Tradition Meets Modernity: Learning Traditional Building using Artificial Intelligence

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Abstract: Indonesia is a country that is famous for its culture, arts, traditional crafts, and even traditional houses. This diversity is reflected in each region by having a unique culture as an icon of the area. Therefore, the diversity of arts and culture needs to be preserved, so that it can be used as education and study material for scientific development. This study aims to create a model of cultural preservation through an application to identify the types of traditional buildings in Indonesia. This research focuses on the preservation of traditional Javanese houses because they have many types with uniqueness in terms of topology and also ornaments. Each building model looks similar visually, but actually different because each ornament and topological form has special characteristics. This is an education for students and the general public to know the history of the building. The concept applied in identifying the type of building uses the concept of Deep Learning as one of the fields of Artificial Intelligence (AI). The research begins with the acquisition of building object data, image analysis, development of application as an educational tool for students or the community, and the last is evaluation. The data was taken by taking pictures directly of traditional Javanese buildings in Indonesia using cameras, smartphones, and drones. The total of 1330 images were captured consisting of traditional Javanese house ornaments which are *Joglo* and *Kalang*. Based on the tests carried out to recognize building objects, the system successfully able to recognize building objects with an accuracy of 99.5%. In terms of education in recognizing building design and culture, this application was tested on students, it can increase students' knowledge on building history by 97%.

Keywords: Artificial Intelligence, deep learning, culture education, traditional houses

1. Introduction

Education in the era of the industrial revolution 4.0 can be done by integrating the world of Information and Communication Technology (ICT) in the automation learning process. Integration is carried out between computational techniques, information processing, and Artificial Intelligence (AI) science in the practice of the world of education so that automation occurs. The application of AI in education is integrated with the development of computing and information processing techniques for practice in learning, both as tools and as part of learning models such as intelligent guidance systems, teaching robots, learning analysis dashboards, adaptive learning systems, human-computer interaction, etc. (Chen, Xie, & Hwang, 2020). In the application of AI in educational practice, AI application

development can be used as a learning tool for the independent learning process. This learning model is the focus of this research, namely development of AI as an learning tool for students. Application of AI in education in the era of the industrial revolution 4.0 provides opportunities for AI science to be applied in the learning process, such as digitizing learning scenarios (Conlon & McIntosh, 2020).

Another study that shows AI as part of AI-based education is the application of digital assistants to support interactive learning (Oestraich, Michael, Torben, & Wrede, 2019). In this study, an application used as a substitute for assistants for students can be consulted regarding problems in learning like consulting with humans. Problems in the real world by adopting the consultation process stored in the computer as a source of knowledge. This concept uses a natural language processing approach which is part of the application field of AI (Oestraich, Michael, Torben, & Wrede, 2019). In a study that discusses how AI is applied in education using paradigms, namely AI-directed, learner-as-recipient, AI supported, learner-as-collaborator, and AI-empowered, learner-as-leader were successfully used to overcome problems in learning media (Ouyang & Jiao, 2021).

Entering 2010 many researchers applied AI in the world of education as a form of education in the era of the industrial revolution 4.0 with a deep AI concept, known as Deep Learning. The development of the AI field with the concept of Deep Learning further enhances AI capabilities such as to make predictions, identification, machine translation, and pattern recognition as well as other applications that may be developed to create intelligent learning media. In the AI paradigm applied in learning, it provides a new nuance for students to be able to learn independently, interactively, and adapt to computing media. Applications that use deep learning concepts for learning that are currently developing include intelligent system-based teachers (Kim, et al., 2015), language translation machines (Yang & Xiangling, 2019), and analysis of student behavior in learning (Kuzilek, Zdrahal, & Fuglik, 2021). In a study conducted by Damio, S.M in 2019 using the concept of computer vision and virtual Reality Laboratory for Virtual Reality (VR) speaking problems, the research resulted in a VR application that can be used by students for presentations (Damio, 2019). These studies show that educational AI provides a new paradigm for teachers and students to be more creative and innovative in learning. The concept of independent learning can be realized by collaborating with ICT in improving teaching strategies (Rahmat, Oi Leng, & Mashudi, 2021).

