e-DoX:DEPED Student Grade Records Management System with Implementation of Advanced Encryption Standard and PKI Infrastructure

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Abstract

This study entitled e-DoX: DEPED Student Grade Records Management System with Implementation of Advanced Encryption Standard and PKI Infrastructure for the Department of Education in the Province of Cavite is an online based application designed to aid private and public schools in submission of reports on promotions composed of Form 18-A, Form 18-E1 and Form 18-E2 to the Division Office of the Department of Education in the province of Cavite. The system would also be eliminating factors such as transportation and storage to maximize time allotment for the evaluation of the submitted reports.

In this study Advanced Encryption Standard and Public and Private Infrastructure was implemented in e-DoX to secure digital data into an undecipherable format that are sent by the schools in Cavite to DEPED application. This data is typically scrambled by using hashing algorithms, which convert data into a secret scrambled encryption format. This is the reason AES and PKI was implemented because it has the highest defined level for data encryption and security that will secure important data such as the student grade records of the schools in Cavite.

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The study covers all of the underlying plans and designs that were considered and executed in order to accomplish the research project. This includes collective plans and blueprints right from the conceptualization of the research project, data gathering on the existing system, knowledge requirements on different technologies included in the system, design and development of the system, up to the software evaluation.

The researcher used Prototyping as the method for development. This type of approach of developing the software is used for people who are usually not good at specifying their requirements, nor can tell properly about what they expect from the software. This type of System Development Method is employed when it is very difficult to obtain exact requirements from the client. While making the model, user keeps giving feedbacks from time to time and based on it, a prototype is made.

The findings of this project based on all of the results gathered during the software evaluation phase were carefully tabulated and analyzed by the proponent to come up with the best possible conclusion and recommendations for the betterment of the research project. The research project during the evaluation phase received an overall strongly acceptable remark from the respondents.

1. Introduction

As the immeasurable growth of technology prosper in our world, comes innovations rise up, from paper-based registration to electronic storage of information, from the manual process of giving letters to online social media, this development cycle will remain until everybody won't seek refinement for their lives. To increase productivity or to keep up with everyday competition especially in the business world, you need to process everything as fast as you can. This is where the records management system comes in, where records are in digital form and information systems are used to create, store, retrieve, distribute and dispose records. The records management process begins with the conversion of paper documents and records to electronic files. Conversion eliminates many of the obstacles created by paper: labor-intensive duplication procedures, slow distribution, misplaced originals and the inconvenience of retrieving files from off-site storage. Because paper files are also costly to process, distribute and store, digitizing paper archives ultimately reduces operating expenses and overhead. Records Management enables more efficient distribution of and control over information, files and records throughout an organization. These will simplify business procedures and expedite business processes by allowing instant access to information; greater collaboration within and among departments and offices; enhanced security for files and records; and the application of procedures that facilitate compliance.

Furthermore, security plays an important role in the security of data. It enables to store sensitive information or transmit it across unsecure networks so that unauthorized persons cannot read it. There is a well-known Advanced Encryption Standard (AES) or also called Rijndael is the most common encryption algorithm widely used in applications. The Advanced Encryption Standard (AES) is well known block-cipher algorithm which is easily portable and reasonable security. For secure exchange of digital data, resulted in large quantities of different encryption algorithms this can be classified into two groups: Symmetric encryption algorithm (with private key algorithms) and Asymmetric encryption algorithm (with public key algorithms). Symmetric key algorithms are in general much faster to execute electronically than asymmetric key algorithms. The most commonly used symmetric encryption algorithm is AES. The input plain text and the cipher key are in state array fashion and hence known as a block cipher. The plaintext input are of fixed size, blocks of 128 bits and produces a block of cipher text of equal size for each plaintext block. The most commonly used symmetric encryption algorithms are the data encryption standard (DES), triple data encryption algorithm (TDEA) and advanced encryption standard (AES). In this research AES was implemented because it provides more secure algorithm than the others, and it is commonly used in records management system.

The Department of Education in the Philippines has been collecting large volume of information for years from different schools all over the country. That information such as school and teacher profiles, student grades and promotion remarks are attached in documents or forms to be specific. There are different types of forms according to

educational level; Form-18A for high schools, Form-18E1 for Grades I to III and Form-18E2 for Grades IV to VI. Mainly these forms are composed of student grades and used for student promotion. Though the Department of Education has their division offices, it is still laborious to collect all of these forms. The Department of Education in the Province of Cavite covers 72 public and 310 private schools in the province they are responsible for governing and managing the basic education that includes gathering of student grades from schools under their supervision. They handle and evaluate all student grades that are inserted in all forms and process it manually. One of the problems in this process is the lack of organization amongst the storage of forms, as time goes by, the storage area of the Division Office is now crowded with tons of folders containing information related to each school in the province of Cavite. Another problem is that there are still forms that need to be sorted to its respective shelf. By the time they are going to search for a certain form and it is not yet properly placed, they are consuming precious time finding these forms. Also, the securities of student grade records are not secure.

Through the development of the student grade records management system for the Department of Education in the province of Cavite will modernize the process of sending required educational forms such as Form 18A, Form 18-E1, Form 18-E2 (Report on Promotions) thru the system that will accept final grades. Routine form processes, such as reviews and approvals, can be automated paperless allowing people to collaborate easier, and reducing the time it takes to review files. Through proper workflow management, each of these employees or machines will pass the work on according to a predetermined procedure. Plus, the risk of losing information is reduced because electronic files are captured and managed in secured repositories. This ensures that data stored in a computer cannot be read or compromised by any individuals without authorization that mostly involves data encryption, decryption, and user access levels.

The conceptual framework of the system which conveys all the required technical essentials and requirements, inputs and processes that must be accomplished for the development of the project that will then be the subject of evaluation. This can also be considered as the visual representation that serves to explain the structure of the system to the users. First, the knowledge requirements play a very vital part in accomplishing the project, technical knowledge and the software development related to it. Software and Hardware requirements were also thoroughly considered, analysis on the best possible resources were made by the researcher to ensure that the product of the project will be beneficial. The main concern of the Process part of the diagram is to illustrate the procedures that must be undergone to methodically transform the inputs to the corresponding output that the system must generate.
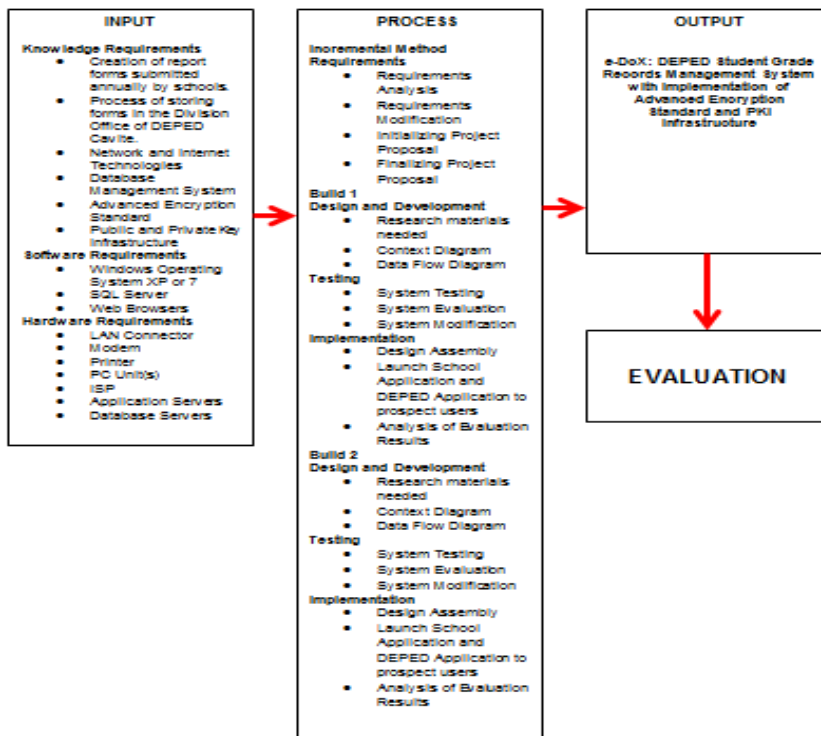
Fig. 1. Input process output (IPO Chart)

Figure 1 depicts the conceptual framework that shows the relation of all required knowledge and technology in order to develop the e-DoX: DEPED Student Grade Records Management System with Implementation of Advanced Encryption Standard and PKI Infrastructure. The figure also shows how the researcher developed the research project and come up with the appropriate functions to provide services that would assist teachers, registrar, principal and the DEPED for faster and more productive transaction. Within the development of the project, the researcher would also like the users to evaluate the system to determine what operation needs improvements.

The core task of the e-DoX is to store and retrieve student grade records from individual school database to centralized database. Securing this data from transfer to the centralized database and authenticating retrieval of data are vital to the system.
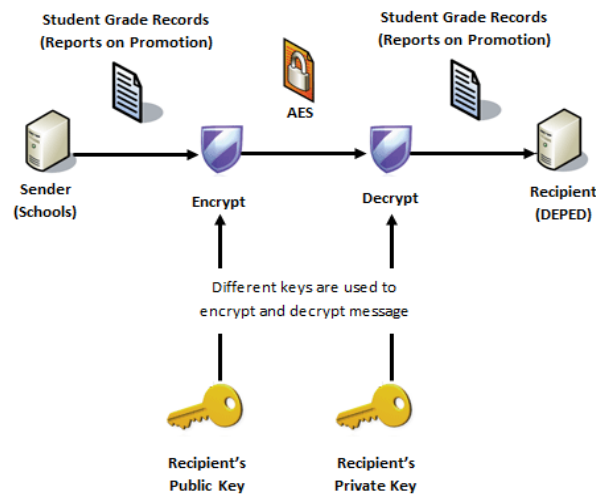

Figs. 2. Security features of e-DoX

Encrypted Data Transfer is one of the featuresthat allow the client machines to send the student grade records over to the main server for storage purposes in DEPED Cavite. However, before the file can be transferred it must be encrypted for security purposes. This is one of the most crucial functions of the system. [26]

The AES algorithm is a symmetric-key cipher, in which both the sender (Schools) and the receiver (DEPED) uses a single key for encryption and decryption. The length of the plain text is fixed to be 128 bits, while the key length can be either 128,192, or 256 bits. The key length selected is of 128 bits. AES algorithm is an iterative algorithm. Every iteration can be called a round, and the total number of rounds is 10, 12, or 14, when key length is 128, 192, or 256 respectively. The 128 bit algorithm is divided into 16 bytes. These bytes are represented into 4x4 arrays called the state array, and all the different operations of the AES algorithm such as addroundkey, subbytes, shiftrows, mixcolumns and key expansion are performed on the state. [27]

In AES algorithm encryption of data consists of ten rounds. Each round consists of four operations or transformations. Only the last round, the tenth round has only three operations to be performed. [27]
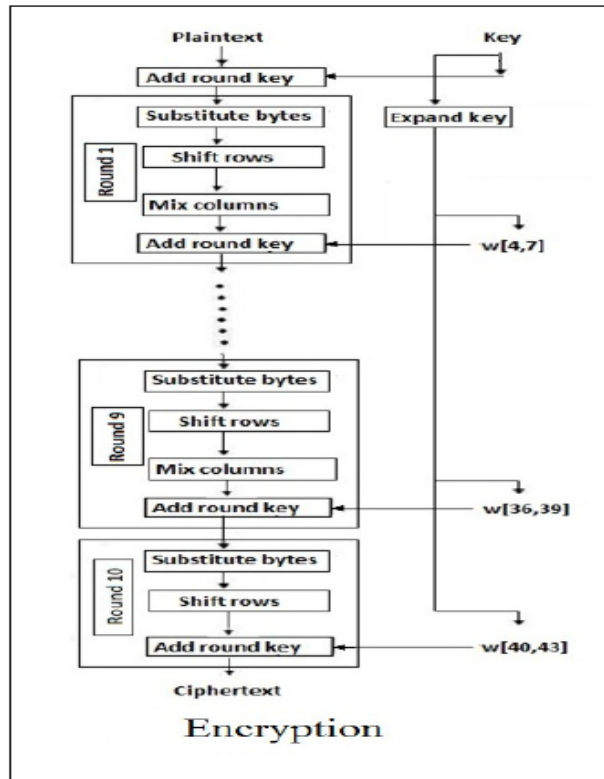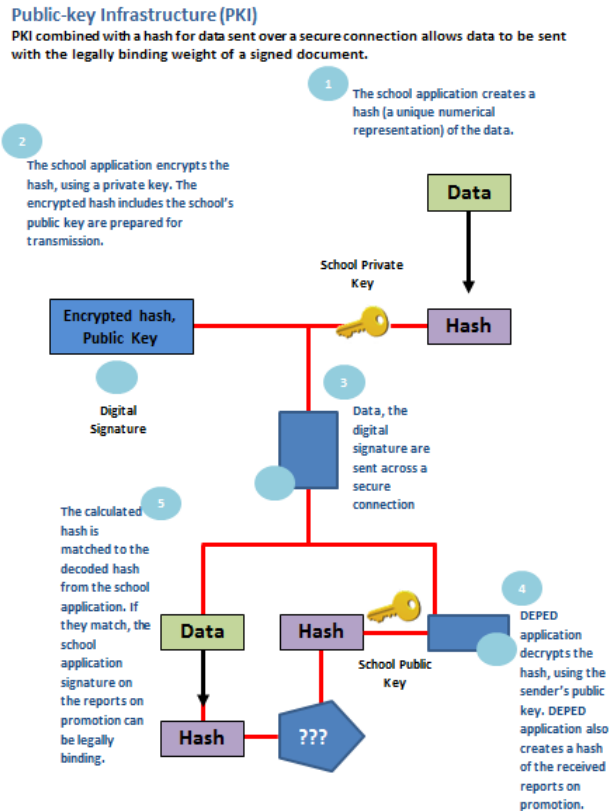
Figs. 3 The flow of AES. [27]

A cryptographic system that uses two keys, a public key known to everyone and a private key, the private key has full control to the key owner, and has to keep in secured environment. A unique element to the public key system is that the public and private keys are related in such a way that only the public key can be used to encrypt messages and only the corresponding private key can be used to decrypt them.

