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Grade Monitoring System: A Prototype for Thulamela Secondary Schools

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Abstract: In South Africa, the Department of Basic Education commissioned that every school must issue out a report card to every learner at the end of each term/quarter as a standard communication tool between parents/guardians and school. To adhere to this, schools distribute messages through various ways in order to summon parents/guardians to come and collect learner report card on specific dates proposed by the school. In Thulamela, a section in the Limpopo province in South Africa, most of the schools require parents/guardians to collect the reports in person. Some parents or guardians usually come across situations whereby it is not feasible to collect the report on that specific date due to unavailability due to work, lack of transportation, poor health conditions etc. In order to overcome such challenges, this study proposes the use of technology in the form of a system that will allow parents or guardians to monitor learner performance which is assessable in an easier and more efficient manner. The study was based on secondary schools which are situated around Thulamela Municipality.

Keywords: Grade, Monitoring System, Thulamela Secondary Schools

1. Introduction

Almost every task that is done today relies in some way on how we collect, process, analyse and retrieve data [1]. The most common electronic devices used for this are personal computers and mobile devices. Personal computers and mobile devices are used in certain schools to speed up some of the schools administration tasks or jobs. For example, schools collect data using forms, the data is captured and converted into digital format. In the area of Thulamela, the above has not become a reality. Thulamela is one of the local municipalities situated in the northern part of the Limpopo province in South Africa. The area is comprised of small towns and 400 rural villages, which classifies it as a rural area [2]. Households situated in rural areas have access to far less services, such as public transport infrastructure, school infrastructure and so on compared to urban areas [3]. The Thulamela Municipality indicates that one of its main challenges is that most schools do not meet the required norms and standards of having a healthy functional school [2]. The schools fall behind in areas such as enrolment, and school attendance due to the distance which learners have to travel [2]. Not surprising, the schools in this area still rely heavily on outdated manual systems to collect, analyse and distribute learner progress reports. Manual systems are time consuming and are vulnerable to human error, natural disasters and theft. This can result in late distribution of results [4], delayed learner progress as well as learners committing suicide over unreleased results [5]. It is therefore an important effort to try and minimise error and improve efficiency in distributing student results.

The proposed system is focused on sharing a learner's performance with parents or guardians on a regular basis. The potential benefits to the parents, teachers and learner is an opportunity to monitor a learners' progress throughout the term, not just at the end. In order

to develop the proposed tool, an overview background of the study area and the identified problem needs to be addressed.

1.1 Background of the Study

There are several issues that contribute towards enabling parents/guardians from collecting learner report in Thulamela. Some of these issues include: location difference, lack of transport, illness and old age. Location difference arises due to employment opportunities since some parents/guardians work far from home, for example in a difference province like Gauteng Province. Hence, some of the children are left alone or under the guardianship of elderly people. Some of the elderly people who stay with these children are too old or ill to walk longer distance. This might lead to late collection of learner report card. There is also a transport issue where some schools and residencies are situated far from each other with no public transport between.

The grading system used in South African report cards is dictated by the Department of Basic Education (DoBE). The DoBE is a subdivision of the Department of Education and is responsible for overseeing the operations of all the schools from Grade R – 12, including adult literacy programs [6]. The DoBE grades learners using seven levels of competence as shown in Table 1. Learners' progress report cards reflect the subjects details that learner is currently doing associated with the overall mark obtained by the learner and assigned level where the mark lies. This grading system is different from other countries which makes it difficult to use the available digital grading systems.

Table 1: DoBE grading system (source:www.ieb.co.za/School/nsc.php)

Scores (%)	Levels	Comments
80 – 100	7	Outstanding
70 – 79	6	Meritorious
60 – 69	5	Substantial
50 – 59	4	Adequate
40 – 49	3	Moderate
30 – 39	2	Elementary
0 – 29	1	Not achieved

1.2 Problem Statement

The schools in the Thulamela area are struggling to communicate learner performance to parents and guardians. This is due to problems such as limited transportation in the area, ill health conditions experienced by some parents, as well as the unavailability of parents and guardians who have moved in search of better job opportunities. A report card is an important part of learners' prospects as it is used to apply in institutions of further learning as well as funding institutes. In situations where a learner does not receive a report card or receives it late, it could ruin the opportunities of receiving a better education. It is therefore important that learners receive the report cards in a timely manner. Therefore, this study proposes the use of technology in a form of a system that will allow parents or guardians to monitor learner performance in an easier and efficient manner. While aiming on minimizing the occurrence of human errors during the computation of learners' grades.

