Dwi Sulisworo
Doctor of Educational Technology, Professor
Physics Education Department, Ahmad Dahlan University, Indonesia
ORCID ID0000-0002-7625-8505
sulisworo@gmail.com

Nanang Suwondo
Master of Physics Education, Assit. Professor
Physics Education Department, Ahmad Dahlan University, Indonesia
nsuwondo@gmail.com

Vera Yuli Erviana
Master of Elementary Education, Assit. Professor
Elementary Education Teacher Training Department, Ahmad Dahlan University, Indonesia
ORCID ID 0000-0003-2543-0886
vera.erviana@pgsd.uad.ac.id

Meita Fitrianawati
Master of Mathematics Education, Assit. Professor
Elementary Education Teacher Training Department, Ahmad Dahlan University, Indonesia
meita.fitrianawati@pgsd.uad.ac.id

THE COLLABORATIVE ENVIRONMENT USING THE INTERNET OF THINGS IN THE THEMATIC BASED LEARNING AT THE PRIMARY SCHOOL IN INDONESIA

Abstract. Information and communication technology is growing rapidly and has an enormous influence on various fields of life, including the area of education. The level of penetration of the use of technology is also high in Indonesia. The Internet of things (IoT) is increasingly being used to support various activities. It can be said that IoT provides new opportunities. However, although there are already many uses in multiple fields, the integration of this technology with education is still a problem for educators. Considering the spirit of the National Education Curriculum reform in Indonesia, there are critical changes in managing learning environment, among them the shift from teacher-centered learning to student-centered learning especially with thematic learning in elementary schools. Thematic knowledge has also been developed in several countries with good results to improve various competencies following 21st century learning such as 4C (critical thinking, creativity, communication, and collaboration). The purpose of this study was to create a learning design that integrates IoT in thematic learning in elementary schools on issues about climate change. For this purpose, it was necessary to prepare an Internet of Things based measurement apparatus using node MCU V3 Lolin which can measure temperature, air pressure, air humidity, altitude, light intensity in various places remotely. Furthermore, the design that was validated using expert judgment approach (by learning strategists, physicists, and teachers) was tested on a small group of students in the fifth grade. The USE questionnaire was used to measure student responses. This questionnaire contains four aspects, i.e., usefulness, ease of use, ease of learning, and satisfaction aspects. Based on the finding, this learning design has a potential opportunity for improving student engagement.

Keywords: climate change issue; curriculum development; elementary student; Internet of things; thematic based learning.

1. INTRODUCTION

Problem statement. The use of IoT technology in learning in Indonesia is still minimal. The implementation of the national curriculum in elementary schools that use a thematic based learning approach is an opportunity to enhance the use of this technology. The key lies in developing an effective learning design to use IoT for thematic based learning in elementary school.

Information and communication technology is penetratingmany sectors in Indonesia. At the same time, the use of the Internet of things (IoT) as an emerging technology is also increasing to support various human activities. It can be said that IoT provides new opportunities [1][2]. With IoT, a device can monitor the environment and control other objects remotely through the Internet network infrastructure such that each object can function interactively in an internetworking architecture. This device can be anything that can receive IP addresses from IoT devices. This device can be a computer, smartphone, laptop, tablet, phablet, or any type of device embedded in an IP address. This device will be able to interact intelligently even without human intervention in collecting and transferring data and making control decisions [3][4].

Analysis of recent research and publications. IoT is expected to be able to provide social benefits in various fields such as policies in the areas of energy, health, transportation, industry, and others. The use of this technology requires sufficient digital literacy in the user community to avoid any errors in utilization [5][6]. The utilization of IoT in learning at school faces some obstacles including the teacher's perception and digital literacy skills [7].

The advantages that will be obtained using IoT will vary depending on variations in skills and resources in each place in Indonesia. It is possible that this technology in some groups (on the periphery) may provide high benefits, but in other groups (in the border and lagging regions) it may not ensure adequate benefits. Somewhere, this technology will look like a paradox. The IoT has many opportunities but it needs to be explored on the practical level. However, although there are already many uses in multiple fields, the integration of this technology into education is still low. Several studies on the use of IoT in education have been carried out at the college level for a variety of learning activities [8][9]. In view of the wide range of utilization of IoT, it is clear that this technology can be used at a lower level than college (primary to high school student) to explain natural or social phenomena, theories, concepts in a better way, improving students' performance. This technology can be utilized not only in the management of education but also in learning inside and outside the classroom; both as a support for learning services and as a medium of learning itself. The utilization of IoT in learning also receives a positive perception from students [10]. The use of IoT will lead to new approaches and methods of collaborative online learning including mobile learning [11-14]. Some researchers showed that mobile learning gives a positive influence on attitudes, engagement and students' achievement [15-17].

