Enhancing student concentration in distance learning: The role of IoT sensors in Kazakhstan higher education institutions

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Abstract

Relevance. The relevance of IoT sensors in various public spheres, including education, has grown significantly, particularly in the context of distance learning which has introduced new challenges and needs for both students and educators.

Purpose. This study aims to analyse how IoT technologies impact the educational process by enhancing students' concentration.

Methodology. Methodologically, the study employs analytical, synthetic, deductive methods, alongside functional and systemic approaches.

Results. The theoretical exploration covers IoT sensors, pedagogical methods, and student concentration, while the practical aspect focuses on specific approaches to utilizing IoT sensors to improve student concentration during distance learning. The findings demonstrate that IoT sensors play a crucial role in enhancing student concentration in educational settings.

Conclusions. The study contributes theoretical insights into IoT sensors and pedagogical methods, as well as practical strategies for their effective implementation. This research underscores the potential of IoT technologies to enhance educational quality, offering valuable insights for curriculum development and future research in this field.

Keywords: distance learning; digitalization; educational process; Internet of Things; academic performance monitoring.

Introduction

When analysing issues related to the application of Internet of Things (IoT) technologies and tools, it should be noted that they are undoubtedly developing extremely quickly and are being integrated into the modern life of society. Undoubtedly, this applies to Kazakhstan too, since it is quite actively implementing the state program “Digital Kazakhstan” and several other plans that provide for the introduction of information and communication technologies in the leading areas, based on which the state functions. Thus, this also applies to the educational environment, in particular, higher education institutions.

At the same time, this issue gained particular urgency during the period from 2019 to 2021 characterised by the implementation of quarantine restrictions, due to the spread of acute respiratory disease “COVID-19”. Hence,

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the learning process has and continues to be implemented in some educational institutions remotely, which in turn causes a number of changes and needs to be reformed. It is through IoT tools and approaches that higher education institutions have the opportunity to provide smooth and effective learning activities to students, while improving their results. In addition, such technologies can improve the level of educational and professional training that students receive and also help them to realise their success in practice [1].

It should be also understood, that IoT technologies, in particular sensors, will significantly improve and modify the organisational structure of higher education institutions, especially improving students’ understanding of educational material by changing the way it is received and processed. Moreover, an important feature of such sensors is that they can be used in the implementation of educational and vocational training of students in different specialties, and even at any educational level. This demonstrates their versatility and their priority for use by higher education institutions [2].

Thus, it can be argued that IoT tools allow teachers to successfully carry out pedagogical activities both in full-time and distance formats. At the same time, special attention should be paid to the fact that these technologies allow remote control of certain subjects, in particular on the basis of the formed network infrastructure, both within a particular educational institution and within a range of higher education institutions. Moreover, by providing students with the opportunity to integrate their professional activities into computer systems, there is an overall increase in efficiency, which in turn is reflected in the future both social and economic development of the state. In addition, IoT technologies in training are used to a greater extent in the form of sensors and actuators, which certainly allows them forming a complete cyber and physical mechanism, the structural elements of which include a number of different technologies, in particular smart grids, smart imagery, intelligent platforms, integrated learning programmes and materials, which altogether form an intelligent and innovative education [3].

Hence, it can be established that in an environment, in which students lose the necessary concentration on the learning process, it is the use of IoT technologies that is a priority approach. This is due to the fact that they allow a combination of the necessary techniques and directions usually used by teachers during traditional teaching. Nevertheless, the advantage of exactly IoT sensors is that during their implementation there is simultaneously visualisation of learning material, development of dialogical learning activities, elaboration of practical foundations of future professional activities, and the improvement of the entire educational environment, which in turn is reflected not only in the knowledge levels of students, but also in the level of professional and educational training provided by Kazakhstani higher education institutions [4].

Therefore, the main objective of this paper is to identify priority approaches regarding the effective implementation of distance learning, in particular ensuring proper concentration of students’ attention, through IoT technologies, in particular sensors. For this purpose, the study has accomplished a number of tasks, including establishing the theoretical meaning of the main terms that form the object of study; considering their properties and specific features; investigating the main benefits of using IoT sensors in higher education institutions during distance learning; establishing the relationship between the improvement of students’ attention span and IoT technologies [5].