1.3 Objectives

The main aim of this study is to develop a web-based system prototype that might be used to monitor and share learners' grades.

This study seeks to address the following objectives:

a. To gather the system requirements of the proposed system –these are high-levels of abstract statements of a system constrains that detail some of the functional

specifications [7]. There are various techniques that can be used to gather system requirements. Some of the techniques that were used in this study are internet search, observations and reviewing the existing systems.

b. To design the proposed system based on its requirements specifications – Unified Modelling Language (UML) will be used to visualize the design of the propose system. UML consist of various diagrams such as use-case, state, activity and sequence diagram. But in this study only use-case diagram was used since it's aimed on demonstrating all the possible actors and interactions in the system.
c. To implement the design of the proposed system – PHP (Hypertext Pre-processor) agent was used to implement the proposed system and XAMPP (Cross-Platform, Apache, MariaDB, PHP and Perl) was used as the Database Management System (DBMS). System architecture diagram was used to visualize the implementation of the proposed system in a high-level manner.

2. Literature Review

The literature of this study is based on the available grade monitoring systems used by other countries and the ones which are been used by South African universities.

2.1 Available Grading Systems Country Wide

There are a number of grading systems which are being used by various educational institutions across the board.
Some of these systems are:

a. GradeBookWizard – It is a web-based system that can be used by teachers, schools and districts. Its features include grading monitoring tool, attendance tracking and a class website solution [8].Its subscription fees of $4.95 (approximately R62.84) per month or $49 (approximately R622.08) per year, per account registered.
b. TeacherEase – It is regarded as the easiest online gradebook and it supports traditional and standards-based grading. It enables standards-based learning by including learning targets, rubrics, assessments system, and report cards. It also comes with a subscription fees which are based upon the number of active employees using the system (teachers, staff, administrators, etc.).
c. Gradelink – It is an integrated management, teaching and learning tools. It is regarded as an online tool that allows users to login with any device which is capable of accessing the internet. Some of the features it contains are categorized into attendance, staff accounts, classes & scheduling, student information, communications, discipline, teacher gradebooks, districts, medical records and tuition & billing, etc. It is standards service includes all features, automatic feature updates, support and training.

The systems presented are either integrated to a management system or an e-learning tool. This makes them cumbersome for the schools in Thulamela as only the report management feature is required. It is however the facts that these systems make use of a different grading system as well as the financial burden attached to them that make them unsuitable to use for schools Thulamela.

2.2 Grading Systems Used by South African Universities

There exist several grading systems that are being used by South African universities based on their functionalities and roles they play on the institution. Only the most common used ones are presented, these include: Integrated Tertiary Software (ITS) and Blackboard systems.

a. ITS system – ITS system is one of the systems that are been used by institutions to manage their information online. It is designed with self-service application that allows students a direct access to their information through a browser-based application also

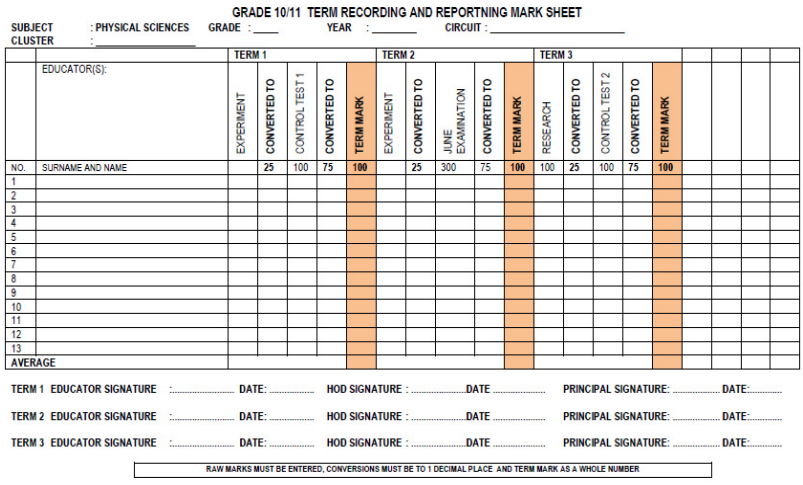
known as Student iEnabler [9]. All the assessments that are recorded by the system are been used to compute the final grade of students.

b. Blackboard system – e-learning (electronic learning) management system that is used by most of the South African universities. It is regarded as a virtual learning environment developed by Blackboard Inc. Its main functions are categorized into two components, namely communication and sharing content. Communications consist of announcements, chat, discussions and mail. While sharing content consist of course content calendar, learning modules, assessments, assignments, grade book, and media library. The grade book focuses on an e-learning where lecturers may post grades on blackboard for student to view them.