Considering the spirit of the National Education Curriculum reform in Indonesia and the equitable access to education, there are critical changes in managing learning environment; among them the shift from teacher-centered learning to student-centered learning [18], especially with thematic learning in elementary schools [19]. Thematic knowledge has also been developed in several countries with good results to improve various competencies following 21st century learning such as 4C (critical thinking, creativity, communication, and collaboration). **The purpose of this study** is to create a learning design that integrates IoT in thematic learning in elementary schools on issues of climate change. The project-based learning environment will encourage students' engagement when studying a particular phenomenon [20-22]. The packaging of teaching materials, IoT technology, and students' interaction developed needs to be considered to achieve the competencies [23]. In the initial phase of this research, it is necessary to consider the optimum learning design that meets the core competency achievement on the selected issues. The funding of this research is from Ministry of Research, Technology, and Higher Education of Republic Indonesia, under University Competitiveness Research Grant for the year 2019 under contract number PTUPT-008/SKPP.TJ/LPPM UAD/III/2019.

2. RESEARCH METHODS

This section describes the method of preparation and conducting of the research as well as experimental base of the research, its participants and investigating facilities. Also the characteristics, criteria, indicators and parameters of assessing are provided.

2.1. Research Phases

This research is development research. The result is the learning design of the theme-based learning using IoT for the fifth-grade elementary school students. The phases of this study include defining the characteristics of learning design, developing the IoT-based learning apparatus, integrating the apparatus in learning strategies, applying learning designs in small groups in certain schools, and measuring the learners' responses.

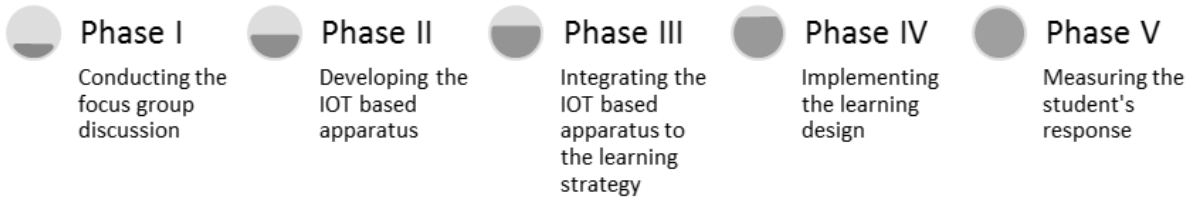


Figure 1. The research procedure

2.2. Focus Group Discussion

The FGD (Focus Group Discussion) is carried out to obtain the initial learning design that meets several requirement aspects, i.e., learning objectives that are following the standard of the national curriculum, the most optimum strategy to use IoT in selected issue using project-based learning, best estimate for the implementation of learning. At this phase, some experts are involved in sharing their expertise and knowledge to find the appropriate learning design. The experts are curriculum experts, learning strategists, learning evaluation experts, and teachers. The output of this phase is the design of the learning plan which includes the stages of project-based learning from several meetings, an evaluation instrument for learning achievement, features needed to be installed on IoT to measure climate parameters.

2.3. IOT based Apparatus

Based on the selection of themes related to global climate change issue and appropriate IoT devices, the environmental parameters to be measured are temperature, air pressure, altitude, light intensity and humidity. Sensors on these variables will be attached in the IoT using nodeMCU V3 Lolin. Users can monitor the parameter in the dashboard of Blynk application. This application should be downloaded from the Google Playstore and installed onto the smartphone. Data acquisition by sensors on IoT will be distributed to users/ students via the Internet network. An important characteristic of the apparatus is that the measurement data of these variables will be monitored by students in other schools in different places. Thus students from different schools will be able to observe each other's environment in different locations. In a wider application, this IoT will be placed in areas with different geographical conditions. By comparing several different parameters, students will be encouraged to think deductively in understanding the global environment. Before being tested, this IoT will be tested on a laboratory scale, especially for the multiple attached sensors. Schematically, the working configuration of this apparatus is shown in Figure 2.

