| **RESEARCH ARTICLE**

Transformative Pedagogy towards Using Internet of Things in Teaching English at King Khalid University Context from Digital Native Perspective

Dr. Elsadig Ali Elsadig Elnadeef
Assistant Professor, English Department, College of sciences & Arts- Dhahran Aljanoub, King Khalid University, Saudi Arabia
Corresponding Author: elnadeef@kku.edu.sa, **E-mail**: eelnadeef@kku.edu.sa

| **ABSTRACT**

This study aims to investigate the greatest efforts exerted by the English Language Center at KKU to transform the traditional teaching style based on teacher-centeredness to student-teaching centeredness using the Internet of Things. The study entails the role of using the Internet of Things (IoT) to improve the quality of teaching English at the English Language Center at KKU and cope with the rapid change among digital natives. This study adopts a descriptive-analytical method, and the main instrument used for collecting data is a questionnaire for teachers to investigate the use of the Internet of Things in teaching English. The study's findings have revealed that using and implementing the Internet of Things in teaching the English language Center at KKU context maximizes teaching quality and grasps learners' awareness and interactivity. Furthermore, it enhances inquiry learning based, flipped class or blended class and autonomous learning. The study recommends implementing the Internet of Things in English classes at KKU.

1. Introduction

Education is connected to the environment from which a student is getting an education; digital age students are connected to technology which has helped in elevating the quality of education. One of the most impactful aspects of technology is the Internet of Things (IoT), which extends internet connectivity into physical devices and everyday objects. This entire system is dotted with effective hardware, electronics and internet connectivity. King Khalid University, a pioneer university in Saudi Arabia, launched training sessions and knowledge dissemination on digital transformative on the Zoom platform between 11/13/2022 and 24/11/2022. The goal of Information Technology Administration at KKU is to disseminate knowledge and information on Digital Transformation, particularly because KKU is one of the universities which premises that the major role of KKU is to construct knowledge copying with rapid life development from various social perspectives, disseminate and distribute knowledge through the teaching process, research conducting and inculcating constructive consciousness among its staff, students, non-academic staff and community; provide societal service to the community through linking KKU with community needs in regard to sustainable development. However, KKU's plan is to develop pedagogical aspects through transformative pedagogy with consideration to quality, digital progress, students' needs in terms of customization, the economy of knowledge perspective and vision for 2030 in terms of sustainable development. As a result, English Language Center at KKU aims to foster the teaching of the English language in an Intensive English Course Program from a pedagogical perspective, technological perspective, interpersonal communicative aspect, the vision of 2030 aspect and economy of knowledge perspective. English Language Center at KKU considers the rapid change in global human life seriously and endeavors to do its best to follow the rapid global progress to provide a superb educational service to KKU's students. Moreover, English Language Center at KKU coordinates with other administrational units at KKU, departments at KKU and local or international universities to follow the rapid progress in the sphere

of education, teaching and learning. This study aims to investigate the greatest efforts exerted by the English Language Center at KKU to transform the traditional teaching style based on teacher centeredness to student teaching centeredness using the Internet of Things.

2. Literature review
The Internet of Things (IoT) currently plays a role in the education industry in terms of the connectedness and intersection between the relevant stakeholders. The Internet of Things (IoT) plays a salient role in promoting education, and it is one of the most important goals in the Sustainable Development Goals in developing quality assurance for the future of students and sustainability in education (Martinez et al., 2021). The application of the Internet of Things has a positive impact on learning excellence because it provides students better access to everything from learning materials to communication channels and gives teachers the ability to measure student learning progress in real-time. Furthermore, the application of the Internet of Things in the education system plays a vital role today because it connects learning to web-based sites that include many videos, assessments, animation, and other material to help the learning process, which can help students gain a broader perspective on new things through better understanding and interaction with their teachers and peers (Sharples, 2005).