Based on these studies, it can be seen that AI in learning provides opportunities for the world of education to develop learning media with intelligent concepts. This led to the idea of conducting research that could be developed for AI-based education, for example, development of applications that can be used to detect the similarity of assignments in a subject or course using the concept of text mining, where text mining is part of AI applications. Summarize text application can be used by students to practice summarizing an article using AI concepts. This paper presents the results of research that develops research ideas for using AI in education. The concept used is similarity detection using image classification theory which is part of scientific concepts in AI, namely deep learning.

This paper discusses the role of AI in the field of education by creating tools that can be used for student practice in studying the culture and history of traditional buildings in Indonesia. In the subject of History and Culture for junior high school students in Indonesia, there is material about traditional houses as part of the subject matter of culture and history in Indonesia. Learning tools made in the form of a software using the concept of AI, namely deep learning. The tools are developed with website technology, so that during the process of using them they must be connected to the internet and suitable for online learning. This tool can be used to identify objects, in this case traditional houses in Indonesia. The purpose of these tools is to provide alternative learning that can be used independently for students and to increase the variety of learning tools for teachers.

This study refers to research conducted by Ergun, et al (Ergün, Barstugan, & Ince, 2020). This study aims to identify historical monuments as an effort to preserve history and culture using the Convolutional Neural Network (CNN) method. The application of AI in cultural preservation can be used as a digital-based learning media that can be used as an alternative medium for students and pursuers to enrich the learning model. The purpose of this study is to show how AI contributes, especially deep learning in creating intelligent learning environments for behavior detection, predictive model generation, learning recommendations, etc. (Chen, Xie, & Hwang, 2020). By applying AI and computing in education, there has been a transformation of knowledge, cognition, and culture so that it has the potential to change education from traditional to modern education.

The research focus in this paper is developing the tools to identify Indonesian culture through traditional buildings, one of which is Javanese buildings. The reason for choosing traditional Javanese

buildings in Indonesia is because they have various types of traditional Javanese buildings, such as Joglo, Limasan, Solo, and Kampung. This traditional houses visually looks the same, but if look closely it has different ornaments and topologies. Therefore, the problem that often occurs in recognizing the types of traditional buildings is the level of similarity between these traditional buildings. As a traditional building that needs to be preserved, its existence is always monitored within a certain period or after a certain event occurs (Manginia, D'Alvia, Muto, Dinia, & Federici, 2018).

In learning about traditional buildings, this has been done using conventional methods through textbooks related to the history of Indonesian culture. As one of the efforts to develop intelligent-based learning media, this research develops a computational-based learning media to get to know traditional buildings that can be done online. The hope is that it can increase students' interest in learning in the context of cultural education related to traditional buildings. In addition, the existence of documentation in digital form allows information related to traditional buildings to be archived at all times, preserved, and accessed at any time to avoid the threat of global contemporary events (Thwaites, Santano, Esmaeili, & See, 2019).

2. Artificial Intelligence in Education

The application of AI Education has become a trending research topic in the last 10 years during the industrial revolution 4.0. Several systematic reviews have been carried out by various research teams to show common problems in AI Education with the finding of problems in the application of AI Education applications, there is a lack of linking between methods in AI and basic theoretical concepts so that it affects the results of implementing AI in education. AI in the curriculum is considered as an effort to adapt to an increasingly competitive industry (Pan, 2016).

AI is a science that makes computers work like humans by using a knowledge base obtained from previous experience, experts in certain sciences, research, and historical data. In the concept of AI, it allows the use of data obtained from a system to develop into a model, understand the complexity of the problem, and solve the problem through these models.

The concept of automation which is the foundation of the industrial revolution 4.0 does not materialize when the use of AI methods is not based on theoretical concepts in AI. For example, the lack of critical reflection of the applied theory, related pedagogical, and ethical implications with the application of AI applications developed in education (Zawacki & Qayyum, 2019). Learning from these shortcomings, AI innovation in education is increasingly being improved, especially with the development of deep learning applications today. One form of AI Education is the application of deep learning in analyzing information, making conclusions, and making decisions or providing recommendations. This means that deep learning-based platforms can be taught with a lot of data that can be automated, so that they can fulfill a variety of tasks.

