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Intelligent Coaching Agent for Enhancing Proactive Behaviors in Human Teamwork Using Supervised Learning Algorithm

Chidi Ukamaka Betrand[1, *], Sylvanus Okwudili Anigbogu[2], Oluchukwu Uzoamaka Ekwealor[2], Ifeoma MaryAnn Orji[2]

[1]Department of Computer Science, School of Information and Communication Technology, Federal University of Technology, Owerri, Nigeria

[2]Department of Computer Science, Faculty of Physical Sciences, Nnamdi Azikiwe University, Awka, Nigeria

Email address:
chidi.betrand@futo.edu.ng (C. U. Betrand)

[*]Corresponding author

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Abstract: Teamwork has been one of the effective responses to the changes over the years in the world of today. Teamwork is being relied upon as a preferred performance arrangement to fulfill visions, execute and achieve goals in all sectors. It is also one of the most important elements in continuous improvement systems, as it facilitates the sharing of information, problem solving and the development of employee responsibility. This study was on an intelligent coaching agent that modeled team performance using the Supervised Learning algorithm. The Object Oriented System Analysis and Design Methodology was used. For effective implementation of this study, some web application languages were used and these includes; Hypertext Markup Language (HTML), Hypertext Preprocessor (PHP), MySQL, Cascaded Style Sheet (CSS), Java Script, Dream weaver, and Fireworks. Dream weaver is an HTML-based application that is used to generate graphical user interfaces. This study was able to arrive at a system that will remove biases in performance evaluation since the performance appraisal is automatic; each task has been assigned a weighted score, so as soon as an employee performs the task the system automatically scores him/her. Making it easy to track individual performance as well as team performance. The system developed utilizes supervised learning to monitor the task executions and determine the weight score for the task before scoring the team. This system will help those that are worthy of keeping their jobs keep it and help improve employees that need to work on some specific areas to develop themselves as plainly revealed. The purpose of this study which is to demonstrate an event based performance approach via the design and implementation of intelligent coaching agents within a team training framework via supervised learning was achieved and the result shows positive impacts on team's performance.

Keywords: Intelligent Agent, Coaching, Team, Human Teamwork, Proactive, Behaviors, Performance, Task Supervised Learning

1. Introduction

Teamwork is viewed as an essential feature of modern management theory and practices. Most organizational activities of today become complex due to advancement in technology, therefore teamwork is a major focus of many organizations. Several authors agree that a team is a group of people that have complementary skills and who share responsibilities for the outcomes. In line with this, Teams enable people to cooperate, enhance individual skill and provide constructive feedback without any conflict between individuals. In similar ways, organizations that emphasize more on teams have resulted in increased employee performance, greater productivity and better problem solving at work. Research study also concluded that team work is necessary for all types of organizations including non-profit

organizations [1]. Three aspects of team definition are important: interaction among individuals, group efforts and interdependence. Team work results in individuals working jointly in a supportive environment to achieve common team goals through the sharing of knowledge and skills. Successful team relies on the synergy between team members in relating to an environment, where all members contribute and participate in order to promote and develop effective outcomes. In line with this, study confirmed that it is possible to design a system of building within every organization for employees so as to promote and distribute best practices and maximum outputs.

Teamwork has been investigated widely and can be defined from many perspectives.

Teamwork is defined as two or more persons who are interdependent in executing a set of activities; interact face-to-face and interact frequently with each other; make differential contributions; and strive to achieve a common goal in respect of a core task [2].

Teamwork is a collection of a small number of individuals with complementary skills who are committed to a common purpose, performance goals and approach for which they hold themselves mutually accountable [3].

Groups become teams when they develop a sense of shared commitment and strive for synergy among members [4]. A group of individuals becomes a team when: leadership becomes a shared activity; accountability shifts from being strictly individual to being both products. The group develops its own purpose or mission; problem-solving becomes a way of life, not a part-time activity; effectiveness is measured by the group's collective outcomes and cross-functional teams are made up of technical specialists from different areas.

Recent advances in the field of intelligent systems are materializing into a wider usage of computers armed with Artificial Intelligence technique to have a better support system to assist in teamwork performance. This study will serve as a platform for building up organizational knowledge and enhance skills development to help team members acquire appropriate skills to perform highly independent tasks. The study is to enhance performance where team interactions are required to ensure organizational.

2. Related Literature

A practical architecture for the computer-based tutoring of teams in order to examine the relationship of various team behaviors, their attitudes, and cognition as antecedents to successful team performance, learning and performance during adaptive instruction guided by Intelligent Tutoring Systems (ITS) was developed [5]. The goal which is to develop and apply findings of this meta-analysis to guide instructional decisions by the Generalized Intelligent Framework for Tutoring, an open-source architecture for authoring, delivering, managing, and evaluating adaptive instruction is evaluated and proven to be effective.