2.1 Internet of Things (IoT) and Digital Native
The Internet of Things (IoT) is referred to as a system of digital and mechanical machines that are interconnected with each other and have a common link with computing devices and objects, as well as people who are equipped with unique abilities identify to transfer [1]data over the network where the interaction human to computer or human-to-human is not required. Furthermore, on the internet of things, all things connected to the internet can be put into three categories, including (1) Things that collect and send information, (2) Things that receive information and act on it, (3) Things that do both (Ashton, 2009).

The Internet of Things (IoT) is any network of devices connected to the internet to exchange information, collect data, or control processes. There are nearly limitless options for IoT-connected devices, and IoT is utilized in many different industries (Graf, 2008). IoT connectivity allows for greater control over environments and processes, and its networks offer customization and automation options that simply are not available when devices are not interconnected. IoT devices connect to the internet and transmit data, and its devices include smart building technology, such as smart lighting, locks, thermostats, speakers, doorbells and more. Once IoT devices are installed, they can be connected and controlled centrally using a computer, tablet or cell phone (Sharples, Taylor and Vavoula,2005).

The term 'digital native' was coined in 2001 by the US author Marc Prensky1. In his article "Digital Natives, Digital Immigrants", Prensky defined digital natives as young people who grew up surrounded by and using computers, cell phones and other tools of the digital age. A digital native is a person who grew up in the presence of digital technology or in the information age. Having grown up in IT's presence, digital natives are comfortable with and fluent in technology. The term contrasts with people who were born before the digital age, who may have more difficulty and be hesitant about learning how to use new technology (Ellen and Rebecca, 2010). Digital natives grew up with the technology that, by and large, became fundamental to social, educational and professional lives. For example, social media has provided new ways to socialize, and online courses have provided new ways to learn. Skill sets were formed in job searching through being familiarized with digital technologies and being adaptable to new digital interfaces, not to mention how communication technology has evolved since communicating through text messages (Erika E,2012).

2.2 Application of the Internet of Things in Education
The Internet of Things (IoT) is a relatively new technology that has changed educational systems by improving learning outcomes, providing more affluent learning experiences, increasing operational efficiency, and gaining real-time, actionable insight into student performance. By implementing IoT-based smart facilities in universities, the environment can be completely transformed. Using IoT technologies can improve the overall facilities. Smart classrooms, smart laboratories, and smart buildings are all part of the plan for a digital campus. To manage these devices and systems, various applications can be developed (Martínez, Trillo-Lado, Blanco, Cambra and Casas, 2021). The demand for higher educational institutions to digitize all contents and events is growing as technology advances. Their main goal is to adopt methods that enable academic and research-related members to work effectively in a digital environment [2] (Ashton, 2009). IoT in education refers to implementing smart IoT solutions in educational environments

---

[1] *As for Big Data, it is information that refers to a diverse and extensive collection of information that is growing at a very increasing rate. In this case, Big data comes from different sources and in various formats. Big data can be classified into structured or unstructured data. Structured Data includes information managed in a database or spreadsheet by an organization; the nature of this data is numerical. Unstructured data is unstructured data that is not included in a predetermined format or model, and the information is not organized. In addition, unstructured data is data collected by social media sources that allow organizations to determine customer needs. Moreover, Big Data can be collected from comments shared through websites or social media, then collected through questionnaires, electronic check-in, and product purchases. Big data is usually stored in computational databases and software that can be analysed (Cui., 2016).*

[2] *A digital university base can be created by combining a physical campus with technology, which provides appropriate settings and services for training, learning, and research. It supports and motivates students to achieve their full potential. A university's digital campus must have technology that supports teaching, education, and*

like schools and colleges. IoT developers have facilitated the shift in teaching approaches from traditional to digital. Notably, students can learn all the subjects, from languages to medical sciences, through graphics and animation. In other words, IoT is helping education to become practical and expand beyond classrooms. Applications of IoT in education have managed to make education and the exchange of information simple, interesting and interactive. With smart boards, a teacher can take a sigh of relief. Infographics, tutorial videos and complex formulae be it for any subject, especially mathematics, could be solved in shorter time frames (Wynn, 2009). Gómez, Huete, Hoyos, Perez and Grigori(2013) enlist the application of the Internet of Things in education as:

1. Smart Boards[3]: The current day students enjoy smart boards way more than blackboards. Smart boards are interactive whiteboards that project subject images. It enables the teachers and students to interact with it. Smart Boards enable the teachers and students to interact with them by simply writing on them or moving them around the class (Jenkins,2009).