Materials and Methods
The topic of this study is not only extremely relevant today, but also multidimensional, as evidenced by its substantive content. Accordingly, the educational environment and the introduction of modern technologies to it requires qualitative approaches to the research of such technologies and the analysis of their effectiveness. This study focuses more on IoT sensors, with the help of which it is possible to increase the level of concentration of students in higher education institutions of Kazakhstan. In order to realise this goal, it is necessary to apply different methodological tools in order to investigate each of the elements of the topic under study in depth.

The first thing to review is the functional approach, which is more of an organisational approach. This can be seen in the fact that its role was important in determining the plan for carrying out the work and setting the purpose and objective of the work. Additionally, through the functional approach, the whole process of conducting the study was divided into three stages, which certainly allowed for a clear and in-depth exploration of all the elements important for the work of the issue under study. The systematic methodological approach was also of great significance and was responsible precisely for its internal and substantive part. This can be seen in the fact that it was due to it that all the methodological tools used were arranged in a logical order, according to the results of some, based on others. Hence, the study has got it perfect form, as its theoretical and practical parts were interlinked and complementary to each other.

It should be emphasised, however, that the general methods of scientific research played a particular role in achieving the aim and objectives of the study. In particular, the method of analysis and synthesis was fundamental to the study, as it was on the basis of these methods that the main results, both practical and theoretical, were obtained. Accordingly, the method of analysis allowed to divide the general issue under study into several, already content-based, elements, among them, IoT sensors and a student concentration. In addition, not only their theoretical content was studied, but also the properties and features identified in the course of their interconnection. As for the synthesis method, it allowed identifying the main attributes and specific features arising from the implementation of IoT technologies in the educational environment based on the obtained theoretical results. Moreover, it has been used to examine the dependence between these categories and the necessary conditions for their effective cooperation.

In addition, the method of deduction was used to form a logical structure in the study. This is manifested in the fact that the course of the research unfolded in the direction from the general to the specific. Thus, at the beginning of the article, the general theoretical concepts and their features were considered, which allowed to define the object of research. At the same time, based on the results
obtained, they were somewhat concretised, in particular, the direct role of IoT technologies in the educational process and in the teacher’s work with students, in particular, in enhancing the concentration of the latter.

The study was carried out in three stages:

1. The first stage defined the organisational framework, in particular the work plan, the aim and the objectives of the study. In addition, a theoretical analysis of the topic under study was initiated.

2. In the second stage, the issue under study was specified and the main goal of the paper was achieved. In doing so, the direct role of IoT sensors in enhancing student concentration was identified.

3. The third stage structured the conclusions based on the obtained results.

Results

The Internet of Things has undoubtedly had quite a pronounced impact on the leading and most promising areas of public life in recent times. Education, of course, belongs to this system, since it plays an important role in the development of the state and levels of its competitiveness in the international arena. This is reflected in the fact that more and more higher education institutions in Kazakhstan are introducing IoT technologies into their activities; moreover, they are successfully co-operating with other innovative tools, while forming an integral ecosystem. As a rule, this is happening gradually, in particular starting with the application of elements that enable the extension of reality, to full-fledged cloud computing and management.

On this basis, it must be agreed that through such cooperation, IoT tools, including sensors, allow for a fairly rapid, and most importantly, effective improvement of the physical educational environment, while making it intelligent and interconnected. Thus, as a rule in pedagogy, IoT is reflected as such things, as an extended smart classroom equipped with augmented reality elements, digital tools, voice command system, and several others with the help of which teachers can not only organise the learning process, but also control and modify it. The fact that these technologies are extremely dynamic deserves special attention, which is certainly an advantage, as they allow higher education institutions to respond to societal changes in a timely manner and provide educational services at a high level.