Public key cryptography was invented in 1976 by Whitfield Diffie and Martin Hellman. It is also called asymmetric encryption because it uses two keys instead of one key (symmetric encryption).

When schools send their student grade records thru e-DoX to DEPED, The schools uses DEPED public key to encrypt the file. DEPED then uses her private key to decrypt it.

Using special digital signature software, the schools client machine creates a message hash (a unique numerical representation) of the transaction, uniquely identifying the data to be signed. The school uses his private key to encrypt the hash. The encrypted hash becomes the digital signature of the message. The sender's certificate, digital signature and data are sent to DEPED. If the involved parties (schools and DEPED) aren't already using a secure connection, the sender can optionally choose to encrypt the data using the recipient's public key. When the student grade records are received, DEPED runs the data through the same data hashing function used by the schools. If the data was encrypted, it is first decrypted using the recipient's private key. DEPED uses the schools public key to decrypt the signature and the hash. If the hashes match, the integrity of the data is validated. To verify the schools' identity, the recipient checks the status of the schools' certificate.

Public-key Infrastructure (PKI)
PKI combined with a hash for data sent over a secure connection allows data to be sent with the legally binding weight of a signed document.

1 The school application creates a hash (a unique numerical representation) of the data.

2 The school application encrypts the hash, using a private key. The encrypted hash includes the school's public key are prepared for transmission.

Data

School Private Key

Encrypted hash, Public Key

Hash

Digital Signature

3 Data, the digital signature are sent across a secure connection

5 The calculated hash is matched to the decoded hash from the school application. If they match, the school application signature on the reports on promotion can be legally binding.

Data

Hash

School Public Key

4 DEPED application decrypts the hash, using the sender's public key. DEPED application also creates a hash of the received reports on promotion.

Hash

???

Figs. 4. PKI infrastructure

Problems always occur in every company on a daily basis. But problems that are always reoccurring are the ones to be solved to maintain the reliability and integrity of the company's mission and vision. That is why the researcher decided to aid the Department of Education in the province of Cavite that was experiencing difficulties when it comes to the annual submission of academic forms by schools. The main problems were preparation, transportation, storage and evaluation. Preparation causes confusion between teachers and school administrators whether the grades are legitimate or not. Transportation was another main problem because faculty members of each school in the province has to find their way to the DepEd Division Office just to submit their Forms that will serve as their annual report on how well was the operation of the school in this particular school year. Storage was another problem because copies sent by schools were kept for future purposes as well as back up, but considering the fact that the DepEd Cavite covers 72 public and 310 private schools they would need a wide space to store these documents. Last thing was the Evaluation, by the time the DepEd Cavite will conduct their evaluation they would be searching the storage room again and get these forms evaluated. This process would be time consuming and needs too much effort to execute.

At the present, there is a mass of different forms like annual reports such as reports on promotions (student grade records) in the form of reports and plenty of file cabinets all over the DEPED Cavite Division office. As a rule, the whole reports on promotions in DEPED are divided into three major categories: 1) reports on promotions produced and submitted by the schools in Cavite 2) reports on promotions received by DEPED 3) legacy reports on promotions.

Overall, the problems concerning the forms in the division office is summarized as follows:

- File cabinets and large file folders occupy a vast amount of the space in the division office.
- There is not any room or repository predicted for storage of the forms. Thus the distribution of the forms in the different rooms causes them to be lost, inaccessible and messed.

- The unruly storage of the forms, which is the consequence of lack of organizing, causes them or the content of them to be inaccessible.

The objectives of the study aims to; improve the process of managing forms on report on promotions submitted to Department of Education in the province of Cavite; develop a model of student grade records management system that can be implemented to other DEPED branches and schools; develop an electronic submission of student grade records (Report on Promotion) from schools to DEPED using the Internet; apply a robust security algorithm using Advanced Encryption Standard and PKI Infrastructure to secure and properly send to centralized repositories preventing unauthorized access to student grade records and; and provide fast and easy retrieval of student grade records.

The study covers the DEPED process of collecting the student grades (Report on promotions), and also recording and maintaining the final grades of all schools covered by DEPED Cavite. Reports covered are official forms of Form-18A, Form-18E1 and Form-18-E2. Advanced Encryption Standard is applied on this study, before the student grade records to be submitted to DEPED; records will be encrypted and stored in the database, once retrieve to the repositories of DEPED, student grade records will be decrypt. PKI Infrastructure to be included in the study.

The system considers that the system depends on human entry; human error sometimes makes information inaccurate; any disturbance or interruption during the process of inputting information would not be recovered by the system; the system response depends on the speed of internet connection;

The abundance of internet connection wouldn't be solved by the system. The study does not cover the actual implementation of the system to DEPED.

In this study, the beneficiary would be elementary and high school public and private schools as well as the Department of Education in the province of Cavite. This would make the operation of the Department of Education much faster due to the electronic storage and retrieving of educational forms specifically the student grades needed for promotions. This would also help the government as a whole in the concept of record management, as we all know that the government produces different kinds of records every day. The concept of this study should be taken for consideration. As for the school staffs such as teachers and registrar, the system would benefit them in terms of passing of form 18A and 18E via online and doesn't require them to travel just to pass these forms to the Division Office in the province. The schools and the Department of Education would also reduce their paper consumption because the storage is in electronic form.

The study would improve the process of handling, storing and retrieving student grade records in DEPED. It will help them lessen the time and effort in passing and storing all the information of each school records in the file cabinet. DEPED have over 13,000 of student grade records such as Form-18A, Form-18E1 and Form-18E2 that must be carefully managed. The study helps education administrators take control of paper and electronic documents to improve efficiency, lower cost, and speed operations with Student Grades record management.

In addition, with instant search ability of DEPED Form 18-A and Form 18-E, decisions can be made quicker and submission of such forms to DEPED is easier. Electronic access to forms in DEPED Division Office and School Registrar reduces the need for storage and improves the speed of operational processes. Remote access to records, even from authorized people off-campus, gives educational leaders on-demand access to records without delays or costs associated with shipping.

Lastly, the study will also benefit, private, public schools and DEPED have a paperless way to manage student records. Information is securely stored by encrypting and decrypting student grades sent by schools and shared among all components of the educational institution, from the Registrar's office, to academic departments, Development offices, DEPED Division Office.

One of the most significant steps in a research project is conducting the literature review. Through this, the readers can familiarize to the study of the researcher. The related and previous studies presented would give the readers and future researchers, an idea of the proposed system of the researcher. The researcher selected and reviewed these studies and previous works to provide information for the readers.

According to Gordon [1], Information Technology (IT) is a field concerned with the use of technology in managing and processing information. Information technology can be an important enabler of business success and innovation. This is not to say that IT equals business success and innovation or that IT represents business success and innovation. Information technology is most useful when it leverages the talents of people. Information technology in and of itself is not useful unless the right people know how to use and mange it effectively.[1]

With the series development in this field of study, inventions such as Information Systems were introduced to provide solutions to enabling a systematic approach in handling information which is vital to every organization. Successfully collecting, compiling, sorting, and finally analyzing information from multiple levels, in varied formats, exhibiting different granularities can provide tremendous insight into how an organization is performing. Taking a hard look at organizational information can yield exciting and unexpected results such as potential new markets, new ways of reaching customers, and even new ways of doing business, which is then made possible by different types Information Systems. [2]

Information System is a collective set of programs that functions to a specific purpose and are generally use to streamline the business processes and is considered by some as the backbone of every company today. It has various types such as Transaction Processing System, Office Management System, Embedded System, Management Information System and etc. [2]

In this project, the researcher developed a system that falls under the Management Information System (MIS) category. As defined by the author, Management Information System is considered business function just as marketing, finance, operations, and human resources management are business functions. Formally defined management information systems (MIS) is a general name for the business function and academic discipline covering the application of people, technologies and procedures-collectively called information systems- to solve business problems. In this context, the MIS can be defined as a system that aims to consolidate the data gathered in the company and make the most out of it through a vast array of purposes and uses. [3]

Part of a fully functional Information System is a great database scheme; database is a structure that contains different categories of information with their classified relationships with each other. Determining the appropriate requirements is the key to the development of a viable database design especially in a complex type of system. [5]

According to Sommerville[20], security is a system attribute that reflects the ability of the system to protect itself from external attacks, which may be accidental or deliberate. These external attacks are possible because most general-purpose computers are now networked and are therefore accessible by outsiders. Examples of attacks might be the installation of viruses and Trojan horses, unauthorized use of system services or unauthorized modification of a system or its data. In securing a system, it is best not to connect it to the Internet. Then, the security problems are limited to ensuring that authorized users do not abuse the system. In practice, however, there are huge benefits from networked access for most large systems so disconnecting from the Internet is not cost effective.

Following Sommerville's[20] definition and importance of security, the proponents intend to provide a security scheme for the system so as to protect the data and information stored in it. However, the security scheme will not be as sophisticated as those found in highly complex systems which requires strict confidentiality on its data. This will be done to avoid the risk of system breach and tampering of data. Security will be in a form of user accounts which will be only limited into three levels of users, namely: administrators, registrars, division officers, principals and teachers.

Workflow management is a system of overseeing the process of passing information, documents, and tasks from one employee or machine within a business to another. Through the proper use of this system, each of these employees or machines will pass the work on according to a predetermined procedure. [9]

Workflow Management would be a big help in organizing the processes on submission and approval of reports on promotions to be passed in the Division Office of the Department of Education in the province of Cavite. As with its strict implementation, the user cannot bypass or skip a process to complete a specific task.

According to a study conducted by Niederriter[21], he found out that for the past several years, the Dean's office and the Faculty Senate have struggled with defining teaching loads at Grustavus for the purposes of determining overload situations and staffing allocations. Several ad hoc committees have looked into the matter, without resolution. At least, since the school year 1992 – 1993, the registrar has tabulated "Faculty Load" data by department, including number of sections (or contact hours) taught full time load (as determined by the department), enrollment, and enrollment per faculty. All of the data is confused by the various ways how teaching loads are calculated and/or discussed; courses, contact hours, and combinations of the two. This has been (and currently is) the source of much frustration for the committees discussing the issue, some have suggested that things would be better to use semester hours instead of courses as a measure, but this ignores the inherent differences in the courses taught and the evaluation tools used.

The author has taken data provided by the registrar's office for both the Fall Semester of 1996 and the Spring Semester of 1997 and tabulated a number of parameters associated with teaching loads. The data provided included first term seminars (for the Fall) and Curriculum II (both semesters), independent studies, etc. However, the purposes of calculation, courses that have arranged times were not counted, including such things as music lessons and independent study research. This was not done as a result of any prejudice, but due to the fact that the number of contact hours and the combined scores could not be measured for arranged courses. This obviously affects some departmental data more than others, particularly music, some science departments, and other areas with a significant number of arranged courses.

Following the constraints that were considered in the research study mentioned above, the researcher had an idea on how to develop the system, particularly the feature wherein faculty loading and scheduling is involved.

According to Allen [22], faculties comprise varied groups of personalities, skills and schedules – providing a logistical challenge to anyone trying to schedule classes. The types and content of classes will vary depending on the type of faculty, but will never meet the needs of all members because of their different levels of experience. Further, the many competing priorities of educational work make it difficult to get faculty in the same room.

Before scheduling classes formally begin, one should do a little advance preparation. Faculty members should be formally consulted about their ideas for classes, which will create buy-in and boost support for classes. Gather information on the faculty members' schedules. If the faculty is at an elementary or high school, hours are fairly the same. Also consider the extra-curricular activities faculty members coach or teach for the school. For universities, teaching schedules vary in addition to their research and administrative duties. While you cannot know everyone's schedule, find out about events – such as conferences or workshops – which many of your faculty will want to attend; these are dates to avoid.

Create a list of possible dates and topics for classes. Use a visible scheduling tool for faculty to indicate availability. Online tools, such as Doodle, or offline tools, such as a sign-up sheet, help faculty choose from a variety of possible dates and times. Since these tools are visible, faculty members can also see the preferred dates of their colleagues. Peer pressure can sometimes work outside the classroom as well.

The visible scheduling tool provides greater transparency for the eventual choice of date and topic. If someone feels slighted when the date does not meet her schedule, it will be obvious why the decision was made. Sometimes, there are difficult choices if there isn't a clearly obvious day or topic preferred by faculty members. Consider whether some faculty members would benefit more from the meeting than others. If some faculty members show more interest or would benefit more, prioritize their schedules over someone unlikely to attend or benefit.

Include faculty members throughout the process by asking for feedback. Ask faculty how the scheduling process and, more generally, the class were for them. If the process met their needs, or if there are improvements necessary, it is useful to hear from faculty members themselves. Effective scheduling will be an ongoing task with multiple options for improvement.

The researcher found it necessary to consider the different factors that may affect the process of faculty loading especially those concerning the faculty members themselves. One factor is the preferred time slot of the faculty

members. It is crucial that this kind of factor be considered so as to allow efficient designation of loads to each faculty member, otherwise, conflicts between the schedule of subjects and the preferred time slots of the faculty members, not to mention their preferred subjects, will be a great problem to the school most specially to the principal themselves.