A conference paper on Intelligent Coaching Space [6] was presented. The article demonstrated an immersive virtual environment in which the users learn a motor right under a virtual coach supervision. The trainees were led through a coaching session. The system combined expertise from several disciplines such as sport, psychology, computer graphics, human computer interaction and computational linguistics. It demonstrated a short coaching interaction that was effective in the real world.

An Intelligent Tutoring System that helps trainees overcome difficulties they face while working in ARDUINO platform [7] was presented. The authoring tool intelligent tutoring system builder was used to design and develop the system. The tool as any normal ITS has four modules: the user interface module, the tutor module, the student module and the domains module. The System is adaptive with the individual trainee's progress and deals with each trainee according to their levels and skills. Evaluation of the system has been applied on professional and unprofessional trainees and the results were good.

PACA-ITS: A Multi Agent System for Intelligent Virtual Laboratory Courses [8] was an intensive design leading to the implementation of an intelligent lab companion (ILC) agent for an intelligent virtual laboratory (IVL) platform. The IVL enables virtual labs (VL) to be used as online research laboratories, thereby facilitating and improving the analytical skills of students using agent technology. The modeling technique used is compatible with ontology mapping based on an enabling technology using the Java Agent Development Framework (JADE), Cognitive Tutor Authoring Tools (CTAT), and Protégé platform integration. The potential Java Expert System Shell (Jess) programming implements the model algorithm criteria that are applied to measure progress through the CTAT for C++ programming concept task on IVL and successfully deployed on the Tutor Shop web server for evaluation.

Explanation-Based Reward Coaching to Improve Human Performance via Reinforcement Learning was presented by [9]. The work proposes a novel mechanism for enabling an autonomous system to detect model disparity between itself and a human collaborator, infer the source of the disagreement within the model, evaluate potential consequences of this error, and finally, provide human-interpretable feedback to encourage model correction. This process effectively enables a robot to provide a human with a policy update based on perceived model disparity, reducing the likelihood of costly or dangerous failures during joint task execution.

Who Should Be My Teammates: Using A Conversational Agent to Understand Individuals and Help Teaming [10], an intelligent agent to help teaming efforts by investigating the real-world use of such an agent to understand students deeply and help student team formation in a large university class involving about 200 students and 40 teams. Specifically, the agent interacted with each student in a text-based conversation at the beginning and end of the feedback was evaluated and found to be resourceful.

The Intelligent Personal Assistance for Task and Time

Management [11] provides a personal assistant to aid a busy worker in managing time and performing tasks. It draws on a diverse set of AI techniques, linked together with a Belief-Desire-intention, BDI-based agent framework. The system provides a number of automated functions and on evaluation gives a positive outcome.

2.1. Concept of Human Teamwork

The notion of a common goal is what actually differentiates a team from other working groups with a certain degree of interaction and exchange of resources. Another unique feature of a team is that some kind of organizational structures are imposed on the team members and also there is an existence of dependency in carrying out tasks to enhance shared resources [1]. Under the concept of team, self- managed teams are described as teams where members are willing to accept change, try new things, take on more responsibility, be held accountable for results, take action instead of waiting for instructions, and act in the best interests of the team rather than the self [1]. Nominal teams are a group in name only and in essence consist of individuals trying to work together. Real teams are defined as teams where individuals understand their assignments; have clear goals and values; communicate in an open manner; operate in a basic climate of trust; and have basic team skills [12]. Effective teams give companies a significant competitive advantage. In a high-functioning team, the sum is truly greater than the parts. Team members not only benefit from one another's diverse experiences and perspectives but also stimulate each other's creativity. Plus, for many people, working in a team can be more fun than working alone. Teamwork is a strategy that has potential to improve the performance of individuals as well as organizations, but it needs to be nurtured over-time [13]. Organizations need to look at strategies for improving performance in the light of an increasingly competitive environment. Top managers need to have the vision to introduce teamwork activities within the organizations, the sensitivity to cultivate it and the courage to permit teams to play an important part in decision making. Teams offer greater participation, challenges and feelings of accomplishment. Organizations with teams will attract and retain the best people and this in turn will create a high performance organization [14]. The conceptualization of team effectiveness that has shaped the last 40 years of theory and research is based on the logic of an input–process–output (I-P-O) heuristic formulated by [14]. In this framework, inputs refer to the composition of the team in terms of the constellation of individual characteristics and resources at multiple levels (individual, team, organization). Teamwork brings benefits in terms of higher productivity, better organizational performance, competitive advantage, increased product quality and quantity which highly contributes to organization-al performance compared to other factors [9].

2.2. Intelligent Agent Considerations

The use of intelligent agents has increased dramatically over the past 5 year, though the majority of people wouldn't think twice about the process that they do that makes their lives easier. The use of intelligence agents has increased beyond the expectations of experts within the management and information technology fields. The use of intelligent agents are being seen in a wide cross section of businesses whether it be in machinery and equipment or within the software programs that they have in their computers and networks.