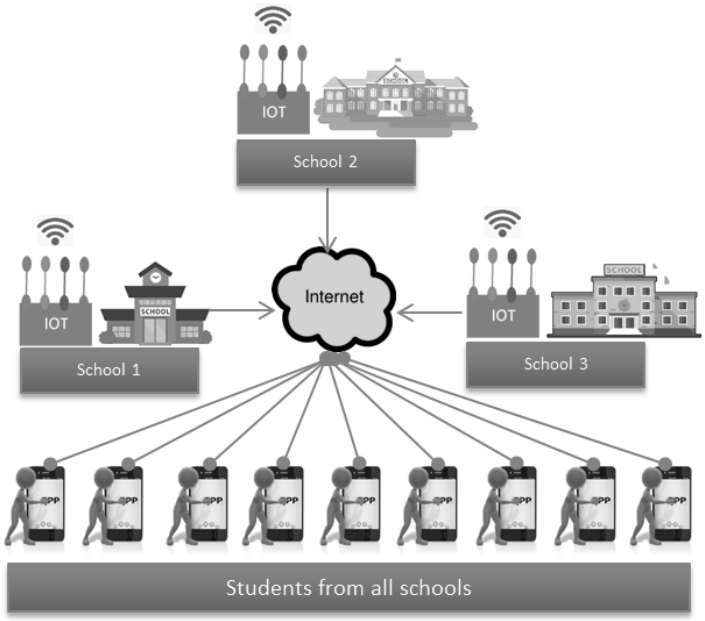


Figure 2. Collaborative environment

2.4. Learning strategy

Following the existing curriculum, there is a suggestion that learning strategy in this sub-theme is managed using a project-based learning approach with steps including observing and describing, questioning and analyzing, showing results, and reflecting. More detailed activities at each learning activity stage will be determined based on expert judgment in the second round of FGD. In this activity phase, the expert involved is the same expert as in the previous FGD. The collaborative learning design produced will then be tested for implementation in a limited simulation among experts. The final result of this stage is a learning design that is ready to be applied at school.

2.5. Trial in asmall group of students

Next, the implementation of the learning design was conducted in an elementary school (SD Muhammadiyah Pakel) in Yogyakarta, Indonesia, with the fifth-grade students. Twenty seven students were involved in this learning activity. Before implementing the learning design utilizing the IoT, the teacher explained how to operate this media. This activity was carried out outside the school hours to ensure that students had no obstacles in using the media for learning.

Based on the lesson plan, students were taught the selected issues in class. After the learning period was complete, students were given a questionnaire. This questionnaire measured the learning design acceptance. The students' response in learning according to valid configurations was measured using USE aspects [24]. Aspects assessed include usefulness, ease of use, ease of learning and satisfaction. The results were analyzed to explain the level of students' acceptance of the learning design. Some suggestions for improvements from students' responses were used as the basis for revisions. After this revision, the valid learning design was found and would be used in a wider range of schools.

3. THE RESULTS AND DISCUSSION

3.1. Focus Group Discussion

Educational reforms in Indonesia began with changes in the National Curriculum in 2013. The main change was the shift of learning orientation from teacher-centered learning to student-centered learning [18]. At the education unit level and also at the level of implementation in the classroom, this change is addressed in the statement of core competencies and basic competencies of each subject. This statement will be written in the lesson plan.

At the elementary school level, the most critical change is the implementation of thematic-based learning [19]. Through the centralized national curriculum, the government develops learning themes for elementary school students. In one semester, there will be 4 to 6 themes. Each theme will be studied by linking or integrating several other subjects. Each theme will be divided into several sub-themes. Each sub-theme will be divided again into several periodic learning activities. In this study, the issue to be studied is about global climate change which is an important issue for all nations. Based on the curriculum structure of elementary school in Indonesia, the issue of climate change is connected to the thematic based learning of the fifth-grade students. The theme is the 2nd theme, i.e. clean air theme. Through this theme, students will learn about natural science, social science, language, culture, and civics. Table 1 shows the structure of this theme.

Table 1

The thematic structure of Clean Air

Theme	Sub-theme	Objectives	Strategy	Activity
2nd theme (Clean Air)	4th sub-theme (Project-based activity: environment observation)	To improve logical thinking and higher order thinking skills	The design strategy of activities is comprehensive and integrative activities that open opportunities to raise questions and explore information that isrelevant to daily life	1. To observe and to describe 2. To ask and to analyze 3. To present the product 4. To reflect

3.2. IOT based learning apparatus

The apparatus was based on microcontroller technology, ie. node MCU V3 Lolin. We equip this IoT with all sensors. This configuration will be used as data acquisition of the climate parameters. Then, all sensors are arranged as shown in Figure 3.

