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mMES: A Mobile Medical Expert System for Health Institutions in Ghana

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ABSTRACT

The importance of health and being medically fit is goal for every human being. Unhealthy situations of human beings are of course very disadvantageous and disastrous to our society. Some public hospitals in Ghana comprising of Korle Bu Teaching Hospital (KBTH), Komfo Anokye Teaching Hospital (KATH), 37 Military Hospital, Ridge Hospital as well as Tema General Hospital are notable hospitals that do their maximum best to provide health needs to Ghanaians. The facilities of these hospitals however, find it difficult to meet the enormous requirements of patients that daily attend hospitals for minor or major treatments as well as check-ups and birth delivery. Various private hospitals have sprung up in Ghana to support and relieve pressure of enormous patient numbers the public hospitals. In addition to limited health facilities, Medical Doctors in both private and public hospitals in Ghana are always under a lot of stress and intense pressure to perform accurate diagnosis and prescriptions for so many daily patients through medical consultancy. Through Artificial Intelligence (AI) techniques, literature review and design-based research methodologies, this paper focuses on how Medical Doctors in Ghana can use a designed Expert System through mobile technology to speed up diagnosis, confirm their own diagnosis, provide advice on found diagnosis and provide advice on certain diseases when diagnosed on a patient. The study is underpinned to Korle Bu Teaching Hospital, which is currently the third largest hospital in Africa and the leading national referral Hospital Centre in Ghana.

Keywords: *Mobile, Medical, Expert System, mMES, Health, MYCIN, Korle Bu Teaching Hospital*

1. INTRODUCTION & BACKGROUND OF THE RESEARCH STUDY

The medical field requires appropriate health infrastructures and expertise for effective delivery and output. Critical stages of sickness and diseases can easily lead to fatal deaths without the required expertise and medical/health facilities. Ghana can boast of both public and private hospitals that have a duty of providing health services to the general public. Apart from KBTH, KATH, 37 Military Hospital, Ridge Hospital and Tema General Hospital, there are various Regional Hospitals and District Hospitals as well as a number of Polyclinics and Rural Clinics.

Established on October 9, 1923, the Korle Bu Teaching Hospital has grown from an initial 200 beds capacity to 2,000 beds capacity. It is currently the third largest hospital in Africa and the leading national referral Hospital Centre in Ghana [1]. Primarily, Korle Bu, which means 'the valley of the Korle lagoon', was established as a General Hospital to address the health needs of the indigenous people under the administration of Sir Gordon Guggisberg, the then Governor of the Gold Coast (former name of Ghana) [1].

Korle Bu gained Teaching Hospital status in 1962 when the University of Ghana Medical School (UGMS) was established for the training of Medical Doctors. The UGMS and five other constituent schools are now subsumed under the College of Health Sciences to train an array of health professionals. All the institutions of the College undertake their clinical training and research in the Hospital.

At the moment, the Hospital has 2,000 beds and 17 Clinical and Diagnostic Departments/Units. It has an average daily attendance of 1,500 patients and about 150 patient admissions [1].

An Expert system is a software that simulates the performance of a human experts in a specific field. Today's expert systems have been used in many areas where require decision making or predicting with expertise [2]. The knowledge engineers gather the knowledge from human expert and represent it into knowledge base. The future expert system will require larger scale knowledge base in order to solve the more complicated real-world problems including medical and health problems [2].

This paper introduces and proposes a Mobile Medical Expert System (mMES) using mobile devices and computing technology so that Medical Doctors in Ghana can speed up diagnosis, confirm their own diagnosis, provide advice on found diagnosis and provide advice on certain diseases when diagnosed on a patient. The paper is organised as follows: After Introduction and Background in Section 1, Section 2 elaborates on the Problem Statement of this paper and Section 3 discusses Importance of Computer Science and Technology in the Medical Industry. The Research Objectives of the paper is discussed in Section 4, Section 5 Reviews Literature and Related Work, Section 6 discusses the Research Methodology and Section 7 elaborates and presents the Proposed System Design and Implementation Strategies. Section 8 elaborates on the Research Discussions, Challenges and Limitations of the Paper. In Section 9, the paper is finally concluded and a recommendation through findings of the research is presented.

2. PROBLEM FORMULATION/STATEMENT

Korle Bu Teaching Hospital (KBTH), the largest health facility, premier teaching hospital and nerve centre of

health care services in Ghana, exists to provide tertiary health care and facilities for educating and training health professionals, conduct and/or collaborates with others to conduct research and provide outreach advocacy services for all categories of persons in Ghana, in a most cost-effective manner while ensuring value-for-money and optimal satisfaction of its patients and other stakeholders [3].

The vision of KBTH is to achieve an enviable, world-acclaimed reputation as a first-class centre of excellence and innovation in specialist healthcare, education/training, research and advocacy [4].

Presently, the KBTH sees an average of 1,500 patients a day at its Outpatients Department (OPD), about 150 of who are admitted. An increase in population, however, and the refusal of most patients to use it as a referral/specialist hospital, not a general one, has rendered KBTH frequently crowded [5].

According to the Chief Executive Officer (CEO) of KBTH, Prof. Nii Otu Nartey, "the argument of most patients had been: 'Why should I go to the polyclinic when I will be eventually referred to Korle-Bu? I will go there straight'. So they come with even malaria, which could be treated at the polyclinics". Often patients complain about long waiting time for consultation and other services [5].