Some use cases of AI for education, namely Voice Assistants such as those developed by Amazon Alexa, Apple Siri, and Google Home which are applications that apply pedagogical concepts. This allows interaction between students and applications developed with various learning materials without the need to communicate with the teacher. As a result, the educational platform can be used anywhere and anytime. For example, Arizona State University uses Alexa for routine campus needs. The Voice Assistant app can answer frequently asked questions students have or follow a student's schedule. Another case of applying AI in education is individual learning focuses on meeting the individual needs of the learner. Examples of individual education platforms being developed such as Carnegie Learning are investing in AI to provide more personalized learning materials by providing features that allow teachers to create individualized instruction, testing, and feedback. As a result, students work with the material they prepared and fill in the gaps in their knowledge. However, from this application, there is no ethical implications in the world of education between campuses, teachers, and students. But despite these shortcomings, digital systems open up a world of endless possibilities.

The need for diversification to explore widely what is possible to explore allows one's insight to be expanded (C. Baciu, 2021), so that the imagination of students is also expected to expand widely. In the literature review conducted (Ahmad, et al., 2020) related to the application of AI applications in education, it includes evaluation of student studies, teaching robots, interpreter dictionaries, independent learning, analysis of student behavior, decision making in education management, and so on. In a study (Yusoff, Hashim, Muhamad, & Hamat, 2021) that applied the Fuzzy Delphi technique, experts gathered elements to develop learning modules. The research resulted in an application to create

a questionnaire as a measuring tool in the learning model.

By implementing the 4.0 industrial revolution in the field of education, it causes a paradigm shift because AI is one of the technologies that drive the emergence of the 4.0 industrial revolution (Mhlanga, 2021). The influence of AI impacting IR 4.0 has been controlled and changed human-computer interaction universally (Shahroom & Hussin, 2018). Through the use of AI, it can be used for students to open up insights about understanding, learn independently, and explore to get more information to assist in the decision-making process, create innovative and creative interaction models, provide an integrated collection of knowledge, and enable tools students interact well.

The role of AI in learning has made it a medium for measuring the performance of educational institutions, government agencies, funding institutions, and industry. In education, many AI applications have been developed from various fields of science, such as computer science, philosophy, psychology, logic, language, and other branches of science. Various AI applications that have been developed have a great influence in various aspects of education which are cognitive, affective, and psychomotor aspects, such as learning tools, learning media, and models in learning. As tools, for example, by developing AI-based software that can support the understanding of learning materials. As a learning medium, for example, with a teaching robot that can provide certain subject matter, and as a learning model create a learning framework that provides an overview of the learning process, such as utilizing Augmented Reality as a learning model that imitates a learning process according to scenarios from the real world. Figure 1 shows AI disciplines contribute and support the learning process in educational aspects with AI applications being developed.

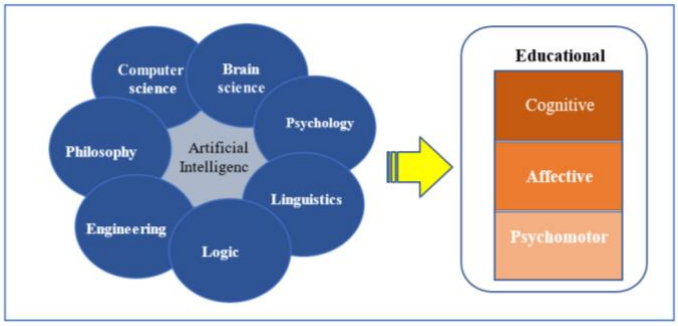

Fig 1. Artificial Intelligence fields that contribute to the education aspect

3. Methods of Research

This research begins by conducting a study on previous research related to AI in education, the application of education in the Industrial Revolution 4.0, digital learning scenarios and the concept of AI and Deep Learning. Furthermore, designing digital learning scenarios for the introduction of traditional buildings, conducting data acquisition of ornaments related to traditional Javanese building models in Indonesia by utilizing the Google Street View application, taking data directly to the location, and interviewing cultural architect experts to obtain related information Javanese traditional building philosophy. The next stage is analyzing the data that will be used in making the system by applying the Convolutional Neural Network (CNN) algorithm which is one of the methods in Deep Learning by going through the stages of training data and testing accuracy using the confusion matrix.

