Bindura University of Science Education doing a module-Introduction to Computer Science. The results of their research clearly showed that expert systems can play a major role to help universities, lecturers and students in Zimbabwe, where brain drain has affected the quality of teaching and learning [5].

4. RESEARCH METHODOLOGY

This is a design-based research paper. The design-based research introduced by [6] involves the analysis of the use and performance of designed artifacts to understand, explain and very frequently to improve on the behavior of aspects of systems [7].

Design research was developed as a way to carry out formative research to test and refine educational designs based on principles derived from prior research. Consistent with the design research framework, the research will be carried out in the following five steps:

1. ***Awareness of the Problem(s)***: Identify the problem(s) by analyzing the deficiencies of the existing systems and describe how to make improvements.
2. ***Suggestion****:* Review the related literature and previous research. Describe how the system can be designed and implemented with feasible, optimized solutions.
3. ***Development****:* Develop and implement the proposed application(s)/system(s) according to the suggested solutions.
4. ***Evaluation****:* Evaluate and experiment the partially or fully successful implementations according to the functional specification.
5. ***Conclusion****:* Discuss and draw conclusions based upon findings in the process of system design as well as the evaluations.

Through a design-based research, the analytical and methodological basis for this study was drawn from literature and exploratory qualitative research about Polytechnic Education, Pedagogy, Expert Systems and M-Learning. Eight (8) questionnaires were administered to first year students of Furniture Design Department, Accra Polytechnic. An interview was also conducted with a Management staff. Eight (8) responses of the questionnaires were received and used for the demographics in table 1.

5. PROPOSED SYSTEM DESIGN AND IMPLEMENTATION STRATEGIES

A. Study Design: The study was conducted as part of a regular course (CLT 101), with eight (8) 2010/2011 First Year Furniture Design and Production students of Accra Polytechnic.

Table 1: Demographics

Gender	Eight (8) Males
Age	25-30 years old
M-Learning and Expert System Experience	Questionnaires received and the interview conducted showed that none of the students had experience on these systems and the Polytechnic had never introduced these systems.
Programme and Course Involved	**Programmme**: HND Furniture Design and Production year one 2010/2011 academic year **Course**: Computer Literacy I – CLT 101.
Mobile Device	All students owned a Mobile phone. No student had used/owned a Smartphone.

B. System Design: The two systems involved in this paper are an M-Learning System and an Expert System. Table 2 shows the system requirements for the design.

Table 2: System Requirements

Requirement	Quantity/Usage
Android and Wi-Fi/GPRS Equipped Smartphone	Eight (8) Mobile Devices For the Students in the M-Learning System
Portable PC – 250 GB Hard Disk, 8 MB RAM, 4.0 Dual Core CPU/Processor, Windows Server OS, Cloud Computing Service Provider	One (1). For Cloud Computing and network resource provider to clients (Students with Smartphone) of M-Learning System and Expert System

(i) The M-Learning System – We propose a Cloud Computing Network platform for the M-Learning System. Most existing network resources and services of Mobile Learning architectures and systems globally, are connected through desktop computing i.e. Wireless Technology through Client-Server architecture for the teachers and learners in which a Server application provides services to Clients.

There is no doubt that cloud computing, which is a new era of technology is an application changer particularly for the relationship between the IT department and the learning organization. Traditionally, IT departments have worked side-by-side with the learning organization, creating platforms and applications that delivered needed information and training. This has often been a slow and labour-intensive process coupled with delays and potential roadblocks for efficient implementation. Often, the needs of learning are not assigned the highest priority by the IT Department of the educational establishment. The network resource delivery modes for Mobile Learning in an institution are depicted below [8]:

- **Old Delivery Model (Desktop Computing)** - The organization buys, installs, maintains, accesses, and controls learning applications and courseware in house.
- **New Model (Cloud Computing)** - The organization accesses the cloud that hosts learning applications and courseware that they need.