Although the research on Artificial Intelligence in Education can be traced back to the 80's, when the first ideas on IntelligentTutoringSystems *(*ITS*)* were introduced, presently it is going through anaccelerated evolution process, mainly due to innovative computer technologies, such as hypermedia, Internet and virtual reality [17]. For decades, a wide variety of ITSs have been used to train individuals on specific tasks [18]. ITSs exist on a spectrum of computer aided instruction (CAI). The most rudimentary CAI system has a basic input-output structure wherein the learner provides an answer to a problem posed by the computer, and it provides feedback. On the other end of the spectrum are the more advanced intelligent systems, which tailor feedback to the learner based on his or her knowledge acquisition and performance in real time. With increasing complexity, ITSs become more difficult to author and require multiple interacting components. Generally, four modules make up the basis of an ITS: a domain model, a learner model, a pedagogical model, and an interface model [19]. One might conjecture that at least one new module would be required for a team tutor. The difficulties of authoring anITS for an individual to perform a specific task have been well documented. This process includes creating several modules that work together to monitor learner progress, assess errors, and provide suggestions relevant to these errors in a manner that is not confusing to the learner [20]. Thus, it does not come as a surprise that far less success has been documented in creating ITSs for training teams. [21]. Early research on agent-based teamwork can be traced back to the 90s [21]. Among researchers in the Multi-Agent System (MAS) community, there has been growing interest in using intelligent agents to simulate and support human teamwork. While multi-agent systems offer promising alternative for developing team training, research in this area has been limited, in this section, we will first briefly introduce theories that have been developed as the foundation of teamwork [21, 22] and then survey major agent-based teamwork architectures, which allow communication and coordination among team members.

Agent-based teamwork systems emphasize agents' communication and collaboration as a team in pursuing certain common goals. Within the Belief-Desire-Intention (BDI) agency paradigm, several theoretical frameworks were proposed to capture the fundamental aspects of teamwork and system modeling of team behavior. Among those, Joint Intentions theory and SharedPlans theory are two widely accepted theories that provide foundation for modeling team behaviors in a computational environment. Based on them, several agent-based teamwork models have been proposed.

3. System Analysis

Measuring team performance in organizations is probably even more complicated than measuring effectiveness. Team performance is measured according to several aspects such as purpose of measurement, attributes or behaviors to be measured, and measurement process-related aspects. Team performance could be analyzed at individual or team level, or could be a measure of team process or team outcome. For some applications, like teamwork training or individual evaluation, it would be appropriate to measure the performance of individuals within a team. While for others applications it will be more convenient to evaluate the performance of the team as a whole. The same way, outcome performance will tell you how well the team did its job regarding how they did it, but when teams' performance is to be tracked and improved through time; process performance should also be measured.

3.1. Analysis of the Existing System

The existing behavior evaluation is centered around Business Alignment and People Performance; their solutions are designed to deliver affordable, instantly available and frictionless total people asset management applications. Their solution can be used to draw insights on valuable assets - human performance and ability - across organizations. However the existing application is more suited to measuring people performance and not organizational performance.

While the above performance management tools offer certain unique benefits, they lack a standard approach for building the decision support framework which makes decision making easier and quicker. Also, the focus is on employee performance, performance appraisals and compensation. While the existing tools and methods enable efficient performance viewing in different forms like graphs, charts etc, they do not provide a quick and easy organizational performance view. The limitations of these tools can be summarized as follows:

Lack of a complete and aligned organizational view of the entire organization.

No flexible parameter choices and prioritization options to forecast real-time change in performance of organization hence do not facilitate decision making.

Absence of a customizable performance management framework that can be suited to a certain kind of business and/or organization.