CNN is used as a method used in this study for the development of a tool that can be used to identify types of traditional Indonesian buildings for students. The reason for choosing the CNN method is because CNN is an algorithm that is very popular in the literature because it is able to handle large amounts of data and CNN has a very good performance in machine learning problems (Albawi, Mohammed, & Al-Zawi, 2017). The way CNN works begins with traditional building data acquisition, segmentation using the Softmax method, conducting data training, and testing the validity of traditional building image data that has been processed for the building identification process. After the analysis was carried out on the results of training and accuracy tests, then making an application for a website-based user interface and the final stage was testing the use of the application to junior high school

students in the Yogyakarta to measure the acceptance of AI applications in the subject of History and Culture.

Figure 2 explains how before the tools are made. It begins with creating a learning scenario related to the use of tools for subjects familiar with traditional house culture in Indonesia. The next stage is to collect knowledge related to traditional houses in Indonesia in the form of historical values and building images in the form of roofs, ornaments, and building typology. The process of data collection by interviewing cultural architect experts and taking pictures to the building site. The digital media production process is carried out by managing image data by extracting images with deep learning, training, and testing the validity of images. Then create a system interface and test it with students.

The test was carried out with 100 students from the junior high school in Yogyakarta, namely SMP Muhammadiyah 2 Yogyakarta. Testing is done by practicing using the application in a computer laboratory independently after being given previous training related to this application. The stage evaluates by testing the accuracy of the system's work and measuring the level of success of the system when practiced by students. The results of the evaluation were analyzed to provide recommendations for the tools used as learning tools to recognize the types of traditional buildings.

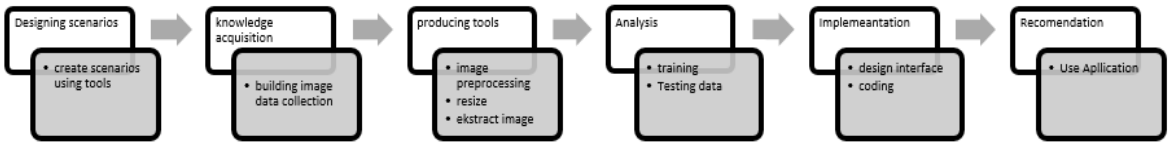

Fig 2. Research Methods

For clarity, the stages in the research are described as follows.

3.1.1 Designing Digital Learning Scenarios

As an initial step, a digital learning scenario is designed so that the production process for making tools is in accordance with the prepared learning plans and actions. It is intended that educational aspects can be achieved with digital-based learning. **The first aspect** includes the cognitive where students gain knowledge after self-study by using tools to recognize traditional types of buildings using AI for History and Culture subject. **The second aspect**, affective, can be done by assessing students' attitudes during the social process and social interaction in learning when using traditional home recognition tools. For example, whether students can accept or reject the existence of these tools. **The third aspect,** namely the psychomotor, can be measured by the physical attitude of students when interacting with the tools made from this research. For example, increasing students' skills in using tools by understanding each instruction contained in the tools and practicing them. The results of using AI application media in History and Culture subject of traditional buildings can be used as an alternative learning tool that is enrichment. This tool can measure the level of acceptance for students and teachers by providing a questionnaire to measure the level of user satisfaction, thus providing recommendations for schools to use this tool to support students in learning of Indonesian traditional building.

3.1.2 Knowledge Acquisition

Knowledge acquisition is a data processing process that is carried out by extracting, structuring, and organizing knowledge from one or more sources. Sources of knowledge can be obtained from a person's expertise in a particular field or several experts to improve framework-based knowledge (N.Jayashri & K. Kalaiselvi, 2018). The knowledge acquisition process is very important because it is the foundation in building AI applications. In this study, the acquisition of knowledge was obtained from experts in Cultural Architects of Yogyakarta, Indonesia from the Department of Architecture, Atmajaya University, Yogyakarta, Indonesia. The knowledge obtained is in the form of information related to the characteristics of traditional Indonesian buildings, especially Javanese traditional houses, building philosophy, building history, building features taken are ornaments and building topology. Building data retrieval in the form of images of ornaments and building topologies such as roofs, pillars, and window shapes of traditional buildings.