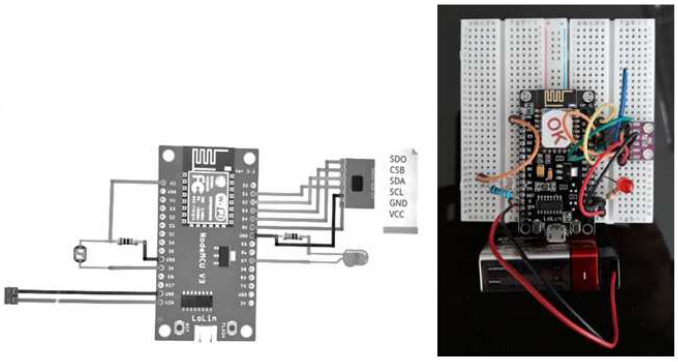


Figure 3. The circuit scheme and the product of the IoT

To monitor the value of the parameters, we used the Blynk app downloaded from Play Store as open source software. Small language programming was used to connect and to link the sensor, the processor and the monitoring app. The result is a monitoring dashboard in Figure 4.

Figure 4. The dashboard in the smartphone using Blynk app for parameter monitoring

3.3. Learning strategy

In this second FGD, the factors for the expert consideration or judgment are how the learning media works (IoT), how to learn the themes, how to achieve the learning competencies, and how to apply the collaborative strategies. Based on these factors, experts decided on the learning procedure or mechanism as a collaborative activity. The result is shown in Table 2.

Table 2

Collaborative activity

No	Procedures	Activities
1.	To observe and to describe	The teacher encourages the students to discuss and to think on the global climate change issue. Students identify the parameters of climate (e.g., temperature, light intensity, air pressure)
2.	To ask and to analyze	Students in groups measure climate parameters in their schools using IoT and monitor the value through the smartphone Students in groups monitor the same parameters measured by other students from other schools through the smartphone Students in groups compare results, guess geographical conditions and the climate of other places (where other schools are located) Students in groups find out explanations of why their resultsare different and what they will affect.
3.	To present the product	Students individually write a narrative about the relevance of climate parameters to the issue of global climate change and geographical conditions
4.	To reflect	Students individually tell about their awareness and what they will do to reduce the impact of global climate change

Furthermore, the design validated using expert judgment approach (by learning strategists, physicists, and teachers) was tested on a small group of students in the fifthgrade. The project-based learning enables students to work collaboratively in understanding a phenomenon. The relevant issues in learning encourage the students' engagement [25] and the use of appropriate technology in understanding the issues [26].

3.4. Learning implementation and students' response

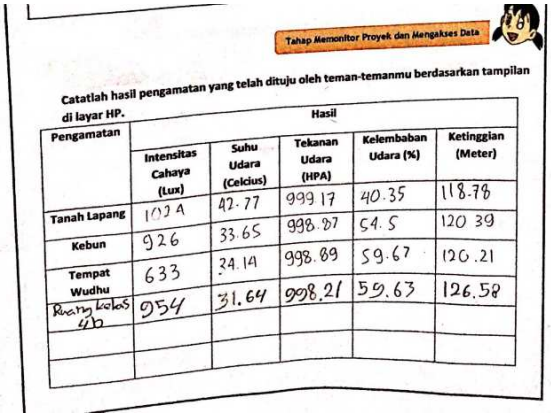
This learning program with project-based learning strategies was carried out in one day for 3x45 minutes. This strategy implementation is suitable if carried out continuously on the same day. In this way, students who had entered a conducive learning environment would not be cut off due to time constraints.

In this learning, students were grouped into groups of three to five members. Each group received a student worksheet. At the beginning of the meeting, the teacher explained the learning activities to be carried out. Two of the students in one class were given the task of bringing IoT to several places (Gardens, Fields and Bathrooms). By using the ON/ OFF feature on the IoT, students in the class knew when to record data. Next students used student worksheets to collect data related to weather parameters. After completing the data collection, all students regrouped in class to discuss the results according to the activities on the student worksheet. Results from each group were displayed in the class (written on the board) to compare results between groups. Next, each group sent their representatives to share the results, and other students provided additional opinions on the group results achieved.

Figure 5 shows the student activity on monitoring the climate parameters. The students monitored in the classroom but the IoT apparatus was in another place far away from the school. They learnt the climate issues by comparing the different data among the several places that they measured.

Figure 6. Student activity on monitoring the climate parameters

They wrote down the data in the student worksheet and analyzed the data to solve the climate issues and problems. See Figure 6 for the part of the worksheet.