2. Attendance-digitalized: Different education institutes have different sets of rules. Some believe that a certain percentage of student attendance is mandatory to allow them to take the examination. With IoT, the management can pull out accurate data on attendance. That data remains free from human error. With IoT based attendance system, calculating student attendance and generating regularity, punctuality and personality reports becomes effortless. The amount of time it saves will tremendously affect employee satisfaction working for the institute. Additionally, to make students more regular in their classes, IoT in education made sure to digitally register the student's attendance. If the student is missing from the institute, a quick electronic message will go to the parents. This is quite a laudable measure of safety that has been taken (Van, 2000).

3. Significant Safety-classroom: Emergency indicators, audio enhancers, Wi-Fi clocks and hearing-impaired notifications are tangible forms that generate security. In any case, there is a short circuit in the institute. The IoT sensors will immediately detect it and will send out an instant alert to reverse the situation. If someone gets stuck in the lift, then an 'automated' real time alert will also be sent. On an environmental note, the significant impact of globalization can be seen in several forms on earth. The chances of earthquakes and sudden and fatal weather changes have become common. This is why schools and other institutes of education are investing in IoT sensors and meters to call it a day or a holiday if any danger of a natural calamity gets detected (Jones, (2019).

4. Adjusting Disability: it was difficult for disabled children to learn and reflect on new things. Learning new things and performing just like any other abled student has become possible with modern technological designs. A part of the population has challenges to the sense of hearing. They can seek help from a system of connected gloves and a tablet to generate verbal speech translated from sign language. Its excellence in converting sound into written language is noteworthy.

5. Mobile Applications and Tablets: Modern students seem to revolve around smartphones, tablets and other screen-oriented electronics. The sensors of the Internet of Things in education collect data and automatically suggest academic topics of interest to the students sitting on the other side of the screen. Smartphones and tablet usage has been made beneficial for the student's grades almost overnight

The implementation of the Internet of Things (IoT) gives education professionals new tools to optimize classwork, improve the efficiency of the learning process, connect with students better, and ensure on-site safety. Andrew (2014) enlists the benefits of putting the Internet of Things and education into a unified framework:

-Improved school management efficiency: Managing an education institution requires filling in a lot of paperwork, keeping track of supply management, and distributing funds properly. IoT solutions lay the groundwork for a faster, risk-free, and interconnected decision-making framework where all the stakeholders (teachers, students, parents, and public officials) are engaged in improving the state of the facility.

-Real-time data collection: IoT allows processing terabytes of data simultaneously, opening a lot of applications for schools and colleges — safety tracking, student progress monitoring, overseeing the professional training of teaching specialists, and many

---

collaborative research. All digital universities face challenges, but only a few have the vision to develop a strategy and put it into action using cutting-edge technology (Daniels, Gregory, Cottom, 2015).

[3] *Classrooms with electronic interactive white boards provide a richer and more consistent learning experience for students and teachers throughout the course of their studies, making it easier to share, add, and edit content with students while bringing online content to support classroom discussions on the fly. Students are encouraged to bring their own devices to class (laptops, tablets, phones, etc.) so that they can complete their classwork and assignments. This enables students to take their classroom work home with them, allowing them to review and reinforce concepts during their free* time(Ellis, (2009)..

more. Ministries and principals could use real-time data to improve the efficiency of testing and grading or when looking for new ways to improve classroom engagement.

-Improved resource management: IoT in education helps establishments run more efficiently, reducing operating and storage costs in the long run. Additionally, facility managers can employ connected IoT devices for education to ensure energy or water consumption efficiency.