In addition to interviews, pictures were also taken from books and the internet related to the

architecture of traditional Javanese buildings, then cropping was carried out to obtain appropriate images. In addition, knowledge acquisition is also carried out by visiting the location of traditional buildings in the Kotagede area of Yogyakarta, Indonesia. The process of taking pictures of this traditional building using several equipment, namely drones, Google street view, digital cameras, and smartphones. Pictures of traditional buildings were taken in the house of Joglo and Kalang.

After the image of the building object is obtained, then the image processing is called pre-processing. Pre-processing is needed to get good quality image data and with the best size in this case using an image size of 180 x 180 pixels which is called scaling. Table 1 is the data obtained for the study, namely the traditional Joglo and Kalang located in the Yogyakarta with a total dataset of 1330 images. The dataset is then divided into two groups of training data and validation data. The training data are 1069 images (80%) of the total dataset, therefore the validation data are rest of 261 (20%) images. The testing data are 61 images are taken for new data. The detail of knowledge acquisition for Joglo and Kalang are listed in Table 1. This is needed in the process of making CNN architecture for identification of building objects. The data that has been recognized by the system during the training process is no longer used, but uses the rest of the data so that the performance of the architectural model can be measured.

Table 1. Knowledge acquisition

Building Type	Training Data	Validation Data	Testing Data
Joglo	325	80	33
Kalang	744	181	28
Total	1069	261	61

4 Digital Media Production

In the process of development of learning media with the application of AI, the concept of deep learning is used. The manufacturing process begins with extracting images from building objects that have been taken at the data acquisition stage. In this study, image extraction is done automatically using the CNN method called augmentation technique. Augmentation technique is widely used by researchers with CNN because it is included in the type of Deep Learning. Its high network depth and widely applied to image data and is suitable for image classification. Augmentation techniques used in this study include flip, random cropping, and random rotation (Suyanto, Ramadhani, & Mandala, 2019).

The augmented data is used for data training on the CNN model that has been designed. The training is carried out using the Adam algorithm as an optimizer available from the Python programming language library. To make AI applications, the data analyzed by using Python programming, while the application interface uses PHP programming. Python programming have a rich libraries and multiplatform capabilities with many programming languages, one of which is PHP. The stages of the learning media development process can be seen in Figure 3.

Fig 3. Process in the development of AI-based digital learning media

4. Results

4.1. Application Usage

After the AI digital learning model for learning History and Culture subject, the next stage is the accuracy testing process. Applications that have been uploaded on the website can be accessed at the address http://bangunancagarbudaya.my.id. It was tested randomly to 100 junior high school students in Yogyakarta. There are given an explanation regarding the use of this application and then

asked to input the image they were looking for on the internet to be matched with the application. After that, observations were made on the students in terms of cognitive, affective, and psychomotor aspects when they used the learning media. To measure satisfaction with the AI application, the students were arranged in a questionnaire after they finished operating it.

4.2. Evaluation

The evaluation process is carried out by giving questionnaires to students who have practiced the application of introducing the traditional building. The results of the measurement of the use of AI applications are then processed for data analysis to obtain mapping results and conclusions can be made regarding the success rate of using AI applications in the field of education, especially in History and Culture subject for the introduction of traditional buildings. The evaluation was conducted to determine the suitability of the learning model designed in the learning scenario with the practice of implementing independent learning using this Educational AI Application.

5. Discussion

This research produces an educational AI tool that can be used by junior high school students in the subject of History and Culture. This tool can be used by teachers as an alternative learning tool that can be used for students to identify the various types of traditional buildings in Indonesia. The tool is an application with web technology that supports online learning. Students can enter a picture of a traditional building into the application, then the system will provide information related to the traditional building in the form of history, location, and name of the building. In order to accurate for the results of the information were provided, the application has been trained using the concept of deep learning by using thousands of building data consisting of ornament, shape, and building typology. In addition, a validity test is also carried out so that the results of building identification are 97% accurate.