Curriculum refers to all courses offered at a school. It may also refer to defined and prescribed courses of studies, which students must fulfill in order to pass a certain level of education. On the other hand, a high school might refer to a curriculum as the courses required in order receiving one's diploma. [10]

As stated above, curriculum would be the basis of the researcher for the development of the system. Curriculum Management would be included in the system to deliver a dynamic approach upon the curriculum of schools and to prevent the probability of omitting the system when the K-12 was in effect.

According to Lemay and Culburn[19] a web browser, is the application used to view pages and navigate the World Wide Web. A wide array of Web browsers is available for just about every platform user can imagine. Microsoft Internet Explorer, for example, is included with Windows, and Safari is included with Mac OS X, Mozilla Firefox, Google Chrome, and Opera are all available as free downloads. Currently, the most widely used is Microsoft Internet Explorer, but competing browsers are increasing their share of the market.

Choosing to develop for a specific browser, such as Internet Explorer, is suitable when a person knows that a limited audience using the targeted browser software will view a website. Developing this way is a common practice in corporations implementing intranets. In these situations, it is a fair assumption that all users in the organization will use the browser supplied to them and, accordingly, it is possible to design the web pages on an intranet to use the specific capabilities of the browser in questions.

In essence of the definition given by Lemay and Culburn[19], the researcher agreed to use a specific browser, Google Chrome, as the system's platform. Since the school application is intended to run on a LAN-based, the researcher has decided to utilize a particular browser so as to maximize its capabilities rather than having it implemented to multiple browsers.

According to Heilmann[4] PHP is a server-side language that has become a massive success for three reasons: (1) It is a very easy and forgiving language. Variables can be anything, and you can create them anytime you want; (2) It is part of the free LAMP stack (Linux, Apache, MySQL, PHP) and thus available on almost any server you can rent on the Web; (3) It does not need a special editor, environment or build process.

PHP would be the main programming language for the development of the research project. Because of its well-known proficiency among the web developers, the researcher decided to make the system in this language to achieve the anticipated functions and results when using the system.

The researcher chose to use mySQL database in creating the database scheme of the developed system. This is a non-proprietary database that is flexible enough for the variety of purposes the researcher need. The researcher is also used to handling databases using the mySQL.

According to Vogel [6] JavaScript is executed directly in the browser and all main browsers contain a compiler or interpreter for JavaScript, it is also case sensitive.

JavaScript is the other web programming language that would strengthen the system. With its help, it would suffice the functions lacking on PHP it would also deliver the system towards its front end service that would be intended on all of the website's users.

In accordance with Lindley, C. and Beighley, L. [7], to understand jQuery, is to know a little in JavaScript, it is a programming language that the Web browser understands. The JavaScript is also a strong and usually used in adding interactivity and vigorous effects into Web pages. The Java Script code interacts in images, text on Web page like in hiding image, moving text, or changing content on a certain period of time. It can make image appear if there's

someone visit the Web page, can do a window pop up for 30 seconds after browsing a Web page or check the site if the visitor filled out the form appropriately. jQuery is an additional library for JavaScript and ensures the hard JavaScript coding work for you. jQuery code includes a line or two of code in your pages.

JQuery would make the system more functional and at the same time deliver interactivity on the system to the users. JQuery teamed up with other web programming language would be so much useful for the development of the system.

As stated by Ullman and Dykes [8] Ajax is a programming method or a particular approach to Web programming. The method involved is to be able to effortlessly update a section of Web application with input from server but does not need for an immediate page refresh. It doesn't mean that it doesn't make connection to Web server. It must be updated at some point by appointments with the server. Anything varies, the Ajax model is the position at which page is updated and moved.

AJAX was also a big help in developing the system. It would make the system more interactive without too many refresh when connecting to the server.

ISO/IEC 9126 serves as a framework or model for providing worldwide acceptable software qualities required for software evaluation. Under this standard, software must possess six main qualities namely: Accuracy, Efficiency, Reliability, Security, User-Friendliness, Flexibility, and Validity.

In this project, the researcher had adapted the concepts and practices provided by this standard in order to ensure the quality of the software created. The essentials of creating good software must undergo this evaluation in order to streamline the contents. Using ISO 9126 as the standard of developing software, The e-DoX: DEPED Student Grade Records Management System with Implementation of Advanced Encryption Standard and PKI Infrastructure can be evaluated by determining its key characteristics based ISO 9126. This would also deliver the system to the right track in rendering services intended to users in the province of Cavite.

The idea of the study entitled "Online Integrated High School Information System For Holy Child Catholic School" by Maliza et al. [11] is to develop and deploy a web-based management information system that enables user to complete their tasks more quickly and accurately as it provides complete information of the students and the school profile. This system includes an online monitoring of student grades report, online grading system to ensure an effective integrated system both for the faculty members and the management and to enhance the job performance of the administration. They also included faculty loading and subject posting feature in the system. In relation to the study entitled Institute of Science and Technology Online Registration System by de Leon et al. [12], having a good grasps on monitoring the records of the students using management information system will surely do a thing, This includes schedule allotment system and grade monitoring system for both the students and the faculty.

Both these complex management information systems included various subsystems that are carefully chosen and integrated into a single system for a better management of resources such as time, effort and money. The idea is similar to the researcher in a way that the chosen functionalities and modules included in the system were carefully and systematically chosen to ensure that they complement each other in order to produce a functional output.

The undergraduate study, "Patient Management System for Christ the King General Hospital" by Cruz et al. [13] seeks for the computerization of handling the records of the patients of the hospital. Since a Hospital is a generally service oriented type of establishment, they pointed out that the integrity of the hospital depends on the quality of the services it ought to provide its patients. They intend to modernize managing patient records & information through application of computer technology. After a series of interviews they had conducted with the head nurse of the hospital, they found out that there were a high percentage of misplaced patient records or kardex mostly on night duties which resulted to several inconsistencies and inaccuracies.

In relation to the study, integrity, accuracy, and consistency of records is also one of the top priorities to be considered in order to rationalize reports it can generate and make it as useful as possible.

The study entitled "DLSU-D D Computer Studies Department Automated Office Management System", by Diaz and Japitana[24], is focused on containing important details about faculty staff and students like personal data, schedules, loading, evaluation reports, attendance progress charts etc. It also includes the utilities required by the department of chair like the pre – loaded templates for altered types of documents that are forwarded to the several locations in school. They also come up in this study due to manual process of the said department in collecting data and generating of reports. They stored all the documents in file cabinets for reference and it cause a lack of space for the documents pile up in their department.

Office Automation is in line with records management system because of its relevance in record management. The developed system would automate the submission of reports from schools to the Division Office of the Department of Education in the province of Cavite.

According to the study of Manikan and Purificacion[14] entitled "File Management and Monitoring System of KasambuhayEstigmatine Foundation Inc", File management and monitoring system may look a bit simple, but the fact is that it has some sort of complexity depending on the level of application. For the enhancement and maintenance, it must be updated twice a year so it will give recent information that they gather such as files, artifacts and others.

The concept of File Management is also relevant to the researchers' developed system. Due to the fact that users would be submitting student grade records, there should also be management in storing and monitoring the submitted forms.

Dela Merced and Jarabe[15], in their undergraduate study entitled "San Miguel Campofrio Automated Filing System", discussed that it is capable of giving information to an employee such as employee background, HRAD sponsored activities attended, offenses and sanctions, work history and other important information that could be used to know the identity of an individual. It also permits accessing their file and manipulating of records such as adding, deleting, editing of employee files with convenience and accuracy. It also provide the report generation.

This would help the proponent on how to properly approach the archiving function of the system that will be used by the Department of Education, Division Office. By giving ample information about the submitted forms, the user would be informed what category the document was under.

As reported by Chen et al [16] in their study entitled "Computer-based Document Management System", the program provides an efficient way to automatically Import, index, categorize, store, search, retrieve, manipulate and archive electronic documents. The program is also capable of managing documents regardless of document type or document format.

In the study of Hijmiragha[17] entitled "Document Management System", the system allows pre-designated users at remotely located computer-based systems to perform document management. Components of the system include public data network, a publication facility, a remote storage facility and documents manager computer-based system. The document manager computer-based system, the publication facility, the remote storage facility are all coupled to the computer-based systems used by the pre-designated users over the public data network. The system allows authorized users from remote locations to perform secure document collaboration, share and archive documents, context index documents, digitally notarize documents, electronically file documents and publish documents.

According to the study of Honda et al [18] entitled "Document Management System", is a document referencing computer applying relationships or links between documents, wherein the documents are managed by a document managing computer, and the relationships or links are managed by knowledge managing computer. The display of the links is controlled according to a variety of conditions. The display of a respective link between documents can be controlled by either a user who sets the respective link or by a user using the document referencing computer to reference documents, thereby enabling related documents to be referenced easily.

Document management system helps businesses to do more in document processing, delivering quality information and optimizing resources that are essential to other business process. That is why the developed project is intended to be deployed online to cater large amount of users and deliver services that would be beneficial to a large amount of intended users.

De Guzman et al. [23] discussed that the course scheduling and faculty loading system is the assigning of classes and professors to a timeslot, room and section. It is done manually in the De La Salle University – Dasmariñas which is time consuming and prone to having more conflicts. Although the conflicts are resolved, a lot of time and resources were used. Finding the optimal or the best schedule will be impossible or will take too much time because of the constraints to be fulfilled such as the room, the university break, the partner days and the number of students. Problem arises when the students and professors needed to change their room assignment or their timeslot.

Course scheduling involves scheduling of the classes of a section, assigning the room and the time the subject will be taken. The challenge is that, the room conflicts and time conflicts are to be eliminated. Faculty loading on the other hand is the scheduling of professor to different sections that the faculty should track. The complexity of the system comes with the number of constraints that should be followed. The higher the requirements of fulfilling a schedule are the complex the system is.

Similar to the aforementioned system, e-DoX has the same constraints to be considered in both faculty loading and course scheduling processes. These constraints should all be taken into consideration and should be examined keenly to meet the requirements of the schools. And besides, this kind of system is undeniably one of those systems that are considered to have the most complex and dynamic processes. Thus, the elimination of conflicts and the analysis of constraints are indispensable to each other.

2. Materials and methods

This part of the study discusses the type of research methodology used by the researcher; the data gathering done during the interview and the evaluation of the respondents.

2.1 Research method used

This study is grounded upon descriptive research design principles in order to capture, analyze and interpret necessary information which eventually led to the final output, e-DoX. This type of research is more of an analytic or statistical type of research wherein the data descriptions must be factual, accurate and justifiable. In order to identify and define the existing business process by which the system was based upon, the researcher conducted observations and interviews The researcher had first conducted a series of observational activities and surveys to ensure that all of the underlying principles and plans were carefully set and planned into achieving the desired output which is in line with the standards set by higher governing bodies (ISO) concerning software quality standards. From these undertakings, the researcher began to develop the system until such time that the final output sufficiently manifested the features, functions and characteristics as planned.

2.2 Locale of the study

The researcher conducted a survey and evaluation on the Division Office of DEPED Cavite and several schools in Cavite specifically principals and teachers to determine the accuracy, efficiency, reliability, security, user-friendliness, flexibility, validity of the system and to support the ideas and concepts of the researcher. Since DEPED and schools in Cavite are the main respondents of the evaluation, the researcher selected several principals and teachers to evaluate the system.

2.3 Respondents of the study

The study started on the month of June, 2012. During the preliminary stage of collecting the data needed in the study, the researcher sought for permissions to conduct a series of surveys and interviews concerning the existing business process of the target client in relation to the objectives of the study. In order to do so, the researcher secured request letters approved by the designated research project adviser and noted by the dean of the graduate studies in MIT. The data gathered about the business process were meticulously consolidated and analyzed to arrive

with ways on how these can be useful to the study. The researcher also conducted a comprehensive research on gathering literatures, theses and systems related to the study as references. Lastly, knowledge requirements needed throughout the study were guaranteed thru additional extensive researches.

In order to begin the entire course of this study, the researcher conducted a series of interviews as part of the data gathering phase of this research. The researcher requested that they be entertained by the target interviewees who are also the intended users of the proposed system. The interviewees include the selected registrar or record keeper officer and principals of each school in Cavite, teachers of each selected schools, the DEPED Division Office specifically the Schools Division Superintendent, Archivist of the Form 18A, Form 18-E1 and Form 18-E2, and the Education Program Supervisor – ICT. Upon analyzing the initial data gathered from the preliminary interview, the researcher was given a clearer picture of the business process they are going to deal with in the course of the study.

2.4 Sample and sampling technique

As mentioned in the previous subchapters, several intended users were involved in the course of this study, specifically in the evaluation phase, to strengthen and increase the acceptance rate of the project. In line with this, the respective evaluators were identified prior to the actual evaluation, and they are as follows: three DEPED officials; one Archivist; one Education Program Supervisor – ICT; eight Information Technology professionals; and twenty four randomly selected teachers. The involvement of the target users is deemed to be highly important in determining the rate of acceptability of the final output.

2.5 Research instrument and technique used

To bring about the effectiveness of the project, the survey questionnaire was utilized by the researcher. The basic objective of this evaluation is to make certain the actual worth of the project as far as possible. The researcher used a standardized tool that was validated by IT professional in evaluating the system. The survey questionnaire is composed of three main parts. The first part of the form is the *respondent's profile* which asks for the age, gender and profession. The second part is the *software project awareness* in terms of accuracy, efficiency, reliability, flexibility, security, user-friendliness and validity. The last part featured the *respondent's recommendations* for the improvement of the system (see Appendix I).

