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An IoT Based Novel Hybrid-Gamified Educational Approach to Enhance Student's Learning Ability

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Abstract: Student's have different level of learning ability due to social and economic aspect they came through their life. Thus it is very necessary to reveal the criteria based on which their learning ability can be improved. This paper investigates these criteria and tries to improve the learning ability of students using a novel gamified educational method. The Internet of Things (IoT) also utilized to collect information to establish a communication network and educational network in this novel gamified educational method. The suggested Educational approach made use of field methods and gamification of course module in an IoT setting for improving learning stages. The presented educational model is tested on engineering students for two course module. The result shows that the rate improvement in learning has almost doubled by utilizing this proposed educational model i.e. from 0.66 to 1.33.

Keywords: *AHP, Educational Outcome, Gamification, IoT, ISM,,Learning rate, MADM.,*

1. Introduction

One of life's fundamental values is education. A person cannot be discovered in the world who doesn't owe his or her introductory and advanced performance to literacy. Education is a series of opinions and conduct performed to negotiate a set of objects[1], [2]. Childhood education is significant in two ways: first, in terms of children's effectiveness, and second, in terms of the deep effects of learning during this era.

We live in a technologically advanced society where technology has an impact on everyone's everyday lives, whether directly or indirectly. Technology has been shown to ameliorate children's literacy[3], [4]. There are a number of reasons why technology should be used in tutoring and literacy rate[5]:

(1) One of the crucial reasons is that scholars are enthusiastic about exercising technology and are at ease with it. Day by day their interest in utilizing the technology in learning things increasing rapidly.

(2) Active engagement, cooperation, active regular feedback, and active participation with real- world specialists are used in the technology.

(3) Provides learners with opportunity to advance their careers.

(4) Customize course accoutrements, submit automated online quizzes can be possible by utilizing technology, and it also saves time of the tutors. It is now easier and more efficient to handle classes[6].

(5) Due to the technology, the online learners can easily get their course material from internet sources.

(6) Using internet networks, this technology assists students in completing their homework. The video lectures and course materials in interactive way can be accessed from internet..

(7) Technology can help teachers be more productive while preparing the course material in less time and money.

The focus of this work is to create a hybrid educational system that can transform a traditional class room interactive session to an ultramodern class room session in both online and offline mode. This work is also utilizes different cutting edge technology i.e. IoT in order to ameliorate the convenience and effectiveness of the tutoring process. Furthermore this will help the student to enhance their literacy performance. The modern class room that are equipped with IoT gadgets along with the hybrid educational system i.e. gamified course structure is utilized to achieve this desired goal rather than traditional literacy.

The following are some of the research questions are formulated in order to find the effectiveness of this educational system:

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(1) Is it possible to boost student's motivation, attention and literacy process by incorporating IoT into game-based learning?

(2) In game-based learning, can IoT help to diagnosis and establish student's communication network and education network for improving learning outcomes?

(3) Do learning situations created with IoT based gamified educational system encourage students to collaborate and communicate during the learning?

(4) Is it possible that the criteria offered, which are tailored to each student's condition, assist the learning process?

The next section discusses recent researches and their findings. The hybrid educational method and its basic elements are briefly explained in the following sections, including IoT, and other field method to establish communication network and educational network in game-based learning. In successive section, diagnosis stage, improvement stage, and evaluation stage for the recommended educational technique of training is discussed. The planned teaching approach is then applied and tested on a group of youngsters, with the findings being presented. The conclusions are then explained.

2. Related Works

Studies and affiliated research in the use of current technologies to ameliorate a student's literacy by raising the student's incitement to learn and enhancing the student's ease of literacy is briefly discussed in this section. The aim of this part is to look at the exploration that has been done in educational methods and teaching learning process and to find out the lacunas in the field of educational methods utilizing cutting edge technologies. .

Three questions about IoT and children have been devised by Manches*et al.* According to research, digitizing toys might influence children's views and behavior, thereby educating them and affecting their daily activities[7].

A learning goal is established by Spyrou*et al.,* and the path to achieving it is broken down into various activities, referred to as learning points, which are implemented as IoT based game. Cameras and microphones like active elements are constantly monitoring the user's impact condition. A learning goal, such as counting, is taken into account. (Each learning goal is divided into a number of learning points.) For illustration, the counting literacy ideal is broken into literacy points of different sizes i.e. smaller or bigger. Each of the literacy points has its own literacy game. The game's difficulty is commensurable to the position of literacy and student's status[8].

An education toy was developed by Abdi and Carus*et al.* for prekindergarten children which is used to educate students in underdeveloped nations. This toy was created using a Raspberry Pi and RFID technology[9].

In the State of Kuwait, the effectiveness of incorporating augmented reality applications as an educational tool for teaching English lower standard students is discussed by some researchers. The study finishes with pertinent considerations and recommendations for the use of augmented reality in education[10].

Using IoT, Uzelac*et al.* were able to identify the characteristics which deviates students' attentiveness during class room teaching. The major goal is to figure out what factors have a big impact on how students pay attention in class. Several metrics were measured in a practical classroom setting with low-cost intelligent gadgets. (This study is based on information obtained from 197 students who participated 14 lectures.) Five parameters with a substantial influence were finally extracted after the studies [11].

In an Investigation conducted by Higgins *et al.,* the long term implications of adopting multimedia technology in education system is discussed for the academic attainment [12].

IoT and gaming are combined by Zhamanov*et al.* (They claim that traditional methods of motivating students are ineffective today.) The authors of this essay look at a classroom that is outfitted with cutting edge technology such as IoT and gaming. Instead of traditional learning, they use IoT to facilitate the learning environment. (They compare and contrast the IoT-enabled learning facilities with contemporary learning techniques.). As per the findings, the IoT enabled classroom method out performs than the contemporary learning techniques, with a 20% increase in attendance, exams[13].

Some researchers have developed an educational application for mobile phones based on user interface design concepts that uses voice recognition based engines to transform text into speech to aid youngsters in learning English[14].

Recently, one research reveals the influence of IoT in social and classroom interaction with the help of web based interface. In this interface training, feedback and results are embedded in the web interface for the students. The wearable smart device are employed to collect data around the classroom and accordingly that displayed on the home screen. This web interface increases the system utilization by adding new features for the instructor. This will help them to maintain control over the student's behavior which cannot be possible in traditional class room session.

Through this web interface the instructor can send messages to the student and parent about the status of the

student's academic label and it can also increase the inter-collaboration among the students, interaction and motivation can also be increased. The outcomes were overwhelmingly favorable. Teachers' messages were received favorably by 100% of students[15].

A new approach has been proposed by the author that has used IoT technology, game-based learning, and plant monitoring[16]. A framework for learning through games has been established, and empirical evaluations of how well the suggested games work in actual settings have been published. The uniqueness of this approach is that the gamified learning is end with taking care of real plant at each level.

L'opez-Faican and Jaen look at how elementary school pupils use mobile-based multiplayer games[17]. A gaming scenario is assessed that can be utilized to develop children's communication abilities and emotional intelligence. Two applications of this type of game are addressed in this study: (1) Game based completion among each other; (2) a game in which participants construct an environment with endless physical space using mobile technology. As per the outcomes, these types of approach evoke positive feelings in children, including excitement, enjoyment, and curiosity. Additionally, studies have indicated that cooperative play has a greater effect on interest, social contact, and emotional connection. Additionally, it was discovered that the participatory method's communication quality was good in terms of maintaining mutual understanding, managing conversations, gathering data, forging agreement, managing time, and being interactive.

