ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

EDUCATIONAL ROBOTICS BASED ON ARTIFICIAL INTELLIGENCE AND CONTEXT-AWARENESS TECHNOLOGY: A FRAMEWORK

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ABSTRACT

Educational Robotics' (ER) use of Artificial Intelligence (AI) ranges from (Science, Technology, Engineering and Mathematics) STEM area, logical mathematical, debugging, LEGO robots, and a lot more. There is an urgent need for (ER) research on policy and use. However, this paper presents a framework for the representation of knowledge about using Educational Robotics and Context-Awareness technology in the learning environment. This framework enables smart class performance in higher education. The purpose of this study presents a new strategy in many aspects. Expanding and optimizing the students' answers and develop the users' participation in communication. The framework introduces a context controller system on the mobile terminal to connect and prepare the data from the robotics indicators. Additionally, it mixes different AI identification services in the cloud to obtain the context information through investigating and understanding the data. We also present a vision of use robotics and context-aware technology in the learning environment to improve and optimize the most benefits from the context information.

Keywords: *Educational Robotics, Artificial Intelligence, Context-aware Technology, E-learning.*

1. INTRODUCTION

Technology has entered every sector of life and add a fingerprint to change them rapidly. Robotics technology has been included in a lot of fields including health care, industry, home devices, and learning. The technology dominates all the students' minds and becomes an indispensable part of their lives. They grow up using all kinds of technology such as laptops, computer games, and Smartphone, but they never think about how it is made or how it is repaired. Educational robotics is a purely technological method of learning [1]. Robotics has attracted a lot of researchers, teachers, and higher education as a very essential learning tool to develop many skills in all educational stages [2] . The 21st century skills highly depend on skills gained by educational robotics like creativity, critical thinking, problem solution, and many other skills [3] . Therefore, educational robotics is a very helpful tool in education and should be used in all schools and higher education institutes. The main purpose is to encourage Educators and schools to integrate educational robotics into their curriculum to create a useful learning environment for students to exhibit their knowledge and develop the important skills needed for their futures. In addition to that, educational robotics improves students' communication, collaboration, and teamwork skills; educational robotics creates a fun and engaging learning environment for students [4] .

On the other hand, the modern expansion of superior knowledge technologies, like broadcast connections, sensors, and the Internet of Things, has allowed adaptive learning through context-aware technology which can discover the student's context and learning content to meet the context. The care for context-awareness is necessary for these systems so that they can gain relevant contextual learning [5]. The skills of a learning environment help to identify the students' context and to adjust its performance which consequently represents a significant part in personalized learning. Context-awareness can make a meaningful distinction in learning performance associated with common educational hall-based learning, because in context-awareness learning situations, learning sources and exercises are modified to suit the learner's recent situation [6].

This paper tries to show that both context-awareness technology and educational robotics fields have earned more research to be strongly applied in various frameworks in higher education. Such robots, besides their prime professions to promote learning, can communicate, have computing abilities, these robots also assists its own learning service (that enables them to conceive information within explicit activities), they also assist performance (which is the enabler of learning) and achieving students' action through immersion and immediate feedback. Certainly, these characteristics would be importantly amplified by context-awareness technology, moving the satisfaction of specifications represented by superior applications in pervasive and distributed environments. [5,7].

2. BASIC TERMINOLOGIES

Before getting involved with the detailed architecture of the Learning environment based on educational robotics, it is imperative to understand some terminologies specific to educational robotics:

During technology advancement, original technology-based firms in education and training are growing. Education is now moving from the usual classroom-centered learning to web-based sources (e-learning) and portable tools (m-learning) [8], immersive education in a context-awareness studying environment, context-awareness circumstances ready to give personalized content anywhere (i-learning) [9] plus a context-awareness method that extends virtual educative knowledge into the physical environment based on what the students want [10].

On the other hand, Robots provide the skills from microelectronics technology as well as give learners the chance for project-based education. Educational robotics provide the following benefits: ease of e-learning activity increases attention in math, builds architecture plus science career, improves learner success scores [11], supports problem-solving, and supports collective learning [8]. In [12], presented a methodology to produce Robot-oriented Generative Education Objects (GLOs) to explain computer science (CS) subjects like programming. The method introduces CS education variability modelling practicing the feature-based methods used in the engineering area. The tool allows us to develop the GLOs plan method significantly (in terms of time and quality) and to produce higher quality and functionality of GLOs themselves. CS shows the propriety of the methodology in the physical educational environment. The central conception about the article is the seamless mixture of couple identified technologies (feature modelling and meta-programming) in producing robot oriented GLOs and their devices.[13] said challenges that Researchers deal with includes:

a. application of robotics as a learning device,

b. experimental trial of the effectiveness of robots.

c. marking of latter attitudes from the application about the robots.