The AI Educational application developed in this study has been tested for accuracy in recognizing objects. Based on the data accuracy test carried out for 20 epochs, the best results were 0.995% with a validation loss of 0.031%. After building and defining the CNN architecture, it was continued by determining the compile model such as optimizer, loss function, and metrics. In this study, the Adam algorithm is used as the optimizer, the loss function uses sparse categorical cross entropy and for metrics, the metrics Sparse Categorical Accuracy is used. Furthermore, to obtain the best model must determine the value of the batch size and epoch. Table 2 shows a summary of the model compile and model fit.

Table 2. Summary of Model Compile and Model Fit

Attributes	Args	Values
Model Compile	Optimizer	Adam
	Loss Function	Sparse Categorical Cross entropy
	Metrics	Sparse Categorical Accuracy
Model Fit	Epoch	200
	Batch Size	64

Figure 5 shows a graph of the results of the accuracy and validity tests carried out. The blue line represents the accuracy data from the training results, while the yellow line represents the data from the validity test results. Table 3 describes the data from accuracy testing and training results for testing architectural models with CNN used in the identification and classification process of traditional building drawings.

Fig 5. Accuracy Results

Table 3. Summary of CNN Architecture

Layer	Types	Filters	Kernel	Output Shape	Parameters
0	Input	1	3x3	(180,180,3)	0
1	Data Augmentation	1	3x3	(180,180,3)	0
2	Rescaling	1	3x3	(180,180,3)	0
3	Convolutional (Conv2D)	16	3x3	(180,180,16)	448
4	Pooling (MaxPooling2D)	16	3x3	(90,90,16)	0
5	Convolutional (Conv2D)	32	3x3	(90,90,32)	4,640
6	Pooling (MaxPooling2D)	32	3x3	(45,45,32)	0
7	Convolutional (Conv2D)	64	3x3	(45,45,64)	18,496
8	Pooling (MaxPooling2D)	64	3x3	(22,22,64)	0
9	Dropout	-	-	(22,22,64)	0
10	Flatten	-	-	30976	0
11	Dense	-	-	128	1,069
12	Output	-	-	5	269
		Total			1,330

After obtaining the best accuracy results, then the learning model tested by applying the AI Education application for junior high school students of Yogyakarta, Indonesia when delivering History and Culture subject. This digital learning model is applied to online learning that occurred during the Covid-19 pandemic in 2020. Based on trials conducted with 100 students, the overall success rate was 97%. The cognitive aspects are 75% and 93%, affective aspect it was 74%, and psychomotor is 53% and 45%. All of aspects in the scale of 4 or 5. For more details, the measurement results for the three aspects of education achieved from the learning model are presented in Table 4.

Table 4. The success rate of the AI Education application

Aspect	Question	Scale	Success rate
Cognitive	1. Historical information related to traditional buildings with this application is clear and easy to understand	5	75%
	2. Overall, the application is useful in increasing user knowledge in getting to know culture through	5	93%

	traditional buildings		
Affective	Feel happy if there is an application for traditional building education that can be used	5	74%
Psychomotor	Overall the application is easy to use, both with the help of teachers and independently through computers, smartphones or other gadgets.	5 4	53% 45%

Figure 6 shows a graph of satisfaction of students when using AI applications.