To that complaint, Prof Nartey responded that the hospital had set up a complaints desk to address those issues but most patients would rather not want to be mentioned in connection with any complaint, making it difficult to follow up. He added that patients would often arrive at the hospital as early as 5.30 a.m., irrespective of the fact that the clinic/medical department they were attending started at 9 a.m., and became very irritated when doctors had to go on ward rounds before attending to them. He thought if an efficient appointment system was run, waiting time could be reduced but it seemed the Ghanaian believed more in the "first come, first served service". That gloomy picture of the Korle-Bu, however, is about to change because a number of projects have been completed and new ones begun [5].

An effective computerised system is required to help KBTH as well as other health institutions in Ghana reduce the number of patients who have very minor sicknesses and diseases and need not attend a referral Hospital such as KBTH or even a Polyclinic. Minor and minimal sicknesses such as headaches, stomach aches/ diarrhoea, flu, cold etc. may not necessarily require the consultation of a Medical Doctor physically. A good substitute of physical consultations in minor sickness cases is a Mobile Medical Expert System.

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

a. How to design a mobile medical expert system for KBTH to enhance health services and delivery?
b. What will be the educational and health implications of patients and KBTH/Health institutions if the proposed mobile medical expert system is implemented?

3. IMPORTANCE OF COMPUTER SCIENCE AND TECHNOLOGY IN THE MEDICAL INDUSTRY

Table 1, below outlines some reasons why Computer Science and Technology is important in the Medical Industry.

Table 1: Importance of Computer Science and Technology in the Medical Industry

FACTOR	REASON
Security	Security and integrity of data in Hospitals is very important. Security in terms of the Hospitals Assets as well as the data of patients is a vital issue for Hospitals. Other factors such as patient retention and satisfaction all boils down to patient data security. The proliferations of ICT, excellent Database Management Systems, cryptography and secure servers with reliable operating systems have taken care of this issue.
Data Storage	Patients Database of Hospitals depending on the number of patients can be extremely large and difficult to handle manually. Computers and ICT through reliable Database Management Systems (DBMS) such as oracle have solved problems of Hospital data storage and shows the importance of Computer Science and Technology in the area of Storage of Hospital data.
Accurate Transactions	Transactions such as tracing patient records and data as well as general clerical and office/administrative duties are currently done through the use of computers and this makes Hospital Transactions more accurate in order to yield good profits.
Fast Transactions	Transactions are also faster in Hospitals through computers. Computers make transactions faster through dissemination of required information or data at a quicker and faster rate.
Telemedicine and Telehealth	Telemedicine is the use of medical information exchanged from one site to another via electronic communication to improve, maintain, or assist patients' health status. Closely associated with telemedicine is "telehealth", which is often used to encompass a broader definition of remote health care that does not always involve clinical services [6]. Videoconferencing, transmission of still images, e-health including patient portals, remote monitoring of vital signs, continuing medical education and nursing calling

	centres are all considered part of telemedicine and telehealth [6].
Artificial Intelligence (AI) and Expert Systems	Artificial Intelligence (AI) helps the Medical Industry to use computers as a Medical Expert System to help Doctors speed up diagnosis, confirm their own diagnosis, provide advice on found diagnosis and provide advice on certain diseases when diagnosed on a patient.

4. RESEARCH OBJECTIVES

The main objectives of this research paper are:

- To analyse how to design a mobile medical expert system for KBTH/Other Health Institutions in Ghana to enhance health services and delivery.
- To propose a mobile medical expert system for KBTH/Other Health Institutions in Ghana to enhance health services and delivery.

5. LITERATURE REVIEW

5.1 Artificial Intelligence and Expert Systems

Artificial intelligence (AI) is the intelligence of machines and the branch of computer science that aims to represent human expertise through computers. Textbooks define the AI field as "the study and design of intelligent agents," where an intelligent agent is a system that perceives its environment and takes actions that maximize its chances of success [7].

The Expert System is a kind of compute program which can solve some difficult problems using specialist's lever and competence in some areas. The structure of Expert Systems are various according to different technologies. However, all of them are based on the original Expert System, such as MYCIN [8].

Expert systems involves the study and design of systems or computer systems that represents, behaves and reasons with expert knowledge in some specialist subject with a view to solving problems or giving advice in areas where human expertise is falling short [9]. Expert systems are a contemporary type of software that is making computers more useful than ever before. An Expert system is a type of Artificial Intelligence (AI) that embodies the knowledge of one or more experts.

According to [7], the advantages of AI- Expert Systems are classified below:

A. ***Permanence*** - Expert systems do not forget, but human experts may.
B. ***Reproducibility*** - Many copies of an expert system can be made, but training new human experts is time consuming and expensive.
C. ***Efficiency*** - Expert systems can increase throughput and decrease personnel costs. Although expert systems are expensive to build and maintain, they are inexpensive to operate. Development and maintenance costs can be spread over many users. The overall cost can be quite reasonable when compared to expensive and scarce human experts.
D. ***Consistency*** - With expert systems similar transactions handled in the same way. The system will make comparable recommendations for like situations. Humans are influenced by recently effects (most recent information having a disproportionate impact on judgment) primacy effects (early information dominates the judgment).
E. ***Documentation*** - An expert system can provide permanent documentation of the decision process.
F. ***Completeness*** - An expert system can review all the transactions, a human expert can only review a sample.
G. ***Timeliness*** - Fraud and/or errors can be prevented. Information is available sooner for decision making.
H. ***Breadth*** - The knowledge of multiple human experts can be combined to give a system more breadth that a single person is likely to achieve.
I. ***Consistency of decision making***
J. ***Achieve Expertise***
K. ***Differentiation*** - In some cases, an expert system can differentiate a learning material from other materials.