This article also reviews the educative potential of robotics into classes plus resolves the next points:

a. A large part of the knowledge gained is applied into fields associated with robotics' through robot development, mechatronics and robot programming

b. a reign of the application of Lego robots is perceived (90%),

c. about STEM, robotics does develop the education performances, particularly in schools and a lot of applications based on reports of educators producing positive responses with individual initiatives.

2.1 Educational Robotics Platforms

The use of robotic platforms in learning environments have been developed in recent times. The most current application of educational robotics is highlighted in programming, mechatronics, robot production, etc., which is more useful for learners who consider engineering as a field. The use of robots promotes the learning acquisition of students [13]. It is essential to indicate the role of the lecturer who teaches on the platform, encouraging the students to correctly use the robot and getting them inspired [14,15]. The practical collections must be small just to provide the learners with the opportunity to manage the platform and correlate the content to the courses taught in the university [16]. A project-based approach has developed in educational robotics, developing interdisciplinary learning chances to create a further significant learning practice. The selection of the platform is one of the conclusive factors in crafting these interdisciplinary learning chances [17] . Table 1 shows some of the robotic platforms that have been used in higher education.

Table 1: Description of Educational Robotic Platforms in Higher Education

Platform	Description
Hexapod robot	It was used in the Electronic Systems and Telecommunication Engineering (ETS) program. The platform intended to simplify learning of programming for students, regarding the application in robotics. The platform includes 39 of the 63 courses of the ITS learning program, comprising nearly 61% of the learned curriculum [18].
LEGO robotics	It is applied in engineering universities to provide students leveraging their expertise and practice to determine a real-world problem and to consistently question and challenge that information as they provide several answers to the challenges as they develop a learning society [19].
Open-Source Mobile Robot (MONA)	Mona is a uniquely affordable, flexible and simple-to-use robotic platform. It is an open-source, low-cost, and open-hardware mobile robot, which had been revealed to be aligned with numerous conventional programming environments. The robot had been strongly applied for both learning and experimentation at the University of Manchester, UK [20].
Robobo Robot	The Robobo base is the foundation while your smartphone is the brain. Modern smartphones include processors, sensors, and communication capacities, low-level sensing, and gestural capabilities provided by the foundation, Robobo which enhanced the learning intelligent robotics [21].
KUKA youBot	It is an Omni-directional mobile conductor platform from KUKA that works as a recommendation platform for industry, analysis and learning at the same time. It consists of a small KUKA arm with 5 degrees of freedom and a plate to include sensors [22].
Car kit Robot	This consists of all the needed hardware for a fundamental independent vehicle. With this kit, learners were capable, not only to extend the understanding of Arduino and minimum circuit knowledge but also, students were able to produce an independent robot that moves into a model town [23].
Pixy	It was a cheap computer vision system intended to achieve with Arduino. It delivered all the image processing onboard; allowing the Arduino, and the learners, to concentrate more on exploration and algorithm improvement [23].
Duckietown	It is an accessible, cheap and adaptable platform for independent learning and analysis. It is a valuable tool since professors and researchers can preserve money and effort. It involves small independent vehicles ("Duckiebots") built from off-the-shelf parts, and cities ("Duckietowns") finished with streets, tracks, signage, traffic lights, barriers, and residents (duckies) in need of transport [24].
OpenROV	It is an accessible source remotely run vehicle. A cheap telerobotic submarine/underwater drone produced to obtain underwater exploration and learning. It is managed from a portable device attached to the submarine via a tether and is provided with onboard LEDs and a camera [25].
Adventure-I	It is a mini AUV model produced for learning and analysis assignments. It is completely provided with one basic propeller and two rudders, without any vertical and lateral thrusters. The administration system was presented with the external monitoring position and inboard administration component to be simple in usage and to obtain location and orientation knowledge [26]