In another study, the authors explores the impact of blended learning and case based learning approach that is applicable for the SSC students of African countries like Nigeria[18]. In another approach authors have investigated the effectiveness of flipped class room by a ADDE design model with the help of Moodle platform[19]. Some researcher have investigated the students' performance on implementing the gamified learning approach and also examine the perception of teachers about the introducing the gaming element in courseware[20]. Some research also had been carried out to investigates the effect of utilizing the GUI based block program language i.e. MIT invent2 App for teaching programming language[21]. Another study had been carried out to differentiate between the smart campus and the digital campus. They also discuss about the role of IoT and the cloud in educational system[22]. Some researcher have present a model which integrates the IoT infrastructure with the academic environment[23]. Some initial research was carried out by some researcher to solve the non-routine problem by problem based learning method[24]. The student has to find the new way to solve the non-routine problem and he will be held responsible of their solution. Flip learning platform apart from the traditional learning approach has been presented by using IoT infrastructure in cloud environment[25]. This model also facilitates the security and privacy of the user data. Some research is also going on to improve the learning methodology based on the computer based games for advanced study[26].

As a result of this research, the following issues and its possible resolutions to the challenges, are evaluated:

1. Boring instructional methods have been utilized to teach the students in the majority of relevant works. Student's primary interests during childhood are games, which they play with a natural inclination and lack of boredom. To teach student, new instructional model is to employ gamified course module, which are engaging to youngsters.
2. The influence of effective criteria has not been taken into consideration while designing educational system. Therefore the expected outcomes in terms of learning rate cannot be achieved. The suggested educational strategy uses MADM techniques to find out and evaluate the effective criteria influencing learning rate as well as significance of each criterion.
3. Unlike the recommended educational strategy, which employs other kids to support and learn from one another, in most of the related works solo learning style is utilized.
4. Neither the student's educational status, learning rate nor the topic of networking, which involves learning by utilizing charismatic or important children in the network to increase motivation, have been addressed in previous studies. By using complicated networks and centrality metrics, the suggested instructional approach will overcome this problem.
5. SDI was applied in the suggested technique as, the crucial key points and interaction with parents and student are not taken into account in the overwhelming amount of information in identifying the pertinent information

3. Materials and Methods

The components employed in the suggested educational technique are briefly detailed in this part.

3.1. Internet of Things

A new technology that can help with data collecting and management is the Internet of Things (IoT). It has the capability of interacting with machine to machine, machine to people and people to people with modern gadgets. Automatic communication and data sharing between entities and objects will be possible[27]. IoT links all objects, enabling apps to govern and control them. In the realms of technology and communications, it is a relatively

new idea that, as a modern technology, allows data transfer across communication networks for any purpose[28]–[30]. IoT has applications in a variety of industries and fields, which including space industries, auto industries, medical sector, education, smart cities, smart farming, transportation, health, and energy[31]–[34].

Since the late 1990s, when the internet first emerged, several scholars have made predictions about its potential. They suggested that the internet might be utilized for services in addition to data sharing. The phrase "Internet of Devices," which describes the capacity to share data and provide services by connecting devices to the internet[35], was first used in 1999 by businessman and supply chain optimization specialist Kevin Aston.

Since the introduction of the internet, the education field has been severely impacted or motivated to leverage the potential of interconnected networks for the benefit of students and teachers. However, this interconnected networks i.e. IoT boosts the use of technology in education by altering traditional teaching methodologies as well as educational infrastructure. It is now revolutionizing teaching and learning pedagogy not just in universities, but also in schools and colleges[36].

3.2. Hybrid Learning Management System

Recently many researchers give their contribution to enhance the learning method in education field using IoT[37]–[39]. Some of the researches were carried on the smart class room, smart attendance system, smart parking system, smart library system etc. in the university. But there is very few research has been carried out which can enhance the educational methodology. Some researcher has presented a novel teaching methodology called IoT based flip learning platform for medical students[25]. In their methodology, they presented a flip educational model to treat patient as a case study. Depending upon their perception and findings, they will be evaluated by the expert doctor. Prior to the IoT Flip learning platform, some research has been carried out on Case Based Learning system called as CBL[24]. In CBL methodology, the students will be given a case of study in their domain, and then each participant will try to solve the case based on their prior knowledge. Then they will be evaluated according to their findings. These practices will improve the personal skill and mindset to solve the cases. All these cases are pre-formulated by the experts in their domain.

Another group of researchers uses the concept of games to improve the learning ability[40]. They uses gaming attributes in the educational model as new generations are more attracted towards the games rather than study. As the youngsters are more engaged with the mobile apps than that of text book reading, so instead of forcibly draw attention to the text book, the text book contain can be transformed into the gaming elements which will be more attractive and attentive for the students of this era.

3.2.1. Case based learning (CBL)

Case based learning is an ideal learning methodology to improve the student's ability to solve the complex problems by critical thinking and creative thinking. In this methodology a single or group of students tries to solve a complex problem apart from their regular problem by critical and creative thinking which is a way of constructive approach of learning. Here apart from the routine problems, some non-routine problems are given to the students which will enhance their exposure to the real life problems. So the students will be held responsible for their assessment and the teacher will only act as a facilitator. In this case, the educator wants the students to be prepared them for the real life problem solver and to become a global citizen in the ever changing technological world.

3.2.2. Case Based Flipped Learning System Based on IoT

Nowadays, many researchers are interested in flip learning when combined with CBL. It has become more well-liked when combined with the IoT. The course materials for the flip learning system are given to the students in the form of video lectures, online lecture notes, and a few surveys[18], [41]. In the initial step, the students first encountered these online course materials. After the introduction is over, the subject matter expert will give the students a job. Depending on their past knowledge, each student will next try to solve it individually or in groups. The final step will be an in-person or online classroom discussion with a subject matter expert. All of the questions brought by the student are answered by the subject matter expert. The students present their assessment report to the expert in the fourth step. The expert assesses the report and provides the student with his analysis. Students are also invited to provide comments on the online course materials and the in-person learning environment. Through an internet interface, the administrator controls all of these workflows. The administrator creates the policies for expert and student evaluations. In addition to being a topic specialist, the administrator is also accountable for the students' personal information security and privacy. Here, many application delivery strategies, including public, private, and hybrid, are used. For instance, the public assessment policy is maintained for the course material application assessment. The hybrid policy for the expert and the administrator covers the preparation, update, assessment process, and feedback to the student application. The entire application maintenance and monitoring policy is maintained for administrator evaluation. The learner will be exposed to difficulties from the actual world using this method. Here, their capacity to solve problems will

increase, which will inspire students to use original thought to address challenging problems in their domain[26].

3.2.3. Gamification

Now day's teachers and the educational institution are facing many challenges due to the adoption of different way of learning and teaching methods. The main cause for this is the lack of modern infrastructure especially in the developing counties. Students are becoming more drawn to computers, palmtops (Tablets), and Smart cell phones in the present day. They spend more time on these devices continuously than they do reading textbooks. This changes the trend in learning from the text book to the smartphone. Here, educational institutions can draw in students and pique their interest by turning the course module into a gamified course module by incorporating the gamification learning mode in the learning technique[42]. This approach will improve each student's ability to think critically and advance their proficiency for a particular activity. Gamification learning approaches not only generate interest but also enhance critical thinking, where traditional teaching methods fall short in this rapidly changing technology world. Gamification makes information transmission, micro learning, assessments, and student competitiveness easier. Through the use of rewards points at various levels of gamification, it also engages pupils to the fullest extent possible.

3.2.4. Implementation of Gamified Education System

Previously, the education system and games are two parallel entity to develop human intellect and decision capability. Therefore to integrate games into the education system means in learning methodology, a proper depth analysis of the existing condition and availability of the resources to implement it is required. Some of the key strategy to implement gamification is discussed below.

1. Characteristics of Learner:

In order to implement a new learning methodology, one has to deeply analyze the characteristics of the learner. This means whether the special methodology is suitable for the learner assuming that the learner has the pre-requisite skills to use the technology or tools. The teacher has to identify the pre-requisite skills to achieve the objective.

2. Objective of the course:

The objective of the course has to be clearly defined. It should be well defined and understood by the teacher and the student himself. If the objective isn't clear or well defined, then the whole learning methodology collapses over it.

3. Content and Activity creation for Gamification:

The course content should be innovative, interactive and objective oriented. It should be full of multimedia content to engage the students. The activities should be focused to achieve the objective of the course and allow the following elements.

a. Multiple performances

b. Feasible

c. Categorized difficulty level (Easy, Medium, Hard)

d. Multipath

4. Addition of gaming element and mechanism

The gaming element should be well designed keeping the course content and objective in view. These elements are the inclusion of the tasks. The student has to perform the task to get points, to promote to the next level and to get reward points which are his assessment points for the evaluator.