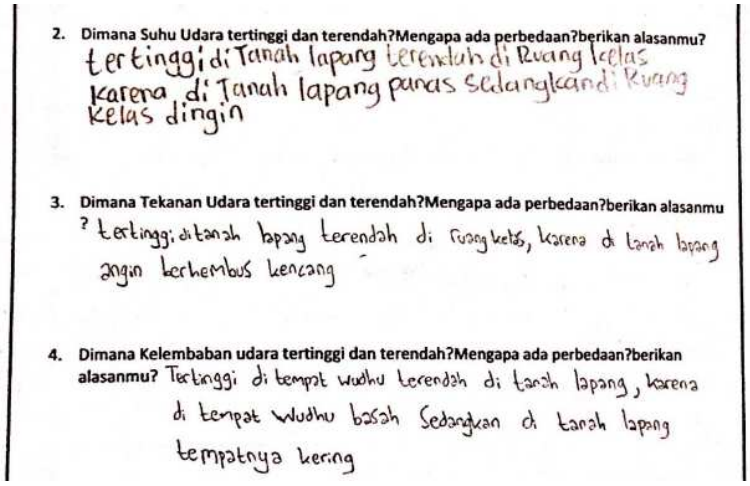
Tahap Memonitor Proyek dan Mengakses Data

Catatlah hasil pengamatan yang telah dituju oleh teman-temanmu berdasarkan tampilan di layar HP.

Pengamatan	Hasil				
	Intensitas Cahaya (Lux)	Suhu Udara (Celcius)	Tekanan Udara (HPA)	Kelembaban Udara (%)	Ketinggian (Meter)
Tanah Lapang	1012 A	42.77	999.17	40.35	118.78
Kebun	926	33.65	998.87	54.5	120.39
Tempat Wudhu	633	34.14	998.89	59.67	120.21
Ruang kelas 4b	954	31.64	998.21	59.63	126.58

Figure 6. The data of climate parameters in the student worksheet. Column 1: place; column 2: light intensity; column 3: temperature; column 4: air pressure; column 5: humidity; column 6: altitude from sea level

Based on those data, the students discussed in group to solve the simple climate problems to facilitate their higher order thinking skills. Figure 7 shows the result of students' discussion.


2. Dimana Suhu Udara tertinggi dan terendah?Mengapa ada perbedaan?berikan alasanmu?
tertinggi di Tanah lapang terendah di Ruang kelas karena di Tanah lapang panas sedangkan di Ruang kelas dingin

3. Dimana Tekanan Udara tertinggi dan terendah?Mengapa ada perbedaan?berikan alasanmu ? tertinggi di tanah lapang terendah di ruang kelas, karena di tanah lapang angin berhembus kencang

4. Dimana Kelembaban udara tertinggi dan terendah?Mengapa ada perbedaan?berikan alasanmu? Tertinggi di tempat wudhu terendah di tanah lapang, karena di tempat wudhu basah sedangkan di tanah lapang tempatnya kering

Figure 7. The discussion result. The main technique is that students find the minimum and maximum value of the climate parameter; and give the reason for this situation (why it happens).

After learning, students were interviewed regarding their level of acceptance of the learning strategies and apparatus. The aspects assessed include usefulness, ease of use, ease of learning, and satisfaction. On the usefulness aspect, all students stated that the applied learning had excellent benefits. They noted that this benefit was mainly on their new insights about how IoT can explain weather phenomena in a real way by comparing different places without having to be in those places. Some students creatively stated that using IoT can be used for remote monitoring.

Concerning the aspect of ease of use, students who could immediately use the learning device were already familiar with similar tools in other school activities (robotics). As for other students, they felt that even though the instrument was new to them, they did not find it difficult to download it to operate the monitoring application (Blynk). How to download the application from the Google Play Store is no different from how to download other ones. The interface on the app is also easy to read the weather parameters listed.

Concerning the ease of learning aspect, students felt there was no difficulty with the worksheet provided in learning. Worksheets were considered easy because they only move data from the monitor screen to the sheet of paper provided. In the discussion, they also felt free to express their opinions. The role of the teacher in facilitating conversations was not that of dominance, but led to making students comfortable. The learning process was dynamic and fun.

As for the aspect of satisfaction, students stated that the media used was interesting and they would tell other friends about it. Some students hoped that this learning could be tried to measure the weather in a place farther away from school. Their enthusiasm during learning testifies that this learning engages students. There were no students who were not actively contributing to the learning process. In general, based on the interview, this application is effective and has a high potential to be used in the thematic based learning.

The technology of IoT eliminates physical limitations and broadens the access for teachers by using any tools that facilitate e-learning efficiently irrespective of location[1]. IoT exercises a significant influence on the learning process by offering access to international resources and various opportunities for students and teachers. Based on various researches,

online learning shows the influences on attitudes, engagement, and achievement [15][16][27]. From the teacher side, there is a tendency that the teacher better embraces the technology. Some teachers still experience difficulties while using technology in learning.

Students' digital literacy enables easy use of IoT apparatus in learning. It becomes one of the essential factors in the use of technology [5][7].A more flexible role for the students in project-based learning will determine their learning success. In learning that utilizes technology, positive engagement encourages learning success. The shifting of the teacher's role to adjusting the learning strategies during this research allowed the students to be more independent in interaction with the apparatus and in sharing understanding with their friends. This strategy enables students to easily adjust to the learning process [28].