Cloud computing is a new technology that has various advantages and it is an adoptable technology in the present scenario of Mobile Learning. The main advantage of the cloud computing is that, this technology reduces the cost effectiveness for the implementation of the Hardware, Software and License for all. Current traditional Mobile Learning deficiencies and problems such as:

- Limited resources of mobile devices (limited processing power, high power consumption and small memory capacity).
- Storage capacity of mobile devices for large capacity-sized materials and
- Expensive investments of hardware and software can all be solved through cloud computing. Cloud services provide the support of various applications and automatic resource management as well as guaranteed Quality of Service (QoS) infrastructures which provide a tremendous value to mobile learning. Now is the better peak time to analyze the cloud and its development and implementation for quality and low cost education all over the world, especially in developing countries. Some benefits and advantages cloud computing presents when compared to desktop computing include [8, 9]:

Cloud computing creates a higher sense of autonomy to the entire organization and individual.

- Cloud computing allows relevant, tailored content to be created for users without the dependence upon IT to

modify, update, or implement any component of the delivery platform.

- Cloud computing also contributes to "greener," more efficient systems, with less waste.
- *In terms of cost*, one can choose a subscription or in, some cases, pay-as-you go plan –whichever works best with that organization's business model.
- *In terms of flexibility* infrastructure can be scaled to maximize investments. Cloud computing allows dynamic scalability as demands fluctuate.
- *In terms of accessibility* data and services are made publicly available.

Security and privacy issues and how company/institution data is protected are some of the disadvantages to cloud computing? Some researchers argue that cloud computing forces organizations to buy into locked, proprietary systems that will cost them more over time [8].

(ii) Expert System - is a computer program that employs the knowledge of human experts to solve problems that usually would require human intelligence. This kind of programs represents the expertise knowledge, about a specific class of problems, as data or rules that can be called upon when needed. Expert systems can also provide some analysis of the problems and they can even recommend to users various actions in order to perform improvements and rectifications. Expert systems arrive at conclusions using reasoning capabilities. The focus of this paper requires human intelligence which can be substituted by an expert system and potentially improve productivity in Effective Pedagogy and Academic Quality Assurance, save time and money, preserve valuable knowledge, and improve learning and understanding [10].

Expert systems consist of two main parts: the knowledge base and the inference engine. The knowledge base contains the expert system knowledge. This can be catalogued as: factual and heuristic. Factual knowledge is widely shared and it can be typically found in books, articles, journals, etc. Heuristic knowledge is more experiential and it is rarely discussed. The heuristic knowledge is derived from good training, good judgment and plausible deduction in the field. These two kinds of knowledge are organized and represented as rules IF-THEN. The inference engine manipulates the information stored in the knowledge base in order to form a line of reasoning using a search pattern technique. This engine is built into program modules according to the problem-solving designed method [4].

Expert systems can perform many tasks: learning, monitoring, control, simulation, design, support and information retrieval, among others. Figure 1, shows the basic components of an Expert System.