2.6 Statistical treatment of data

The descriptive statistics using the mean standard deviation frequency and percentage was employed to present the demographic characteristics of the respondents and level of the system effectiveness.

2.6.1 Mean

This is the average of the scores – the mathematical center of a distribution. It used symmetrical, unimodal distributions of interval or ration scores. The formula for mean is:

$$\overline{x} = \frac{\sum x}{n}$$

Where:

$\sum x$ = sum of all scores

n = number of scores

2.6.2 Standard deviation

The standard deviation is a measure of variability used to identify whether the SD is homogenous or heterogenous. The formula for standard deviation is:

$$\sigma = \sqrt{\frac{\sum(\overline{x} - x)^2}{n - 1}}$$

2.6.3 Percentage

It defines as the part of expressed in hundredths. The formula for percentage is:

P = (n/t) x 100

Where:

P = percentage

n = number

t = total number of respondents

2.6.4 Frequency count

Frequency Count allows users to specify the binning parameters "from Minimum to Maximum", and the step by increment or interval number. The tool will provide some reference value of the minimum, maximum, and step.

Table 1.Types of data and their statistical tool according to the variable of the study.

Variables	Types of Data	Statistical Tool
Evaluator's Profile in terms of:		
✓ Age;	Normal	Frequency and Percentage
✓ Gender; and	Normal	Frequency and Percentage
✓ Profession	Normal	Frequency and Percentage
Level of the System's Effectiveness in terms of:		
✓ Accuracy	Interval	Mean and SD
✓ Efficiency	Interval	Mean and SD
✓ Reliability	Interval	Mean and SD
✓ User-friendliness	Interval	Mean and SD
✓ Security	Interval	Mean and SD
✓ Flexibility	Interval	Mean and SD
✓ Validity	Interval	Mean and SD

2.6.5 Coding scheme

The thirty-six (36) respondents evaluated the system using the following scale:
    5 – Strongly Agree
    4 – Agree
    3 – Slightly Agree
    2 – Disagree
    1 – Strongly Disagree

The obtained mean was interpreted using the following:

Numerical Rating Scale	Adjectival Rating
4.50 – 5.00	Strongly Acceptable

3.50 – 4.49	Acceptable
2.50 – 3.49	Slightly Acceptable
1.50 – 2.49	Unacceptable
1.00 – 1.49	Strongly Unacceptable

2.7 Design and development of the system

This chapter included different business and technical models used in conducting the study. The techniques, plans and strategies used in planning, designing, and development were systematically analyzed and discussed.

2.7.1 System development process model used

Developing a Student Grade Records Management System with Implementation of Advanced Encryption Standard and PKI Infrastructure is difficult to do because there will be series of tests and revisions before it will become functional. Therefore, there are some useful tools in building in integrated system methods such as System Development Life Cycle models which include prototyping.

Prototyping is the process of rapidly building a working model or mockup of a system or selected parts of a system. A prototype is capable of exhibiting the dynamics of system objects such as data entry and entry screens, output reports, system event flow, and logical data descriptions.

The primary goal of prototyping is to provide through the working model early insight into the system's characteristics. The prototype can be used to form the basis of the system requirements, or determine system feasibility, with a high level of user involvement.

The study included creating rough drafts of how the proposed system would look like and what the pages would contain. Through prototyping, the proponent had a more organized approach and modifications of the system could easily be implemented compared to working with the system directly where there is a great possibility that the internal workings of the system could encounter certain errors.

The researcher developed a preliminary release or version of the system where the key requirements and functionalities were used as a basis. With continuous testing and evaluation of the initial release, the researcher were able to come up with series of releases, and these releases were developed through the integration of the results gathered from the tests, evaluations, and feedbacks. When the results are to be implemented, the proponent used prototyping before directly applying the modifications directly to the system itself.
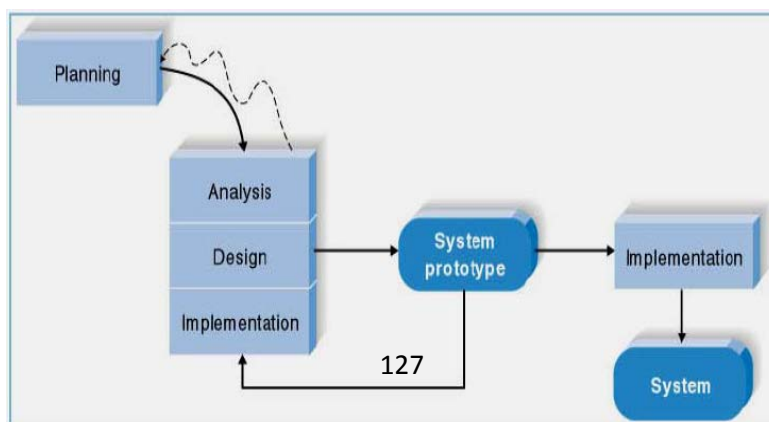
Figs. 5. Systems development methodology – prototyping [28]

2.7.1.1 Planning

This phase is the fundamental process of understanding why an information system should be built. The planning phase determines how the researcher will go about building the information system [28].

The researcher executes the planning stage during the project initiation. The proponent identified the prototype initiatives and develops a Project Plan. The project plan establishes the agreement between the researcher and the user organization. It specifies the accomplishments, by which they will be accomplished, the time frame, the cost, and the prototype method and tools to be used.

2.7.1.2 Analysis

The analysis phase answers the questions of who will use the system, what the system will do, and where and when it will be used. During this phase the researcher investigates any current system(s), identifies improvement opportunities, and develops a concept for the new system [28].

This phase was critical to the success of the development project. The requirements must be actionable, measurable, testable, related to identified needs or opportunities, and defined to a level of detail sufficient for system design.

For the analysis, the researcher conducted an interview to gather the data needed and went to DEPED Cavite Division office and several schools in Cavite to observe how the manual system works. The problems of the present system, as the users encountered them, have been extracted from more than fourteen hours interviews done by the researcher; the interviewees being principals, teachers, registrar, Division officer, DEPED IT Supervisors, archivist and end users of the system.

2.7.1.3 Design

In this phases it is decided how the system will operate, in terms of the hardware, software, and network infrastructure; the user interface, forms, and reports that will be used; and the specific programs, databases, and files that will be needed [28].

The researcher considered different aspects in the design of the student grade records management system. Each aspect must reflect the goals that the researcher and DEPED were trying to achieve. Some of the aspects that the researcher incorporated in their study are the following: compatibility, extensibility, fault-tolerance, maintainability, reliability, reusability, and usability. For the design of the software, the researcher also used data flow diagram and entity relationship diagram along with normalization.

2.7.1.4 Implementation

During this phase, the system is either developed or purchased (in the case of packaged software). This phase is usually the longest and most expensive part of the process [28].

Implementation is the process of writing, testing, debugging/troubleshooting, and maintaining the source code of computer programs. This source code is written in a programming language. The purpose of programming is to create a program that exhibits a certain desired behavior. Coding requires expertise in many different subjects, including knowledge of the application domain, specialized algorithms and formal logic.

The researcher used PHP for the coding and the interface and for the system to be available for the schools and DEPED, the researcher created two applications both for the schools and DEPED. Upon creating it errors were expected to emerge since the codes must also be correct and compatible with the technology Advanced Encryption Standard and PKI that supports, further debugging was done until there are no errors found.

2.7.2 Design of the system/software

This tackles the technical view on the development of the project. Processes are carefully analyzed by the researcher for the design of the system.

2.7.2.1 Functional decomposition diagram

A large or complex function such as the e-DoX is more understood when broken down using functional decomposition diagram. The main purpose of functional decomposition diagram is to break up a large or complex business operation or function into smaller and more manageable chunks. It facilitates understanding of the business operation or function and hence is a useful tool in conducting analysis and design of the e-DoX.

2.7.2.1.1 Schools application

This serves as an application intended for school users. The application will collect and maintain the student grade record thru data entry of periodical grades. This sub-system is used by the schools under the Division of DEPED Cavite. At the end of the school year student final grades will be collected and to be submitted to DEPED. This is the main functionality of this application. Grades entry will be encrypted once submitted to DEPED. It also includes the following functionalities:

a.   School registration

This function allows the principal to send the school information to DEPED application and this validate if the school is recognized by DEPED. School Registration ID and Encryption key will be sent to school once the school registration is approved by DEPED. This will serve as key for decryption of the submitted reports on promotion.
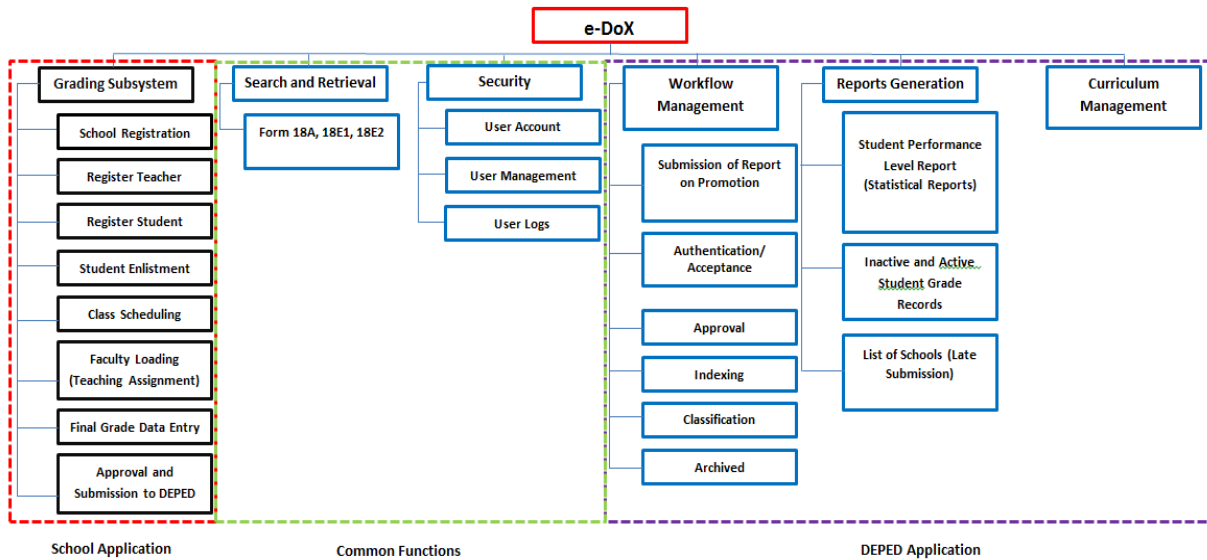
Figs. 6.The Functional decomposition diagram of the system.

b. Register teacher

Once the curriculum vitae are completed the School HR will register the employee (Teacher) to permit the teacher to use the school application. This preceding allows the principal to create a faculty load.

c. Register student

This function registers the student through student registration. Student Information is essential for reports on promotion such as birthday that computes the average age of the students per section. This preceding allows the registrar enlist the student.

d. Student enlistment

This function enlists the student to a particular section. This preceding allows the teacher to do grade data entry.

e. Class schedule

Class Schedule is one of the function uses by the principal. The function of the class schedule is to create a schedule, sections and set the maximum capacity per section, and to assign an adviser per section.

f. Faculty loading teaching assignments

Faculty loading is another function uses by the principal. The function is to assign a section and subjects to a teacher.

g. Final grade data entry;

This function is very vital; teachers use this function to enter the grades of the students. Grades are entered and use for preparing a report on promotion.

h. Approval and submission to DEPED.
This function is use to approve the reports on promotion and to submit the reports to DEPED.

2.7.2.1.2 DEPED application

The DEPED Application manages and defines a series of tasks within DEPED to produce a final outcome/s. Once the report on promotions are received this will be queued under Submission of reports on promotions; the authentication process of the grade records is done thru the use of the PKI infrastructure. The system will decrypt the encrypted file and authenticate the sender's file. The acceptance of the reports on promotion will notify the sender (Schools) that the file is received and accepted. The next task is indexing processes, is a function that will set the properties or attributes of the file, the properties is use for easy retrieval of the form and unique identification of the reports on promotion and easy retrieval. Once the attributes are set the form will undergo in classification processes. The form is classified as form 18A and 18E1 and 18E2. Lastly, the reports on promotion will be archive.

Another function of the DEPED application, includes the Curriculum Management, this will allow the division officer to create a curriculum that can be download by the schools thru school application. The following functionalities:

a) Curriculum management

   This function will allow DEPED to create a curriculum that can be downloading by the schools thru school application and the school will conform to the curriculum given by DEPED.

b) Workflow management

   This function is very crucial for the DEPED; business rule should be followed within an organization in order to come up a final output.

   • Submission on report on promotion

     DEDED will receive all submitted reports on promotion by the schools on this function.

   • Authentication/Acceptance

     This serves to authenticate and accept the reports on promotion submitted by the schools.

   • Approval

     DEPED use this function to approve the reports on promotion submitted by the schools.

   • Indexing

     Once the reports on promotion are approved by DEPED, the application will assign an attributes to the reports on promotion.

   • Classification;

     This can classify the reports on promotion as form 18A, 18E1 and 18E2.

   • And Archived.

     All Legacy reports three years below from the current year will be archived automatically in archived database. This allows freeing up some space in the DEPED database.

2.7.2.1.3 Search and retrieval

This is one of the crucial functions of the system. This function would allow individual student or parents to request for the copy of their grades; the schools can retrieve and search the student grade records in the system and generate

a report such as the Form 137-A. This function is beneficial for the school registrar and DEPED for easy retrieval of the Forms such as the Form 18A and 18E. The schools may also get another copy of student grade records from DEPED approved reports on promotion in case of lost.