-Global interconnectedness: The global nature of IoT helps education professionals create uniform teaching standards and ensure equally efficient school and college training worldwide. The Internet of Things can support global peer-to-peer professional training tools, where educators worldwide can exchange tips and best practices. Students, on the other hand, will be able to share learning materials internationally, improving the accessibility of education all over the world (Connolly, 2001).

-Addressed safety concerns: The Internet of Things has an array of security applications schools, colleges, and pre-schools could benefit from. Among them are on-demand video-monitoring tools, student escort drones, smoke and vaping sensors, etc. These platforms bring parents and students more confidence in the safety of their learning environment, help promote positive habits and make it easier for facility managers to keep the institution in order.

2.3 The Challenges of IoT in Education
The Internet of Things helps to improve education by making classrooms smarter. The rapid advancement of global computing and Internet of Things (IoT) technology, such as cloud computing, big data, and analytics, helps to illuminate the importance of training and research quality. It also affects society and promotes a new digital philosophy. Every day, the number of online classes and degree programs grows exponentially. It increases the digital momentum in educational institutions, particularly in higher education. Educational institutions may face a number of challenges in integrating IoT devices on campus, including (Neal, 2010):

-With the integration of mobile learning apps for student evaluation, the use of various IoT-based applications is growing. Students can use these common applications to learn resources, cope with assignments, and work on projects. Teachers use other apps to demonstrate technical concepts, simulations, and other activities.

-IoT provides incredible opportunities for delivering digital courses while maintaining instruction quality. Students' differing ethics, academic honesty, plagiarism, and data fraud in scientific societies are highlighted in this digital instruction. As a result, IoT-based educational applications, tools, and technologies for teachers and scientists are being developed to improve research and address ethical issues in higher education institutions.

-The use of e-learning management systems such as Blackboard and Moodle generates a lot of audio and video data. Students can access this data when they need it in IoT-based classrooms and labs equipped with the latest equipment for lecture recording and web streaming. IoT must provide extra agile and firm service level agreements to handle this data during online courses.

-High implementation cost: Implementing[4] IoT solutions for education requires significant hardware and software power. To deploy a custom platform or a connected device, public offices or school principals must hire a robust

tech team skilled in software development, data science, and other fields. Hardware license fees and maintenance costs are other factors that increase the cost of an IoT product. Unfortunately, not all publicly funded schools can afford such expensive innovations and design custom IoT solutions.

-In-class ethics: Before implementing global IoT-based data sharing systems, the worldwide tech community needs to design a framework for fighting fraud and ensuring all shared data is tamper-proof.

-Lack of data processing infrastructure: When implementing IoT solutions, public office workers and educational facility managers must choose a reliable computing platform and data tools. The on-premises infrastructure some institutions adopt for data storage is likely too outdated and unstable to empower connected IoT-based solutions.

-[5]Security and privacy concerns: Collecting and processing various forms of digital data will put educational institutions on the map for hacking threats. Before deploying an IoT solution, project stakeholders need to build a contingency plan for data breaches,

---

[4] *One important aspect of the internet is the Internet of Things (IoT). It enables internet connectivity to physical devices and objects. Additionally, students can learn new skills, practice arts, and find resources for their homework on the internet. At the same time, teachers also benefit from IoT training to enhance their teaching methods. In developing big data and IoT technology in education, the prominent role of all stake-holders, from policymakers to students, is needed to make it progressive and sustainable in the future.*

[5] *It is possible to monitor students' activities using the institute's portal. IoT sensors can collect data and offer a personalized learning plan. Further, they can also suggest the topics or resources which might help the students. IoT will also benefit teachers by tracking whether their students have completed the assessments. Additionally, IoT can track learners' progress and notify the concerned authorities if they face any issue in a particular topic. To prevent misuse of internet facilities, schools can employ WiFi*

security attacks, and other threats. Increasing awareness regarding the importance of data security among students is essential to the innovation implementation process.