5.1.1 Medical Expert Systems (MESs)

Since the 1980s, development of expert systems, both in theory and practice has gained tremendous success and development, and demonstrated its great vitality and value [9]. But it also shows it's obvious shortcomings and deficiencies, such as the system's vulnerabilities, limitations and inability to share the knowledge content the unity of solution strategy, lack of uniformity for the system interfaces, difficulties of system development and maintenance and so on, especially in the medical expert system that relates to a wide range and whose categories are very numerous, the performance becomes more apparent [10, 11].

The medical field may make more use of the expert systems than any other field. Dozens of advisory programs have been developed to help physicians diagnose a particular illness and in some cases, to prescribe treatment. The oldest medical expert system is called MYCIN [12]. MYCIN is an expert system developed at Stanford for diagnosing blood diseases. It is one of the widely studied expert systems because of its success. MYCIN was one of the first expert systems to use production rules and to employ the backward-chaining inference method [12]. Production rules are IF-THEN statements that express chunks of knowledge that are readily applied to problem solving. Backward-Chaining refers to the search method used by the computer to look through the production rules and find the appropriate solution [12].

A major feature of MYCIN is that its rule base is completely separate from its inference program. This permits the MYCIN knowledge base to be discarded, creating empty MYCIN or EMYCIN. EMYCIN is the model after which the modern expert development shells are patterned [12].

Some other MESs include: ONCOCIN, PUFF, CASTNET/GLAUCOMA, GUIDON and Drug Interaction Critic.

Table 2 below, summarizes some of the medical expert systems available today

Table 2: Medical Expert Systems

Medical Expert System	Purpose/Function
ONCOCIN	Assists physicians and medical doctors in treating cancer patients with chemotherapy by selecting the appropriate treatment based on the patient's diagnosis and previous treatment.
PUFF	Helps identify lung disorders.
CASTNET/GLAUCOMA	Helps diagnose glaucoma and other eye diseases and prescribes treatment.
GUIDON	Instructional system to teach how to select antimicrobial therapy for bacterial infections.
Drug Interaction Critic	Advisory system that helps doctors prescribe drugs when other drugs are being used.

Source: [12]

5. 2 Mobile Wireless Network Technologies

Mobile wireless technology is any wireless technology that uses radio frequency spectrum in any band to facilitate transmission of text, data, voice and video (multimedia) services to mobile devices at anytime and anywhere. With the introduction of mobile network data services such as General Packet Radio Service (GPRS), Enhanced Data rates for GSM Evolution (EDGE) and Third Generation (3G) in particular, innovative applications and services are gradually becoming popular. A mobile device is no longer considered being luxury item; rather it is considered being necessity item in Ghana and worldwide. The number of mobile users is rapidly increasing all over the world. The average penetration rate of mobile subscriptions was 50.7% of the global population at the end of 2007. Total subscriptions are expected to rise to 5.32 billion by 2013 from 3.42 billion at the end of 2007 [13].

A wireless mobile communication network enables users equipped with mobile terminals to initiate and receive phone calls. This capability is referred to as cellular telephony. The cellular telephony has evolved to include many services that are based on the transmission of data and multimedia services and not just voice. Cellular telephony derives its name from the partition of a geographic area into small cells. Each cell site is covered by antennas, radio transmitters and receivers to create a radio coverage area in the mobile network. The set of cells forms the radio access network and the radio frequencies used for the transmission of calls and data can be reused between cells. Communication from the mobile terminal to the cell site is referred to as uplink transmission while communication from the cell site to the mobile terminal is called downlink. Voice and data exchanged between a mobile terminal and regular phone networks or internet are transmitted via the mobile network which consists of the mobile operator's radio access network and core network as shown in figure 1. The spectrum of radio frequencies available for communication is limited and a benefit of a mobile network is its ability to reuse radio frequencies in different cells, provided that radio interference does not affect the calls. This reuse provides for an increased network capacity as more mobile subscribers can be supported in a given geographic area. As the number of mobile subscribers increase, more cells can be added or existing cells can be split into smaller ones.

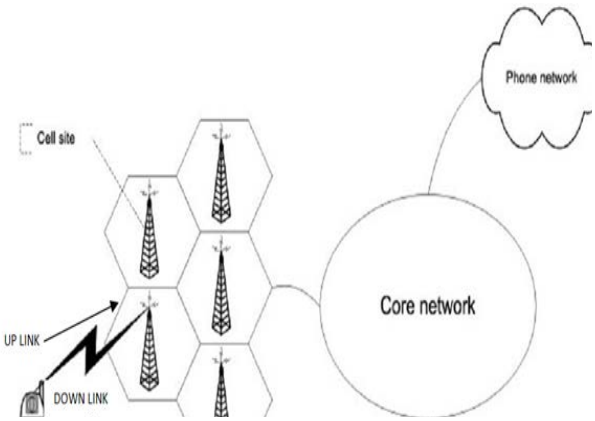

Figure 1: Mobile Wireless Technology and Network Connectivity

5.3 Mobile Services

Services are activities or benefits offered for sale that are essentially intangible. In economics and marketing, services are generally referred to as the non-material equivalent of a good or product. There are two types of services: core services and support services. A mobile service is the service that an end-user receives on the mobile terminal from the mobile network operator. The mobile service has undergone tremendous changes since the inception of mobile wireless technologies. The evolution of the mobile technologies is mainly driven by the demand of new services as shown in figure 2.