The systems discussed in the previous section are not compatible to the South African DoBE grading system. All schools are using the DoBE student Management System (SMS) known as SA-SAMS, therefore an additional system with similar features will not benefits them. Hence, these school require a standalone system that aims on filling the gap of providing a monitoring system for learner performance to parents and guardians. Schools around Thulamela have limited resources including books, hence the subscription fees will be costly to them. ITS and Blackboard are designed to accommodate a large number of student and their target is based on higher institutions. These systems are been govern by their own companies and higher institutions pay a certain amount depending on the number of students they have just to maintain it. Majority of schools around Thulamela have less than 700 learners, therefore it will be too costly for them to maintain such systems.

2.3 Grading System Used by Thulamela Secondary Schools

The process of issuing progress report cards begins with the recording of learner results. This is the responsibility of the teachers. Figure 1 depicts a template that is currently used by Thulamela secondary schools to record learners' grades. Teachers record learners' grades on a grading book or mark sheets.



GRADE 10/11 TERM RECORDING AND REPORTNING MARK SHEET

SUBJECT : PHYSICAL SCIENCES GRADE : ____ YEAR : _____ CIRCUIT : _____
CLUSTER : _____

		TERM 1					TERM 2					TERM 3							
	EDUCATOR(S):	EXPERIMENT	CONVERTED TO	CONTROL TEST 1	CONVERTED TO	TERM MARK	EXPERIMENT	CONVERTED TO	JUNE EXAMINATION	CONVERTED TO	TERM MARK	RESEARCH	CONVERTED TO	CONTROL TEST 2	CONVERTED TO	TERM MARK			
NO.	SURNAME AND NAME		25	100	75	100		25	300	75	100	100	25	100	75	100			
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AVERAGE																			

TERM 1 EDUCATOR SIGNATURE : ..... DATE: ..... HOD SIGNATURE : ..... DATE ..... PRINCIPAL SIGNATURE: ..... DATE:.....

TERM 2 EDUCATOR SIGNATURE : ..... DATE: ..... HOD SIGNATURE : ..... DATE ..... PRINCIPAL SIGNATURE: ..... DATE:.....

TERM 3 EDUCATOR SIGNATURE : ..... DATE: ..... HOD SIGNATURE : ..... DATE ..... PRINCIPAL SIGNATURE: ..... DATE:.....

RAW MARKS MUST BE ENTERED, CONVERSIONS MUST BE TO 1 DECIMAL PLACE AND TERM MARK AS A WHOLE NUMBER

Figure 1: Mark-sheet

Some of the educators use mark sheets to collect data thereafter he or she will then use that mark sheet to record data into the South African School Administrator and Management System (SA-SAMS) system after going through all the errors and concerns of learners. SA-SAMS is a new management system developed by the department of education as a way of demonstrating the importance of data to schools and decision makings [10]. It aimed at reducing duplication of data generated by separate applications that were being used by schools. Some of the system applications include an Administration System for Learners, Curriculum-related Data, Finances, Timetabling, and Library. Around

2007 this system was distributed across South African and is now it is available online with an installation and user guide [10].

2.4 Grade Monitoring System

The proposed system will be designed as a prototype with the aim of gathering more requirements for the final product. Requirements that influenced the development of the proposed system are:

- It should be a web-based system
- It should allow educators to add and assigned subjects
- It should allow teachers to add assessments and assign marks to the associated learner
- It should compute learners' grades based on the seven levels of competence
- It should allow learners, parents and guardians to have a portal for viewing the results or grade

The target group that might benefit from the implementation of the proposed system is:

- Parents and Guardians – They will be able to view learner grades from areas convenient to them. Having access to the results, parents or guardians may also be able to contribute where necessary or find a tutor for a specific topic or subject as a way of boosting learner performance. They might also be able to apply on behalf of the learner's to other institutions, while waiting for a hard copy.
- Learners – They will be able to see results on time. It will also be easy to track their performance and put more effort in areas they are struggling. Having a direct access to their results might help to produce it to third parties as a way of providing a direction for their extra lessons.
- Educators – the proposed system will allow educators to capture learners' marks. This process seeks to decease human errors and some of the computational steps taken of using calculators to compute learner grades, as well as recording learner details on a grading book or mark sheet.