3. The Purpose of the Study

Internet of Things (IoT) assists in forming a digital campus system serving as an important platform for students to access a variety of resources, and it helps personalized education, which is a student-centered teaching approach allowing students to personalize their learning activities by allowing them to work at their own pace, in their own style, and under their own conditions. The Internet of Things improves English teaching quality by integrating technology into learning and teaching processes. Pedagogically students construct a lot of data every day coming from different sources, and some instructors use SNAPP (Social Network Adapting Pedagogical Practice) at the same time in their teaching process also contribute by which they can measure how interested the student is in a particular course (Baharia & Dawson, 2011). LMS (Learning Management System), which was implemented in teaching English at KKU, helps instructors create tests and assignments using existing information automation. These implementations are an advantage of IoT in the education system because this system generates a lot of data that keeps all parties and the educational process updated (Adzharuddin and Ling, 2013). Through IoT, some institutions and schools offer their teachers and staff flexibility to work from home (hybrid), which means that the physical presence of teachers and staff is not mandatory and using remote systems, people can work from home (Maspul and Amalia, 2021b).

Citing the above statements, the researchers intend to investigate the greatest efforts exerted by the English Language Center at KKU to transform the traditional teaching style based on teacher centeredness to student teaching centeredness using the Internet of Things by answering the following questions:

1- To what extent can the Internet of Things promote teaching the English language as an intensive English course at KKU?

2- What are the English teachers at KKU's perceptions towards the implementation of the Internet of Things in teaching English at KKU?

3- Can the Internet of Things transform the teaching English approach from teacher-centred based towards student centered based, inculcating autonomous learning culture?

4. Methodology

4.1 Participants

The study sample was chosen from male and female English language instructors working for KKU who teach the English language at English Language Center. The total number of chosen instructors are 50 instructors ranging from associate professor, assistant professor and lecturer with experience ranging between 4 years to 9 years teaching the English language as an intensive English course at English Language Center at KKU.

4.2 Instrument for Data Collection

The data are collected through the questionnaire from fifty respondents who teach the English language at English Language Center. This questionnaire consisted of a transformation of the qualitative (nominal) variables (Strongly agree, Agree, undecided, Disagree, strongly agree) to quantitative variables (5,4,3,2,1) respectively; also, the graphical representation has been done for this purpose. The statements in the questionnaire have been analyzed in terms of frequencies and percentages. The questionnaire includes three categories to support the questions s of the study.

4.3 Procedure

The study is based on a descriptive analytic approach, and SPSS version 28 was used for the analysis. The questionnaire was distributed to the participants electronically, and Cronbach's alpha was used to measure the reliability of the questionnaire`s items, which is .801, indicating high internal consistency.

5. Results

5.1 The Analysis of the Teachers' Questionnaire

5.1   Statement (1): The Internet of Things can promote teaching the English language as an intensive English course at KKU.
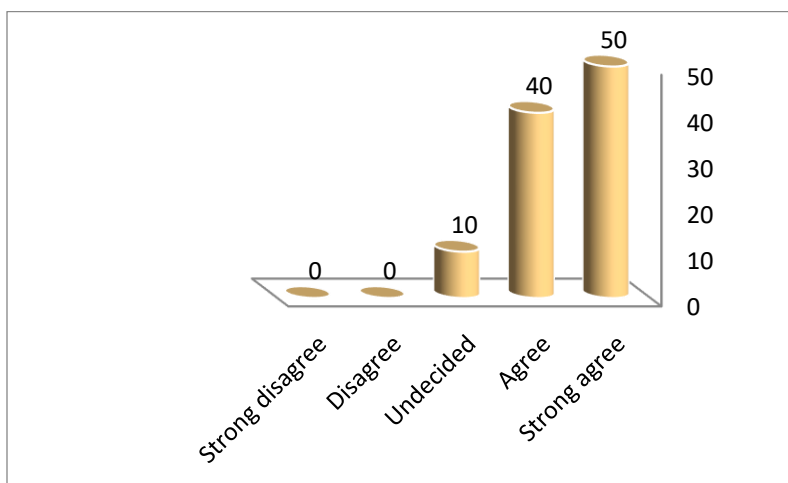

Table (5.1): The Internet of Things can promote teaching the English language as an intensive English course at KKU.