It was this condition that was a priority in the choice of approaches and tools for organising the educational environment in a distance learning mode. Accordingly, the optimality of the IoT was in the speed of reforming the learning process and its success in organising remote work. At the same time, another issue subsequently came up, regarding the regulation of a number of indicators necessary for successful learning activities, one of which was the level of student concentration on the learning process.

Concentrating learners’ attention is a property of attention, which is the focus of consciousness, concentration, an increase in the level of sensory, intellectual or motor activity to retain information about a particular object in short-term memory and to the intensity of communication with it. In other words, the concentration of learners’ attention implies the emergence of a temporary center of human psychological activity. In order to determine directly the role and application of IoT sensors to enhance such an indicator, it is necessary to study their essence and properties. This theoretical analysis is very important, as it will make it possible to identify promising aspects of such a tool and determine effective directions for its implementation directly in the context of student concentration [6].

Hence, first of all, the essence of the IoT should be explored in order to understand its main benefits, particularly in an educational environment. Thus, the term “Internet of Things” or “IoT” was formulated and established in 1999. Undoubtedly, it has gained main demand during the last ten years. This is due to the widespread adoption of innovative technologies and the global digitalisation that has characterised every developed nation. Therefore, the concept is about the interaction of different objects from which technology emerges and is realised, being able to communicate with each other and with the physical environment.

Based on this, it can be established, that its essence is revealed in the performance by various devices of a certain series of actions and functions, without involving human beings. Accordingly, in general, this category is in contact with a multitude of elements with which mankind interacts on a daily basis. Among them, a set of devices can be distinguished, in particular in housing, in transport, and in the workplace, which, primarily by equipping IoT technologies, can satisfy the interests of the individual. This is reflected in the fact that these elements are empowered with the ability to process information and to analyse it, compare it with each other, and, based on the algorithms formed, to make decisions and implement a set of fixed actions [7].

Concretising this notion and reviewing it within the field of education, it can be established that it is aimed at its comprehensive development. This includes both students and teachers. In particular, IoT sensors are used to optimise the learning process, thus improving the level of professional training of students. At the same time, these technologies are characterised by a number of features that allow not only an in-depth consideration of their theoretical foundations, but also identify the benefits during practical implementation. Thus, attention should be paid to the fact that the introduction of IoT technologies will increase accessibility and reduce the cost of training.

At the same time, the IoT allows the modernisation of the educational environment, making it more versatile, with a combination of the individual characteristics of a particular study group, if necessary. It should be understood that IoT sensors encompass a set of features that are not limited to learning activities, but also make it possible to influence the safety of the learning process and the psychological emotional state of the student. Thus, IoT sensors can be considered quite multidimensional, as evidenced by the extensive scope of their capabilities.

Accordingly, higher education institutions that base their activities on digital and information technology are characterised by greater academic performance and popularity among students. This factor indicates that their development and implementation allow for a gradual increase in the level of educational services in each higher education institution in Kazakhstan. This priority is
revealed in the fact that teachers using IoT technologies can influence both the quality of the learning process and the success of their communication with students. Accordingly, through such sensors, they can independently analyse the level of knowledge and training of students and their personal characteristics, in particular their concentration on the learning process. In this way, the educational IoT makes it possible to monitor students’ remote activities, their academic performance and their concentration in learning [8].

This approach has become particularly relevant during the implementation of distance learning. This is due to a range of problems caused by a dramatic change in social relations and the introduction of global quarantine. Accordingly, higher education institutions have faced a system of slowing down obstacles and reducing the quality of the educational services provided. These factors can be divided into external and internal factors that have a complex impact on students’ learning activities. Accordingly, the external ones include epidemiological conditions and restrictions on student attendance at higher education institutions. As for the internal ones, they were mostly composed of human potential, in particular, the readiness of the subjects of the learning process to change it drastically. Thus, the introduction of digital tools and innovative technologies, including IoT tools, was almost the only condition for the establishment and rapid recovery of the educational environment [9].