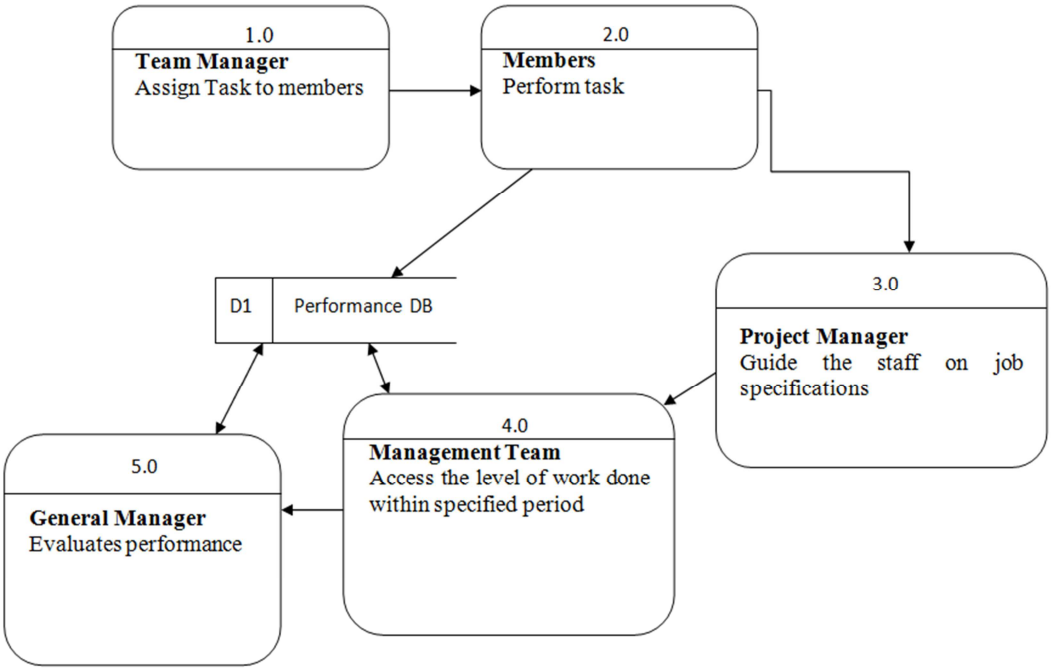

Figure 1. *Data Flow Diagram of the Existing System.*

3.2. Design of the Proposed System

The proposed intelligent coaching agent for enhancing behaviour in human teamwork will enable an auto-determinant appraisal score for every staff in an organization. A manager or project team head can provide weight values to agreed appraisal metrics. Management can detect staff's attitude to work automatically through intelligent approaches such as Staff-Computer Inactivity Time, Staff-Email response time. An appraisal administrator can view non-editable appraisal scores at will and it also allows management to provide informed judgments and decisions based on the appraisal outputs.

The architecture of the agent-based Intelligent Performance evaluation model is presented in this thesis. The model consists of three tiers, namely the Staff Client Agent or Staff-Agent tier, the Data Interpreter Server tier, and the Score tier as shown in figure 2.

The Staff Client Agent or Staff-Agent tier is the major component where data about staff and the context of the

computing environment of staff, otherwise called staff service-delivery environment, is provided to the data interpreter middleware. The followings are the subcomponents of the Staff Client Agent: Profile Manager, Project Manager, Attendance Manager, Communication Manager, and Leave Manager.

The Profile Manager is a reader component, for retrieving useful staff information needed for the appraisal computation.

The Project Manager Component, which focuses on the tasks and projects delivered by a staff, is an important component of the staff-agent. The project manager has three major functions, namely Project Weighted Score Computation, Project Throughput Scoring Manager, and Project Duration Store.

In a service-delivery environment, the role of the Project Manager (PM) component is to extract project title and its weighted score value. The PM component achieves this through direct request from line-manager or a project scoring document.

Project Throughput Scoring function is carried out after a successful project sign-off. This function computes the rate at which project are delivered efficiently.

Project Duration function gives the time frame of a project. Managers must estimate the calendar time required for executing a project successfully.

The Attendance Manager Component is a primary component for retrieving punctuality information of each staff member. This component informs the appraisal system of the attendance rate of every staff member. The Communication Manager Component retrieves useful information about the staff-response rate per email. This component interacts with the mailing system and retrieves useful mail information. The communication manager component helps to determine staff effectiveness, collaborations and contributions in organizational tasks, projects and duties.

The Leave Manager Component captures Leave information per staff, Leave Frequency, and Current staff pending projects on the Leave Handover document.

The Data Interpreter Server is the middle tier component. This component interprets information retrieved from the 1st Tier of the architecture. The 2nd Tier manages all information received from the components of the 1st Tier. Other roles played by these components include representation of information in format acceptable by the 3rd tier. The information bus stores all information about staff, project, communications and attendance per time.

In the 3rd Tier: The Score Tier, staff-friendly metrics were selected and infused flexibly by allowing organization appraisal human resource manager input weight worth/value per metric. Staff weighted means computations are managed by the Score-Manager component. The second tier provides the weighted values per metrics. These weighted values of the metrics are retrieved by the various components of the 1st Tier.

In the application developed, the system makes provision for the employee work details to be captured. The system captures some details about the work schedule of an employee as well as the supervisor for that project.