3. Methodology

The development of a system requires protocols to be followed when developing a specific system. There are a number of software development methodologies (SDM) that can be followed during the development of a system. Some of the SDM are Waterfall, Prototype, Incremental, Spiral and Rapid Application Development (RAD) methodology. Each methodology documents the development of the system lifecycle in a different way. The Software Development Lifecycle consist of protocols that governs a specific software development methodology. The use of software development methodologies is driven by the capability of simplifying the software development processes by listing all the activities needed and techniques required in those activities [11].

A comparison will be used to analyse the different methodologies discussed in the previous sections. The comparison of the SDM will be based on whether the prototype been discussed is favourable or unfavourable to a specific methodology.

Table 3: Comparison of Software Development Methodologies

	Software Development Methodologies				
Problem situation	Waterfall [12] [13]	Prototype [12] [13]	Incremental [12] [13]	Spiral [12] [13]	RAD [12] [13]
Unclear objectives	unfavourable	favourable	favourable	favourable	favourable
When pressure exists, while implementation is required	unfavourable	favourable	unfavourable	favourable	Unfavourable
Incomplete requirements	unfavourable	favourable	unfavourable	unfavourable	favourable
Developing web-based system	unfavourable	favourable	favourable	favourable	favourable
Unstable requirements	unfavourable	favourable	favourable	favourable	favourable
Developing a system prototype	unfavourable	favourable	unfavourable	favourable	Unfavourable

The comparison of SDM was based on the favourable and unfavourable situations. The chosen software development methodology is selected looking at the benefits it contains. Prototype is the chosen methodology that is going to be followed when developing the proposed system. This methodology is chosen because all the situations stipulated in the comparison are favourable (see Table 1). Prototype methodology consists of several variants of software prototype. These software prototype variants are classified into two main types namely: throw-away and evolutionary. The selected software prototype is throw-away and it is based on the "do-it-twice" principle. The reasons behind selecting throw-away instead of evolutionary are:

- It is considered as the first software prototype.
- It allows a developer to familiarize himself with the development environment which is PHP and HTML.
- It can be used as a demonstration tool.
- It can be used to gather more requirements from the clients which are both parents/guardians and educators

Figure 2 depicts a prototype methodology that was followed when developing the proposed system.

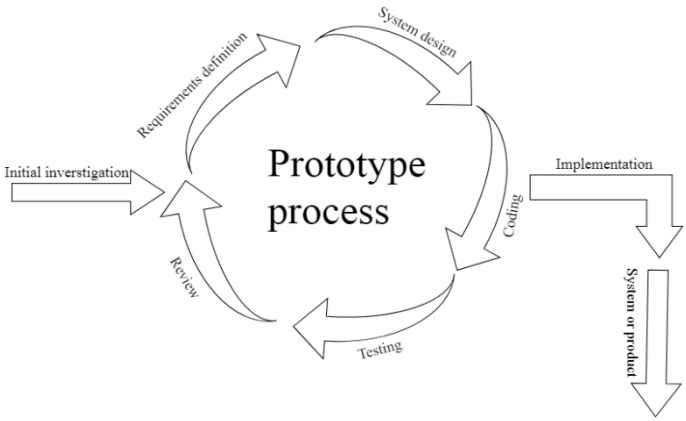


Figure 2: Prototype methodology model [13] [12]

3.1 Requirements Specifications

System requirements specifications detail the descriptions of the constraints, behaviour, and services of the system. Requirements specifications of a system may either be functional or

non-functional requirements. In short, functional requirements define what the system does and non-functional requirements define how it should be done. In this case, the non-functional requirements define how the system should perform a particular task.

a. Functional requirements

A functional requirement describes an interaction between the system and its environment through the use of functions which are implemented on that system [14]. Functional requirements of the proposed system are:

- Registration – it must enable the register button if the database is empty, else the register button will be disabled
- Login – allow authorized users to login
- Creating user accounts – allow school administrator to register users
- Adding and assigning subjects to educators – allow educators to add and assign subjects
- Adding and assigning marks to learners – allow educators to add and assign marks of the assessments to a specific learner
- Viewing marks – allow educators, learners and parents/guardians to view marks
- Changing password – allow users to reset their passwords
- Logout – logout if the account is not been used
- Sending notifications – send notifications as soon as learner grades are been updated

b. Non-functional requirements

Non-functional requirements describe all the constraints and behaviour which are not required by the users. These requirements are required by the system to perform a particular task. Non-functional requirements of the proposed system are:

- Reliability – the system will provide consistent and accurate performances based on its intended functions. All the system failures will be minimized and assigned a meaningful error message
- Authentication – only authorized users are the ones which are going to interact with the system. All users are authorized based on their user roles assigned to them
- Flexibility – the system will be developed in a manner it will be easy to enhance and change as the requirements changes or increase
- Usability – proposed system will be development in such that the interfaces are easy to use when users interact with the system
- Efficiency – the efficiency lies on the response time and data storage. The system data will be store in a database

The functional and non-functional requirements of the system have been discussed. The following section will discuss architecture of the system and its implementation.

4. Technology Description

This section provide tools that are used to develop the propose system. There are various tools that can be used, but this study used PHP as the programming language, XAMPP as the DBMS and Email API (application programming interface). PHP acts as the controller for the proposed system, while XAMPP acts as a storage environment for the proposed system. Email API only used to send alerts to learners and parents/guardians whenever learner grades are been updated.

5. Developments

This section focuses on the use-cases and implementation of the proposed system. Prototype methodology was adopted towards the implementation of the system. It is worth

noting that this section only indicate the system use-cases, architecture and implementation side of it. Thus one should not expect each step addressed in a unique section.

5.1 Use-Cases

The use-cases are scenario based techniques that seek to describe all the possible actors and interactions taking place on the system. Figure 3 depicts the interaction of actors and their roles. Actors use objects to interact with the components of the system and its environment.

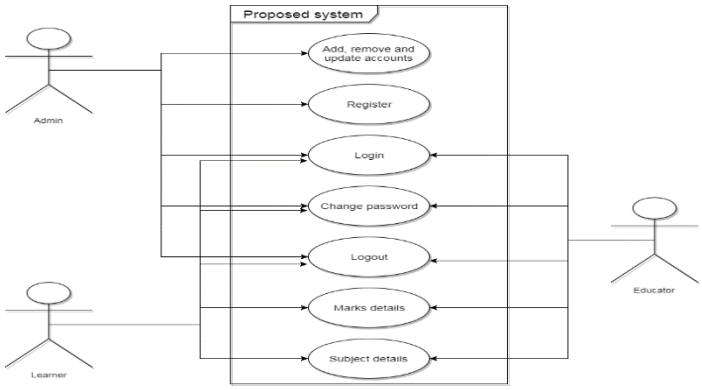


Figure 3: Actors Roles

A tabular form will be used to transfer the use-case diagram into a structured description. The aim is to represent some of the key actors and their roles in a scenario form as the user or actor interact with the system.

Table 4: Adding and assigning subject details

ID	Uc3
Title:	Entry Request (Subject Details)
Primary Actor:	Educator
Description:	Add subject details to the system
Trigger:	Educator requested "Subject Details"
Preconditions:	Educator has already logged in
Post conditions:	Prompt required details to add and assign subject to an educator
Normal flow	Adding subject details • Educator select "Subject Details" • Enter subject details as requested by the system • Submit details • Subject details are stored to the database • Retrieve subject details and displace it to Subject Table
Alternative flow	• Subject details already exists or signed to an educator • Failed to add subject to the system
Frequency of use	Low
Assumptions	Subject has successfully added and assigned to an educator

Table 5 depicts the procedure taken by an educator to add assessment details and to assign marks to learners.

Table 5: Marks Details

ID	Uc4
Title:	Entry Request (Marks Details)
Primary Actor:	Educator
Description:	Add marks details
Trigger:	Educator requested "Marks Details"
Preconditions:	Educator has already logged in Subject details has already added and assigned to an educator Learner account already exist
Post conditions:	Prompt required details to add and assign marks to learners
Normal flow	Add marks details • Educator add the assessment of his or her subject • Assessment details are updated on the database • Record learner marks as specified on "learner details" • Learner marks are stored on the database • Filter details on the Mark Table
Alternative flow	• Failed to update assessment details • Failed to update learner marks details
Frequency of use	High
Assumptions	Marks details has successfully added

The main role for the learner profile is to view grades as they are been updated on the system. Table 6 depicts the how learners grades can be viewed using learners profile.