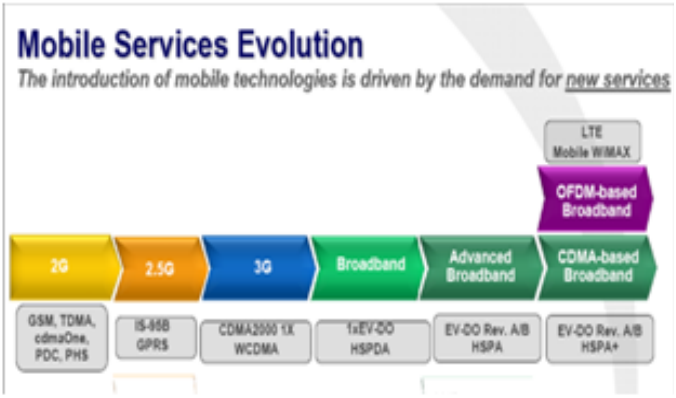

Figure 2: Mobile services Evolution
Source: Samra, S. (2009) "CDMA2000 Path to

From a voice centric system that enables users to place phone calls over the air mobile technology have evolved to support many data services. The following services below could be used for communication among patients and medical doctor's of the proposed Mobile Medical Expert System (mMES) in this paper.

5.3.1 Text Messaging

Text messaging is the ability to send and receive short messages on a mobile terminal. These messages are referred to as Short Message Service (SMS). This was created as part of Global System for Mobile Communications (GSM) networks. SMS is said to be smart service because it can store messages in the network when the target mobile device is switched off and forwards the message when the mobile device is switched on.

5.3.2 Instant Messaging (IM)

Instant messages (IM) are short text messages exchanged between users that want to chat in real time. After a user signs on to IM from a mobile device, a list of friends (referred to as a buddy list) appears on the mobile subscriber's screen using familiar screen names. The mobile subscriber can send a message to the IM service requesting to see, with the help of special icons, who is online and available to chat. IM messages can be sent only to users that are online.

5.4 Related Work

In *(Qu et al., 2008)* [2], a novel object-oriented fuzzy expert system framework which constructs large-scale knowledge-based system effectively is proposed. In this method, rules and facts in the system are organized into different object groups respectively. The fact objects can keep the features of traditional object-oriented model such as the inheritance, capsulation and polymorphism. The rule objects contain several specific components to process fuzzy information and imprecise inferencing. Due to object-oriented techniques, knowledge representation and maintenance can be much more convenient than traditional expert system. Two different inference strategies with fuzzy features under this framework are also presented and proved in [2]. Finally, a case of health evaluation expert system is discussed in [2].

According to Service Oriented Architecture (SOA) and soft-bus idea, one new solution of the medical expert system design based on the service soft bus architecture is proposed in *(Li et al., 2010)* [10]. By studying the medical expert system integration, interface standardization, the system infinite expansion and global interoperability, the result of the research in [10] has a great significance in overcoming the local application of the system and the redefinition of the system architecture.

In (*Yan et al., 2002*) [15] elaboration is given on how the Internet has opened up an unprecedented opportunity to build up powerful large-scale medical expert systems. In these systems, a cost-effective medical knowledge acquisition and management scheme is highly desirable to handle the large quantities often conflicting, medical information collected from medical experts in different medical domains and from different regions. To this end, in [15], a demonstration is given on how a medical knowledge acquisition management system can be built upon a three-tier distributed client server structure.

In [16] a presentation of a web based medical expert system that performs self training using a heuristic rule induction algorithm is given. The data inserted by medical personnel while using the expert system is subsequently used for additional learning. The system is trained using a hybrid heuristic algorithm for induction of classification rules that was previously developed by [16]. The SA Tabu Miner algorithm (Simulated Annealing and Tabu Search based Data Miner) is inspired by both research on heuristic optimization algorithms and rule induction data mining concepts and principles. In [16] the performance of SA Tabu Miner with other rule induction algorithms is compared for classification on public domain data sets.

Malaria is a deadly disease that is killing millions of people every year. Different countries of the world, governmental and non-governmental organizations including World Health Organization have taken it as a challenge to address the issue of deaths associated with malaria. Prompt and accurate diagnosis is a major key in medical field. This prompts the need to develop a diagnosis and therapy system that could be accessed anywhere, anytime taking the advantage of the fast growing internet technology. A machine learning technique rough set was used in [17] on labelled sets of malaria fever symptoms collected to generate explainable rules for each level of severity and appropriate therapy is provided. The labelled

database in [17] was divided into five cases of malaria and the classification accuracy on training dataset is 100% while that of testing data set is 94%. The web based system for malaria diagnosis and therapy in [17] was developed using HTML and PHP as front end and MYSQL as backend.

6. RESEARCH METHODOLOGY

A review of relevant literature in accordance to the objectives of this paper were explored and adopted in order to solicit the right information needed for the analysis. In accordance to the goals of this research/project, the design-based research methodology was employed to carry out this research. This is because design-based research is a systematic but flexible methodology aimed to improve educational practices through iterative analysis, design, development and implementation based on collaboration among researchers and practitioners in real-world settings and leading to contextually-sensitive design principles and theories [18]. 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, this 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.

Figure 3, below shows Design-Based Research Phases according to [19].