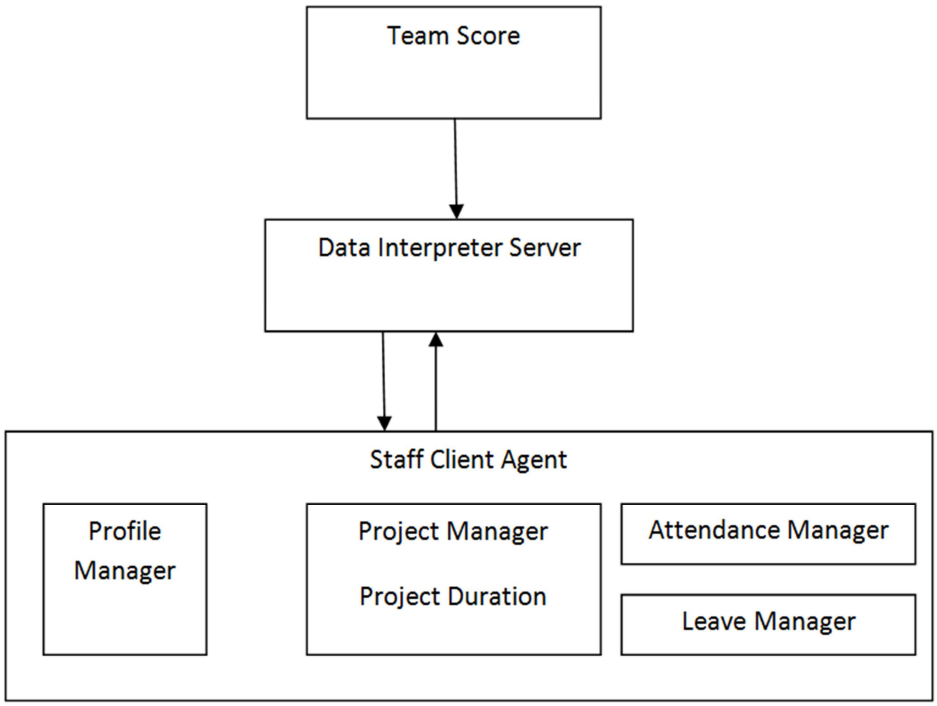

Figure 2. *The architecture of the agent-based Intelligent Performance evaluation model.*

The application also makes provision where new employees are added. This section allows new projects to be included stating explicitly, the duration of the project, the project description, name of the project and who will be the supervisor of the project. As many projects as desired can be added in this section. This platform is also used to enter new

employee's details i.e. new employee registration. This section allows employees to be added to the system. It accepts valid information about the employee such as the name, contact details, date of birth, residential address, emergency contact details, and so on. As many employees as desired can be added to the system via this platform.

The application also has a platform where projects are rated. This page allows the supervisor to check the status of projects if they have been completed or not. It also provided relevant information as regards a project. Information that can be gotten includes project description, project start date, expected date of project completion, status of project.

4. Methodology

The main goal of this study is to enhance behavior in human teamwork. We monitored performance based on tasks assigned to team members. To implement the intelligent coaching agent for enhancing behaviors in human teamwork, Object-oriented analysis and design methodology (OOADM) was adopted. The Object-oriented analysis and design methodology approach was motivated by the kind of system we built- a usable and evolvable system.

Intelligent Coaching Agent:

The intelligent coaching agent for enhancing behaviors in human teamwork was designed to appraise the employee performance and illustrated how intelligent coaching agents – supervised learning can be used as a support tool for the assessment of employee task performance. We have shown how it provides a weight score for each task and later used for the evaluation of the team performance in terms of job executed as against the expected performance. We have also indicated how it gives managers the ability to incorporate accuracy levels for the staff performance appraisal. The new system allows employees, team managers and general manager to access their performance records from any point of internet access point.