Table 6: View Learners' Grades

ID	Uc5
Title:	Entry Request (View Marks)
Primary Actor:	Learner
Description:	Learner view marks details
Trigger:	Learner requested "View Marks"
Preconditions:	Learner must be logged in
Post conditions:	Learner View Marks • Learner select "View Marks" • Displace all the grades or marks associated to that learner
Normal flow	Learner View Marks • Learner select "view Marks" • System retrieves marks details of that specific learner from the database • System display learner marks on "Student Marks" table
Alternative flow	Marks details are not available
Frequency of use	High
Assumptions	

5.2 System Architecture

System architecture represents the conceptual model that defines the structure, and the behaviour of a system [15]. Figure 4 exemplifies the system architecture and how the system components work together as one tool. As mentioned in the previous sections that the controller used to develop the system is a PHP agent. Also, the Database Management System (DBMS) used to store data is called XAMPP (Cross-Platform, Apache, MariaDB, PHP and Perl). XAMPP uses a Structured Query Language (SQL) database and it queries data through the use of MySQL statements.

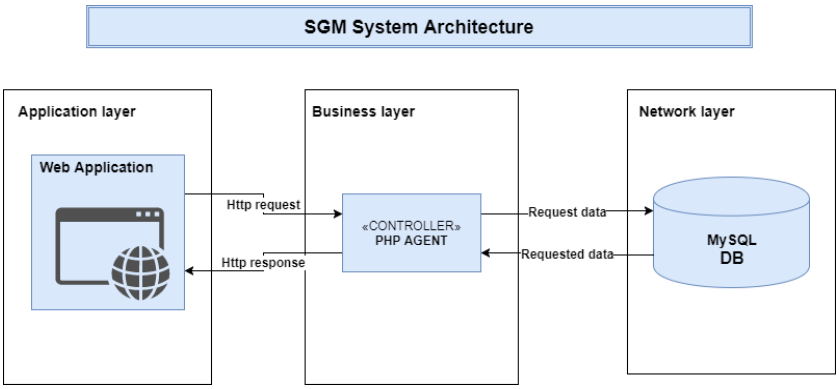


Figure 4: System architecture

5.3 User-Interface Design

User-interface design is the representation of the actual system [16]. It also presents the high level interaction between users and the system components. All the user account are managed by the admin account. Figure 5 depicts the login page that will be used by authorized users. All the authorized users are then classified based on their roles they have been assigned to during the account creation process. Users are authenticated through this page whether their details exist on the database, if exist that user is granted access to the system.

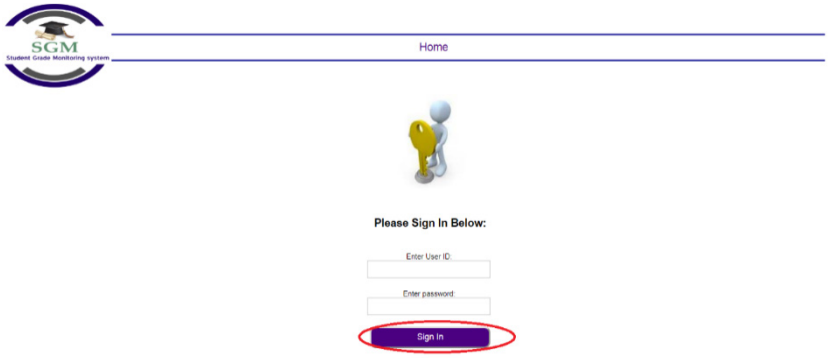


Figure 5: Login Page

Figure 6 depicts a welcome page of an educator profile. All functions can be accessed through the "Menu" button on the left. Educators are responsible for adding subjects and assessments, including assigning marks to learners.

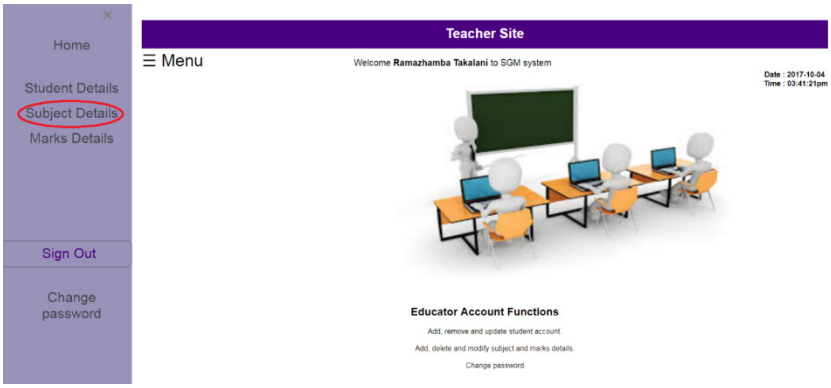


Figure 6: Teacher welcome page

Figure 7 shows how educators can add and assign subjects. An educator will be able to view all the subjects including their instructors. Further, an educator will be allowed to update subject details which are associated with his or her User ID.