3.2.5. E-learning platform using IoT

The CBL, Flip learning system and the gamification requires a course material in digital form that will be assessed by the different user. For this requirement, a well-designed architecture is presented that support the above requirement. Some of the possible functionalities that can be added to the infrastructure is AR (Augmented Reality), smart board, 3d visual device, different mobile applications and innovative AI objects etc.[43]. In fig. 4, the architecture represents the multimedia data sharing mechanism using connected devices. This connected sharing mechanism transforms the campus into an e-campus[44]. This communication model is meant for the domain expert, learner and the administrator.

Fig. 1 and Fig. 2. represents a work flow of the multimedia data creation up to the end user. This dataflow diagram represents how a campus can be made e-campus which is the new trend of education. The data generated in traditional class room will be recorded and transformed into digital form and then stored and managed by a server. The server facilitates the service using the IoT build infrastructure. The end user can assess the data by using their mobile device.

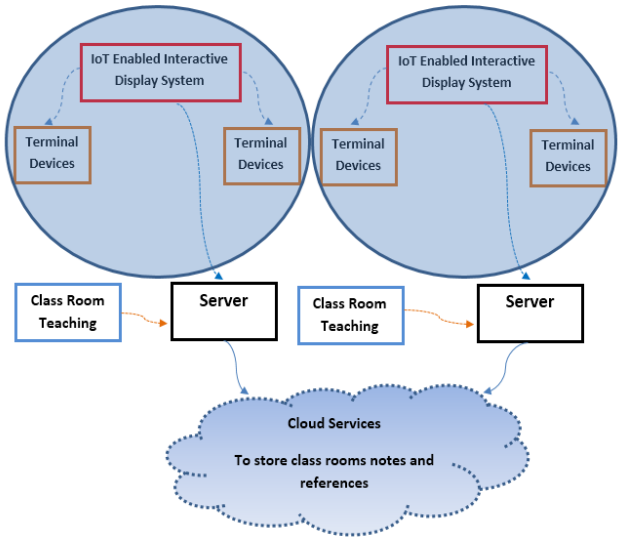

Fig. 1. Multimedia Data sharing medium using IoT within the smart campus

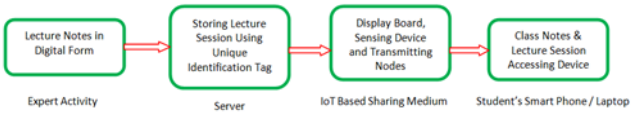

Fig. 2. Multimedia data sharing Model using IoT.

3.3. Proposed Hybrid LMS Model

Learning is a continuous process which starts with the birth of the human being till its death. But a fast learner needs an effective tool to enhance its knowledge sot that he can deliver its knowledge for the benefit of the society. The learner should be focused to lead the society through his wisdom rather than just getting a job. So the learning should be more focused towards the lifelong lesson. The students should get the knowledge through real time scenario which is provided by our proposed Learning Management System (LMS) by exploiting the power of IoT. When IoT works in congestion with the LMS, it creates a real time learning scenario for the student which enhances their skills to face the real life problems by critical and innovative thinking. Now days different LMS are present in the market such as Moodle, Chamilo, Open edx,Totara learn, Canvas, Open OLAT etc. but these LMS have their own pros and cons. Therefore our proposed model is created over the Moodle LMS as it is open source and supported by global development community. But while choosing the Base LMS for our proposed model, we considered the following points i.e. selection of LMS learning objective as per our need, skills of the LMS deployment team, accessing the current strategy, getting opinion of all the team members, analyzing all the technical aspects and limitations, realization of function available to face real world problem, adaptability, scalability and data tracking capability etc. our proposed model is developed by using PHP, Java and Python (for the IoT module implementation).

The proposed Learning Management System consists of a student access system which is regulated by the administrator along with the domain expert or teacher. The working flow diagram of the proposed system is presented in fig. 6. The student can access the study materials from anywhere at their convenient time using their own credentials. The course material i.e. Class notes, Video lectures, previous projects and some hands on exercises in digital form, are prepared and uploaded to the server by the domain expert or teacher. All the course materials are verified by the admin as well as the domain expert. These materials are also updated at regular interval based on the feedback from the students and expert after completion of each session if required. The student access system consists of three learning methodology i.e. 1) CBL, 2) Flip Learning, 3) Gamification. The student has to choose the learning method as per his convenience. After learning the course materials, the student can discuss their doubts in the class room with the expert as well with their colleagues. Then an assessment test is conducted to see the course progress. The expert gives his/her feedback for each participating students and gives the progress report of that students based on the individual student attendance, attention level in the class and the active participation in the questionnaire session in class room which is collected by the some sensors or IoT devices.

3.3.1. Selective Dissemination of Information (SDI)

Users receive pertinent and customized information through Selective Dissemination of Information (SDI) depending on their unique interests and choices. The provider builds a profile of the user's information requirements and continually updates new interests or any other pertinent content that matches the user's profile. It is a proactive method to information distribution. In today's dynamic and quickly changing world, SDI lets users remain up to speed with the most recent information in their area of interest, which may be quite helpful.

A person is always kept abreast of current developments in their profession thanks to the SDI system. The SDI system offers information as a service and as a product, but it differs from a newspaper or magazine in that it does not provide equal access to information for all people. The informational list is personalized and specific to each person. Every delivery made to a person is based on their needs and interests. Understanding user interests and needs is a need for information delivery, as is providing pertinent, timely information to satisfy those needs.

3.3.2. Multiple Attribute Decision-Making (MADM)

MADM methods are frequently employed in a variety of fields. One reason for success is that these approaches have the potential to mirror real-world circumstances and make them simple and clear for most people. These judgments may be based on more than one element, rather than

simply one. Multiple decision-making techniques are used by MADM[45]. In this study, it was discovered that certain characteristics were helpful in raising children's educational and learning levels.

3.3.3. Analytical Hierarchy Process (AHP)

Instead than outlining a "correct" course of action, the AHP assists decision makers in identifying the course of action that best satisfies their objectives and their comprehension of the issue., which Thomas L. Saaty initially introduced in 1980. (A pairwise comparisons-based method for modelling the decision-making process was introduced, enabling managers to evaluate various circumstances.) AHP has a variety of uses, including those in business, finance, politics, and other industries[46]. Some researcher are also utilize the AHP technique in academic settings as it is based on mathematics and psychology. It is also used to calculate the learner's performance factor in academics. In this work the weights of the most effective criteria is calculated using AHP for determining student's academic performance.

3.3.4. Interpretive Structural Modeling (ISM)

ISM is a methodology by which the relationship among effective criteria can be identified and evaluated. It explores the connections between the criteria on many different levels. It has the capability to establish the relationships between criteria whether they are interdependent, either individually or collectively. The steps that are involve in ISM are determination of variables, preparation of effective questionnaires, evolving structural self-interaction matrix (SSIM) along with primary and final reachable matrix, segmenting the surface element, modelling, penetration power analysis and evaluating the criteria's level of dependability[47]. In this work, the criteria which can be a possible capability of enhancing other criteria is determined through the ISM.

3.3.5. Complex Networks and Centrality Measures.

Numerous nodes connecting to one another make build a complex network. One of the most important methods for studying how many realities interact with one another is complex network analysis[48]. One of the most crucial considerations when analyzing complicated networks is centrality. With several structural and parametric drivers, centrality is a descriptive characteristic of actors or groups of actors that may be used to define and estimate the relationships between them in complex networks[49].Measures of centrality are commonly used to identify prominent, strong, or influential individuals[50]. More centrality indicates better status, more communication, and a more advantageous location for an entity. The most well-known indices used to assess the centrality of various networks are degree centrality, closeness centrality and others. Making smarter decisions could be aided by understanding the network's structure. In this study, complex networks and centrality metrics were utilized to assess each child's educational status as well as which children may aid other children in learning more effectively.