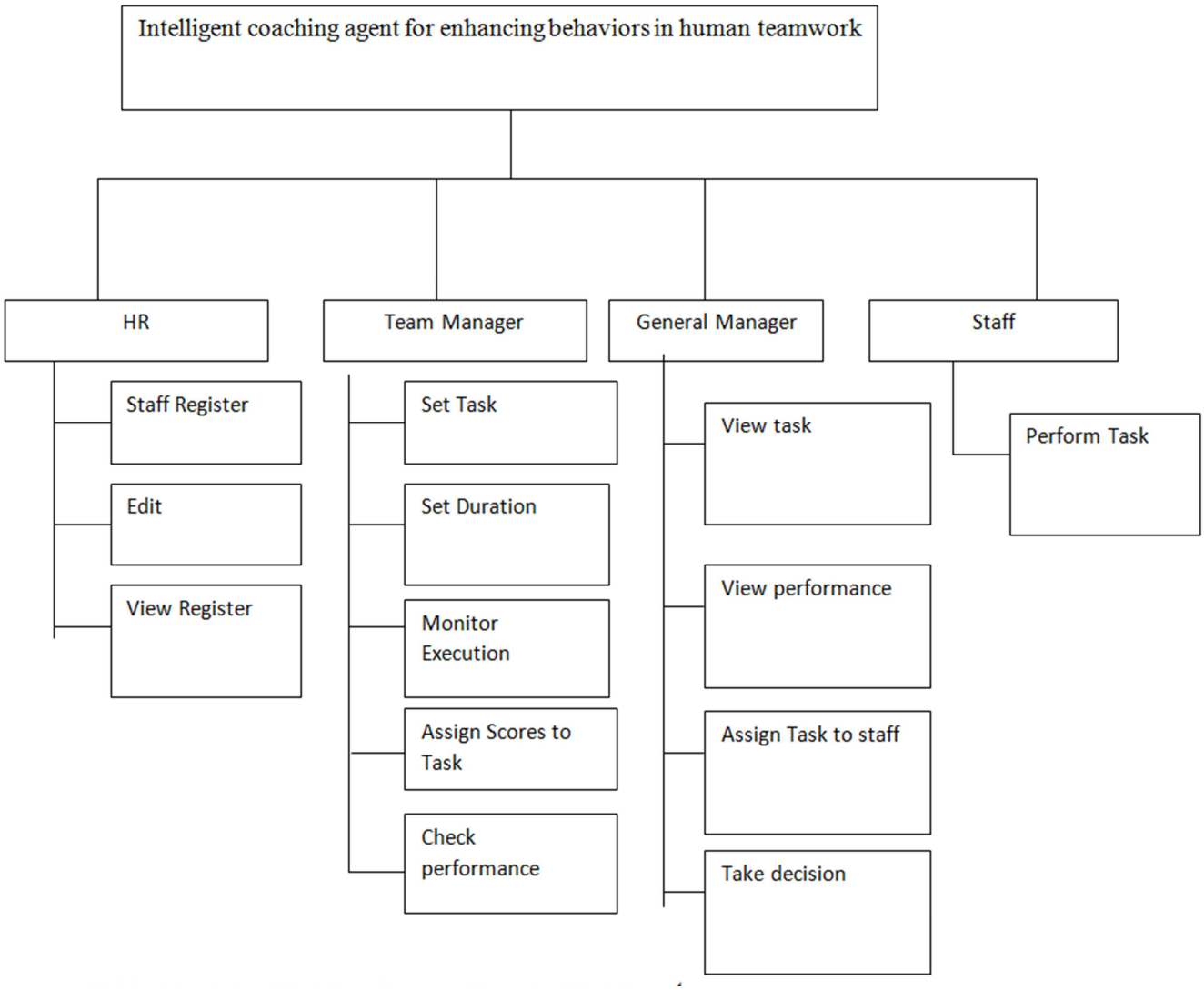

Figure 3. *High Level Model of the Proposed System.*

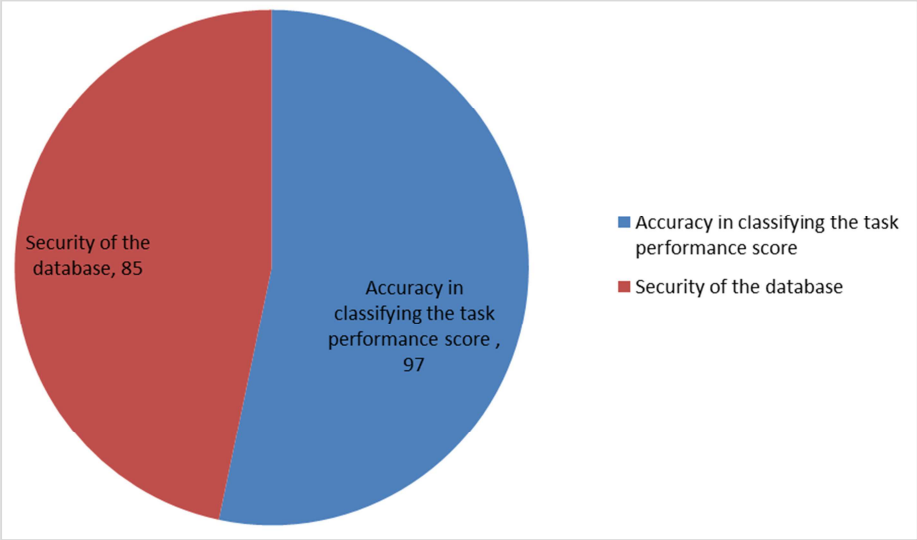

Figure 4. *Performance grading of the proposed system.*

Table 1. *Actual Test Result versus Expected Test Result.*

Module	Expected Test Result	Actual Test Result
Log in page	Should allow users to login to the main menu of the system developed	The login page provided interface where you can enter your username and password. This page verified the access password before launching the platform or deny the user access if wrong password was provided
Index Page	Should contain the home page containing links to other modules that can be used by admin	The home page displayed platform and contains all the links to the various modules for HR, Team Manager, Staff or General Manager
Create Users	To be used to create users and assign them access to the database	The form allowed the user to enter the user name and password of user and assign access level to the user
Staff Registration form	To be used to register staff	The form was used to register staffs in the team and store it in the database
Set Task form	It is expected to allow team manager to set task	The form opened the task for the team was setup by the team manager
Assign score form	Was expected to allow the team manager assigned weight score to task	The form was used to assign weight score to various task setup by the team manager
Perform task Form	Was expected to allow staffs enter task performed	It displayed form that allowed the staff to enter task executed and the number of times it was executed
Performance form	Expected to display team performance	It used supervised learning approach to display team's performance sheet and determine the performance percentage