2.2 Curricula in Educational Robotics

The studies utilized robotics as an enriching agent in architecture education, science, technology, mathematics, and programming learning. Most of these studies that use educational robotics as mindtools depend on constructivism. Also, educational robotics can be implemented as mindtools promoting information buildup during the study of significant real projects [27]. For example, educational robotics had been used in teaching mathematics (i.e. decimals, coordinate algebra), studying computer science (i.e. programming), and also interestingly, in the engineering study cycle (i.e., identifying constraints, produce possible solutions, analysis and correct answer based on results). Moreover, educational robotics used in science to learn physics such as displacement, time, and velocity. Additionally, some researchers recommended that activities and exercises must be managed because the position where the activities are performed is needed to show clear learning results and proof of learning. This has many benefits

1. The activities planned and executed are simply performed as a lesson. This is proper to the variety of goals and evidence of learning. It is more comfortable to understand the connection with the learning hall's curricula.
2. The proof of learning lets people verify if the activity performed the required outcomes or not. Furthermore, it could be used to estimate the real influence of educational robotics in the short term, which is significant because it has not been quantified yet and it would produce arguments towards the implementation of educational robotics activities [13, 28].

3. AIM OF THE RESEARCH

based on this definition of Educational Robotics in Context-Awareness Technology, a research framework is proposed in Figure4. This framework describes seven essential phases: determine the platform based on its features, select the design methodology, describe the architecture, apply a prototype, initial tests to a prototype, implement experiments, and apply in real life with students. The proposed framework emphasizes the ideology for pursuing better higher education and thus had better to be improved the educational robotics as smarter education by enhanced the robot sense using context-awareness technology, which address the needs for smart pedagogies as a methodological issue and smart learning environments as technological issue, and advances the educational goals to cultivate smart learners as results. Smart environments could be significant influenced by smart pedagogy. Smart pedagogies and smart environments support the development of smart learners

4. RESEARCH FRAMEWORK

4.1 The proposed Learning Environment

Both context-awareness technology and educational robotics fields have earned more research to be strongly applied in various frameworks in higher education [31]. Such robots, besides their prime professions to promote learning, can interact; own computing abilities; essentially completely own sensors and actuators to sense and improve their environmental context as seen in Figure1.

The robot serves both as the learning aid that enables us to conceive information within definite activities and behave similarly to the enabler of education and implementing student action through immersion and direct feedback [32], these characteristics would be importantly magnified by context-awareness technology, via the realization of conditions modelled by superior applications in several different environments, particularly those identified by a great level of criticality[33]. These are the states in which the aim is to catch the greatest and immense knowledge in the operational area, to allow information-intensive communication with its characters [5,7]. As shown in figure1, the control RR of the ER system show how inputs of ER related to the educational environment in the robot system.

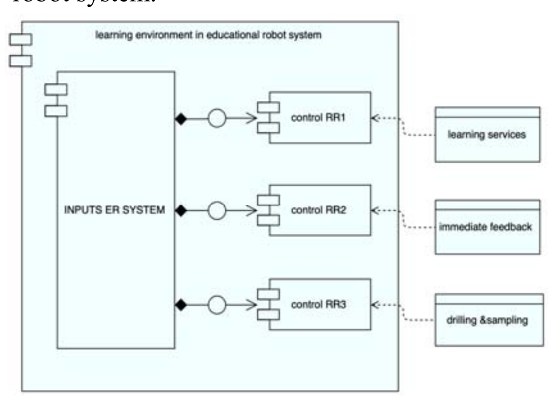

Figure 1: Learning environment in ER

ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

4.2.1 Context-awareness technology in higher education

Context-awareness technology includes six main phases and can provide access to asset information context in higher education and provide effective prediction to detect complex problems and solve them [33] as shown in Figure 2.