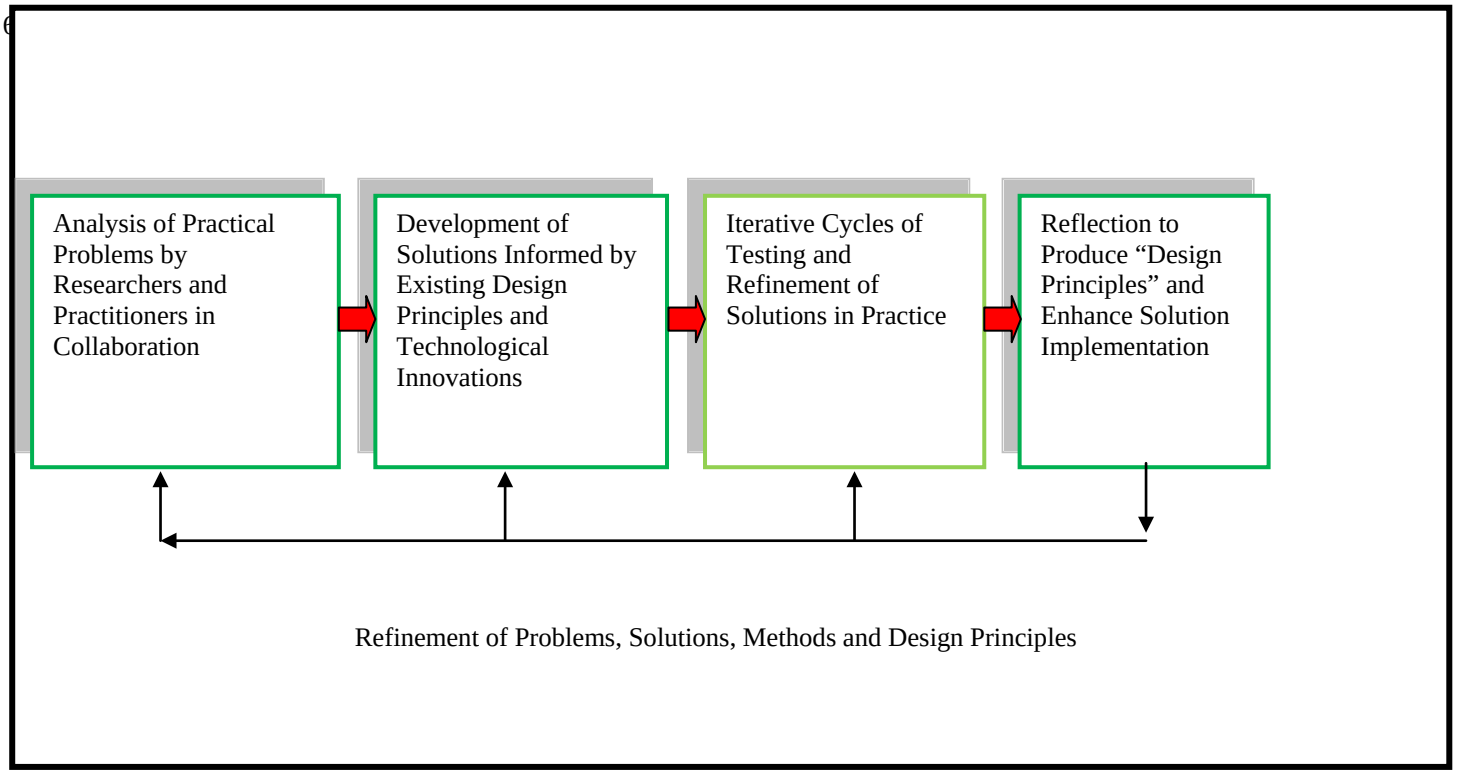

Figure 3: Design-Based Research Phases

7. PROPOSED SYSTEM DESIGN AND IMPLEMENTATION STRATEGIES

7.1 Proposed System Requirements

Table 3, shows the systems requirements of the proposed mMES

Table 3: System Requirements

Requirement	Quantity/Usage
Android and Wi-Fi/GPRS Equipped Smartphone	The numbers of patients who consult the Medical Doctor through mMES.
Portable PC – 350 GB Hard Disk, 8 MB RAM, 6.0 Dual Core CPU/Processor, Cloud Computing Service Provider	One (1). For Cloud Computing and network resource provider connected to the mMES to be eventually distributed to clients (Patients with Smartphones).

7.2 Computer Network System Design

This paper proposes a cloud computing server for the network design of the proposed Mobile Medical Expert System (mMES). Cloud computing will obviously introduce hardware (HaaS) and software (SaaS) resources which will not allow the equipments to be an enormous waste of resources.

In developing nations and Africa, when it comes to tapping into technology, there is too much time consumed for implementation. Cloud computing drastically reduces time for implementation, which helps the organization (Hospital), the government and the people in a very big way.

Some differences between Cloud Computing Technology and Desktop Computing for network connectivity are depicted in Table 4 below.

Table 4: Cloud Computing vs. Desktop Computing for Network Connectivity

Network Platform/ Differences	Cloud Computing	Desktop Computing
Delivery Mode	The institution accesses the cloud that hosts health applications and courseware that they need.	The institution buys, installs, maintains, accesses, and controls health applications and courseware in house.
Cost	Less Cost	Costs more
IT Staff Dependence	No IT Staff dependence	IT Staff dependence required
Resource Flexibility	More Flexible	Less Flexible
Data Accessibility	More Accessible	Less Accessible
Data Storage and Safety	More Reliable	Less Reliable
Computing Power	Stronger	Weak

7.3 Medical Expert System (MES) Design

An expert system is an artificial intelligence application that uses a Knowledge base of human expertise to aid in solving problems. The degree of problem solving is based on the quality of the data and rules obtained from the human expert. Expert systems are designed to perform at a human expert level. In practice, they will perform both well below and well above that of an individual expert. The expert system derives its answers by running the knowledge base through an inference engine, a software program that interacts with the user and processes the results from the rules and data in the knowledge base. Expert systems are used in applications such as medical diagnosis, equipment repair, investment analysis, financial, estate and insurance planning, route scheduling for delivery vehicles, contract bidding, counseling for self-service customers, production control education and training. Tasks such as: monitoring, design, control, simulation, learning support and information retrieval, among others can be done through the use of expert systems.

As elaborated in the problem statement/formulation, patients with sicknesses such as minor headaches, minor stomach aches, and minor malaria need not be report to a major referral Hospital such as KBTH in order to release some amount of work pressure on Medical Doctors. To solve this problem, this paper through mobile technology and cloud computing network technology proposes a Mobile Medical Expert System (mMES) that has the knowledge base of diagnosis, advice and treatment of these minor sicknesses mentioned earlier.