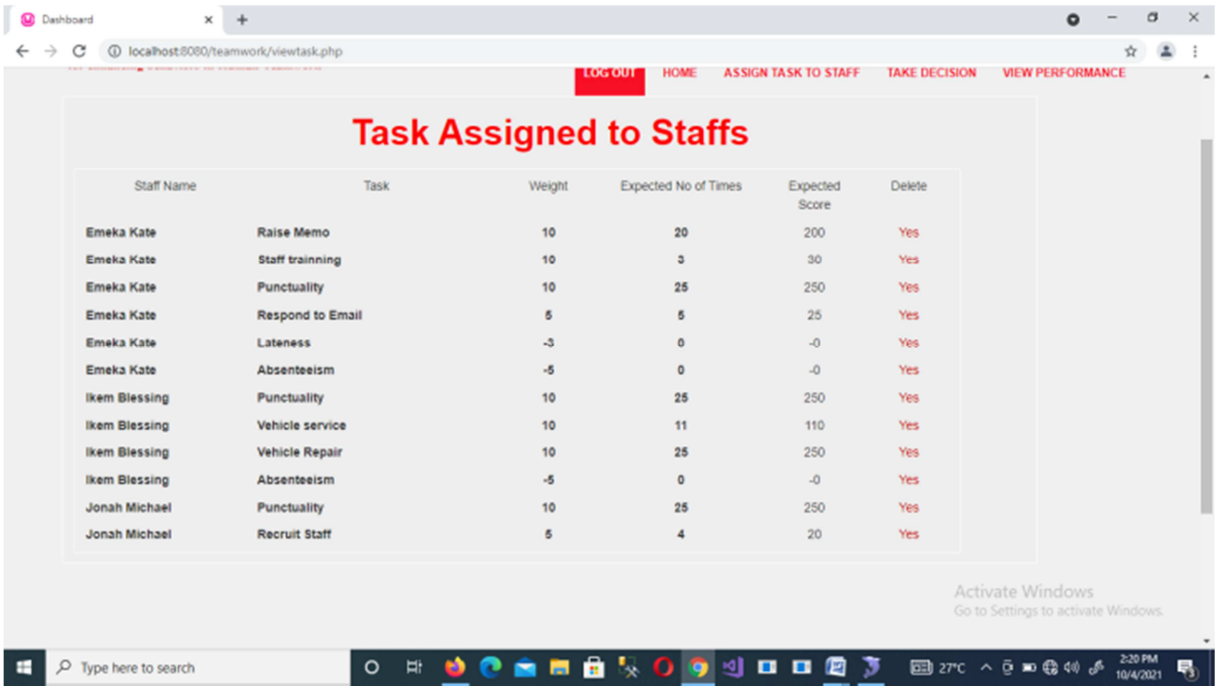

Figure 5. *Result interface on assigned tasks to staffs.*

5. Contribution to Knowledge

This research work will give more knowledge on Supervised learning and its application in performance monitoring. Effective way to enhance team performance using weight score for various kinds of tasks.