Answer	Number	Percent
Strong agree	25	50.0
Agree	20	40.0
Undecided	5	10.0
Total	50	100.0

Figure (5.1): The Internet of Things can promote teaching the English language as an intensive English course at KKU.
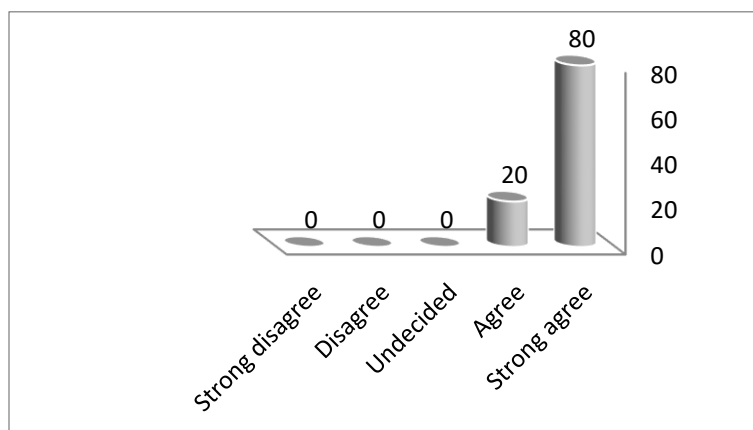

It is clear from the above table and figure that there are (25) respondents in the study's sample, with a percentage (50.0%) strongly agreeing with the statement. There are (20) respondents with a percentage (40.0%) who agreed on that and (5) respondents with a percentage (10.0%) who have undecided about that. This indicates that most respondents support the statement.

5.2 Statement (2): English teachers at KKU's perception towards the implementation of the Internet of Things in teaching English at KKU is positive.

Table (5.2): English teachers at KKU's perception towards the implementation of the Internet of Things in teaching English at KKU is positive.

Answer	Number	Percent
Strong agree	40	80.0
Agree	10	20.0
Total	50	100.0

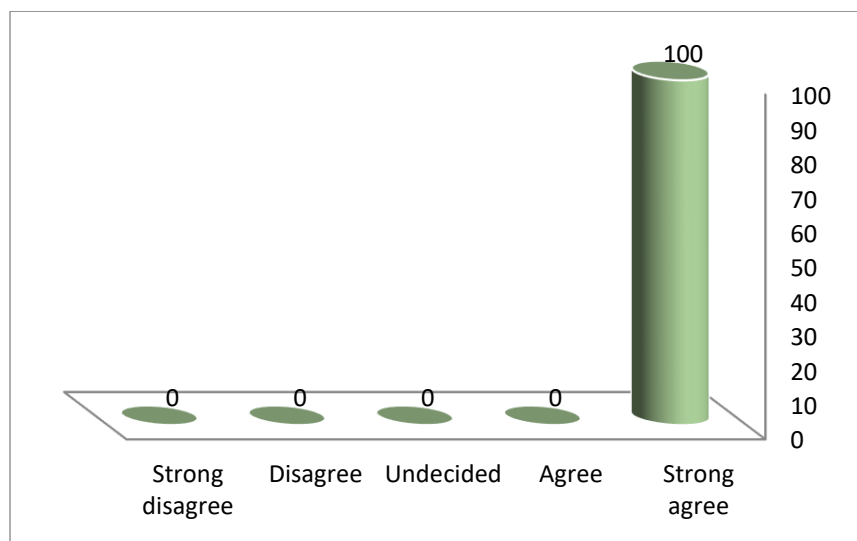Figure (4.2): Multimedia and students' motivation.

It is clear from the above table and figure that (40) respondents in the study's sample, with a percentage of (80.0%) strongly agreed with the statement. There are (10) respondents with a percentage (20.0%) who have agreed on that. This indicates that the majority of the respondents support the statement.