Patients would initially register as user through and interface and interact with the mMES and the Medical Doctor through cloud computing, mobile technology and devices. The Medical Doctor will advice the patient through their mobile devices according to his/her interaction with the mMES.

7.4 Proposed System Scenario

The proposed System Scenario involves the following steps:

1. Patients logs into the System with mobile device through cloud server, after registration through the Hospital Administrator.

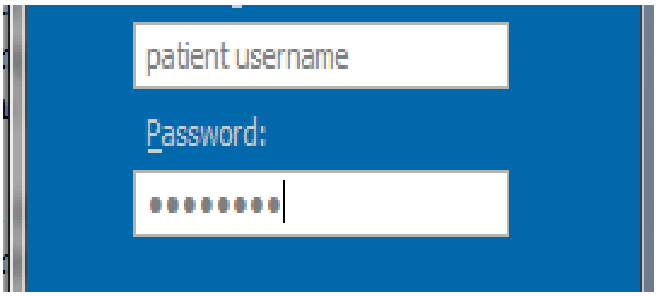

Figure 4: mMES Log in Interface

2. After Logging in, the patient initially interacts with the Medical Expert System through by a Medical Diagnostics Interface on his/her mobile device. This is depicted below in Figure 5.

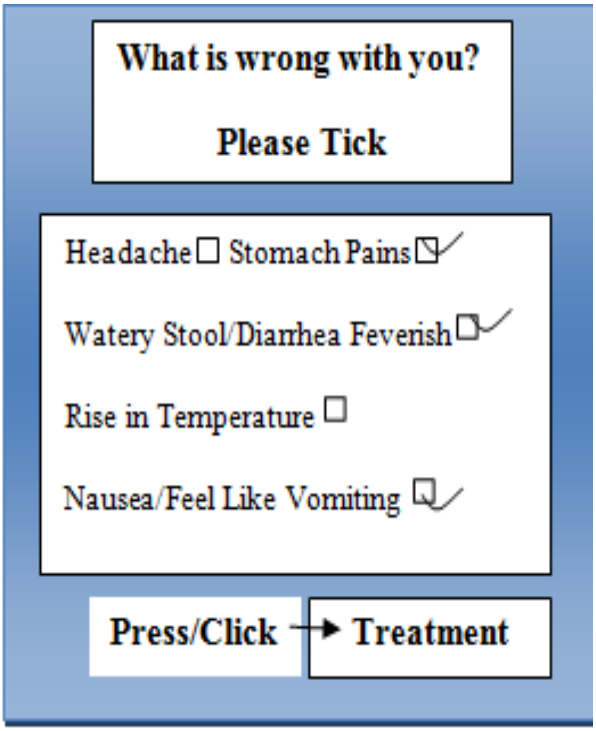

Figure 5: mMES Medical Diagnostic

3. After clicking of "Treatment", the next interface if the patient's mMES Prescription and Treatment advice. This is depicted below in Figure 6.

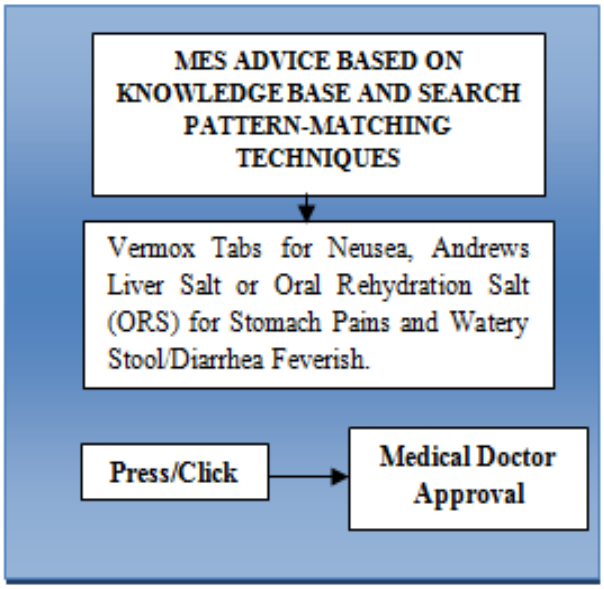

Figure 6: mMES Medical Treatment Advice

4. After click Medical Doctor Approval, a query of patient's diagnosis and mMES advice is sent to the Medical Doctor's mobile device for approval of mMES advice or non approval of mMES advice for onward consultation of Medical Doctor physically. This is depicted below in Figure 7