Hence, students were enabled to complete assigned learning tasks continuously and to attend lectures and seminars, including remotely, through video conferencing, in Skype, Google Meet, Zoom, or Teams. In addition, teachers were given the opportunity to generate training reports and other teaching materials, and also to assess students’ performance, in particular, monitor their progress. The L.N. Gumilyov Eurasian National University has created a website with sensors which recognises users when they log into the account, checks the user when taking an exam, and monitors the concentration of students when studying (Figure 1, 2). The study involved 100 students in SmartCity, Information-Computing Technologies.
Thus, IoT technology allows the entire educational environment to be qualitatively reformed too, even in the distance format. Consequently, students have to a certain extent been able to organise their own activities, both academic and research. In addition, they are able to organise and hold individual meetings both within the student circle and with professors. This demonstrates the mobility of the learning process, as they are able to receive learning material in several formats at once, whether text, audio, or even video. Moreover, IoT accounts for the rapid adaptation of teaching aids to the current societal context, as they are in electronic form and can be quickly edited. All of this demonstrates the priority that the IoT has for the educational environment and the development of the state as a whole. However, quality control of the student’s activities, namely their concentration on the learning process, remains an important issue [8].

Discussion
Having studied the theoretical structure of the paper, the specific aspects of the issue under study should be considered, in particular the analysis of the most effective practices of applying IoT technology in higher education institutions of Kazakhstan during distance learning. In addition, an important task in this part of the paper is to establish its role in the course of increasing students’ attention span. Thus, ten popular approaches consisting in the implementation of IoT sensors in the learning process can be considered.

First and foremost is the task-based learning method. Its essence is revealed in a radical change in the fundamental principles of teaching material delivery by teachers. Accordingly, the implementation of this process undoubtedly takes place at the expense of IoT, as its properties allow to comprehensively cover a number of thematic exercises and tasks. It accordingly changes the way lectures and other information are presented to students. In addition. It should be understood that this is the way in which the teacher can independently control the stage and dynamics of students’ mastery of the learning material.

Nevertheless, the main feature is that such learning activities clearly track the progress of each student in relation to a particular topic. In this way, the teacher can establish each student’s level of concentration according to the set learning objectives, moreover, individually select a set of exercises that would engage and motivate a particular student to learn. In doing so, it is possible to provide automatic feedback based on the Internet of Things, which is certainly an element of a significant importance in such studies. In addition, this kind of continuous monitoring allows the teacher to analyse the success of their chosen approach and tools, which is more reflected not only in the actual learning outcomes of the students, but also in the quality of their communication with each other and with the teacher during the training [10].

The next, quite common example of the application of IoT technologies in the educational process in higher education institutions of Kazakhstan, are smart classrooms. The presence of such classrooms is characteristic of 71% of universities, which indicates their effectiveness and priority for the development of both students and the entire educational environment. In general, their main feature is that they are equipped with modern digital technologies, allowing for the empowerment of all subjects of the educational process. As a rule, the scope and essence of such changes depend on the specific educational and professional direction of the student.

Accordingly, each of the specialties is characterised by a number of features that play an important role in the process of learning and acquisition of certain skills. Thus, for future medics, the use of IoT technologies in the context of AR is a priority. This is due to the fact that this approach not only improves the quality of learning, but also increases students’ interest in learning activities, as all practical work becomes as realistic and therefore interesting for them. In addition, intelligent classrooms are characterised by the presence of automatic face identification, which certainly facilitates the learning process in a distance learning format. Accordingly, this mechanism ensures that lectures and other methodological activities are only attended by the individuals in the respective study group [11].

Also, this feature can be used by students to systematically attend online classes, which certainly saves the teacher a lot of time in monitoring their attendance. At the same time, IoT sensors are able to monitor students’ activity in completing their academic tasks and their mastery of the required material. This approach is very promising for the development of an educational distance learning environment, as it allows the teacher to fully monitor it, directly as in traditional teaching. Moreover, such analysis makes it possible to identify the main problems encountered by students in learning and using specific learning topics or skills. Finally, such sensors make it possible to monitor students’ activity and, if it slows down, to set special breaks in order to increase their concentration [12].