5.3. Statement (3): The Internet of Things can transform the teaching English approach from teacher centred based towards student centered based, inculcating autonomous learning culture.

Table (5.3): The Internet of Things can transform the teaching English approach from teacher centered based towards student centered based, inculcating autonomous learning culture.

Answer	Number	Percent
Strong agree	50	100.0
Total	50	100.0

Figure (5.3): Computer-based lessons are more effective than traditional lessons.

It is clear from the above table and figure that there are (50) respondents in the study's sample, with a percentage (100%) strongly agreeing with the statement.

5.4 The result of the Chi-square test
The Questions of the Study

Table (5.4) Internet of things promote the digital teaching of Unlock at KKU

No	Statements	Median	Result
1	The Internet of Things can promote teaching the English language as an intensive English course at KKU.	10	Agree
2	English teachers at KKU's perception towards the implementation of the Internet of Things in teaching English at KKU are positive.	50	Strongly Agree
3	The Internet of Things can transform the teaching English approach from teacher centered based towards student centered based inculcating autonomous learning culture.	5	Undecided

Table (5.4) has shown that

Statement One:

The calculated value of the median for the respondents' answers to the first statement is (1). This value means that most of the respondents agree that the "Internet of Things can promote teaching the English language as an intensive English course at KKU.".

Statement Two:

The calculated value of the median for the respondents' answers to the second statement is (2). This value means that most of the respondents strongly agree that "English teachers at KKU's perception towards implementation of Internet of Things in teaching English at KKU are positive".

Statement Three:

The calculated value of the median for the respondents' answers to the third statement is (3). This value means that most of the respondents are undecided that the "Internet of Things can transform teaching English approach from teacher centered based towards student centered based inculcating autonomous learning culture."

6. Discussion
The first question in this study examines if the Internet of Things can promote teaching the English language as an intensive English course at KKU. The results of the study show that English instructors agree. This finding goes in align with Martínez, Trillo-Lado, Blanco, Cambra and Casas et al. (2021). This indicates that implementing IoT in the educational sphere can promote teaching English quality.

The second question in this study examines if English teachers at KKU's perception towards the implementation of the Internet of Things in teaching English at KKU are positive. The results of the study show that English instructors strongly agree. This finding aligns with Gómez, Huete, Hoyos, Perez and Grigori et al. (2013). This indicates that most English teachers' perceptions towards implementing IoT are positive, and they believe that digital learners need to construct a digital learning environment.

The third question in this study examines if the Internet of Things can transform the teaching English approach from teacher centered based towards student centered based, inculcating autonomous learning culture. The results of the study show that English instructors are undecided. This indicates that the implementation of IoT is not guaranteed to transform the teaching English approach from teacher centered based towards student centered based, inculcating autonomous learning culture though this is the major goal of teaching in this digital age.

All in all, the study reveals that implementing IoT in teaching English can help develop teaching quality, stimulate learning, create a positive, safe environment, match the students' desires and needs and formulate positive interactivity.

7. Conclusion and Implication of the Study
Based on the above findings, implementation of IoT at the English Language Center is necessary to improve the English teaching language and to match the goals of KKU in its rapid quality and efficient progress to be one of the world lead universities. Hence, some tips can be stated:

- Internet of Things should be implemented at KKU, and English Language Center can be digitalized center.
- Computerized and device-based classrooms present an interactive platform for students that should be installed in English classes. In addition, mobile applications can be better used for teaching some topics as students can simultaneously access their textbooks and graphic, 3D visualizations.

- Immersive learning methods should be implemented at KKU to excite and motivate students to participate in group assignments and activities. Also, they can scan barcodes available in textbooks to revise through digital content.

- English instructors should be trained professionally through computerized tools and IoT training to make learning immersive and fun for students. Besides accessing the course content through barcodes, students can better grasp the concepts through graphics and sounds.