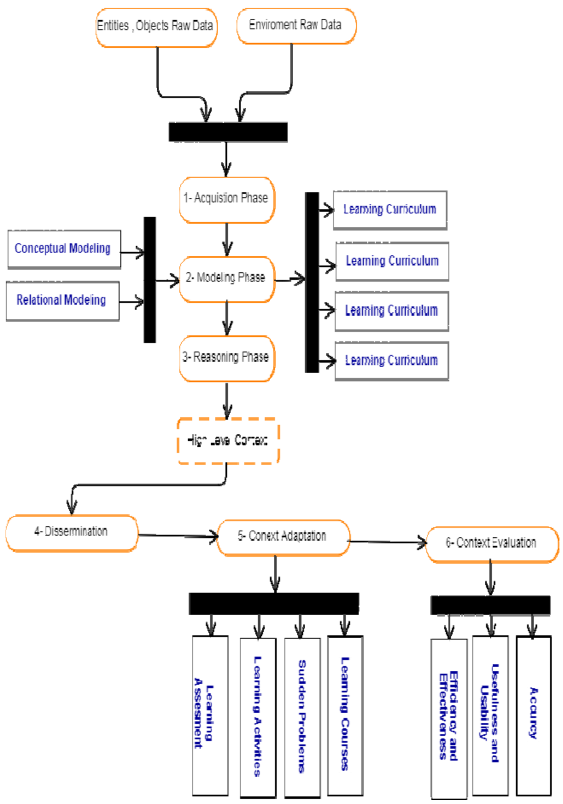

Figure 2: Phases of Context-Awareness Technology in Learning Environment

- Acquisition phase: it comprises of sensors, actuators and communication devices. The main aim of this phase is to capture and filter raw data about students' environment, enable new interactions to students and others to obtain efficient and valuable context information, and link it to the real-world to adapt to changing situations.
- Modelling phase: it is used to aggregate, analyze and generate conceptual and relational models. In other words, we discover entities (students, courses, locations, time, situations, activities and other objects in the learning environment), which are called the conceptual model. After that, we detect the relationship between students and objects to convert raw data in the acquisition phase to significant context information.
- Reasoning phase: It is used to infer new and relevant context information that can be used for synchronizing learning events with the natural conditions and students' feedback about their communication with students in the learning environment.
- Dissemination phase: it allows entities (students) to communicate with objects in the learning environment and produce the ability to query objects, change their state and support abstract processes to be turned into obvious and more understandable processes.
- Adaptation phase: the main aim of this phase is to adapt to the dynamic events of the learning environment such as activities, situations, intercommunication among students, learning courses and problems.
- Evaluation phase: this phase is the final phase to enrich context by assessing its accuracy, validity, usability, and effectively.

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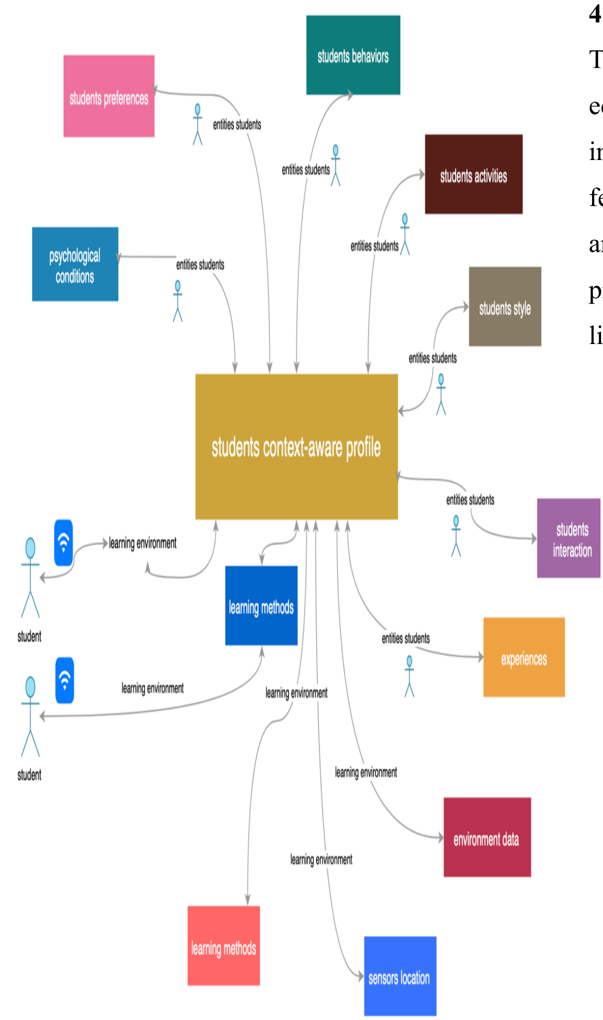

Figure.3: Students' context-awareness profile

Context-awareness technology can be described in higher education as seen in Figure 3. It identifies the entities (students) and personal data like behaviors, preferences, psychological conditions, interactions, experiences, learning styles, and activities. Student needs to communicate with other objects in the learning environment. These objects can be interpreted in environment data such as location, time, curriculum, learning methods, and sensors data to form the personalized context-awareness profile to each student and provide the appropriate services [34].