3.3.6. Degree Centrality

A network metric or indicator known as the degree centrality measure may be used to examine the network's structure and node location. Degree centrality is the number of connections a node in a network possesses[50]. This statistic links the amount of direct connections a knot has to the network to the location of bumps in the network. The number of connections that each knot in the network has is used to calculate its degree of centrality. Actors who are more centrally located have more possibilities and job opportunities than actors who are less centrally located.

The absolute degree centrality of the node vertex_i is calculated as:

$$C_D(i) = \text{degree of vertex i.} \quad (1)$$

The relative degree centrality of node vertex_i is calculated as:

$$C_D(i) = \frac{C_D(i)}{n-1} \quad (2)$$

Where n-1 is the largest possible degree of a network with n nodes.

3.3.7. Closeness Centrality

Those nodes may be of relevance in some circumstances because they are close to other network nodes. These nodes transmit information over the network in fewer steps. Closeness centrality is the name for this form of centrality.

The closeness centrality C_i of node vertex_i is calculated as:

$$C_i = \frac{n}{\sum_j d_{ij}} \quad (3)$$

Where d_{ij} is the minimum distance within node v_i and node v_j.

3.4. Proposed Educational Approach

This section explains the three steps of student status diagnosis, improvement, and assessment that make up the proposed educational system. To make the educational process more appealing to pupils, an educational hybrid LMS is provided. From educational methods utilizing the Internet of Things, communication networks and training have been derived as shown in Fig. 3. Centrality measurements were used to examine networks and determine the educational state of academics during the phase of identifying the suggested educational approach. MADM strategies have been used in the period of raising student academic standing. The student's status has been

updated, along with possible solutions, using SDI.

The phases of the suggested learning process in the IoT environment are given in this section. The following are the steps in the suggested learning process:

(1) The categorization of instructional resources by n modules depending upon number of students as shown in Fig. 4.

(2) A student's distribution of each instructional component.

(3) To make learning easier for the scholar, each of the n modules is divided into m sub-module.

(4) The instructor instructs each youngster on the portion that has been allocated to him.

(5) Students are expected to gather and teach sub-modules according to the guidelines given below:

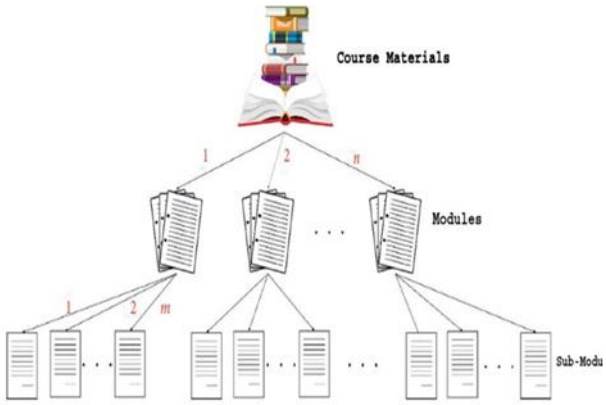

Fig. 3. Proposed Educational Approach

(i) Whenever student 'i ' tries to communicate with student 'j', student 'i' offers student 'j' the student identification QR code, which student 'j' scans using a smart phone.

(ii) After that, student 'I' instructs student 'j' in the sub module.

(iii) If the instruction goes well, student 'i' and 'j' will receive several badges.

(6) The Lecture notes and materials along with badges indicated on each student's training list are assessed after a set amount of time to see if the scholar has learnt them correctly. If a student fails, his or her educational badges will be withdrawn from the list of completed trainings.

(7) Students are graded on the number of effective trainings they have taught to other students as well as the number of successful trainings they have learned.

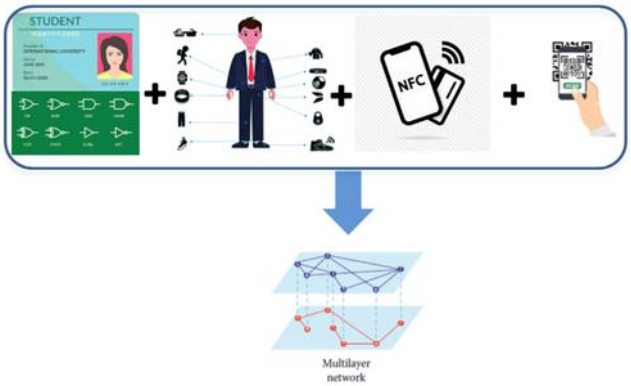

Fig. 4. Categorization of Instructional Resources

A multilayer network is developed in the sixth phase of the teaching process. The communication network between students is one layer, and the education network between students is another. In both levels, the nodes are student. The student's communication is represented by the links in the communication network structure as shown in Fig 5, and students educate each other in the education network. The following are the rules for building networks:

(i) Initially a communication network is built up whenever a student 'i' tries to connect with another student 'j' for teaching process. Scanning the QR code on each student's login site will reveal their references to one another.

(ii) When student 'i' effectively teaches student 'j', a directed link is formed to the education network from student 'i' to the student trained, i.e., student 'j'.

(iii) When a student learns or teaches many trainings to another student, they may be identified by scanning the QR code on each other's login site. The number of trainings will be influenced by the education network connectivity.

(iv) Pupils have the freedom to pick who they want to teach or learn from

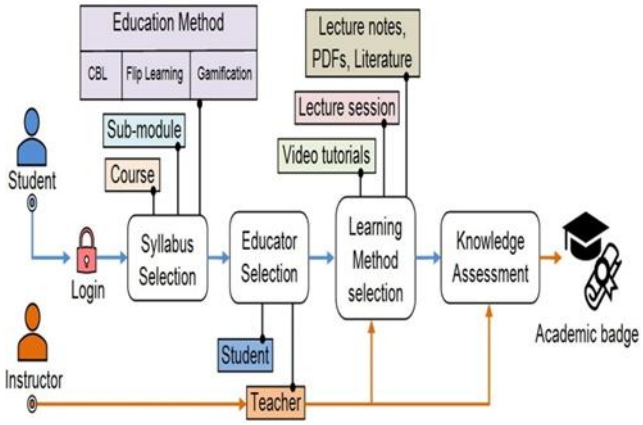

Fig. 5. Extraction of Communication and Education network from Game based Education system through IoT Components.

3.4.1. Diagnostic Phase of the Student's Status

The state of the learner is connected in this area based on an examination of the communication and educational networks from the educational game. Critical network bumps (scholars) and peak scholars are identified using complex network analysis and centrality measurements and placed in various orders. Based on the communication network study, the following labels can be considered:

(i) High input communications: these nodes in the communication network with a high input degree are really youngsters who have been recommended by a significant number of instructors. Other youngsters are quite interested in communicating with these students. (These students are said to be charismatic.)

(ii) Low input communications: nodes in a communication network with a low input degree centrality.

In actuality, only a few youngsters attend their training sessions. (These children may be spiteful or lack social skills, and they may be uninterested in other children.)

(iii)High output communications: nodes in the communications network with a high output degree centrality. Indeed, many children have gone to many youngsters for instruction. Almost all youngsters are able to converse with these children.

(iv)Low output communications: nodes in the communications network with a low output degree centrality. Youngsters who have difficulty talking with other children, in reality.

Based on the education network study, the following labels can also be considered:

(i)High teaching: The students those have successfully educates other students are considered as high output degree of centrality node and referred as High Teaching in education network. These children have a significant capacity for self-education and for considering educational variables.

(ii)Low teaching: In actuality, students (nodes) who have failed to educate other student appropriately have also failed to teach them well are considered as low output degree of centrality node and referred as Low Teaching in education network.. In this case, there are two possible outcomes. Those with high output communication did not get instruction, and neither did those with low output communication. The child's other categories can be examined to diagnose this.

(iii)High learning: The students who have actually been successful at learning from other kids are considered as High learning and their input degree of centrality is high in education network. .

(iv)Low learning: a lack of input centrality in the nodes. (Here, there are two options.) Children in the communication network either did not have low input communication or did not have low input communication but did not learn well.