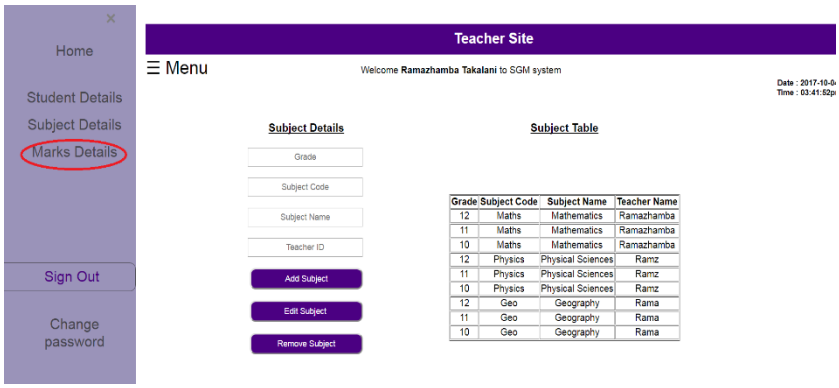


Figure 7: Add subjects details

Figure 8 represents how assessments and learners grades are added and updated on the system. Once an educator has updated learners' grades, an automatic email alert will then be seen to that particular learner as a way of notifying him that his grades are now available on the system.

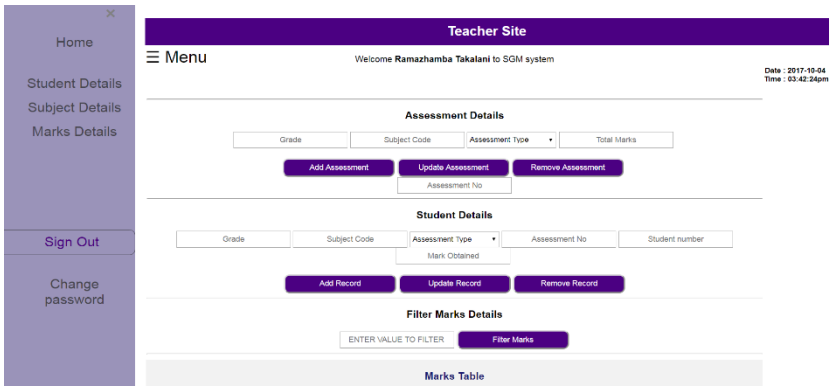


Figure 8: Add Assessments and Assign Marks to Learners

Figure 9 shows the results of learners in a table format after grades have been updated.

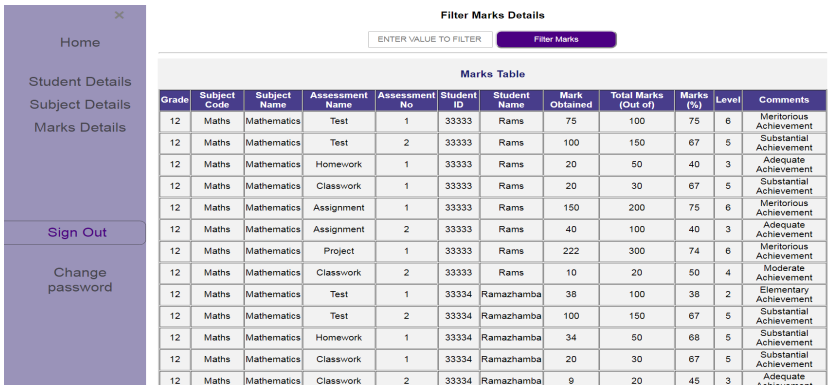


Figure 9: Teachers marks view

Figure 10 portrays learners welcome page. This profile can also be used by parents or guardians to monitor their children performances.