4.2.2 Educational robotics

The design of educational robotics in higher education is divided into seven main phases as seen in Figure4. Determine the platform based on its features, select the design methodology, describe the architecture, apply a prototype, initial tests to a prototype, implement experiments, and apply in real life with students.

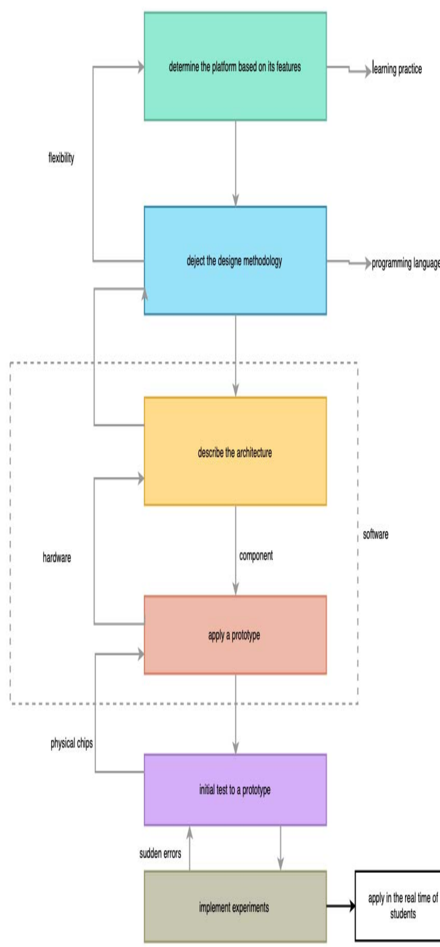

Figure 4: Suggested Phases of Educational Robotics.

1- Determine the platform based on its features:

This platform aims to present students with the learning practice that moves behind the gain of information or particular practices as it allows true potentialities appreciate to ease reconfiguration,

ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

adaptability, and versatility [35]. We gave a brief description of the basic features of the platform [36]:

- **Reconfiguration:** links or formative parameters can be before its performance or while it is being used.
- **Scalability:** the platform complications can be adjusted according to the requirements.
- **Compatibility:** connections with Arduino shields and intelligent devices are flexible and simple.
- **Concurrency:** processing and connections can be paralleled.
- **Protection:** integrity and secondary protections are incorporated. It is also enabled in the incorporation of student security.
- **Prototyping:** student automatic prototypes can be incorporated by professors or learners to confirm the platform.
- **Flexibility:** the platform is sensitive to adjustments or modifications.

2- Select the design methodology

To understand working with the complexity of the platform, we want to determine guide procedures used to reach the aim and manage the platform. These procedures help to analyze and design systems [37]. Here, a brief approach about some of these methodologies.

- Rapid Application Development methodology (RAD): it had been devoted to decreasing drastically the duration required to produce and operate information systems. It has great support to recognize developers' perceptions, generate computer tools and programming languages for computer science education [38].

Object-Oriented methodology: it is a proposal to model programming of architecture software as the system consists of things which have features expressed to its description, its interactive behaviors, its events according to their functional dependence and each feature has a value [39].

Soft Systems methodology: it has been generated from this constant cycle of interference in lower administration constructions and learns from the results [40].

- **V-Model** methodology: an analytical method regularly manipulated in engineering software programming. It is employed to construct connections between test activities, analysis and design [41].
- **Extreme Programming methodology**: it is an active methodology centered on encouraging interpersonal connections for software development [42].
- **SCRUM methodology**: it is quick and adaptable to control software development methodology. The improvement is executed repeatedly and increasingly. Each repetition, called Sprint, has a planned period between 2 -4 weeks, resulting in a different software version which is ready for use [43].
- **V-Model** has been a fitting methodology due to its abilities to promote hardware and software components of educational robotics. Furthermore, it can enhance the processes of analysis, designing, and developing the prototype.

3- Describe the architecture

This phase includes the components of educational robotics model, such as hardware and software. First, we must determine the hardware which involves the hardware employed to develop the educational robotics model. Second, we need to distribute it into the main hardware and subcomponents. Third, we

ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

must discover the recognized specifications for hardware which proper for educational aim. Fourth, define the hardware which is required on the platform. Finally, we determine the appropriate software [36]

4- *Apply a prototype*

We must generate the primary model of educational robotics. As well as, prepare the design of the mainboard, connections, dimensions, and physical chips [36].