Out of these labels, new combination can be possible by combining labels from same or different network. Some of the new possible combinations are given below.

(1) High output communications and effective teaching: The students who have successfully suggested a lot of pupils for instruction.

(2) High output communication, ineffective teaching: The students who have successfully referred many students for teaching but, failed to have very good at it.

(3) High input communications, high learning: Many children have requested teachers and have made academic progress.

(4) High input communications, poor learning: despite several attempts to educate these pupils, their learning has been difficult. This shows that these kids learn poorly regardless of their teacher or the type of education they get. They may, for instance, be less precise and pay less attention.

(5) Low output, high input communications: Despite the large number of individuals who have come to educate these kids, they have had trouble communicating with other kids in order to teach them their instructional cards. This is due to low output, high input communications.

(6) Low output, low input communications: The students who have difficulties to have talk to other students, whether they're teaching them anything or just trying to learn something.

(7) High output, high input communications: These pupils are very good at making and maintaining connections with others.

(8) High output, low input: These students interacted with other students without difficulty for educational objectives, while other students were reluctant to communicate with and instruct them.

(9) These students have demonstrated exceptional teaching and learning skills.

(10) These kids had excellent teaching skills but awful learning abilities.

(11) These pupils weren't the best instructors, but they made up for it in terms of learning ability.

(12) Ineffective teaching and learning: For these students, neither teaching nor learning have been successful.

(13) Low output communications, low teaching: These kids found it difficult to interact with other kids in order to

instruct them, therefore they were unable to do so.

(14) Poor input communications, poor learning: Since few kids came to teach these kids, little has been taught.

From the above combinations, the student's status can be determined. The student that fit the description of "poor teaching, low learning" could have trouble communicating and thus acquire minimal instruction. This holds true even if these children are classified as having "poor output communication, low input communication." By taking into account other centrality in the communication network, such as proximity centrality, we may also identify youngsters who are able to teach and exchange knowledge and educational materials on the network more rapidly and assign them educational sections that must be taught fast.

3.4.2. The Improvement Stage

In this stage, the steps that must be taken in order to enhance the education of children. In the sections below, the solutions are labelled and categorized.

3.4.2.1. "High Teaching" is one of the categories. It is advisable to provide a certain educational segment to these youngsters if we wish to teach it to the majority of children. Because these youngsters engage with a large number of children and are effective teachers.

3.4.2.2. "High Input Communications" is one of the categories.

These students are charming because so many people gravitate toward them. As a result, it's critical to assess which other categories these students fit into. If these categories students fall into the categories of students who are facing difficulties to communicating and teaching, their communication and instruction need to be improved if they are to educate a varied group of kids.

3.4.2.3. With "Low Teaching" as one of the categories. This part focuses on the improvement of students who fall into the "poor teaching" category. The following can also be used to the initial phases of instructor-to-student instruction (the teacher presenting the educational material given to the kid).

Child teaching criteria were derived from publications, books, and expert enquiries as shown in Fig. 6. After that, to uncover the most successful criteria, a questionnaire was created, and with the help of professionals, the assessment of each factor in the child

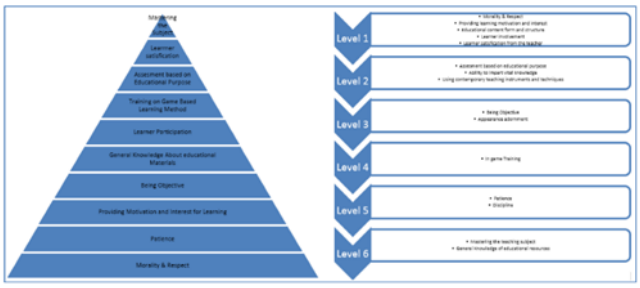

Fig. 6.(a) Heirarchi of Effective Criteria on Teaching Process, (b) Levels of effective criteria evaluated for teaching process from ISM technique

teaching process is determined. Linguistic factors were employed to create the questionnaire, which were then transformed to a five-scale Likert scale. As per the survey for the teaching criteria, the Cronbach's alpha value which is a scale of reliability is calculated as 0.779. It indicates that they were reliable as the calculated value is above 0.7 which is a threshold value for reliability. As per experts decision, the criteria above the weighted average as the important criteria, as shown in Fig. 7. Following that, we employed the ISM approach to look into which criteria may be underlying others, as well as their effect and reliance. Fig. 7 depicts the degrees of effectiveness criteria collected using the ISM approach in the teaching process.

To weight the beneficial indications gathered throughout the teaching process of the student, the AHP approach was applied. The Weights of Effective criteria and its level of priority are shown in Table 1 and Fig. 8. It's worth noting that the discrepancy rate was 0.02301, which validates the AHP surveys' dependability because it's less than 0.1. Table 1 and Figure 11 show that "in-game training" is the most effective method for educating children.

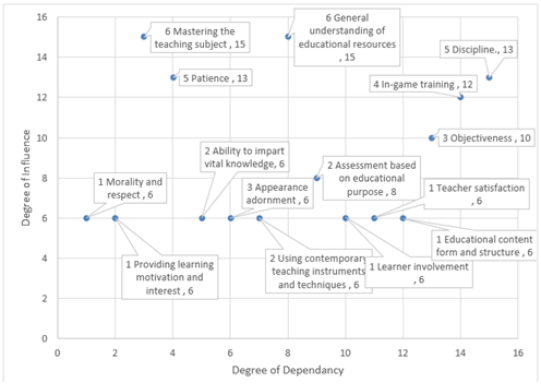

Fig. 7. Depicts the ISM model's MICMAC diagram of successful criteria for the student's teaching process depending on the degree of reliance and influence.

Table 1. Weights of Effective criteria and its level of priority

Level of Priority	Name of Criteria	Weights
1	Morality and respect	0.05781

2	Providing learning motivation and interest	0.08058
3	Mastering the teaching subject	0.08458
4	Patience	0.06451
5	Ability to impart vital knowledge	0.04587
6	Appearance adornment	0.02482
7	Using contemporary teaching instruments and techniques	0.02526
8	General understanding of educational resources	0.06054
9	Assessment based on educational purpose	0.03916
10	Learner involvement	0.04894
11	Teacher satisfaction	0.04983
12	Educational content form and structure	0.12542
13	Objectiveness	0.07958
14	In-game training	0.13854
15	Discipline.	0.07455

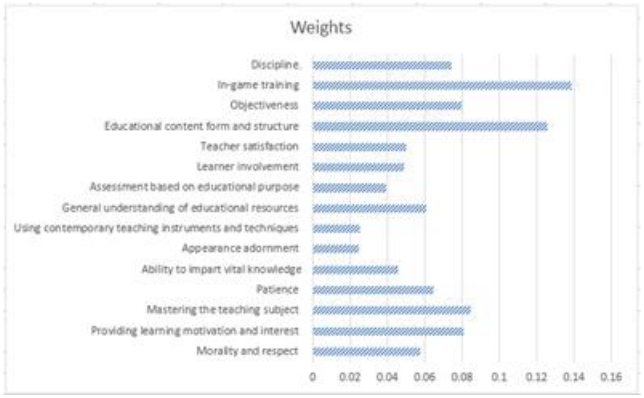

Fig. 8. Weights of Effective Criteria evaluated by AHP Technique

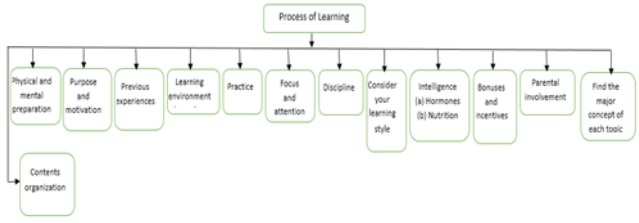

Fig. 9. Effective Criteria for Learning Process

3.4.2.4. Categories including “Low Learning”.

The growth of youngsters who fit the "poor learning" description is the main topic of this section. The following guidelines can also be used to teacher-to-child education in its first phases. The standards for children's learning came from articles, books, and professional inquiries. The following are some criteria for a child's learning process:

(1) Physical and mental preparation, (2) Purpose and motivation, (3) Previous expertise, (4) Scenario for effective Learning, (5) Contents design, (6) Find the major concept of each topic, (7) Focus and attention, (8) Discipline, (9) Consider your ease of learning style, (10) Bonuses and incentives, (11) Parental involvement, (12) Practice, (13) Intelligence

Then, to establish effective criteria, a questionnaire was created, and with the help of experts, the assessment value of each factor in the child's learning process is determined as shown in Fig. 9.. Linguistic factors were employed to create the questionnaire, which were then transformed to a five-scale Likert scale. Cronbach's alpha value for the surveys on the relevance of child learning criterion was 0.728, indicating that they were reliable. As per experts decision, the criteria above the weighted average as the important criteria.