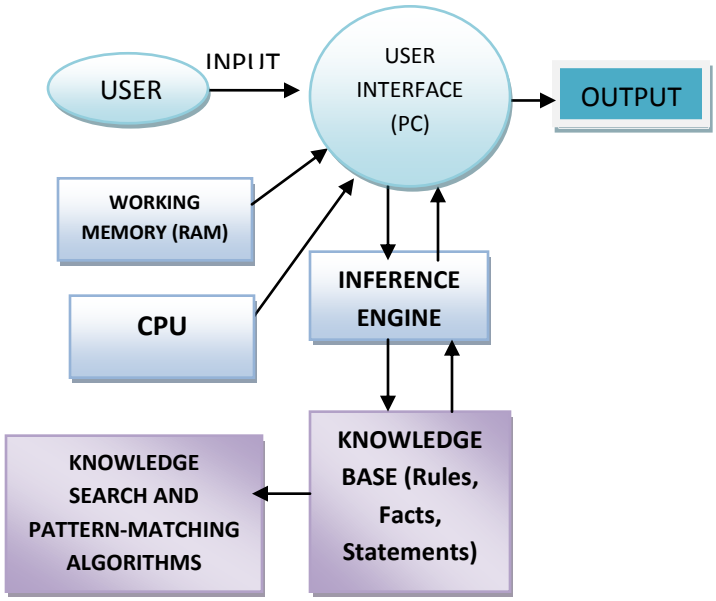

Figure 1: Expert System

(iii) Proposed System Scenario

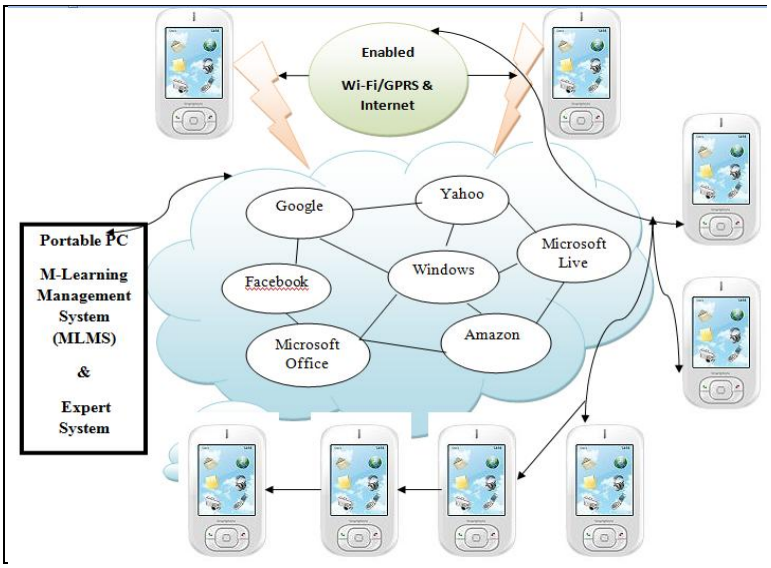

Figure 2: M-Learning Environment Architecture

Portable PC acting as a server to be used by the teacher, with an integrated M-Learning Management System (mLMS) and an Expert System.

The students interact with the m-learning platform by means of a **cloud computing communication system**. This

system is responsible for: detection of users entering or leaving the m-learning cell, organization and release of work sessions with students/learners and exchange of data between students/learners and the learning environment. It will also manage and optimize in an intelligent manner the communications performance of the m-learning cell. The Portable PC will interact with the student's Smartphones using the "cloud". It is responsible for the dialog, communications and transactions with the students/learners. It is also responsible for performing all the tasks and activities requiring intelligence using the expert system. A user entering the m-learning cell or coverage area will be registered and authenticated as a participant.

Students will access learning materials tasks and assignments from the Portable PC through the 'cloud'. Once the student has finished an assignment or examination, he transmits/sends the results from his Smartphone to the mLMS for evaluation. The expert system, having a knowledge base of how the assignment should be marked/evaluated (marking scheme), evaluates/marks the students and awards a score. Feedback is provided to the student via e-mail for him to know the correct answers and how he was supposed to answer the questions asked. Five questions listed below represent an assignment given to the students in the mLMS:

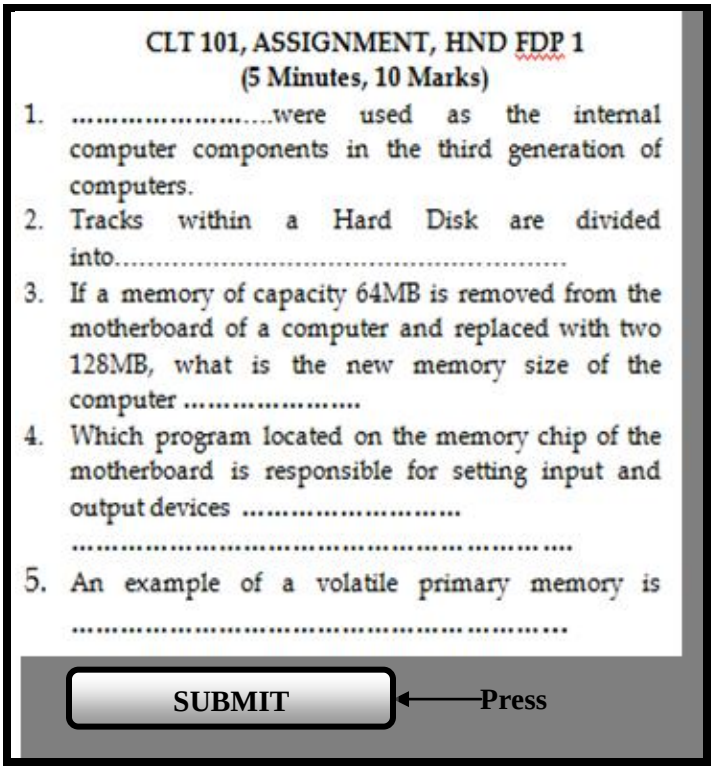

Figure 3: Student's Assignment From mLMS

The students had five minutes to answer the above fill in questions by typing the correct answers in the gaps of the questions using their Smartphones. After submission, the mLMS consults the expert system for evaluation. This expert system will use a simple knowledge base comprising of an evaluator/marking scheme below to evaluate/mark the assignments of the students:

(**2** Marks, For the Right Answer, **10** Marks - Total)
1. Silicon
2. Sectors
3. 128 MB
4. Basic Input Output System (BIOS)
5. Random Access Memory

Figure 4: Expert System Evaluator/Marking Scheme

After evaluation, the above feedback as well as the score of the student is sent to his e-mail address. There are also options for students to ask questions and answers will be given based on the knowledge base of the course contents of CLT 101, the inference engine will search for the required answer and provide it for the student through the mLMS.

6. CHALLENGES AND DISCUSSIONS

During implementation, pedagogical issues and implications, have to be observed and attended to. From the questionnaires administered, most students of Accra Polytechnic owned a Mobile Phone but hadn't used a Smartphone especially for learning before. The usage of a Smartphone for the learning process by the students is important for M-Learning implementation. In terms of cost, the Polytechnic being a public institution should be able to convince the stakeholders of the importance of this system and should be able to afford most of the needed requirements. The change in learning and pedagogy involving learners and teachers making meaningful connections to available networks and resources and other people needs education because of ICT adaption and educational mode change from face-to-face. Pedagogical implications had to be introduced to the students in order for the proposed systems to take off. Positive results of implementation will have a good impact of ICT on education to the students, teacher and the Polytechnic as a whole. Design of expert systems, provides an additional facility for students to learn and practice problem based learning and simulations. Teachers who have large numbers are also less pressured because the expert system can aid in teaching activities such as marking and feedback responses. M-Learning and Expert

Systems will also allow the Polytechnic through availability of funds deploy full mobile learning education mode integrated with expert systems to enhance teaching and learning in order to admit more students.

7. CONCLUSION AND FUTURE WORK

In this paper we presented a basic m-learning environment architecture. If implemented, mobile learning and expert systems can employ their aptitude to adaptively adjust the training for each particular student on the bases of his/her own rapidity of learning which allows students to gain deep understanding of fundamentals to be able to follow the more advanced topics and courses than CLT 101, within a specified field. In addition, expert systems will provide the excellent alternative to the private tutorial and individual training. However, both mobile learning and expert systems are technology inclined. Therefore students, especially non technologically-inclined students, should be introduced to these systems pedagogically before implementation. The system presented involved eight students and can further be developed and implemented in the future through the same procedure to involve more students who do not have access to tertiary education because of limited facilities and infrastructure in the Polytechnic.

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