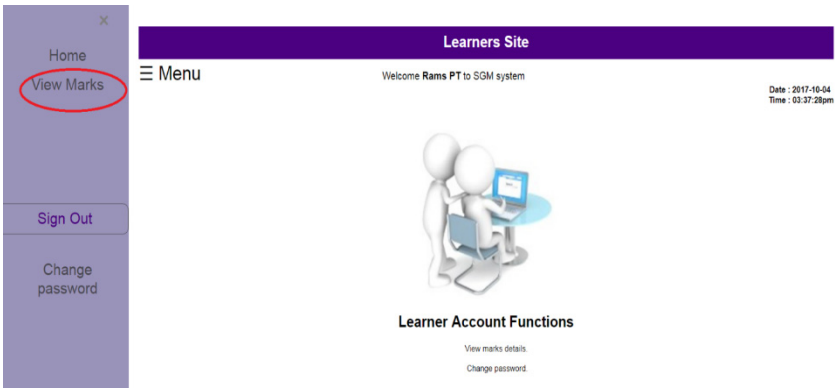
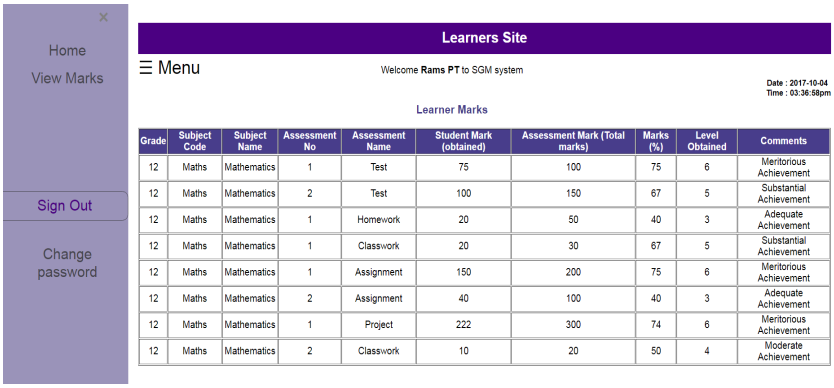


Figure 10: Learners Welcome Page

Figure 11 depicts the results or updated assessments given to that particular learner. In this case, it shows the results of a learner named Rams PT.



Grade	Subject Code	Subject Name	Assessment No	Assessment Name	Student Mark (obtained)	Assessment Mark (Total marks)	Marks (%)	Level Obtained	Comments
12	Maths	Mathematics	1	Test	75	100	75	6	Meritorious Achievement
12	Maths	Mathematics	2	Test	100	150	67	5	Substantial Achievement
12	Maths	Mathematics	1	Homework	20	50	40	3	Adequate Achievement
12	Maths	Mathematics	1	Classwork	20	30	67	5	Substantial Achievement
12	Maths	Mathematics	1	Assignment	150	200	75	6	Meritorious Achievement
12	Maths	Mathematics	2	Assignment	40	100	40	3	Adequate Achievement
12	Maths	Mathematics	1	Project	222	300	74	6	Meritorious Achievement
12	Maths	Mathematics	2	Classwork	10	20	50	4	Moderate Achievement

Figure 11: Learners Marks View

All the functionalities of the proposed system are met.

6. Results

The proposed system was presented to a senior educator and some of the students around Thulamela for reviews. The feedbacks were acknowledged and are been considered to be included on the future work. The reviews can be categorized into two namely technical and additional features, where technical lies of the design and user friendly of the system when it comes to data organizations as it is represented. Additional features lies on enhancing the proposed system.

7. Conclusions

This section will conclude by revisiting the possible limitations that might affect the implementation or rollout of the proposed system, future research and provide concluding remarks.

7.1 Limitation of the Proposed System Implementation

There are number of factors that may affect the implementation of the proposed system in Thulamela region. Some of these factors are:

- Most schools do not have Internet access
- Majority of schools do not have a website
- Only a few schools offer computer related subjects, hence it may lead into computer illiteracy to some areas

7.2 Future Works

In terms of future research, the proposed SGM system can be used as a prototype that can be enhanced to include the following functionality:

- Generating a graphical representation of the learner grades
- Creating a communication channel that allows parents and guardians to respond or engage with the educators
- Flag under-performing learners who seek for help or extra classes
- Adding SMS notifications
- Password recovery mechanism
- Printing of reports

7.3 Conclusion

The grading of learners in South Africa remains the same over the previous years. It relies on using calculators to compute and record grades onto a grading book or mark sheet. This is a traditional method wherein educators are given templates to use by their schools, with the aim of ensuring the consistency of learner grading. This method of grading might lead to human errors such as duplication of information.

This study proposes a system that will compute learner grades and allow parents or guardians to monitor learner performance regularly. Furthermore, the system helps with eliminating the need of parents or guardians collecting card reports in accordance to specified dates and times.

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