- KKU should use IoT-based systems to store and distribute data in specially designed applications. With the help of special software, students from around the globe can sign in for distance learning programs.

- English Language Center at KKU should activate barcode-based systems or biometric attendance, which can save a lot of time while generating regularity and punctuality reports. Additionally, IoT can mechanically notify the parents if their ward is absent from the lecture.

Publisher's Note: All claims expressed in this article are solely those of the authors and do not necessarily represent those of their affiliated organizations, or those of the publisher, the editors and the reviewers.

References

[1] Al Zidjaly, N. (2012). Scollon, Ron. The encyclopedia of applied linguistics. London: Blackwell. https://doi.org/10.1002/9781405198431.wbeal1043.

[2] Andrew D. (2014). Great internet age divide is a myth, 2014, http://www.heraldscotland.com/news/education/great-internet-age-divide-is-a-myth.25672713

[3] Ashton, K. (2009). That 'internet of things thing. *RFID Journal, 22*(7), 97-114.

[4] Connolly, P. J. (2001). A standard for success. InfoWorld, 23(42), 57-58. EDUCAUSE Evolving Technologies Committee (2003). Course Management Systems (CMS). Retrieved 25 April 2005, from http://www.educause.edu/ir/library/pdf/DEC0302.pdf

[5] Cui, L., Yu, F. R., & Yan, Q. (2016). When big data meets software-defined networking: SDN for big data and big data for SDN. *IEEE Network, 30*(1), 58-65.

[6] Daniels, J., Gregory, K. and Cottom, T.M (2015). Digital Sociology MiniConference, organized in conjunction with the Eastern Sociological Society meetings, February 27–28. http://digsoc.commons.gc.cuny.edu/conference-papers-2015/

[7] Ellen J and Rebecca E (2010). Digital natives: where is the evidence?, *British Educational Research Journal*.

[8] Ellis, R K. (2009). Field Guide to Learning Management, ASTD Learning Circuits, archived from the original on 24 August 2014, retrieved 5 July 2012

[9] Erika E. S (2012). The Digital Native Debate in Higher Education: A Comparative Analysis of Recent Literature. *Canadian Journal of Learning and Technology*.

[10] Gómez, J., Huete, J. F., Hoyos, O., Perez, L., & Grigori, D. (2013). Interaction system based on the internet of things as support for education. *Procedia Computer Science, 21*, 132-139.

[11] Graf, S. (2008, November). Adaptivity and personalisation in ubiquitous learning systems.In Symposium of the Austrian HCI and Usability Engineering Group (pp. 331-338).Springer, Berlin, Heidelberg.

[12] Jenkins, H (2009). Confronting the Challenges of Participatory Culture: Media Education for the 21st Century (PDF). Cambridge, MA: The MIT Press. Archived from the original (PDF) on 2013-12-03.

[13] Jones-Kyle M. L. (2019). Learning analytics and higher education: a proposed model for establishing informed consent mechanisms to promote student privacy and autonomy. *International Journal of Educational Technology in Higher Education. 16* (1): 24. doi:10.1186/s41239-019-0155-0. hdl:1805/21571. ISSN 2365-9440. S2CID 195766461.2021 LMS Data Spring 2021 Update, 2021.

[14] Martínez, I., Zalba, B., Trillo-Lado, R., Blanco, T., Cambra, D., & Casas, R. (2021). Internet of Things (IoT) as Sustainable Development Goals (SDG) Enabling Technology towards Smart Readiness Indicators (SRI) for University Buildings. *Sustainability, 13*(14), 7647.

[15] Sharples, M., Taylor, J., & Vavoula, G. (2005, October). Towards a theory of mobile learning. In Proceedings of mLearn.

[16] Wynn, J. (2009) Digital sociology: emergent technologies in the field and the classroom. *Sociological Forum, 24*(2), 448--456

[17] Van-Lier, L. (2000). From input to affordance: social-interactive learning from an ecological perspective. In J. Lantolf (ed.) Sociocultural theory and second language learning. Oxford: Oxford University Press, 245–259.