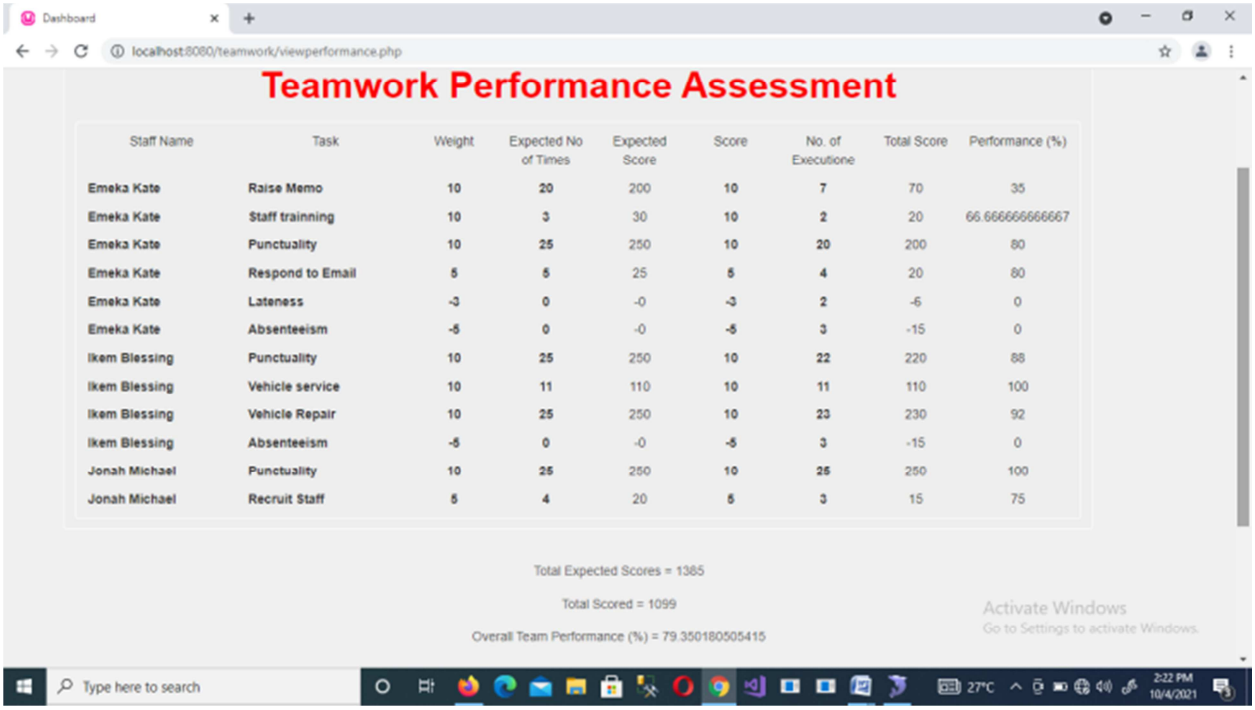

Figure 6. *Result interface assessment of team performance.*

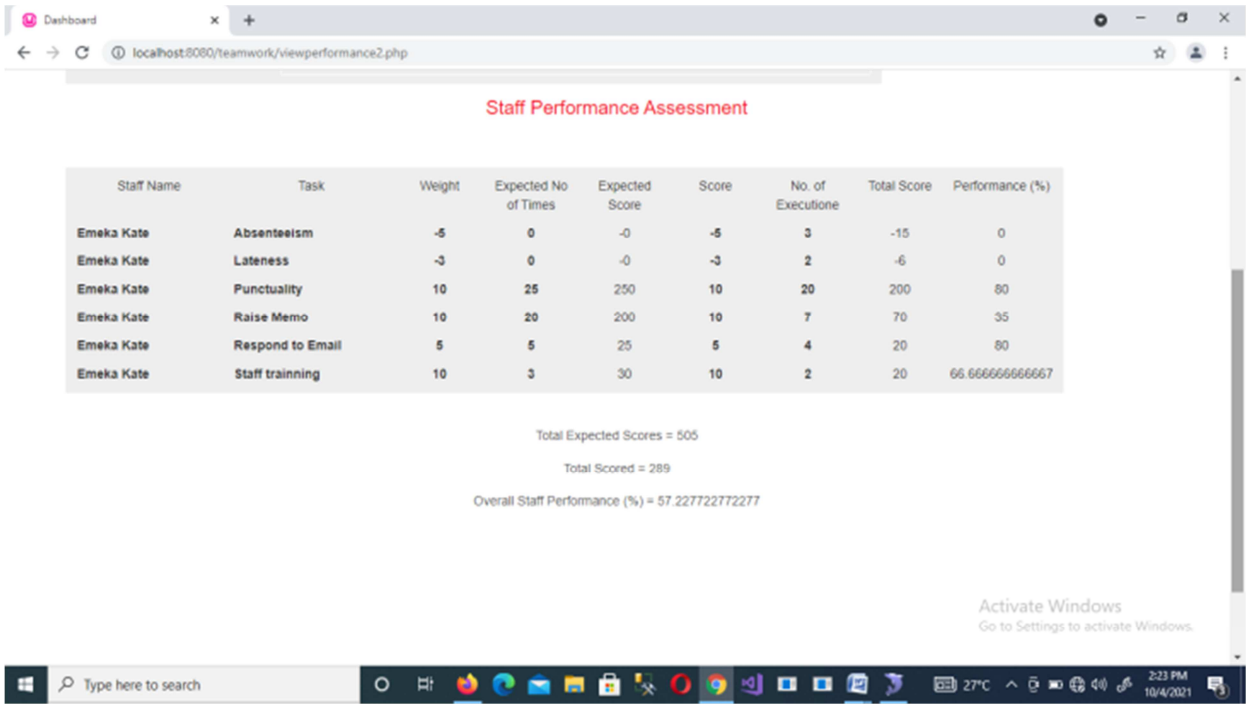

Figure 7. *Single instance of a team member performance assessment.*

6. Future Work

The study concentrated more on evaluating task performance in teamwork. It is therefore recommended that the system be expanded to integrate human resource management systems and biometric based attendance monitoring systems so as to have a full functional HR system for an establishment.

7. Conclusion

The research work was able to monitor employee performance more especially in a teamwork scenario. Performance evaluation is a systematic and continuous process that helps establishments assess its staff to give appropriate appraisal to the individual and teamwork performance. There is a need for proper evaluation of performance for employees because it will help determine the productivity of every employee in the organization. Also for the team work performance, proper evaluation is needed for avoidance of biasness to get the adequate productivity level of the team in the organization. This research has developed a system that will remove biases in performance evaluation for the employees of an establishment. Performance appraisal is automatic; each task has been assigned a weighted score, so as soon as an employee performs the task the system automatically scores him/her. Hence it is easy to track individual performance as well as team performance. The system developed utilizes supervised learning to monitor the task executions and determine the weight score for the task before scoring the team. This system will help those that are worthy of keeping their jobs keep it and help improve employees that need to work on some specific areas to develop themselves as plainly revealed. While the system appraises the teamwork performance, the output will help the general manager to know when to promote a staff or reward the team based on their performance.

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