2.7.2.2 Requirements modeling

2.7.2.2.1 Context diagram and diagram 0

The initial context diagram is the overview of the e-DoX School Application and DEPED Application that helps grasp basic data movement, and its general nature limits usefulness. The context diagram includes basic inputs and outputs, and the general system. The context diagram will be the most general one, a bird's-eye view of the data movement in the e-DoX and broadest possible conceptualization of the e-DoX.

In the other hand, Diagram 0 is more detailed than the Context diagram permit is achievable by exploding diagrams.
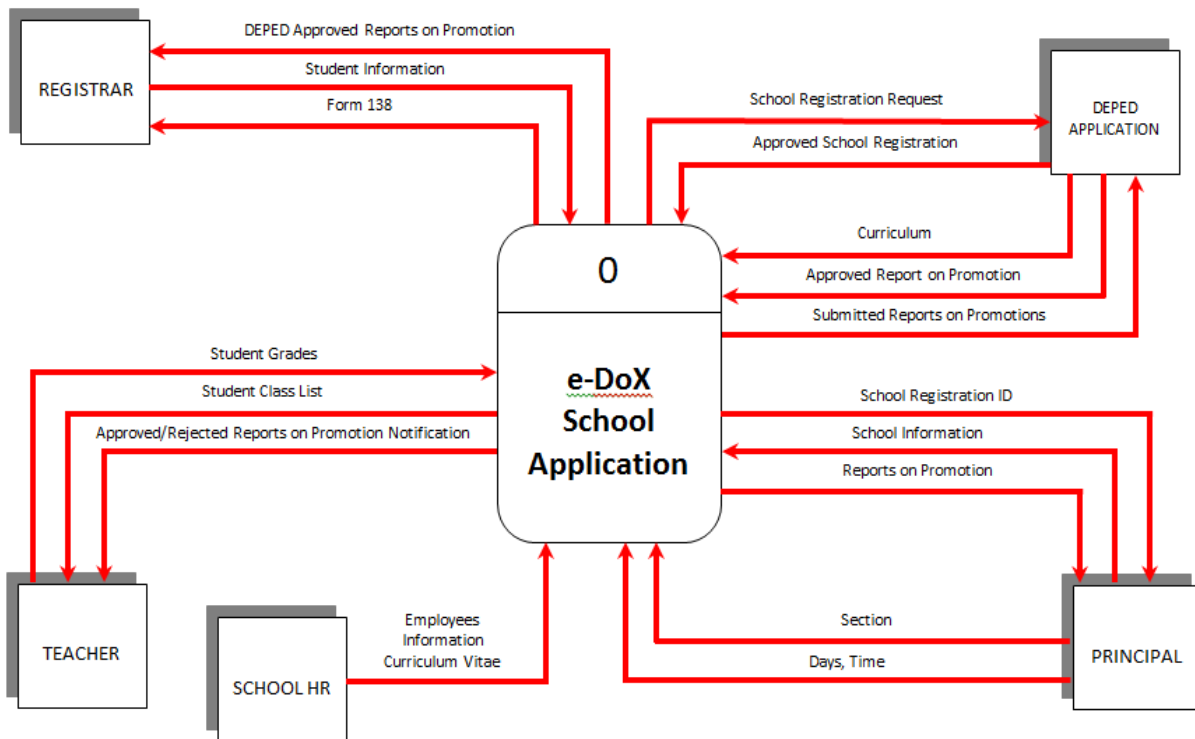

Figs. 7. School application context diagram

The context diagram of the school application comprises five external entities. These entities are used to depict an external entity that can send data to or receive data from the system.

The external entity DEPED application propagates the school curriculum which will be downloaded by the school registrar on a certain school year. The curriculum is followed by the schools and used by the school principal whom is responsible in creating a schedule for each section composes of time, days, grade/year level, and subjects. Schedules and sections that composed of individual students, registered and enlisted by the school registrar are assigned to individual teachers which serve as their faculty load and class advisee. Every periodical term the teacher will enter the student periodical grades, to compute the final grade and prepares a report on promotions to be received and approved by the school principal. The school registrar will submit the approved reports on promotion to DEPED application for approval. Once the reports on promotion is received and approved by the DEPED Division officer the schools is notified that the submitted reports on promotion is approved.

The principal is also in charge for the school registration; the school information is entered in the school application and sent to DEPED application for the approval of request of school registration. Once approved the DEPED application will generate a school registration ID that will serve as public key and private key for authentication of the sender of the reports on promotion.
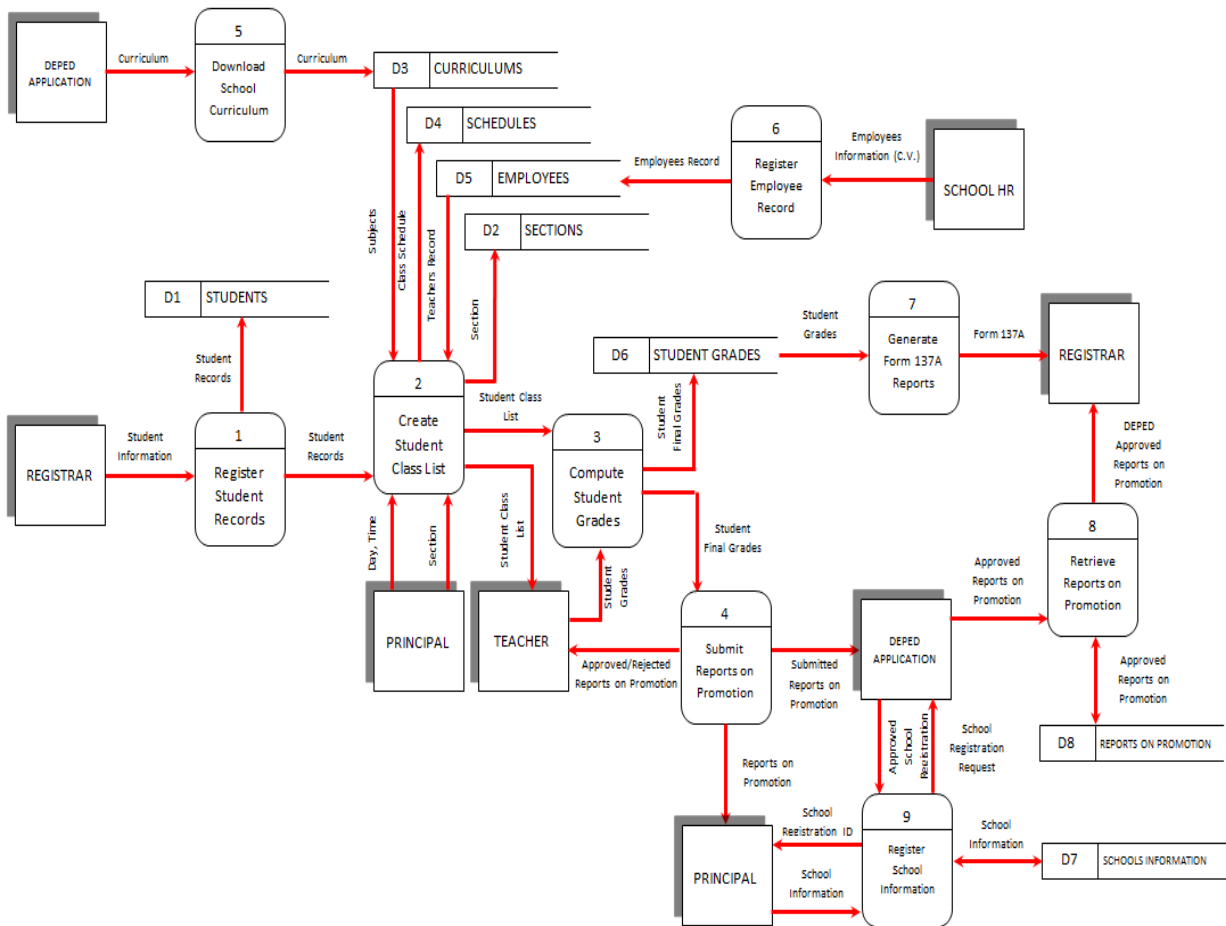
Figs. 8. School application diagram 0

Lastly, the external entity School HR is responsible of entering the information of an employee in the curriculum vitae. After the data entry, employees shall be registered as specific users of the school application.
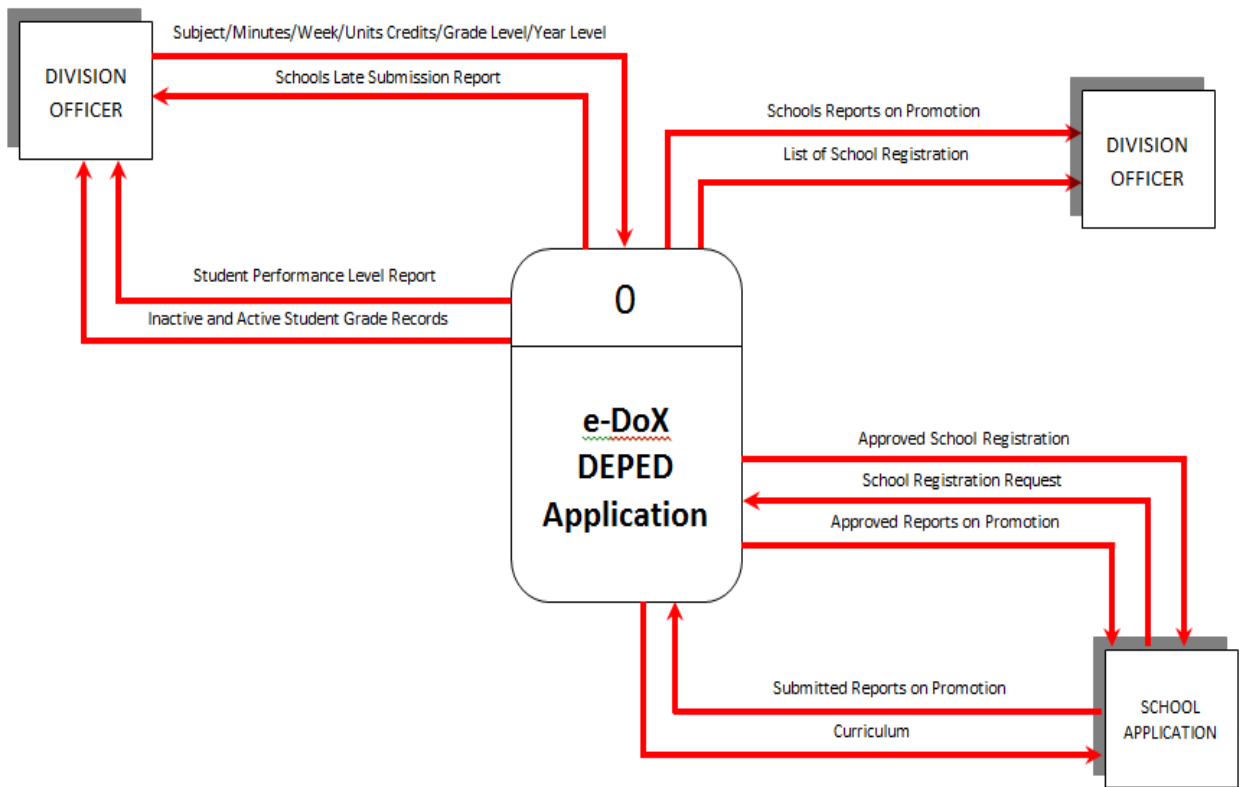
Figs. 9. DEPED application context diagram
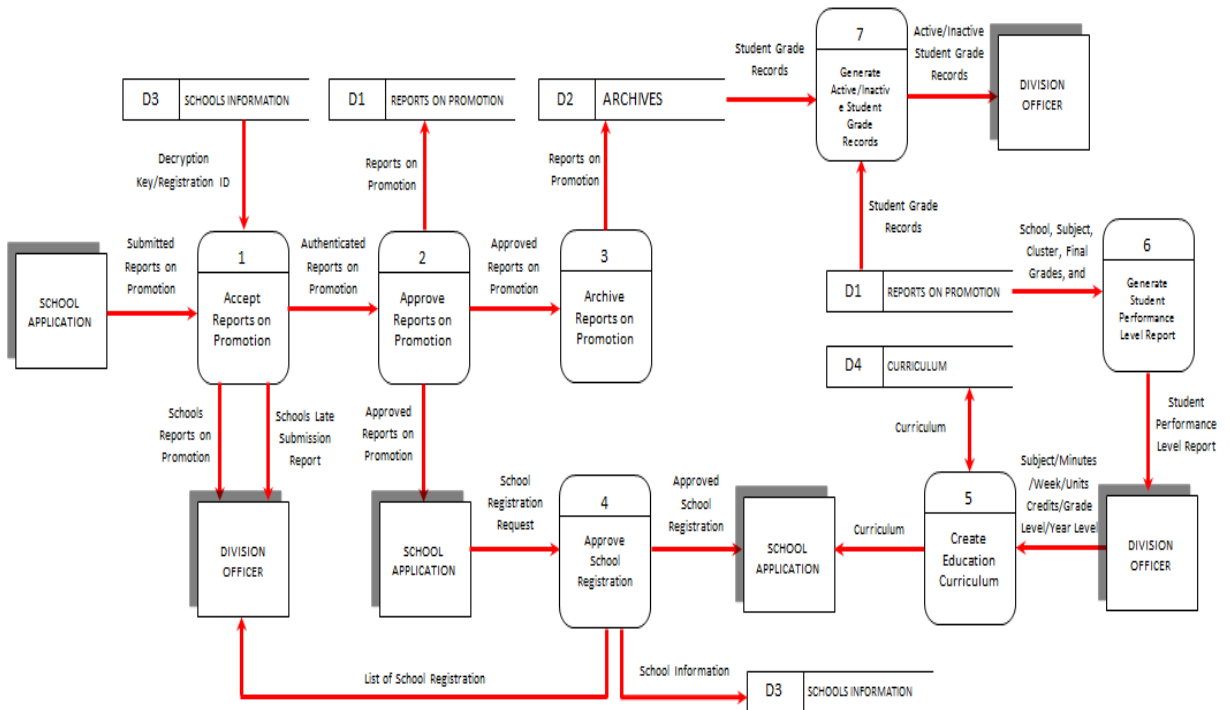
Figs. 10. DEPED application diagram 0

The context diagram of the school application comprises two external entities. These entities are used to depict an external entity that can send data to or receive data from the system.