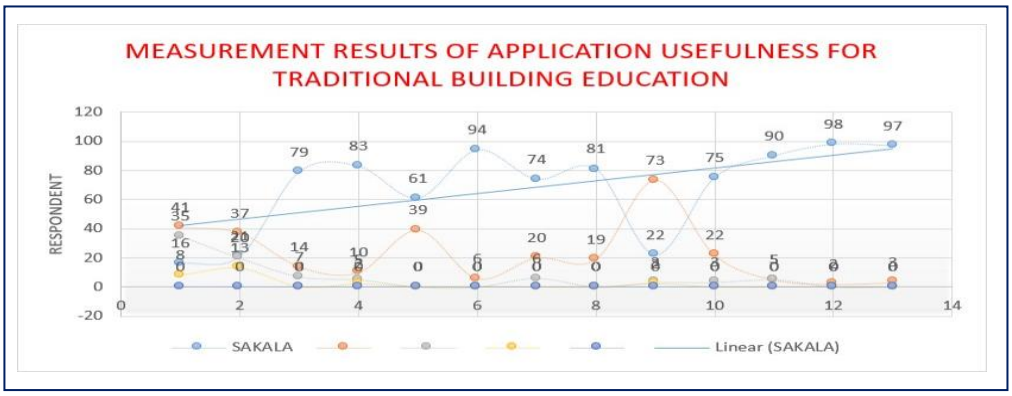

Fig 6. Student satisfaction when using AI applications

Based on Figure 6, it can be seen that traditional building identification application has been tested online by students a questionnaire containing questions related to students' interest in using the application. The questions cover three aspects, namely cognitive, affective, and psychomotor. The majority of students stated that the educational AI application for the identification of traditional buildings provide benefits by 98% and provide motivation to study independently by 91%. The results of this measurement show educational AI has made is a real contribution to education. By collaborating ICT into the education system has motivated educators to be more creative in using and developing learning models, such as applying a student-centered learning approach where students can build their own knowledge, seek meaning, and find solutions independently (Hopper, J. H, 2016). Furthermore, educators provide their views by showing that the integration of ICT will make the student learning process easier and provide a motivating learning environment for students (Rahmat M. K., 2019). Another finding in this study proves that the deep learning concept applied in the development of tools for identification of traditional buildings can achieve a very good accuracy value of 99.5% by applying the CNN technique as part of AI science.

6. Conclusion

Based on the review of the research results and discussion, it can be concluded that the application of AI Education in History and Culture subject to identify Indonesian traditional buildings can be stated according to the designed learning scenario. Measurement of the use of applications for Junior High School students of Yogyakarta, Indonesia shows that 97% of AI applications for early exposure can be accepted as an alternative media for digital learning for History and Culture subject. The recommendations from the evaluation is expected to contribute to the education sector to provide a learning model that supports the industrial revolution 4.0, so that students can learn independently with digital media that is in accordance with the current era. From the evaluation, it was also found that the digital learning scenario that applies this AI Education can fulfill the cognitive aspect by 75%, the affective aspect by 74%, and the psychomotor aspect by 53%. Thus the success rate in learning about Indonesian traditional buildings with AI implementation Education can be used as an alternative learning model for the Industrial Revolution 4.0 era.

7. Suggestion for Future Research

From the research that has been done, there are still shortcomings in terms of AI Education application products that are applied to the introduction of traditional buildings. It needs to be further developed to add a variable level of similarity between an object and other objects that are indicated to be similar. The current research has not been able to overcome the problem for similar building that can say the percentage value of the similarity, this needs to be developed. For further research, we can use object parameters with a scale of 3600 by improving the data analysis model using the Transfer Learning Method to increase the performance. It is also necessary to use students from architecture study program as respondents in the system test to obtain the wide view of knowledge.

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9. References

Ahmad, K., Qadir, J., Al-Fuqaha, A., Iqbal, W., Elhassan, A., D. Benhaddou, & Ayyash, M. (2020, Juni 20). Artificial Intelligence in Education:. *resiearchgate*.

Albawi, S., Mohammed, T. A., & Al-Zawi, S. (2017). Understanding of a convolutional neural network. *International Conference on Engineering and Technology (ICET).* Antalya, Turkey: IEEE.

(n.d.).

C. Baciu, D. (2021). Creativity and diversification: What digital systems teach. *Thinking Skills and Creativity*.

Chen, X., Xie, H., & Hwang, G.-J. (2020). A multi-perspective study on Artificial Intelligence in Education: grants, conferences, journals, software tools, institutions, and researchers. *Computers and Education: Artificial Intelligence*, 1-10.

Conlon, M. M., & McIntosh, G. L. (2020). Perceptions of realism in digital scenarios: A mixed methods descriptive. *Nurse Education in Practice*, 1-7.

Damio, S. M. (2019). Virtual reality speaking application utilisation. *Asian Journal of University Education (AJUE)*, 235-244.

Mhlanga, D. (2021). Artificial Intelligence in the Industry 4.0, and Its Impact on Poverty, Innovation, Infrastructure Development, and the Sustainable Development Goals: Lessons from Emerging Economies? *Sustainability MDPI*.

Rahmat, H., Oi Leng, C., & Mashudi, R. (2021). Innovative Educational Practice for Impactful Teaching Strategies. *Asian Journal of University Education (AJUE)*, 53-60.