Learning by using IoT in integrative learning receives a positive feedback from students. It matches the research finding that STEM learning with IoT facilities tends to encourage students' learning satisfaction [10].

3. CONCLUSION AND PROSPECTS FOR FURTHER RESEARCH

Teachers have sufficient skills to use information and communication technology, including IoT technology. They can also apply this technology in theme-based learning, especially in elementary schools. Project-based learning approach (recommended by the Ministry of Education of Indonesia) encourages students to be more active in expressing their learning interest and tends to provide opportunities for success in achieving better competencies. The theme of climate change gave students' possibility to better understand the interrelationships of various climate parameters and how these parameters influence each other. Besides, awareness of different data has encouraged students to think more critically on the issues studied. Some aspects that still need to be explored are how other subjects can be integrated into the thematic learning in this learning design. This constitutes the prospect of further research.

REFERENCES

[1] M.B. Abbasy, & E.V. Quesada, "Predictable influence of IoT (Internet of Things) in the higher education," *International Journal of Information and Education Technology*, vol. 7, no. 12, pp. 914-920, 2017.

[2] S. Kuyoro, F. Osisanwo, & O. Akinsowon, "Internet of Things (IoT): An Overview," In Proc. of the 3th International Conference on Advances in Engineering Sciences and Applied Mathematics (ICAESAM) (pp. 23-24), 2015.

[3] M. Lamri, S. Akrouf, A. Boubetra, A. Merabet, L. Selmani, & D. Boubetra, "From local teaching to distant teaching through IoT interoperability," In *2014 International Conference on Interactive Mobile Communication Technologies and Learning (IMCL2014)* (pp. 107-110), IEEE, 2014.

[4] J. Marquez, J. Villanueva, Z. Solarte, & A. Garcia, "IoT in education: Integration of objects with virtual academic communities," In *New Advances in Information Systems and Technologies* (pp. 201-212), Springer, 2016.

[5] A.J. van Deursen, & K. Mossberger, "Any Thing for Anyone? A New Digital Divide in Internet-of-Things Skills," *Policy & internet*, vol. 10, no. 2, pp. 122-140, 2018.

[6] P. Tan, H. Wu, P. Li, & H. Xu, "Teaching management system with applications of RFID and IoT technology," *Education Sciences*, vol. 8, no. 1, pp. 26, 2018.

[7] L.B. Carver, "Teacher perception of barriers and benefits in K-12 technology usage," *Turkish Online Journal of Educational Technology-TOJET*, vol. 15, no. 1, pp. 110-116, 2016.

[8] H. Aldowah, S.U. Rehman, S. Ghazal, & I.N. Umar, "Internet of Things in higher education: a study on future learning," In *Journal of Physics: Conference Series* (vol. 892, no. 1, p. 012017), IOP Publishing, 2017.

[9] L. Banica, E. Burtescu, & F. Enescu, "The impact of internet-of-things in higher education," *Scientific Bulletin-Economic Sciences*, vol. 16, no. 1, pp. 53-59, 2017.