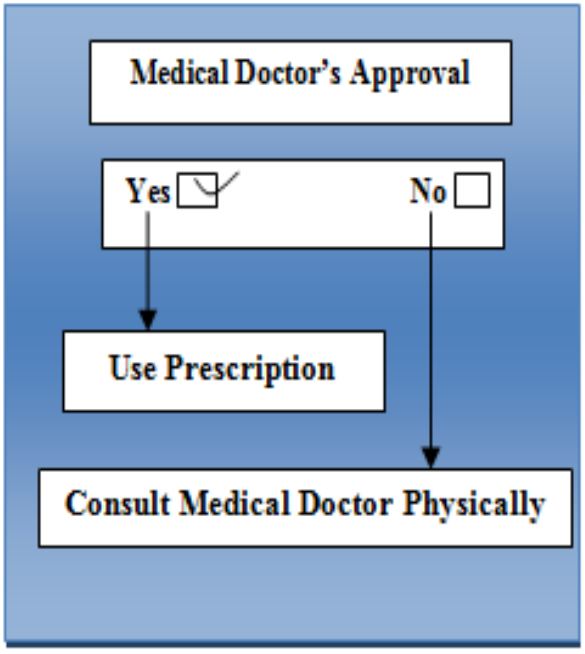

Figure 7: Medical Doctor Approval

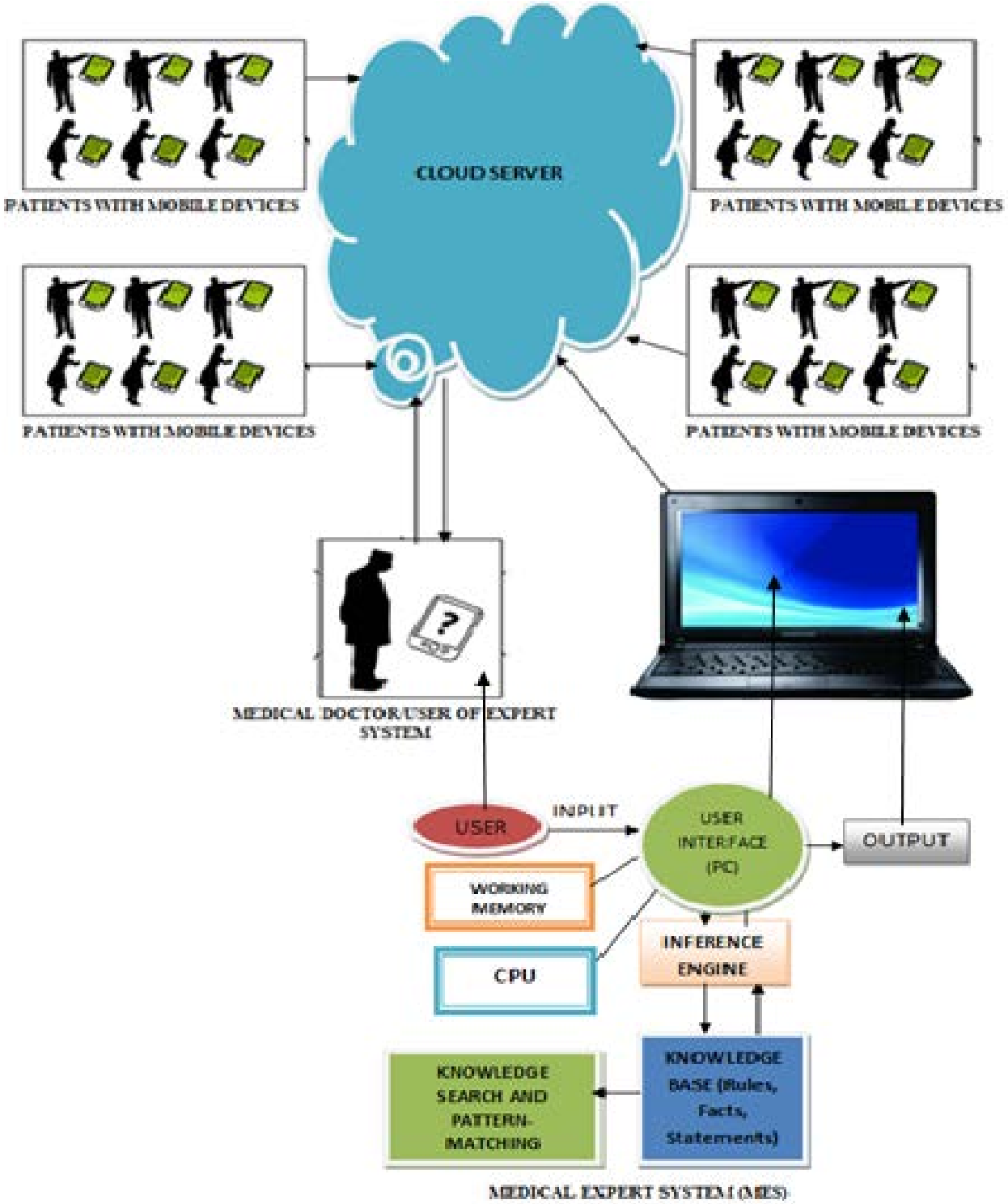

Figure 8: Proposed Mobile Medical Expert System (mMES)

Since the diagnosis, treatment and prescriptions are very important in the medical field it is important for Medical Doctors to collaborate with Medical Expert Systems to reach an agreement when a treatment is prescribed. In this way the Medical Doctor advices/confirms the treatment of the patient faster and at a quicker rate by the help of the mMES. In the proposed system of this paper and with reference to figure 7, if the Medical Doctor chooses "Yes" to a patients query then "Use Prescription" will be sent back to the patient's mobile device as a response message. However, if the Medical Doctor doubts diagnosis and responds 'No" to the mMES advice, a message will be sent to the patient's mobile phone for physical consultation of the patient. However, it is in a very exceptional case that the Medical Doctor will respond "No" to an advice since the mMES will be developed through the knowledge base of human Medical Doctor Experts.

8. RESEARCH DISCUSSIONS CHALLENGES & LIMITATIONS

During implementation, patients who are not literate in using a mobile device to the extent of interacting with a mMES interface have to be taught how to use the mobile device for such activities. Patients who are very conversant with mobile device usage in terms of interface interactivity will also have to be trained on the procedures of how to use a mMES. The proposed system in this paper is purely technological inclined and would require technical knowhow of using mobile devices efficiently. Since the proposed system is featured with mobile technology, interaction with the system can occur anywhere and at anytime. Mobile devices belonging to patients and Medical Doctors should always be in and "ON" state. The proposed system would fail especially in terms of Medical Doctor's approval responses if the mobile device of a Medical Doctor is in an "OFF" state. The use of the system by the elderly and people who are not very conversant with enhanced mobile device usage is a challenge and limitation of the proposed system in this research paper.