Of course, the role of IoT sensors in teaching a foreign language in higher education should be noted. At the moment, most of the educational institutions base their activities on trilingualism, so foreign language acquisition is becoming an increasingly urgent and acute issue in the educational environment. In this case, IoT is a comprehensive mechanism to address a number of problematic issues that arise during the aforementioned process. Accordingly, the role of such sensors manifests itself in several areas at once, in particular speaking, writing, listening, and reading. Moreover, IoT technologies allow modifying the curriculum and approaches directly during the implementation of the learning process, which undoubtedly indicates their flexibility and high adaptability, which is a particularly important factor for distance learning [13].

At the same time, IoT sensors can be used as “native speakers” to increase students’ concentration on learning a foreign language, i.e. to imitate live communication, while both mastering the material and consolidating it. At the same time, universities in Kazakhstan quite often systematically use various IoT applications and sensors, which, of course, only improves the quality of students’ learning activities. As a rule, functionally, they are aimed at automatic and continuous monitoring of the activity and progress of specific individuals in order to identify their
The most important role, as they provide subjects of memory. It is in this context that IoT technologies play use their knowledge and skills in order to consolidate them of a foreign language, they definitely need to constantly learning activities with the opportunity to gain experience relevant to them. Accordingly, the performance of such activities is also reflected in the level of foreign-language professional competence of the future specialist, which is certainly an important quality, especially in today’s labour market [14].

Speaking about concentration, attention should be paid to the specifics of the process of monitoring the physical and mental health of students. This is because such factors significantly influence their motivation to carry out learning activities, which in turn is reflected in their interest and concentration. In addition, it should be understood that this is how IoT sensors can help to develop the overall higher education environment in Kazakhstan. At the same time, through the use of various IoT tools, students can monitor their physiological data and react to it in time, especially when selecting an education programme. By analysing the overall data for a study group, it is possible to establish at what time the students’ body activity is more active, and accordingly, based on these results, the study schedule can be logically formed. Undoubtedly, this allows higher education institutions, in particular, to influence students’ concentration and their activity during learning activities [15].

At the same time, such an approach will make it possible to determine whether the current tools are effective and whether they affect students’ minds. It is clear that analysis of such sensors is not quite possible during distance learning, but nevertheless, even a partial study of this issue will improve the quality of educational services provided by higher education institutions and the level of their perception by students. After all, obtaining data by teachers on the characteristics of each promising student’s activity will allow them to select more engaging and motivating exercises, which will definitely increase their level of concentration on the learning process as a result [16].

Analysing the above-mentioned sensors and IoT tools, which are quite common among Kazakhstan universities, it should be noted that all of them are aimed at personalising the learning process. Undoubtedly, the control of students’ concentration during distance learning and also its regulation is possible only with the introduction of individual approaches and tools for both pre-defined study group and a particular student. This is because only when specific sensors and factors are analysed, is it possible to select and implement truly quality mechanisms. Thus, the Internet of Things makes it possible to implement a seamless learning process even under conditions of abrupt and dynamic social and political changes, in particular during distance learning [17].

The statistics, which stand as indicators of the increase in student concentration as a result of the introduction of IoT sensors, are undoubtedly positive. First of all, it is manifested in the fact that half of the higher education institutions, of various kinds, use the above-mentioned technologies in their work. Thus, this approach is a priority for the future development of higher education in Kazakhstan. In addition, examining the data on the implementation of IoT technologies, it should be emphasised that its dynamics over the last 5 years has clearly increased. Accordingly, in 2017 the number of use of such tools in higher education institutions was only 7%, in 2018 – 19%, in 2019 – 46%, in 2020 – 61%, and in 2021 – 77%. This pattern is quite logical, since it was in the period from 2019 to 2021 that the learning activities mainly took place in a distance learning format, which obliged higher education institutions to change their approaches to its organisation. As for the data from the IoT sensor engagement results, they indicate that the concentration rate of students during online classes was mostly 52%; in turn, they increased to 78%. Certainly, this difference indicates the effectiveness and promise of the approaches and ways of implementing IoT sensors in learning discussed in the paper [18].