Rahmat, M. K. (2019). VISUAL ART EDUCATION TEACHER'S BELIEFS AND. *Asian Journal of University Education (AJUE)*, 285-294.

Shahroom, A. A., & Hussin, N. (2018). Industrial Revolution 4.0 and Education. *International Journal of Academic Research in Business and Social Sciences* , 314-319.

Yusoff, A. F., Hashim, A., Muhamad, N., & Hamat, W. N. (2021). Application of Fuzzy Delphi Technique to Identify the Elements. *Asian Journal of University Education (AJUE)*, 292-304.

Ahmad, K., Qadir, J., Al-Fuqaha, A., Iqbal, W., Elhassan, A., D. Benhaddou, & Ayyash, M. (2020, Juni 20). Artificial Intelligence in Education:. *resiearchgate*.

Albawi, S., Mohammed, T. A., & Al-Zawi, S. (2017). Understanding of a convolutional neural network. *International Conference on Engineering and Technology (ICET).* Antalya, Turkey: IEEE.

Chen, X., Xie, H., & Hwang, G. J. (2020). A multi-perspective study on Artificial Intelligence in Education: grants, conferences, journals, software tools, institutions, and researchers. *Computer and education: Artificial Intelligence*.

Conlon, M., & Gwenne L. , M. (2020). Perceptions of realism in digital scenarios: A mixed methods descriptive. *Nurse Education in Practice*.

Ergün , M., Barstugan, M., & Ince, I. (2020). articleDeep learning-based weathering type recognition in historical stone monuments. *Journal of Cultural Heritage*.

Hamilton, E., Rosenberg, J., & Akcaoglu , M. (2016). The Substitution Augmentation Modification Redefinition (SAMR) Model: a Critical Review and Suggestions for its Use. *TechTrend*, 433-441.

Hopper, J. H. (2016). Digitizing the easel: Student perspectives on tutorial videos in the art. *Art Education*, 23-28.

K. Suyanto, N. Ramadhani, & S. Mandala. (2019). *Deep Learning Modernisasi Machine Learning untuk Big data.* Bandung-Indonesia: Informatika Bandung.

Kim, C. M., Kim, D., Jiangmei, Y., Hill, R., Doshi, P., & N.Tha, C. (2015). Robotics to promote elementary education pre-service teachers' STEM engagement, learning, and teaching. *Computer & Education*, 14-31.

Kuzilek, J., Zdrahal, Z., & Fuglik, V. (2021). Student success prediction using student exam behaviour. *Future Generation Computer System*, 661-671.

Manginia, F., D'Alvia, L., Muto, M. D., Dinia, L., & Federici, E. (2018). Tag recognition: A new methodology for the structural monitoring of. *Measurement*, 308-313.

N.Jayashri, & K. Kalaiselvi. (2018). Knowledge Acquisition – Scholarly. *4th International Conference on Cyber Security (ICCS) 2018* (pp. 334-339). India: INTERNATIONAL JOURNAL OF ADVANCED STUDIES OF SCIENTIFIC RESEARCH (IJASSR).

Oestraich, H., Michael, W., Torben, T., & Wrede, S. (2019). Interactive Learning of Assembly Processes using Digital Assistance. *Procedia Manufacturing*, 14-19.

Ouyang, F., & Jiao, P. (2021). Artificial intelligence in education: The three paradigms. *Computers and Education: Artificial Intelligence*, https://doi.org/10.1016/j.caeai.2021.100020.

Pan, Y. (2016). Heading toward Artificial Intelligence 2.0. *Engineering*, 409-413.

Thwaites, H., Santano, D., Esmaeili, H., & See, Z. S. (2019). A Malaysian cultural heritage digital compendium. *Digital Applications in Archaeology and Cultural Heritage*.

Yang, Y., & Xiangling, W. (2019). Modeling the intention to use machine translation for student translators: An extension of Technology Acceptance Model. *Computers & Education*, 116-126.

Zawacki, O., & Qayyum, R. A. (2019). Open and Distance Education in Asia, Africa and the Middle East. In *Book series (BRIEFSEDUCAT).* Springer Open.