5- *Initial tests to a prototype*

We conduct tests to be certain if the prototype performs the aim and the specifications of the design. The main aim of this phase is to find errors or issues which do not fit design specifications [36].

6- *Implement experiments*

We execute the final experiments to verify the effectiveness and quality of educational robotics model [36].

7- *Application in real life with students*

We implement educational robotics model in real life with groups of students and observe the results to adapt sudden events in the learning environment [36]. Consequently, educational robotics is a powerful and inspirational motivation to improve knowledge and educational levels for students in higher education because of their reconfigurable, flexible, adaptable and cost-effective educational robotics. Furthermore, they enhance programming and designing skills for students.

4.3 The Mixed Framework of Educational Robotics in Context-Awareness Technology

Most advanced educational robotics should be included with sensing devices in order to perform complex processes. In fact, these capabilities would be significantly magnified by context-awareness technology, especially in several computing environments. In these environments, the main aim is to collect the greatest and most widely spread information in the learning space, to enable information-intensive communication within the whole educational factors. In the current framework, various devices combined with the robot works, such as smartphones, physical and virtual sensors, servers, and networks through complex and heterogeneous internet architecture to provide continuously interaction context awareness with students, robots, and learning environment. Figure5 shows the abstract framework to interact between ER and context-awareness technology in the learning environment to improve and optimize the most benefits from the context information [31].

Conceptually, the role of educational robotics in a learning environment based on context-aware technology as depicted in Figure 5 is:

- Educational robotics as a smart device: Information is built, developed, and reconstructed by communication within intelligent devices. Learning elements and methods can be self-organized and changed according to learners' real-time preferences and psychological states. Information context is realized as smart robots, which can stimulate and co-operate with surrounding environments [44].
- Robot as a Service (RaaS): allows an intelligent assistant to obtain a robotic thing to execute activities. The robot executes an assistance endpoint for a student to check [45].
- Robot as a Learning Object (RaLO): this increases the knowledge of an LO behind the implicit field (learning content) to a

physical domain (robot hardware and environmental methods that are described by the hardware) [46].

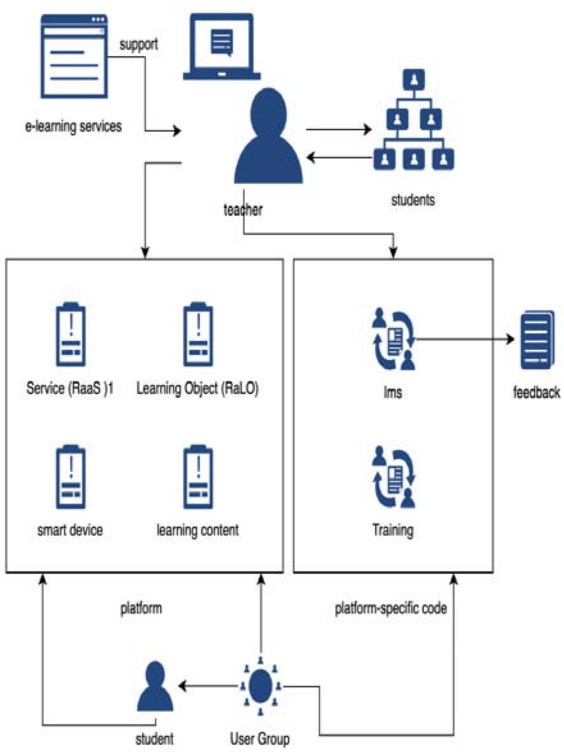

Figure. 5: Framework of educational Robotics in Context-Aware Technology

Finally, the main contribution of context awareness technology besides educational robotics in the learning environment as follows:

- Enriching the learning situations by supporting contextualized learning using physical devices such as sensors to present information context about learning activities.
- It also synchronizes learning content with the student's context, surrounding environment and its influence on learning experiences, which is a consequence of personalization of learning services delivery [47].
- Building a new knowledgebase on context awareness and previous knowledge of students by interacting with smart physical mobile robotic learning objects surrounding him. Consequently, it provides instant feedback supporting the immersion of students and subsequent reflective thought processes in rich, co-operative learning environments [32].