The division officer is responsible of receiving and approving the school registration and reports on promotion submitted by the schools through school application. Reports on promotion will be stored to DEPED repository for later use. Grades submitted by the schools are used to prepare a report such as the student performance level, and school late submission. Legacy reports on promotion will be archived and considered as inactive student grade records. Inactive records are past five years. The Division officer is responsible of disseminating and creating of curriculum.

2.7.2.2.2 Use case diagram

The use cases are now being used regardless of the approach to systems development. It can be used as part of the SDLC. Use case model describes what a system does without describing how the system does it; that is. It is a logical model of the system. The use case model reflects the view of the system from the perspective of a user outside of the system.
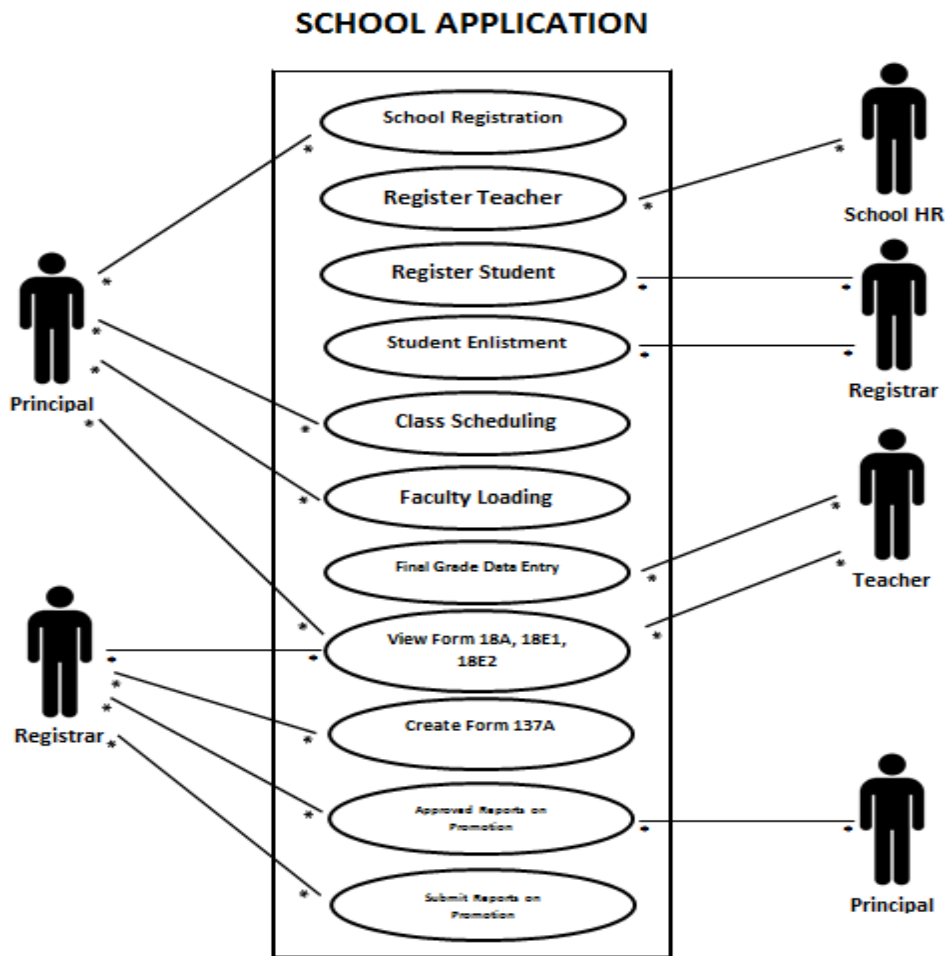
Figs. 11. Use case diagram of school application

The school application is consist of four actors that directly interact with the system. These are the School HR that registers the user such as teachers and other employees; Registrar who is responsible of student registration, enlisting of the student, approving the reports on promotion, printing reports of Form 137A, 18A, 18E1 and 18E2 and submitting the reports on promotion to DEPED; Teachers is in charge in data entry of student grades; lastly the principal register the school to DEPED, creates sections, schedules, faculty loading and class advisee, and approving the reports on promotion.
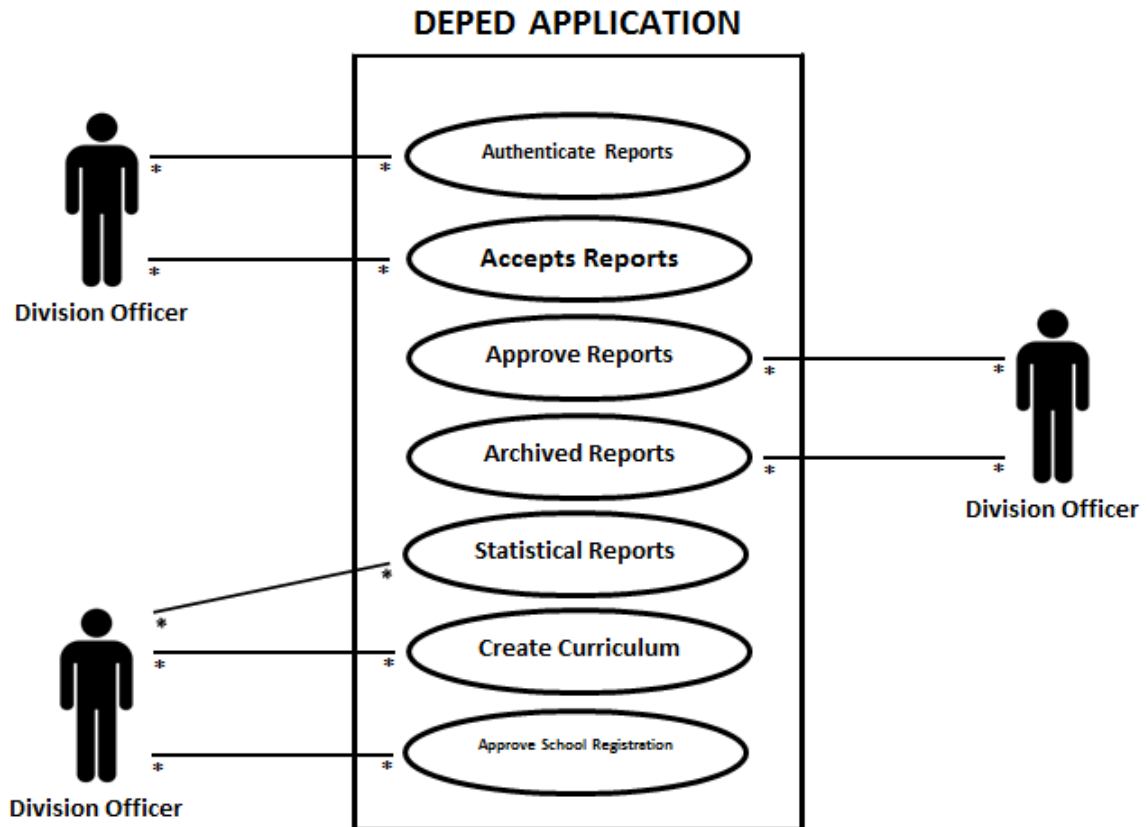
Figs. 12. Use case diagram of DEPED application

The DEPED application has an actor that directly interacts with the system. The division officer authenticates the reports on promotion submitted by the school registrar, accepts and approves the submitted reports on promotion and archives it; curriculums are created by the division officer and propagated to school applications; all school registration requests are approved by the division officer.
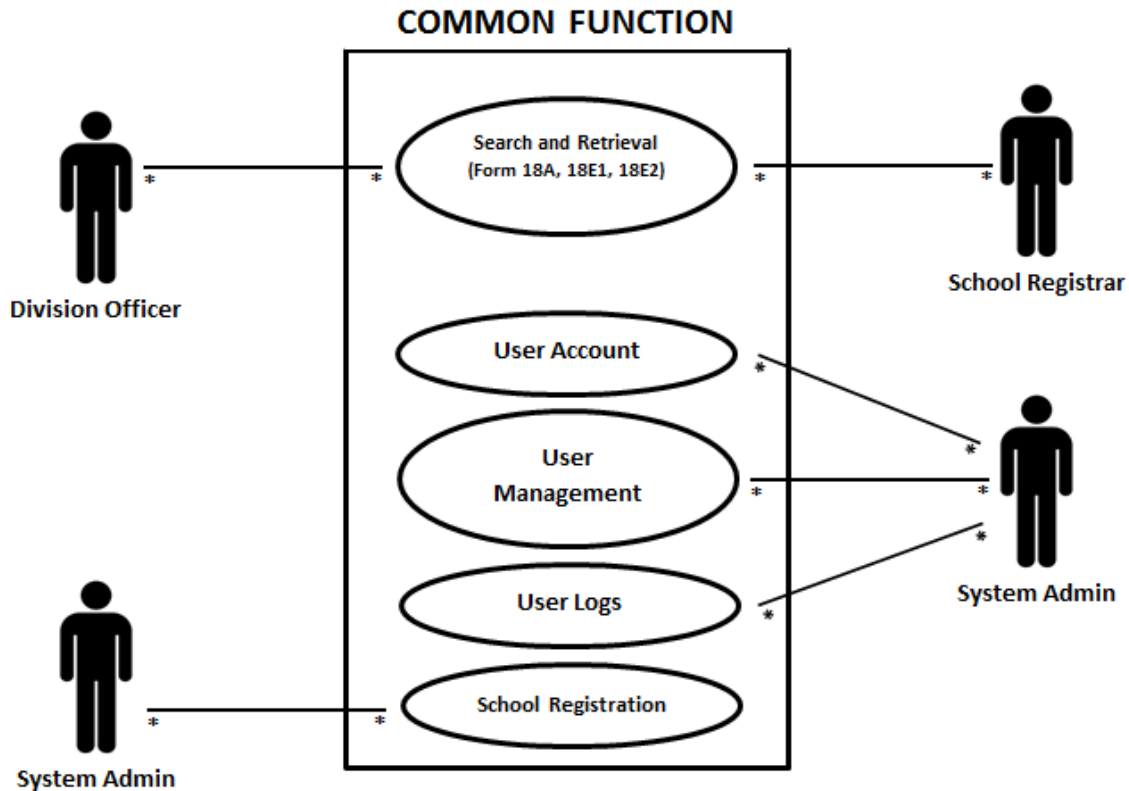
Figs. 13. Use case diagram of common function

The figure depicts the common function of school and DEPED application consists of three actors that directly interact with the system. The division officer and school registrar is capable of searching, retrieving and print reports such as Form 137A, 18A, 18E1 and 18E2. Creating of user accounts, User Management, User logs, reports on user logs and school registration are tasks by the system administrator.

2.7.2.3 System architecture

As depicted in Figure 4 it shows the proposed System Architecture. In the presentation tier this would allow the intended end-users to access the system through the use of a Web browser and it's Graphical User Interface. This layer can access the School Application that is intended for schools and DEPED Application for DEPED use.

The Application Tier is where the server-side processing is being carried out. These connect the interface into the Database Tier for storing and retrieving of data from the database. The AES and PKI Infrastructure for Digital signature will be implemented and executed in this part. AES is a security mechanism to be used for submission of the student grade records (Report on promotions) to DEPED. The student grade record is encrypted before sending it over the network.