On this basis, it can be argued that, at the moment, the considered technologies and tools are advanced, both for students and teachers. This demonstrates that in the context of global informatisation, only the transition to digital and developed technologies will provide universities with the opportunity to provide quality educational services and be competitive, not only within domestic education, but also abroad. It should be emphasised, that the advantage of IoT sensors is their versatility; accordingly, they can be involved in various curricula and plans, regardless of the professional direction of the study group. Moreover, it is due to their high individualisation that the teacher is empowered to independently determine the level of attention and activity of students from different faculties and specialties, during the mastering of specific learning material [19].

Hence, the teacher can identify effective and prioritised approaches for each of them, while meeting their personal interests and needs. It should be understood that the use of smart devices and sensors certainly automates the learning process, which is a prerequisite for a fast and successful distance learning process. At the same time, it is an approach that highlights its main advantages and identifying other necessary tools for its improvement. Finally, IoT sensors are the most effective tools for controlling and developing students’ concentration on the learning process, during the implementation of online classes, and their specific assignments and exercises, on distance learning platforms [20].

Conclusions
The research resulted in a set of important conclusions revealing both the theoretical and the practical part of the article. Accordingly, the general theoretical concepts constituting the object of the study were explored at the beginning of the study. In particular, this refers to the categories of IoT sensors and student concentration. However, the topic was considered in the context of the distance learning process. Thus, the general framework and
the role of the Internet in the implementation of learning activities of students in higher education institutions of Kazakhstan were studied. In addition, at this stage, the immediate essence and priority of IoT for the development of educational environment in the context of global digitalisation was established.

In the next step, specific provisions related to IoT technologies in Kazakhstan higher education institutions were considered. In particular, the ways and approaches to their implementation were investigated, and the directions of each of them were identified. At the same time, it should be noted that it is in this part of the paper that the role and relationship of such sensors with the implementation of a successful distance learning process was defined.

Hence, IoT technologies, in particular, sensors are currently the highest priority tool for the remote provision of educational services to students. In addition, it should be noted, that it is this element that allows higher education institutions in Kazakhstan to develop successfully and increase competitiveness. This is confirmed by the statistical data investigated in the article.

Accordingly, the pre- and post-use data were examined, particularly in the context of the level, concentration of students on the learning process. In addition, the dynamics of these technologies in the educational environment, directly in Kazakhstan, over the past 5 years was determined. In terms of future research, it would be useful to consider the involvement of artificial intelligence in the training of future specialists.

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Conflict of Interest
None.

References
Підвищення концентрації студентів у дистанційному навчанні: Роль датчиків Інтернету речей у вищих навчальних закладах Казахстану

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Анотація

Актуальність. Актуальність датчиків Інтернету речей у різних суспільних сферах, включаючи освіту, значно зросла, особливо в контексті дистанційного навчання, яке поставило нові виклики та потреби як перед студентами, так і перед викладачами.

Мета. Це дослідження має на меті проаналізувати, як технології Інтернету речей впливають на освітній процес, підвищуючи концентрацію уваги студентів.

Методологія. Методологічно в дослідженні використано аналітичний, синтетичний, дедуктивний методи, а також функціональний та системний підходи.

Результати. Теоретичне дослідження охоплює датчики Інтернету речей, педагогічні методи та концентрацію уваги студентів, тоді як практичний аспект зосереджується на конкретних підходах до використання датчиків Інтернету речей для покращення концентрації уваги студентів під час дистанційного навчання. Результати дослідження демонструють, що датчики Інтернету речей відіграють вирішальну роль у підвищенні концентрації уваги студентів в освітньому середовищі.

Висновки. Це дослідження поглиблює теоретичні уявлення про датчики Інтернету речей та педагогічні методи, а також практичні стратегії їх ефективного впровадження. Це дослідження підкреслює потенціал технологій Інтернету речей для підвищення якості освіти, пропонуючи цінну інформацію для розробки навчальних програм і майбутніх досліджень у цій галузі.

Ключові слова: дистанційне навчання; діджиталізація; освітній процес; Інтернет речей; моніторинг академічної успішності.