Successful implementation of the proposed system in this paper requires effective and strict strategies of KBTH and other health institutions on patients to comply and use the mMES through registration. Patients should not necessarily be forced to use the mMES, but rather be strategically convinced of its importance and reasons for its implementation KBTH/other health institutions as elaborated in this research paper.

It must be emphatically stated that there are various degrees of medical illnesses, the mMES proposed in this paper in solely for minor sicknesses which may not need Hospital attendance, so as to relieve the enormous pressure of Medical Doctor's in Ghana. The proposed system therefore cannot treatment major and serious sicknesses such as accidents and dental cases but give a medical advice on treatments of such issues which will eventually need the physical consultation of a Medical Doctor.

9. CONCLUSION AND RECOMMENDATION

9.1 Conclusion

This paper proposed a Mobile Medical Expert System (mMES) that can be used to solve problems of too many patients seeking daily medical attention in Ghana. This research showed that some of these patients need not attend a major referral Hospital such as Korle Bu Teaching Hospital in Ghana, which is the largest referral Hospital in Ghana and the third in Africa, because their sicknesses are minor and may not require hospital attendance. The proposed system when implemented will not only reduce patient numbers but also help Medical Doctors to speed up diagnosis and treatment of patients through the advice and interaction with a mMES.

9.2 Recommendation

This research paper recommends that Korle Bu Teaching Hospital and all other public and private Hospitals in Ghana should develop Mobile Medical Expert Systems to help and advice patients with medical treatments and Medical Doctor's in their daily medical tasks.

REFERENCES

[1] About Korle Bu Teaching Hospital (2011) – Korle Bu ICT Unit in Collaboration with PR Unit; Retrieved from: *http://kbth.gov.gh/pages/about.php* (Accessed on 28/05/2012).

[2] Qu, Y., Tao, F. and Qui, H. (2008). "A Fuzzy Expert System Framework Using Object-Oriented Techniques". *IEEE Pacific-Asia*

Workshop on Computational Intelligence and Industrial Application, pp. 474-477.

[3] Mission Statement of Korle Bu Teaching Hospital (2011) – Korle Bu ICT Unit in Collaboration with PR Unit; Retrieved from: *http://kbth.gov.gh/pages/about-2.php?infocat=about&id=5426* (Accessed on 29/05/2012).

[4] Vision Statement of Korle Bu Teaching Hospital (2011) – Korle Bu ICT Unit in Collaboration with PR Unit; Retrieved from: *http://kbth.gov.gh/pages/about-2.php?infocat=about&id=5425* (Accessed on 29/05/2012).

[5] Privitise Korle Bu Teaching Hospital – CEO (2012), Retrieved From: *http://todaygh.com/2012/03/24/privatise-korle-bu-prof-nartey/* (Accessed on 29/05/2012).

[6] What is Telemedicine? Retrieved From: *http://www.icucare.com/PageFiles/Telemedicine.pdf* (Accessed on 30/05/2012).

[7] Jaryani, F., Sahibudin, S., Ibrahim, S., Rahman, N.A. and Daruis, R. (2011). "Intelligent Reflective E-Portfolio Framework Based on Artificial Intelligence Expert Systems Techniques", *IEEE 978-1-61284-840-2/11*, pp. 214-216.

[8] Wu, H.. (2008). "Research on English Teaching Reading Based on Expert System" *IEEE International Conference on Computer Science and Software Engineering*, pp. 450-453.

[9] Ignizio, J. (1991). "Introduction to Expert Systems". *ISBN 0-07-909785-5*.

[10] Li, X., Li, Y., Chen, J., Zhang, L., Lv, X., and Shi, Y. (2010), "The Research and Design of Medical Expert System Based on the Service Soft Bus Architecture", *IEEE International Conference on E-Health Networking, Digital Ecosystems and Technologies*, pp. 69-72.

[11] Zhongzheng SHU (1994). "A Medical Expert System with Double-Layer Reasoning Model". Transactions of Nanjing University ofAeronautics & Astronautics. Vol.3, pp.376-383.

[12] Frenzel Jr. L.E., (1987). "Understanding Expert Systems". First Edition, *Sam's Understanding Series*.

[13] Informa (2008), "Global Mobile Forecasts to 2013, 8th edition, Informa telecom & Media, UK.

[14] Samra, S. (2009) "CDMA2000 Path to LTE" CDMA Development Group.

[15] Yan, H., Jiang, Y., Zheng, J. and Fu, B. (2002). "Internet-Based Knowledge Acquisition and Management Method to Build Large-Scale Medical Expert Systems", *IEEE Proceedings of the Second Joint EMBS/BMES Conference*

[16] Chorbev, I., Dragan, M. and Ilija, J., (2009). "Web Based Medical Expert System with a Self Training Heuristic Rule Induction Algorithm", *First IEEE International Conference on Advances in Databases, Knowledge, and Data Applications*, pp. 143-148.

[17] Adetunmbi A.O, Oguntimilehin A. and Falaki S.O (2012). "Web-Based Medical Assistant System For Malaria Diagnosis and Therapy" *GESJ: Computer Science and Telecommunications |No.1(33)*, pp. 42-53.

[18] Wang, F. and Hannafin, M.J. (2005) "Design-Based Research and Technology-EnhancedLearning Environments" *ETR&D*, Vol. 53, No. 4, pp. 5–23, ISSN 1042–1629.

[19] Amiel, T., & Reeves, T. C. (2008). "Design-Based Research and Educational Technology: Rethinking Technology and the Research Agenda". *Educational Technology & Society*, *11* (4), pp. 29–40.

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