The Database Tier is where the database server for the system is being handled. In the proposed system design, the student grade records will be collected centralized and consolidated from different schools are being stored and retrieved.
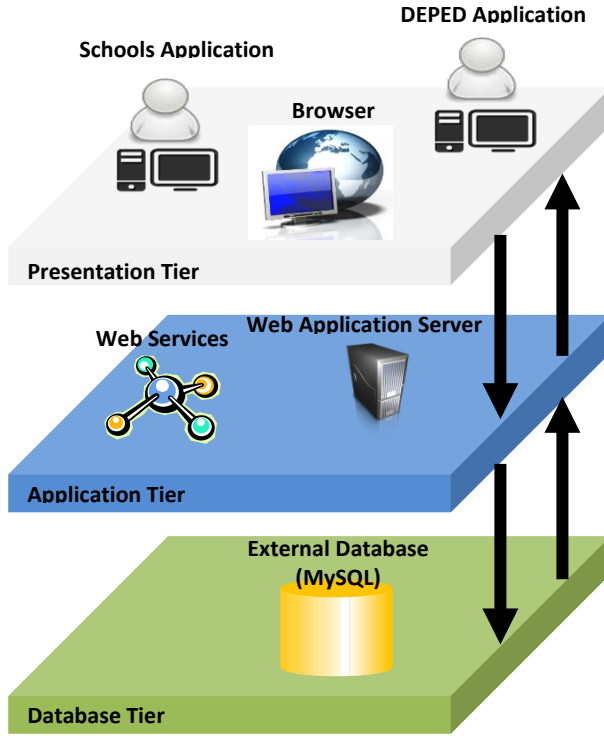
Figs. 14. System architecture

2.7.2.4 Data modeling

Data modeling techniques and tools capture and translate complex system designs of e-DoX into easily understood representations of the data flows and processes, creating a blueprint for construction.
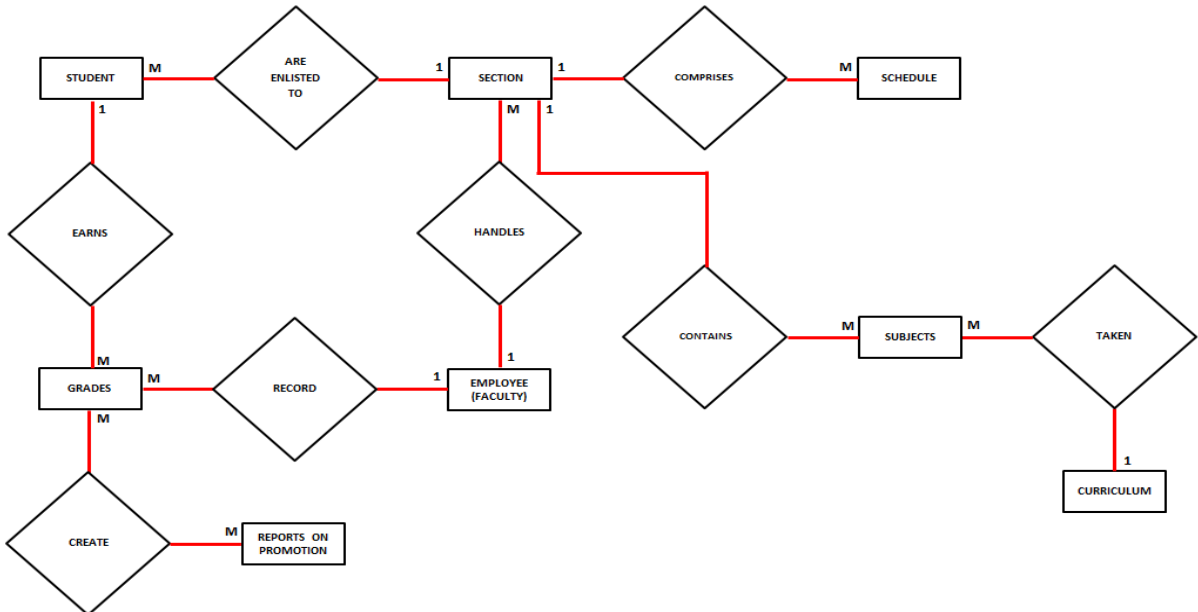
Figs. 15. Entity relationship diagram

2.7.2.5 Software and hardware specification

This tackles resources that are needed by the system to run properly and deliver desirable results to every user.

2.7.2.5.1 Software specification

This refers to the required applications to be able to run the system and also resources for the development of the e-DoX: Student Grade Records Management System with Implementation of Advanced Encryption Standard and PKI Infrastructure.

The researcher tend to use the following software in able to develop the system: Windows 7/8 Operating system; Recent version of Mozilla Firefox or Google Chrome; PHP and AJAX for server side scripting and interaction; CSS, jQuery and HTML for the interface of the system; SQL Server or XAMPP for the database management of entered data; and notepad ++ for the text editor.

The researcher recommends the following software for the users to be able to use the system: Windows 7/XP Operating System and recent Version of Mozilla Firefox or Google Chrome.

2.7.2.5.2 Hardware specification

This contains the hardware resources that are needed in order to use and develop the system.

To obtain the expected response from the system the researcher recommends this hardware specification: Pentium dual core 2.5-megahertz (MHZ) processor or faster; at least 1 GB of RAM; at least 1.5 GB of available space on the hard disk; CD-ROM or DVD-ROM drive; Keyboard and a Microsoft Mouse or some other compatible pointing device; Video adapter and Monitor with VGA (800x600) or higher resolution. A Database server with central processing unit of Dual Intel Xeon 2 x E55xx; 24 GB of RAM; and 1000 GB SATA2 of storage. And an application server with central processing unit of Intel Core i3-2100 or i5-2500; 4 GB of RAM; and 2 x 500 GB SATA2 of storage.

3. Results

This part shows the whole computation of the level of system effectiveness in terms of grand mean and standard deviation.

Table 2. The overall mean and standard deviation of system's effectiveness

Level of System's Effectiveness	Mean	SD	Interpretation	Rank
1. Accuracy	4.46	0.57	**Acceptable**	6
2. Efficiency	4.58	0.58	**Strongly Acceptable**	4
3. Reliability	4.55	0.57	**Strongly Acceptable**	5
4. Security	4.73	0.50	**Strongly Acceptable**	1
5. User-Friendliness	4.38	0.74	**Acceptable**	7
6. Flexibility	4.66	0.50	**Strongly Acceptable**	2
7. Validity	4.59	0.57	**Strongly Acceptable**	3
Grand Mean and SD	4.56	0.58	**Strongly Acceptable**	

Table 57 shows that system's overall finding is **Strongly Acceptable** with a grand mean of 4.56 and standard deviation of 0.58. The system's security ranked as first with the highest mean value of 4.73. Moreover, the system's flexibility, validity, efficiency, and reliability also rated as strongly acceptable with mean values of 4.66, 4.59, 4,58 and 4.55, respectively. In terms of accuracy and user-friendliness, the system was given rating of acceptable which also implies that the evaluators were satisfied on the system developed.

Based on the results of evaluation, the researcher can conclude that the software project is now ready for implementation.

4. Discussions

This contains a comprehensive overview of the study accepted. It includes the summary of important findings from which conclusions are drawn.

1. Out of thirty (36) respondents, majority are female (61%), others (39%) and 31-35 years old (34%) respectively.
2. Over all, the research project got 4.56 mean with *Strongly Acceptable* interpretation where the respondents gave *Heterogenous* response (SD= 0.58). Security got the number 1 ranking which means that the system is protected which is the main concern of the study is to provide a robust security.

Based on the aforementioned findings, the following conclusions were drawn:

1. The developed e-DoX: DEPED Student Grade Records Management System with implementation of Advanced Encryption Standard and PKI Infrastructure has successfully met the business requirements in the system are highly appreciated by the potential users and has met the intended processes but is also expected to improve in time being.
2. The system has highly adhered to all of the criteria set in the software evaluation for monitoring software quality and system effectiveness.
3. The developed system is strongly acceptable to the I.T. Experts and most especially to the end-users.

Based on the summary of findings, the recommendations are hereby drawn:

1. Adjust the report and screen layout in the browser to fit in the required output. Since the question on "the system is error-free?" obtained the lowest mean of 4.25, where the project commits report and screen layout issues due to browser compatibility, it is recommended that the setting of the browser should always be parallel to its desired system output.

2. Create help menu in any type of system. Since the questions on "the system provides help menu?" obtained the lowest mean of 4.08 and "the over-all design of the system is suited to the knowledge level of the users?" obtained a mean of 4.42 and "the system report and other output is easy to understand?" obtained a mean of 4.44 and "the system provides *adequate* feedback/message boxes?" obtained a mean of 4.47 it is recommended that all type of system must have *help menu and feedback/message boxes and simple user-interface* for the users to easily understand the system process.

3.*Deployment plan must carry out.* The Deployment plan is recommended how the e-DoX will be deployed, installed and transitioned into an operational system in DEPED and schools in Cavite. e-DoX deployment plan contains an overview of the system, a brief description of the major tasks involved in the deployment, the overall resources of DEPED and schools needed to support the deployment effort such as hardware, software, facilities, materials and personnel, and any site-specific implementation requirements. DEPED and Schools user involvement and participation influence by a number of variables that must be carefully balanced in order to ensure success of the involvement. Risk exists in e-DoX and must be anticipated and managed in order to achieve success.

4. *Pilot testing for DEPED Cavite and Schools.* Pilot testing is recommended to see the usefulness, usability and to confirm if the system is ready for full-scale implementation, including an evaluation for endorsement to DEPED main. Pilot testing is recommended to perceived how stable the system and how beneficial the system.

5. *Perform software evaluation after a year of implementation.* Carrying out an evaluation after a year of implementation will show the long term impact of the system, great improvement in the management and effectiveness of the organization (DEPED) and system. This will allow seeing that the system was able to achieve its objectives.

6. *Conduct an economic feasibility or business case.* This will enable DEPED and schools to assess the viability of e-DoX before financial resources are allocated and to have concrete presentation how DEPED will have pesos savings from the use of the system. This will convince DEPED main to use/implement the system across the Philippines. The business case will also detail the reasons why e-DoX should be funded and should be prioritized higher than other projects of DEPED.

Acknowledgement

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Appendix

Appendix A

Form 18E1

DepEd Form 18-E-1

REPUBLIC OF THE PHILIPPINES
DEPARTMENT OF EDUCATION

REPORT ON PROMOTIONS
(GRADES I - III INCLUSIVE)

SCHOOL YEAR 20_____ 20_____

Due the day after the last day prescribed for regular classes.

Division _____

School _____

GRADE _____

Date _____

Teacher _____ # _____

NAMES (Surname first, listed alphabetically)	HOME ADDRESS	YEARS IN SCHOOL	AGE	TOTAL NUMBER OF DAYS IN GRADE	FINAL RATING	ACTION TAKEN	REMARKS
TOTAL AGE OF PUPILS							

7 - 9

Appendix B

Form 18E2

REPORT ON PROMOTIONS
(GRADES IV - VI)

regular class day for pupils in Grades IV-V.

CURRICULUM _____

School _____   City _____   Division _____   GRADE _____   SECTION _____

Date _____   #

NAMES (Surname first, listed alphabetically)	HOME ADDRESS	YEARS IN SCHOOL	AGE	TOTAL NUMBER OF DAYS IN GRADE	FINAL RATING IN										GENERAL AVERAGE	ACTION TAKEN

Total age of pupils

AVERAGE _____

The (average cumulative) system was used.

0-015852

Appendix C
Form 18A

_____

Republic of the Philippines
Department of Education
DepEd Complex, Meralco Avenue, Pasig City

DepED
DEPARTMENT OF EDUCATION

JUL 1 5 2011

DepEd MEMORANDUM
No. **157** , s. 2011

IMPLEMENTATION AND ORIENTATION/BRIEFING OF BATCH 7-LUZON CLUSTER
(e-Classroom Packages for Elementary Schools) OF THE DEPED
COMPUTERIZATION PROGRAM (DCP)

To: Regional Directors
       Schools Division/City Superintendents
       Heads, Public Secondary Schools
       Regional and Division ICT Coordinators

1.   The Department of Education (DepEd) through Technical Service-Information and Communication Technology Unit (TS-ICTU) has facilitated the procurement of equipment and is now ready to implement Batch 7-Luzon Cluster (e-Classroom Packages for Elementary Schools) under the DepEd Computerization Program (DCP).

2.   A total of 1,643 elementary schools in Luzon have been identified by the TS-ICTU and the Bureau of Elementary Schools (BEE) based on BEIS 2009-2010 with a student population of more than 900 enrollees. On the other hand, the Visayas-Mindanao Cluster of Batch 7 shall be implemented once this has been awarded to the winning bidder.

3.   For effective and efficient deployment of the Program, the regional director (RD)/schools division/city superintendent (SDS) shall mobilize its ICT-Technical Committee composed of the regional ICT coordinator/SDS, designated regional/division ICT coordinators, accountant and supply officer as members. The Committee shall perform the following functions:

       a. Validate the readiness of the schools and compliance to the counterpart requirements;
       b. Assist the schools in preparing for the delivery of the computers;
       c. Monitor the utilization of the computers in their respective regions; and
       d. Submit reports on the implementation of the Program.

4.   To ensure the proper and prompt deployment of these packages, the TS-ICTU together with the BEE shall conduct a two (2)-day, orientation/briefing for the Luzon roll-out. Please refer to the enclosure for the schedule.

5.   This activity aims to:

       a. orient the schools of the **counterpart requirements** needed before the delivery of the computer packages;
       b. orient them on the **inspection and acceptance** of the computer packages;
       c. give the participants technological updates that can be used for **technological purposes and effective governance** through an ICT-aided environment; and
       d. introduce to them the learning application software programs and other authoring tools installed in the computer units.

Appendix D
DepEd Memorandum Order 157

6.   The orientation/briefing shall be conducted simultaneously in three (3) different venues: (a) Tagaytay International Convention Center (TICC), Aguinaldo Highway, Tagaytay City; (b) MIMOSA, Clark Pampanga; and (c) Teachers Camp, Baguio City.

7.   The participants to this activity are regional ICT coordinators, division ICT coordinators, school heads, and school ICT coordinators.

8.   The transportation expenses of regional and division ICT coordinators, school heads and school ICT coordinators shall be charged to local/region/division/school funds. Accommodation and traveling expenses of speakers, facilitators and secretariat/support staff from the Central Office and other incidental expenses such as supplies and briefing kits shall be charged to the Maintenance and Other Operating Expenses (MOOE) Component of the DCP.