Fig. 10 Levels of elevated criteria evaluated for Learning process using ISM technique

The ISM technique was then used to establish the degree of influence and dependency as well as which criterion may fall below other criteria which is shown in Figure 10. The ISM model's effective requirements for a student's learning process based on dependence and influence are shown in Figure 11's MICMAC diagram. Then to weight the elevated criteria, AHP technique is used which is given in Table 2 and Figure 12 display the relative importance and weight of the criterion. Furthermore the discrepancy rate is calculated which is found to be 0.0231. This value indicated that dependability of AHP surveys is true as it falls below the threshold limit 0.1.

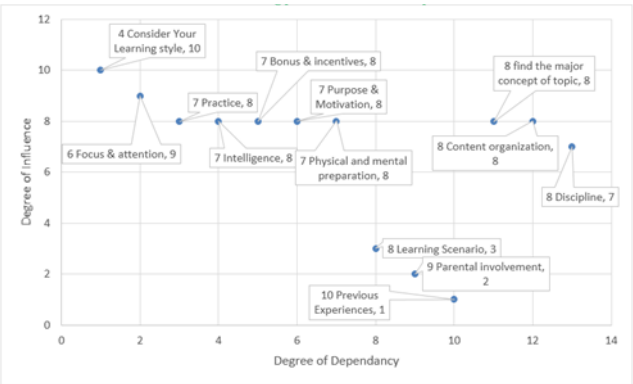

Fig. 11MIC-MAC Diagram of ISM model for effective criteria of learning process

Table 2. Weights of Effective criteria and its level of priority

Level of Priority	Name of Criteria	Weights
1st	Purpose & Motivation	0.07781
2nd	Practice	0.08058
3rd	Physical, mental preparation	0.08458
4th	Focus & attention	0.08451
5th	Intelligence	0.16587
6th	Parental involvement	0.02482
7th	Learning Scenario	0.04526
8th	Consider Your Learning style	0.03916
9th	Previous Experiences	0.06054
10th	Bonus & incentives	0.04894
11th	Discipline	0.05983
12th	Content organization	0.12851
13th	Find the major concept of topic	0.09958

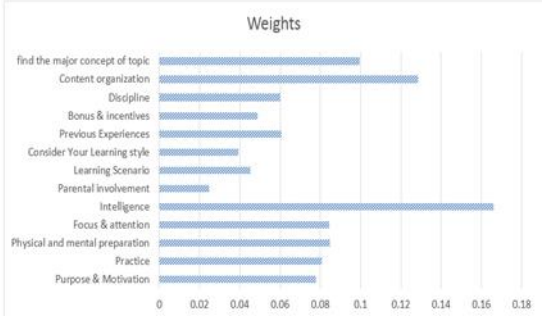

Fig. 12 Weights of Effective Criteria evaluated by AHP Technique

Table 2 and Fig. 12 demonstrate that "intelligence" is the key element in a child's ability to learn

3.4.2.5.Student with High Closeness Centrality in the Communication Network

The students who have high closeness centrality can be given assignments to teach topics that need to be taught rapidly since they can deliver their learnings more swiftly over the network.

Using SDI System.

A new phrase is recently added to the information science field i.e. Selective Dissemination of Information (SDI). In this work we have used it to improve students' educational. Generally this system accepts key word from documents and materials, and it works on those keywords and matching functions to alert users to papers that match. As a result, the keywords to enhance the student's academic performance may be selected and entered into the SDI system depending on the labels the child obtains and the areas in which they do so. In addition to the instructions offered in this study, articles, books, and other resources relevant to the child's labels and category will be given to the system in order to improve the educational process. Any of the ways can be employed by SDI as given below.

(1) Manual Mode: This case is said to be employed when the teacher informs the status of the student and choose the keyword and insert in the SDI system.

(2) Automated IoT Based Mode: This case is said to be employed when there is no human interaction for inserting the keywords in the SDI system. Here the devices are interconnected. The students of different categories and level are entitled with a keyword and this key word is utilized by SDI system to deliver the matched documents of the student’s interest.

Role of Parents and their Influence on Student’s Academic Performance.

In the earlier section we ave already discussed that parents are informed of about their wards status as well as the most recent methods and materials. To properly communicate, parents should also consider the following aspects:

(1) In order for children to successfully implement the suggested solutions, parents should build positive relationships with them.

(2) Parents should avoid conflict and stress at home to give their child a good circumstance for study.

(3) Parents should seek the advice of mentors while putting the solutions into practice.

(4) Parents should use caution while using the suggested solutions. A certain period should be set up for the

youngster to enjoy leisure activities, watch TV, and do schoolwork each week.

(5) Parents should make an effort to minimize their kids' fear of disobeying orders.

(6) Parents may not have enough time to nurture their children in today's atmosphere since they are too busy with a multitude of activities. It's crucial to keep in mind that parents should take both the quality and the amount of time into account. Parents might make the most of their restricted availability. Quality of the communication is essential at this time.

3.4.3. Evaluation Stage

In this stage the discussion is focus on the methods for assessing student's academic growth when adopting the suggested educational strategy and methodology. Replaying the game allows for evaluation and retrieval of multilayer communication and educational networks. Then, using two local and generic metrics that are explained below through which the educational growth of students may be gauged.

3.4.3.1. Local Measures

The independent development of the student can be assess though this measures. The following are some suggested actions:

(1) The input degree of each node (child) in the primary communication network is compared to the input degree of that node in the secondary communication network.

(2) The output degree of each node (child) in the primary communication network is compared to the output degree of that node in the secondary communication network.

(3) A comparison of each node's (child's) input degree from the primary education network with that node's input degree from the secondary education network.

(4) A comparison of each node's (child's) output degree from the primary education network with that node's output degree from the secondary education network.

(5) A comparison of each node's (child's) input degrees from the original communication network to the whole communication network.

(6) Comparison of each node's (child's) output degrees from the original communication network to the whole communication network.

(7) A comparison of each node's (child's) input degrees from the original education network to the whole education network.

(8) A comparison of each node's (child's) output degrees from the original education network to the whole education network.

3.4.3.2. General Measures

This metric is used to assess how far all pupils have progressed in their schooling. The following are some suggested actions:

(1) A comparison of the original communication network's average degrees with the secondary communication network's average degrees.

(2) A comparison of the beginning education network's average degrees with the secondary education network's average degrees.

(3) A comparison of the distance between the original communication networks's average degrees and the total network's average degrees.

(4) A comparison of the distance between the beginning education network's average degrees and the total network's average degrees.

4. Implementation and Testing of the Proposed Educational Method

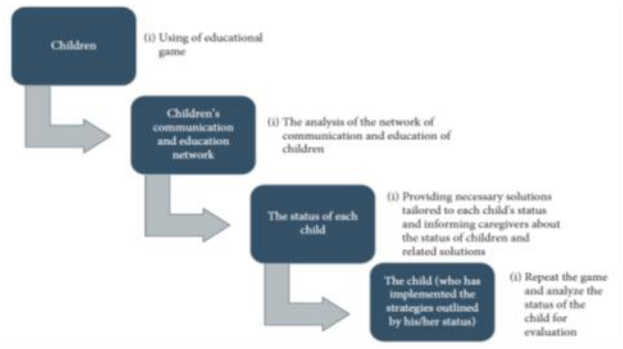

Fig. 13 Data flow of Student's Evaluation Approach

This section evaluates the suggested pedagogical approach in two Higher Class Engineering teaching in the Digital Electronics. Three students (n = 3) participated in the first English-language Higher Class test, and two more students (n = 3) participated in the second.