[10] J. He, D.C.T. Lo, Y. Xie, & J. Lartigue, "Integrating Internet of Things (IoT) into STEM undergraduate education: Case study of a modern technology infused courseware for embedded system course," In *2016 IEEE Frontiers in Education Conference (FIE)* (pp. 1-9). IEEE, 2016.
[11] M. Abdel-Basset, G. Manogaran, M. Mohamed, & E. Rushdy, "Internet of things in smart education environment: Supportive framework in the decision-making process," *Concurrency and Computation: Practice and Experience*, pp. 1-12, 2018.
[12] M.T. Sarıtaş, "The emergent technological and theoretical paradigms in education: the interrelations of cloud computing (CC), connectivism and internet of things (IoT),"*ActaPolytechnicaHungarica*, vol. 12, no. 6, pp. 161-179, 2015.
[13] Z. Tianbo, "The internet of things promoting higher education revolution," In *2012 Fourth International Conference on Multimedia Information Networking and Security* (pp. 790-793). IEEE, 2012.
[14] M.R.M. Veeramanickam, & M. Mohanapriya, "IOT enabled future smart campus with effective E-learning: i-Campus," *GSTF Journal of Engineering Technology (JET)*, vol. 3, no. 4, pp. 81-87, 2017.
[15] K. Fabian, K.J. Topping, & I.G. Barron, "Mobile technology and mathematics: Effects on students' attitudes, engagement, and achievement," *Journal of Computers in Education*, vol. 3, no. 1, pp. 77-104, 2016.
[16] H. Heflin, J. Shewmaker, &J. Nguyen, "Impact of mobile technology on student attitudes, engagement, and learning,"*Computers & Education*, vol. 107, pp. 91-99, 2017.
[17] T. Rashid, &H.M. Asghar, "Technology use, self-directed learning, student engagement and academic performance: Examining the interrelations," *Computers in Human Behavior*, vol. 63, pp. 604-612, 2016.
[18] Ministry of Education and Culture of Indonesia. *Regulation Number 67 Year 2013: Basic competencies and curriculum structure for elementary school*. [Online]. Available: http://bsnp-indonesia.org/id/wp-content/uploads/2013/06/Salinan-Permendikbud-No.-67-th-2013-ttg-KD-dan-Struktur-Kurikulum-SD-MI.zip
[19] Malawi, A. Kadarwati, & D.P.K. Dayu, *Pembaharuan Pembelajaran di Sekolah Dasar* [Learning Reform in Elementary School]. Magetan, Indonesia: AE Media Grafika, 2018. (In Indonesian)
[20] A.M. Craft, "A Study of How Science, Technology, Engineering, and Mathematics (STEM) Project-Based Learning (PBL) Can Improve Student Engagement", *Dissertation*, 2017.
[21] C.R. Henrie, L.R. Halverson, &C.R. Graham, "Measuring student engagement in technology-mediated learning: A review," *Computers & Education*, vol 90, pp. 36-53, 2015.
[22] H. Mäenpää, S. Varjonen, A. Hellas, S. Tarkoma, &T. Männistö,"Assessing IOT projects in university education: a framework for problem-based learning," In *Proceedings of the 39th International Conference on Software Engineering: Software Engineering and Education Track,*pp. 37-46, IEEE Press, 2017.
[23] C. Ma, S. Kulshrestha, W. Shi, Y. Okada, &R. Bose, "E-learning material development framework supporting VR/AR based on linked data for IoT security education," In *International Conference on Emerging Internetworking, Data & Web Technologies*, pp. 479-491, Springer, 2018
[24] A.M. Lund, "Measuring usability with the use questionnaire," *Usability interface*, vol. 8, no. 2, pp.3-6, 2001.
[25] A.M. Craft, &R.M. Capraro, "Science, Technology, Engineering, and Mathematics Project-Based Learning: Merging Rigor and Relevance to Increase Student Engagement,"*Electronic International Journal of Education, Arts, and Science (EIJEAS)*, vol. 3, no. 6, pp. 140-158, 2017.
[26] H. Gillow-Wiles, &M.L. Niess, "A Reconstructed Conception of Learner Engagement in Technology-Rich Online Learning Environments," In *Handbook of Research on Transforming Mathematics Teacher Education in the Digital Age*, pp. 577-607, IGI Global, 2016.
[27] S. Boulianne, "Does Internet use affect engagement? A meta-analysis of research," *Political communication*, vol. 26, no. 2, pp. 193-211, 2009.
[28] S.K.Howard, J. Ma, &J. Yang,"Student rules: Exploring patterns of students' computer-efficacy and engagement with digital technologies in learning,"*Computers & Education*, vol. 101, pp. 29-42, 2016.

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КОЛАБОРАТИВНЕ СЕРЕДОВИЩЕ З ВИКОРИСТАННЯМ ІНТЕРНЕТ-РЕЧЕЙ ПІД ЧАС ТЕМАТИЧНОГО НАВЧАННЯ В ПОЧАТКОВІЙ ШКОЛІ ІНДОНЕЗІЇ

Дуі Сулісворо
доктор з освітніх технологій, професор
кафедра фізики, університет Ахмад Даглан, Індонезія
ORCID ID 0000-0002-7625-8505
sulisworo@gmail.com

Нананг Сувондо
магістр з фізики, доцент
кафедра фізики, університет Ахмад Даглан, Індонезія
nsuwondo@gmail.com

Віра Юлія Ервіана
магістр початкової освіти, доцент
кафедра підготовки вчителів початкової освіти, університет Ахмад Даглан, Індонезія
ORCID ID 0000-0003-2543-0886
vera.erviana@pgsd.uad.ac.id

Меіта Фітріанаваті
магістр з математики, доцент
кафедра підготовки вчителів початкової освіти, університет Ахмад Даглан, Індонезія
meita.fitrianawati@pgsd.uad.ac.id