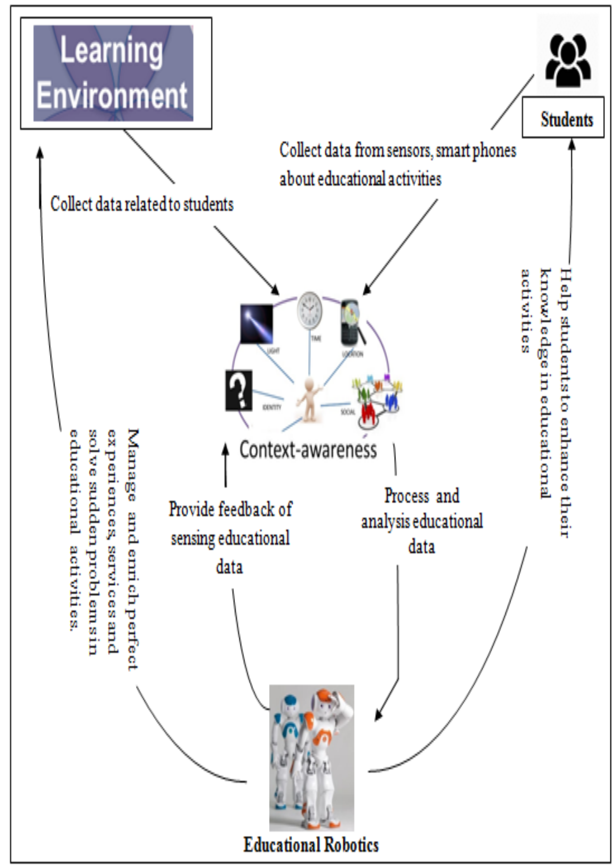

Figure 6: An Overview of the Proposed Framework

The merger between educational robotics and context-awareness technology encouraging student engagement which represented a basic role in enhancing students' skills and helps to obtain synchronizing feedback. Consequently, it supports students to gain more knowledge and overcome errors and achieving a positive influence on algorithmic thinking [48].

ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

5. CASE STUDIES BASED ON THE RESEARCH FRAMEWORK

Jianbo shi is a cognition-based context-awareness cloud computing structure, produced to improve the robot's sense settings including the user's sentiments. Based on the identified context knowledge, robots could optimize their answers and develop the user's participation. The structure includes a customizable context monitoring system at the mobile terminal to receive plus prepare this information of the robot's sensors. Additionally, this mixes different AI recognition assistance in the cloud to extract the context data through investigating and following the data. Once the context data is extricated, the events are shifted backwards from the mobile to producing a fitter choice in the next interactions. The results prove that this suggested structure could significantly increase the interaction and intelligence of mobile robots [29]. The case study Štuikys demonstrates has proved that the effect of practicing robot-based settings for education. This was done by applying technological features in this e-learning context to the original frame while easily mixing various stages from the method and considering it in entirety. The e-learning environment for collaborative learning has the following benefits:

(1) the tasks studied are associated with mechanics, physics, mathematics, and computer science, improves learner action into education,

(2) develops the learner skills to critically analyze and contrast another problem-solving algorithm and the analysis and result display[12].

6. LIMITATION

The findings of this study have to be seen in light of some limitations:

- The lack of capabilities to apply some aspects of the study.
- Difficult to persuade officials to apply the study

7. OPEN RESEARCH ISSUES:

The results of this research can be used in building an integrated system for how to use robots in designing smart classes and e-courses based on artificial intelligence

8. CONCLUSION

The current framework which is based on educational robotics and context-awareness technology presents a deeply exciting learning environment in college, encouraging collaboration among learners, and realizing the generation of innovative experience in a reflexive method instructed by the professor. Additionally, these researches as regards using educational robotics for teaching in universities have been supported by diverse theories and the feedbacks given by instructors shows this can be considered as an instrument for teaching in higher institutions of learning. From the results gotten (either positive or negative), it can be compared to the real behavior of the student, hence given the professor some confidence level that such performance can be replicated in his/her class. Moreover, it is important to know that there are laid down prerequisites for improving human knowledge and AI. In conclusion, it is fundamental to focus on the new job, the lecturers perform on students' learning as this may be quite demanding and tasking. It would require some level of intuition, creativity and

ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

adaptability which cannot be performed by computers.

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