6 students attended Higher Class in Digital Electronics (n = 6). The recommended instructional strategy has been tried out on nine students in all. Additionally, the Student's in charge individual and parents have given their consent in accordance with all requirements. The students were between the age of17 and 20. Two themes were brand-new to the students who were chosen for the experiment in conjunction with the teacher. Logic Gates and MUX were the modules in digital electronics subject.

The educational game was created in accordance with game-based learning. The teacher taught an Logic Gate to each student before assigning it to them in the educational

game (m = 1). The students had to use each other's names and teach other students their logic gates.

According to the terms they had effectively taught or mastered, students were awarded points. Another card was taken into consideration as an identifying card in order to identify the student's communication network. The identification and educational cards are displayed in Figure 14.

The networks for communication and education were removed using IoT. Each student's identity and educational cards had a QR code on them. When referring to other students to teach logic gates, each student scanned the QR code on the ID card. Additionally, he would scan the QR code on the educational card of the youngster he had successfully taught his term to.

Fig. 14. Identification and testing of Educational Cards

The educational game was created in accordance with game-based learning. The teacher taught an Logic Gate to each student before assigning it to them in the educational game (m = 1). The students had to use each other's names and teach other students their logic gates.According to the terms they had effectively taught or mastered, students were awarded points. Another card was taken into consideration as an identifying card in order to identify the student's communication network. The identification and educational cards are displayed in Figure 14.The networks for communication and education were removed using IoT. Each student's identity and educational cards had a QR code on them. When referring to other students to teach logic gates, each student scanned the QR code on the ID card. Additionally, he would scan the QR code on the educational card of the youngster he had successfully taught his term to. Communication and educational networks were created by scanning ID and ID cards with QR codes. Using complex networks and centrality measures, the educational game's communication and pedagogical networks were analyzed.. The number of interactions each student had with the other and the number of logic gates they were able to successfully teach were used to assess each student's standing.

ISM and AHP, two MADM techniques that were included in this academic model. These techniques are put into practice to deliver answers depending up on each student's current situation. After delivering the solutions, the instructive game was played once again at the conclusion. Subsequently the student's educational status and academic performance is evaluated on the basis of first and second studies.

5. Results

The modification to the recommended instructional strategy is discussed in this portion. The Fig. in 15 (a) shows a communication network established for scenario 1 and figure 15 (b) shows an educational network established for scenario 2.

In the experiment 1, a three node communication network is presented which has two input and output links. In this scenario if a node is having less than 1 i.e. half of the input links with other then it is treated as student of low communication.

There were no children with inadequate communication abilities, as shown in Figure 15(a). Figure 15(b) labels Child 1 as a poor learner because there are fewer input links than Child 1. A weak educator is a node in the educational network that has less than half of the total output links. In Figure 15(b), Child 2 was labelled as having limited educational abilities because there were fewer output connections than 1.

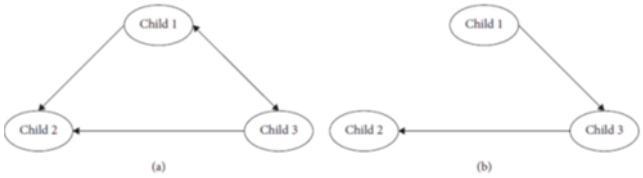

Fig. 15. (a) Established Communication network of Exp.-1 (b) Established education network of Exp.-1

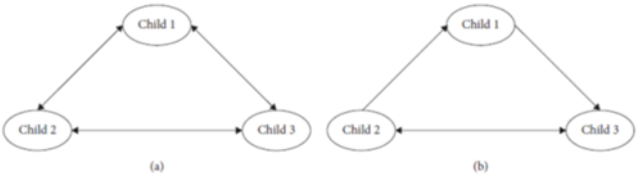

Fig. 16. (a) Established Communication network of Exp.-2 (b) Established education network of Exp.-2

Then the second experiment is conducted after assessing the result from the experiment 1 and putting it into practice. Figure 16(a) presents the communication network established on the second experiment for the Higher Class student, and Figure 16(b) presents the educational network established on the second experiment.

Table 3. Student's performance for first experiment and second experiment using L.M. and G.M.

Experiment No.	Measuring Type	Node	No. of Logic Gates Learned	No. of Logic Gates Taught
Exp.-01	L.M.	Node 1	0	1

		Node 2	1	0
		Node 3	1	1
	G.M.	Avg. of all Nodes	0.66	0.66
Exp.-02	L.M.	Node 1	1	1
		Node 2	1	2
		Node 3	2	1
	G.M.	Avg. of all Nodes	1.33	1.33

*L.M.- Local Measure, G.M.- General Measure

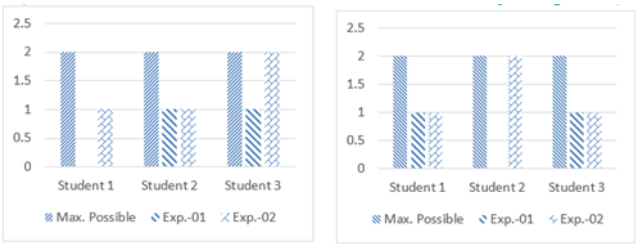

Fig. 17. Performance Diagram of Students in terms of no. of Logic gates learned and taught in Exp-01 and Exp-02

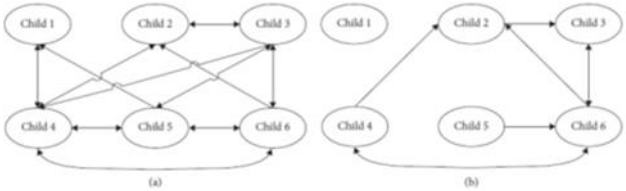

Fig. 18. (a) Communication Network and (b) Educational network derived from exp-01.

Table 3 contrasts each student's performance and assessment (as represented in the local and general evaluation metrics stated in the preceding sections) resulted from first and second experimental setup. The educational network's student performance graphs from the first and second experiments in the Higher Class student are shown in Figure 17. As shown in Figure 17, the second experiment showed an increase in both the child teaching rate and the child learning rate. The proposed instructional approach was also evaluated using a different Higher Class student that included six students.

The communication network from the first experiment's findings is shown in Figure 18(a), and the education network is shown in Figure 18(b).

These networks are examined, and the proposed solutions are explained. Student 1 had little interaction with other students, as seen in Figure 18(a), for example. As a result, this student received a substandard education and just two pupils encouraged him to teach other students.

This youngster sought to develop his communication abilities after being classified as having low input and output. All save student 1 have turned to student 4 for instruction after he was recommended to by the other youngsters. This young person was characterized as pleasant and having great input and output communication. But as can be seen in Figure 18(b), despite obtaining several recommendations, this young person has struggled in the educational processes. Due to the charismatic nature of the boy, efforts were made to improve his teaching and learning abilities so that he and individuals he refers to may both help others learn more language. Additionally, Figure 18(b) shows that student 6 learned more effectively. We made an effort to pinpoint the factors that supported his learning and to promote those factors in other students.

After examining the first network setup with three nodes, the second network setup was examined on the second group comprises with 6 nodes. Figure 19(a) depicts the network setup for communication of the second experiment, and Figure 19(b) depicts network setup for education of second experiment. Based on the outcomes of the first and second studies, Table 4 contrasts each student's performance and evaluation. Figure 20 displays the findings from the first and second studies' student's performance graphs in the communication and educational networks.

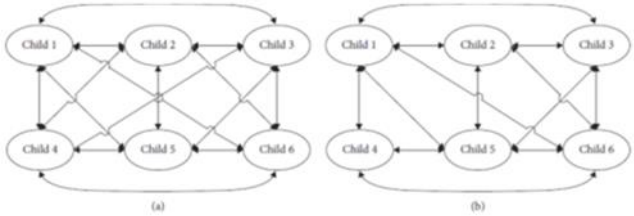

Fig. 19. (a) Communication Network and (b) Educational network derived from exp-02.