Анотація. Інформаційно-комунікаційні технології швидко розповсюджуються і мають величезний вплив на різні сфери життя, охоплюють й освітню галузь. В Індонезії також спостерігається високий рівень впровадження технологій. Технологія Інтернет-речей (IoT) все частіше використовується для підтримки різних видів діяльності. Можна сказати, що IoT надає нові можливості. Однак, незважаючи на її використання в багатьох сферах, інтеграція цієї технології в освітню галузь залишається проблемою для педагогів. Враховуючи загальну тенденцію реформи Національного курикулуму в Індонезії, в управлінні навчальним середовищем спостерігаються значні зміни, серед яких перехід від навчання, орієнтованого на вчителя, до навчання, орієнтованого на студента, особливо що стосується тематичного навчання в початковій школі. Результатом впровадження тематичного навчання в деяких країнах було підвищення рівня сформованості компетентностей XXI століття, таких як 4C (критичне мислення, творчість, спілкування та співпраця). Метою даного дослідження було створення навчального дизайну для початкової школи, який інтегрує IoT у тематичне навчання з питань зміни клімату. Для цього необхідно було підготувати вимірювальний прилад на основі Інтернет-речей з використанням nodeMCU V3 Lolin, який може вимірювати на відстані температуру, тиск повітря, вологість повітря, висоту, інтенсивність світла в різних місцях. Крім того, дизайн, який був верифікований за допомогою експертного підходу (шляхом залучення стратегів з освіти, фізиків і вчителів), був перевірений на невеликій групі учнів п'ятого класу. Для оцінки відповідей учнів була використана анкета USE. Ця анкета містить чотири аспекти: корисність, простоту використання, легкість навчання та аспект задоволення. Аналіз результатів показав, що запропонований навчальний дизайн має потенціал для поліпшення навчальної активності учнів.

Ключові слова: проблема зміни клімату; розробка навчальної програми; учень початкової школи; Інтернет-речі; тематичне навчання.

КОЛАБОРАТИВНАЯ СРЕДА С ИСПОЛЬЗОВАНИЕМ ИНТЕРНЕТ-ВЕЩЕЙ ВО ВРЕМЯ ТЕМАТИЧЕСКОГО ОБУЧЕНИЯ В НАЧАЛЬНОЙ ШКОЛЕ ИНДОНЕЗИИ

Дуи Сулисворо
доктор по образовательным технологиям, профессор
кафедра физики, университет Ахмад Даглан, Индонезия
ORCID ID 0000-0002-7625-8505
sulisworo@gmail.com

Нананг Сувондо
магистр физики, доцент
кафедра физики, университет Ахмад Даглан, Индонезия
nsuwondo@gmail.com

Вера Юлия Ервиана
магистр начального образования, доцент
кафедра подготовки учителей начального образования, университет Ахмад Даглан, Индонезия
ORCID ID 0000-0003-2543-0886
vera.erviana@pgsd.uad.ac.id

Меита Фитрианавати
магистр математики, доцент
кафедра подготовки учителей начального образования, университет Ахмад Даглан, Индонезия
meita.fitrianawati@pgsd.uad.ac.id

Аннотация. Информационно-коммуникационные технологии быстро распространяются и имеют огромное влияние на различные сферы жизни, включая сферу образования. В Индонезии также наблюдается высокий уровень внедрения технологий. Технология Интернет-вещей (IoT) все чаще используется для поддержки различных видов деятельности. Можно сказать, что IoT предоставляет новые возможности. Однако, несмотря на ее использование во многих сферах, интеграция этой технологии в образовательную отрасль остается проблемой для педагогов. Учитывая общую тенденцию реформы Национального курикулума в Индонезии, в управлении учебной средой происходят значительные изменения, среди которых переход от обучения, ориентированного на учителя, к обучению, ориентированного на студента, особенно что касается тематического обучения в начальной школе. Результатом внедрения тематического обучения в некоторых странах было повышение уровня сформированности компетентностей XXI века, таких как 4C (критическое мышление, творчество, общение и сотрудничество). Целью данного исследования было создание учебного дизайна для начальной школы, который интегрирует IoT в тематическое обучение по вопросам изменения климата. Для этого необходимо было подготовить измерительный прибор на основе Интернет-вещей с использованием nodeMCU V3 Lolin, который может измерять на расстоянии температуру, давление воздуха, влажность воздуха, высоту, интенсивность света в разных местах. Кроме того, дизайн, который был верифицирован с помощью экспертного подхода (путем привлечения стратегов по образованию, физиков и учителей), был проверен на небольшой группе учеников пятого класса. Для оценки ответов учащихся была использована анкета USE. Эта анкета содержит четыре аспекта: полезность, простоту использования, легкость обучения и аспект удовольствия. Анализ результатов показал, что предложенный учебный дизайн имеет потенциал для улучшения учебной активности учащихся.

Ключевые слова: проблема изменения климата; разработка учебной программы; ученик начальной школы; Интернет-вещи; тематическое обучение.