9.   Please refer to the following enclosures:

          Enclosure No. 1 - List of Recipient Schools

Republic of the Philippines
Department of Education
DepEd Complex, Meralco Avenue, Pasig City

DepED

DepEd O R D E R
No. **46** . s. 2011

JUN 0 1 2011

**REVISED GUIDELINES ON THE IMPLEMENTATION OF THE DEPED
INTERNET CONNECTIVITY PROJECT (DICP)**

To: Regional Directors
         Schools Division/City Superintendents
         Regional and Division ICT Coordinators
         Regional and Division Accountants
         Heads, Public Secondary Schools
         All Others Concerned

1.   The Department of Education (DepEd) has launched the DepEd Internet
Connectivtiy Project (DICP) pursuant to DepEd Order No. 50, s. 2009 entitled,
*"Launching the DepEd Internet Connectivity Project and Directing All Public High Schools to
Subscribe to Internet Connectivity Services."* This shall complement the deployment of
ICT equipment to the secondary schools.

2.   All **7,019** secondary schools, including annexes and extensions based on the
Basic Education Information System (BEIS) data for School Year (SY) 2010-2011 as of
March 31, 2010 are entitled to receive their funding under DICP.

3.   High schools which are within the coverage of the Telecommunication Companies
shall receive a maximum amount of not more than Forty-Eight Thousand Pesos
(PhP48,000.00) per annum for payment of their internet service fees.

4.   On the other hand, the secondary schools that can only be covered through
Satellite Technology shall be provided with a maximum amount of Ninety Six Thousand
Pesos (PhP96,000.00) for one (1) time payment for installation fee and internet service
fee.

5.   The following are the revised guidelines on the implementation of DICP:

   a. All **Division   Offices   (DOs)   through   the   Schools   Division/City
      Superintendents shall ensure that all secondary schools within their
      jurisdiction or respective areas are connected to the internet.**

   b. A team headed by the SDS and composed of the following: (1) the Division ICT
      Coordinator; (2) the Division Accountant; and (3) the Technology and
      Livelihood Education (TLE) Supervisors; and other representatives needed by
      the team shall be tasked with the following:

      (1) facilitate the process of internet connection of the schools;
      (2) assist the schools in conducting canvasses/shopping whether
          implementing units or non-implementing units;
      (3) facilitate the payment of the internet subscription of the non-
          implementing units and implementing units; and
      (4) submit monthly or quarterly reports to the Central Office on the
          utilization of funds.

**Append
ix E**
DepEd

Order

No. 46

(2) Within the coverage of Satellite Companies:

For schools with at least ten (10) computers, they shall connect through satellite broadband internet service. The required Committed Information Rate (CIR) is 64 Kbps uplink and 256 Kbps (burst) downlink.

f. Unenergized secondary schools and newly-created secondary schools, awaiting

(5) Once the request for additional funds have been received, processed and approved, the Budget Division, FMS, Central Office shall immediately transfer the allotment received from the Department of Budget and Management-Central Office (DBM-CO) to the respective DOs based on the listing of recipient secondary schools, through the issuance of Sub-Allotment Release Orders (SUB-AROs).

(6) Upon receipt of the Sub-ARO, the Division Offices (DOs) shall record such receipt in the Registry of Allotments and Obligations for Maintenance and Other Operating Expenses (RAOMO) being maintained by the respective units.

(7) The cash allocation corresponding to the allotment transferred to the respective units will be issued by the concerned DBM-ROs, subject to the submission of requests for release of Notice of Cash Allocations (NCAs), supported by copies of Sub-AROs for reference.

(8) Funds which will expire but have an existing contract that will end the following year must comply in accordance to DepEd Order No. 115, s. 2010.

j. Allotment under the DICP shall be used solely/exclusively for payment of internet connectivity services.

6.   All DOs are directed to make sure that all secondary schools are connected to the internet before the opening of classes this June for SY 2011-2012.

7.   All RDs through the Regional ICT Coordinators are directed to monitor/validate the compliance of their respective Divisions with this Order and submit the DICP Regional Compliance or Consolidated Report (format enclosed) to **Director Mari Paul C. Soriano**, Technical Service, DepEd Central Office via email address: dicp@deped.gov.ph.

8.   Immediate dissemination of and compliance with this Order is directed.

ALBERTO T. MUYOT
Undersecretary
Officer-in-Charge

Encl.:
        As stated

References:
        DepEd Order: (Nos. 115, s. 2010 and 50, s. 2009)

To be indicated in the Perpetual Index
        under the following subjects:

FUNDS   PROJECTS
INFORMATION TECHNOLOY   SCHOOLS
POLICY

Appendix F
Endorsement Letter

Republic of the Philippines
Department of Education
Region IV-A (CALABARZON)
DIVISION OF CAVITE
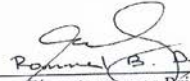**Trece Martires City**

1st Endorsement
May 27, 2013

Respectfully returned to **ROMMEL B. DY**, researcher, Technological Institute of the Philippines, Quezon City, with the information that this Office interposes no objection to the attached request to conduct a study entitled **"E-DOX: DEPED STUDENT GRADE RECORDS MANAGEMENT SYSTEM WITH IMPLEMENTATION OF ADVANCED ENCRYPTION STANDARD AND PKI INFRASTRUCTURE"**, provided that the following conditions will be taken into consideration:

1. There should be **PROPER COORDINATION WITH THE PRINCIPALS OF TRECE MARTIRES CITY NHS, TRECE MARTIRES CITY CABEZAS ANNEX, GOVERNOR FERRER NHS, OSORIO NHS AND LUIS AGUADO NHS;**

2. The activity **SHOULD BE SCHEDULED AFTER CLASS HOURS;**

3. The activity **SHOULD NOT DISRUPT CLASSES NOR INTERFERE WITH THE REGULAR ACTIVITIES OF THE SCHOOL;**

4. Participation to this activity is **STRICTLY VOLUNTARY;**

5. The School Head concerned should submit to this Office a **completion report** regarding the conduct of the activity, and

6. A copy of the research shall be submitted to the Library Hub through the Division Librarian, for utilization of other researchers in this division.

YOLANDA V. CARPINA, Ph.D.
Schools Division Superintendent

AGREEMENT

I agree to submit a copy of the research to the Division Library Hub through the Division Librarian for the utilization of other researchers in this Division.

Signature over Printed Name

School/District: _TIP Cubao Quezon City_

Contact No.: _0919 416 6188_

Appendix G
Evaluation Letter

TECHNOLOGICAL INSTITUTE OF THE PHILIPPINES – QUEZON CITY

DR. YOLANDA V. CARPINA
Schools Division Superintendent
Division of Cavite
Trece Martires City, Cavite

DEPARTMENT OF EDUCATION
DIVISION OF CAVITE
RECEIVED
RECORDS SECTION
DATE __5/27/13__
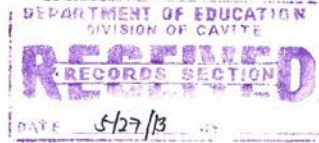
Dear Dr. Carpina:

Warmest Greetings!

I am completing a master's research project at Technological Institute of the Philippines Cubao, Quezon City taking up Master in Information Technology and presently conducting a research project entitled **"e-DoX: DEPED Student Grade Records Management System with Implementation of Advanced Encryption Standard and PKI Infrastructure"** and need your help to realize its objectives. The objective of the research is to improve the submission of Reports on Promotion submitted by schools in Cavite.

In line with this, I would like to seek your assistance may I be allowed to conduct a survey with some selected schools as to determine if I attained my target objectives. The names of schools I intend to conduct my survey with are listed as follows:

1. Trece Martires City National High School
2. Trece Martires City Cabezas Annex
3. Governor Ferrer National High School
4. Osorio National High School
5. Luis Aguado National High School

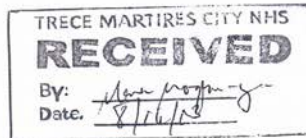Furthermore, I would like to request the persons whose titles appears below to conduct the evaluation:
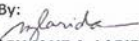
1. IT-Teacher
2. Guidance Councilor
3. Student Record Officer
4. Classroom Adviser (Computer Literate)
5. Principal

Your approval will be of great assistance to the success of this research project. Rest assured that all information gathered shall be treated with strict confidentiality and for academic purposes only.

Respectfully,

Rommel B. Dy

Noted By:

Ms. MARY JANE A. LARIDA
Research Project Adviser

Dr. BARTOLOME T. TANGUILIG III
Dean, Graduate School

Appendix H

August 16, 2013

Principal
This School

Dear Sir/Madame:

Warmest Greetings!
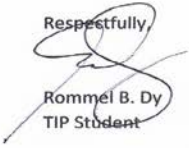
I am currently developing a master's research project entitled **"e-DoX: DEPED Student Grade Records Management System with Implementation of Advanced Encryption Standard and PKI Infrastructure"**. The objective of the research is to improve the submission of reports on promotion submitted by schools. In connection with this, I would like to request your assistance and authorization to conduct a software evaluation to the following person whose titles appears below:

1. IT Teacher
2. Guidance Councilor
3. Student Record Officer
4. Classroom Adviser (Computer Literate)
5. Principal

Additionally, attached herewith the endorsement signed by Dr. Yolanda V. Carpina from the Department of Education Division of Cavite. Rest assured that all information gathered shall be treated with strict confidentiality and for academic purposes only.

Thank you and hoping for your favorable response regarding this matter.

Respectfully,

Rommel B. Dy
TIP Student

TRECE MARTIRES CITY NHS
RECEIVED
By: _____
Date: 8/16/13

Appendix I
Research Project Evaluation Instrument

Part I. Respondents' Profile
Direction: Supply the information requested below by writing on the space or by checking (which corresponds on your profile.
Name (Optional):
Age (as of last birthday):
Gender: Male ☐   Female ☐
Profession: ☐Programmer /Software Developer   ☐Database Administrator   ☐   End-User   ☐Others Pls. Specify   _____

Part II. Software Characteristics
Direction: Based on **"e-DoX: DEPED Student Grade Records Management System with Implementation of Advanced Encryption Standard and PKI Infrastructure"**, answer the following questions as completely, honestly and accurately as you can. Check (☐

Legend:
        5 – Strongly Agree   2 – Slightly Disagree
        4 – Agree   1 – Strongly Disagree
        3 – Slightly Agree

Accuracy	5	4	3	2	1
1. The system is capable to do correct and accurate calculations (if needed).	☐	☐	☐	☐	☐
2. The system is error-free.	☐	☐	☐	☐	☐
3. The system generates the correct output in all types of reports.	☐	☐	☐	☐	☐
4. The overall system satisfied the **e-DoX: DEPED Student Grade Records Management System with Implementation of Advanced Encryption Standard and PKI Infrastructure.**	☐	☐	☐	☐	☐

Efficiency	5	4	3	2	1
5. The system produces consistent and correct result in fast response time.	☐	☐	☐	☐	☐
6. The system uses efficiency **input** needed data.	☐	☐	☐	☐	☐
7. The system produces efficient **output** needed data.	☐	☐	☐	☐	☐
8. The system has efficient backup.	☐	☐	☐	☐	☐
9. The system *immediately* displays the available data for the user.	☐	☐	☐	☐	☐

Reliability

	5	4	3	2	1
10. The system procedure was based on manual procedure.	☐	☐	☐	☐	☐
11. The system provides the actual Information of system;	☐	☐	☐	☐	☐
12. The system is capable of producing backup copies of all types of data.	☐	☐	☐	☐	☐

Security					
	5	4	3	2	1
13. The system has a security password to prevent unauthorized access of data.	☐	☐	☐	☐	☐
14. The system secures important data that only the *administrator account* can access (disabling menu/s etc.)	☐	☐	☐	☐	☐
15. The system manifests protection on its entire content and structure.	☐	☐	☐	☐	☐

User-Friendliness					
	5	4	3	2	1
16. The over-all design of the system is suited to the knowledge level of the users (satisfactory user-interface).	☐	☐	☐	☐	☐
17. The system gives positive or understandable remarks.	☐	☐	☐	☐	☐
18. The system provides *Help menu.*	☐	☐	☐	☐	☐
19. The systems report and other output is easy to understand.	☐	☐	☐	☐	☐
20. The system provides *adequate* feedback/message boxes.	☐	☐	☐	☐	☐

Flexibility					
	5	4	3	2	1
21. The system has an option for Input changes	☐	☐	☐	☐	☐
22. The system has an option for Output needed	☐	☐	☐	☐	☐
23. The system conceptual design *can be changed* showing its scope, over-all architecture and relationship to other systems.	☐	☐	☐	☐	☐

Validity					
	5	4	3	2	1
24. The system **Input** data meets the true and actual procedure.	☐	☐	☐	☐	☐
25. The system **Process** data meets the true and actual procedure.	☐	☐	☐	☐	☐
26. The system **Output** data meets the true and actual procedure.	☐	☐	☐	☐	☐

Part III. Suggestions/Recommendations
Direction:
Give some suggestions and recommendations for the improvement of the "**e-DoX: DEPED Student**

Grade Records Management System with Implementation of Advanced Encryption Standard and PKI Infrastructure".

Suggestions and Recommendations:

Respondent's Signature
Over printed name

Thank you

Appendix J
Certificate of Statistical Analysis

Certificate of Statistical Analysis

This is to certify that the research manuscript entitled:

e-DoX: DEPED Student Grade Records Management System with Implementation of Advanced Encryption Standard and PKI Infrastructure

submitted by:

Rommel B. Dy

_____
Proponent's Signature over Printed Name

for the degree Masters in Information Technology under the Graduate School has been tabulated and analyzed by the undersigned statistician with respect to appropriate measurement tools and techniques.

Lynette D. Perido

_____
Statistician's Signature over printed name
Affiliation: LPU-Cavite
Contact #: 0926-710 9994

Date of Completion: 10/10/2013
(mm/dd/yyyy)