From the table 4 and figure 20, it can be clearly seen that the academic progress of the students are improved dramatically. Additionally, as indicated in Table 3, the use of the suggested educational approach in the higher class student has practically doubled (from 0.66 to 1.33) the rate of academic improvement of students as per the G.M. As a result of the second upper class student's continued to use of the suggested educational approach, the academic improvement is also in same proportion i.e. twofold increase in the number of students tested.

As a consequence, we may anticipate that the results of the suggested instructional approach will be appropriate for various demographics. The proportion of the students who learned in the first and second experiments is shown in Table 5.

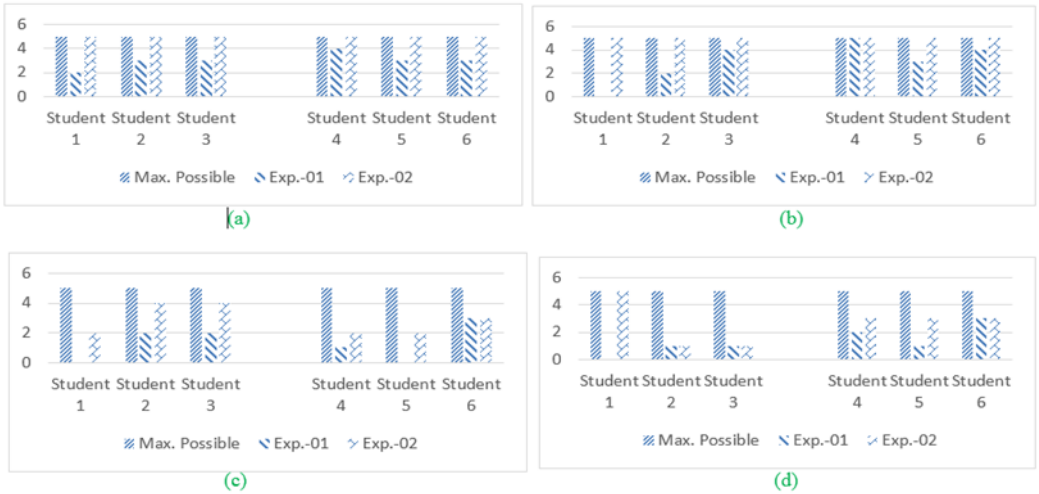

Fig. 20. Performance Diagram of students (a) Communication Network from exp-01. (b) Education Network from exp-01. (c) Communication Network from exp-02. (d) Education Network from exp-02.

Table 4. Student's Performance using Local and General Measures for Exp. No.-01 & Exp. No.-02.

Experiment No.	Measuring Type	Node	No. of Input Communication	No. of Output Communication	No. of Module Learned	No. of Module Taught
Exp. No. 01	L.M.	Node 1	2	0	0	0
		Node 2	3	2	2	1
		Node 3	3	4	2	1
		Node 4	4	5	1	2
		Node 5	3	3	0	1
		Node 6	3	4	3	3
	G.M.	Average	3	3	1.33	1.33
Exp. No. 02	L.M.	Node 1	5	5	2	5
		Node 2	5	5	4	1
		Node 3	5	5	4	1
		Node 4	5	5	2	3
		Node 5	5	5	2	4
		Node 6	5	5	3	3
	G.M.	Average	5	5	2.83	2.83

Table 5. Module-wise Student's learning rate in percentage

Study	Experiment No.	Module Knowledge in Percentage
Logic Gates	Exp-01	34
	Exp-02	67.5
Multiplexure	Exp-01	28.3
	Exp-02	57.4

The following are additional benefits of the suggested pedagogy:

(1) Since games are appealing to students, utilizing them to teach them may be highly successful and helpful. From the previous research we know that a teacher can't control all the student in the academic session because of their high level of mobility, especially during gamified approach of education. Thus by utilizing the IoT technology, indicated in the recommended educational approach, it is possible to automatically and independently isolate the

communication network and the instructional network from the educational game.

(2) Traditional approaches do not extract and analyses the student population's communication and educational networks. Different student statuses have been seen using the recommended educational method, which makes use of centrality measures and a knowledge of complicated networks to accelerate students' learning. What's more, these outcomes may be executed in real academic process with extraction of networks using IoT technologies, helping the instructor swiftly assess the status of the pupils, particularly in high-node networks.

(3) Finding the most recent information and techniques to help a student with their diagnosis is either not done or takes a lot of time in traditional ways. The instructor and parents will receive the most recent knowledge and techniques to quickly improve their child's diagnostic condition in the recommended educational method, which uses SDI. In addition, the suggested approach, which uses SDI, allows parents and teachers the accessibility of data through different media and gadgets, how many documents and contents there are, who wrote them, when they were published, etc. With conventional ways, it was not feasible to boost the simplicity and effectiveness like this.

(4) The recommended educational approach makes it possible to increase ease, accuracy, and efficiency. As in all steps, including figuring out the student's states in the academic, delivering answers, and during evaluation, are finished automatically and as fast as possible.

6. Discussion

The outcomes demonstrated that the suggested educational approach can enhance student's communication skill while they are learning. By improving their communication skills, students can teach one another new things. In conventional systems, only tutoring between educators and students is taken into account; student-to-student education is not. The results of this study's data demonstrated that considering student-to-student education enhanced the educational process.

Additionally, the study questions and Tables 3 and 4's findings indicate that the suggested remedies employing MADM approaches have been successful in enhancing children's educational standing.

The condition of each student is diagnosed independently in the suggested technique, and remedies are offered in line with each child's situation, which is not taken into account in conventional methods. Additionally, as shown by Table 5's findings, the suggested educational approach has been able to sustain a twofold increase in the pace of children's learning while also increasing the number of children evaluated. The proposed teaching technique employed the art and creativity of fusing games that students find appealing with technology like IoT, with the goal of improving learning by raising students' interest and engagement in the learning process. The results demonstrated that this goal had been accomplished.

7. Conclusion

This research work outlines a strategy for educating students. The suggested instructional approach made use of tools and technology which includes Gamified Course module in conjunction with IoT along with some field methods such as SDI, MADM etc. All of them were all discussed individually initially. Diagnose, improve, and evaluate were the three steps of the suggested educational approach. While just one of the stages is often taken into account in similar studies, all three phases are taken into account in the suggested instructional strategy.

In this suggested work, the academic network i.e. in terms of communication and education is established using IoT was used. The youngsters were divided into several groups that reflected their status and the networks were analyzed using centrality metrics. Solutions were offered for several categories using MADM approaches. In addition to offering solutions, we considered the children's learning preferences. Local and General metrics were established for evaluation during the evaluation phase. The proposed instructional strategy was evaluated over the course of two studies with a total of nine students. The outcomes demonstrated that the suggested educational approach might enhance students' learning. The most significant outcomes of the approach is to automate diagnosis stage of the student’s academic label using cutting edge technologies and methods. Using the SDI approach, the students’ academic status can be evaluated and the best solution can also be provided to them. The educational game used in this study was created such that each youngster would impart knowledge to the others. There was no attempt made to group the students into different category and have each group teach the students in the other group of different category. This restriction forbade the use of extra network measures like betweenness and page rank centrality. Future study might include taking into account group games and utilizing different centrality metrics in the analysis of the networks that are produced.

Author contributions

Sushil Kumar1 Mahapatra1: Conceptualization, Methodology, Software, Field study, abstract, **Binod Kumar2 Pattanaik2:** Data curation, Software, Validation, abstract **Bibudhendu3 Pati3:** Visualization, Investigation, Writing-Reviewing and Editing. **Suprava Ranjan4 Laha4:** Writing-Original draft preparation, References & Grammar Check **Saumendra5 Pattnaik5:** Abstract,

Discussion, **Bibhuprasad6 Mohanty6:** Conclusion, abstract

Conflicts of interest

The authors declare no conflicts of interest.

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