



## Effectiveness of Artificial Intelligent Independent Learning (AAIL) with physics chatbot of global warming concept

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**Abstract:** This research aims to analyze the effectiveness of Artificial Intelligent Independent Learning (AAIL) with physics chatbot of global warming concept. Method of research uses the Research & Development method referring to the ADDIE development model. This research was conducted with 64 students at Senior High School in Indonesia who were divided into chatbot-based experimental groups and control groups. The results of this study were obtained by conducting the normalized gain  $\langle g \rangle$  test of 0.60 (medium category) for the control group and 0.87 (high category) in the experimental group. As for the results of the Cohen's D effect-size test, the result was 0.93 with high category AAIL for increasing learning outcome. Thus, the developed AAIL chatbot has high effectiveness in increasing learning outcome.

**Keywords:** artificial intelligent; independent learning; physics; chatbot; global warming

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### Introduction

Education is important for everyone without exception and education is also helpful in the formation of one's character. Everyone is obliged and has the right to get a proper education for the future (Sinha et al., 2020). Education, indeed, cannot be separated from the name of technology. In education, technology has a significant and relatively large role where technology can be a means to support the learning process (Geng et al., 2019). Therefore, with technological developments like this, both students and educators must be able to use and make the best use of technology to have a positive impact and support the continuity of the learning process (Ashrafi et al., 2022). As a global call to action to secure freedom and harmony. Educational ambitions are reflected in Sustainable Development Goal 4 (SDG 4) of 2030. This goal aims to ensure inclusive and equitable education and promote lifelong learning opportunities for all by 2030 (English & Carlsen, 2019). Technological developments in the world of education today are proliferating. In facing the modern era of this advanced industrial revolution, using sophisticated information and computer technology in education is essential (Haleem, et al., 2022). Today's learning involves computerization and sophisticated computing. Technology is proven to increase students' interest in learning because it has an attractive appearance, so students will avoid boredom while attending lessons. Technological advances have significantly influenced the world of education (Shaturaev, 2022).

Every aspect of our life is supported by technology (Rakhra, et al., 2021). In today's highly connected world, digital technology systems can record, monitor, and adjust every interaction between connected things. Like the Internet of Things or what we usually know by the acronym IoT, which is a technology that allows for control, communication, collaboration with various hardware devices, data via the internet network. So, it can be said that the Internet of Things (IoT) is when we connect something (things) that are not operated by humans, to the internet (Chander et al., 2022). IoT plays an important role in the industrial revolution 4.0. One of the developments in information technology is Artificial Intelligence or can be abbreviated as AI. Artificial Intelligence is a technology that enables computer systems, software, programs, and robots to "think" intelligently like humans (Zhang et al., 2022). Artificial intelligence first appeared in 1956 with the support of John MacCarthy. Artificial intelligence enables machines to learn from experience, adapt user inputs and perform human-like tasks. AI only started to enter Indonesia a few years ago and until now it has not been widely used because it requires a lot of tools and costs to create an AI program (Gonda & Chu, 2019).

The application of AI development that we can use in education is chat robots or what we usually call chatbots, which is a chat technology that can replace a human job in providing material via chat on mobile phones. As for some of the research conducted by previous researchers, namely as follows. AI Based Chatbot to Self-Learn and Self-Assess Performance in Ordinary Level Chemistry" shows that the application of Edubot supports independent learning and self-evaluation targeting ordinary level chemistry subjects (Mahroof et al., 2021). Intelligent tutoring chatbot for solving mathematical problems in High school" shows that an intelligent bot was developed to guide students how to solve function problems in mathematics, especially about determining the value of a parameter in such a way (Nguyen, Pham, & Tran 2019). A Review of Chatbot development for Dynamic Web-based Knowledge Management System (KMS) in Small Scale Agriculture shows the importance of a web-based knowledge management system framework with chatbot applications in utilizing information sharing platforms to disseminate knowledge (Ong et. al 2021). Based on the research above, a web-based information sharing platform is proposed involving databases with Python using MongoDB. The Design of an Intelligent Chatbot with Natural Language Processing Capabilities to Support Learners shows that there has been a positive response from students in using chatbots for revision in programming courses (Wong, 2022). Chatbot Development as a Digital Learning Tool to Increase Students' Research Knowledge shows that his research has positive results, namely the use of chatbots supports learning and can increase student knowledge (Vanichvasin, 2021). Conversation Technology with Micro-Learning: The Impact of Chatbot-Based Learning on Students' Learning Motivation and Performance" shows that from the data obtained, it can be concluded that students need Artificial Intelligence Chatbots as learning media because they can create more effective learning without the need for face-to-face meetings (Yin et al., 2021). Recently the chatbot system is gaining popularity because of its wide application, other reasons are because the chatbot system is easy to approach, improves customer experience, can manage many customers, and is cost effective (Krishnan et al., 2022). Chatbot is a computer program designed to be able to carry out conversations with users via text or voice media, usually carrying out short conversations (Nirala et al., 2022). The way chatbots work is to use a natural language processing system to analyses sentences entered by users. In simple terms, chatbots identify the keywords entered and search for the most appropriate response sentences from their repository or database (Huang & Chueh, 2021). Of course, the scope of what will be questioned is already limited so that it will not go outside the scope that has been determined.

Chatbot is an automatic program developed by simple algorithms in artificial intelligence and designed to communicate directly with humans. Chatbot has two main components, namely Chat which can be interpreted as a conversation, and Bot is a program that contains some data and, if given input, will provide answers (Lee & Yeo, 2022). Chatbot is an example of an implementation of a natural language programming algorithm. Chatbots give people an unusual experience in conversation. The artificial intelligence embedded in the chatbot will allow it to simulate conversations with human-like conversations. Therefore, people will get the same experience whether talking to humans or chatbots (Gnewuch et al., 2022).

With the work system carried out by chatbots, later users will easily find the information they want. In general, chatbots have three main elements in operation, namely users, instant messaging applications, and the chatbot itself. Based on the scope of questions and answers, chatbots are divided into two types, namely virtual assistants, and chatterbots (Suhel et al., 2020). So far chatbots are often used in business activities, such as in customer service or providing product information (Cîmpeanu, 2021). In learning, we can use WhatsApp Auto Reply, which is a feature on WhatsApp Business that is used to answer incoming messages automatically. WhatsApp Auto Reply can be a solution for learning at any time because it is not limited to business operating hours, besides that it is also safe to use, and cost-effective compared to other chatbot applications (Mufadhol et al., 2020). Conversation is unique in that it bridges the gap between human-human interaction and human-computer interaction (HCI) (Choudhury et al., 2020). Global warming of essential because can add a broader insight and get to know more about the state of nature and to be a motivation to maintain and grow a sense of love for this universe (Handayani & Putra, 2019).

However, the application of chatbots in education is currently lacking, especially in physics education. Chatbots in physics learning have not been carried out much, hail mini, this can be proven by entering the keyword physics educational chatbot on Google Scholar, only one article can be found on the Google Scholar page (click). This gap can be seen from previous research on educational physics chatbots, including that chatbots can offer an interesting, interactive, and personalized learning journey that allows students to uncover complex physics (Manson et al., 2023). AI chatbot to answer questions based on any document or website in just 60 seconds physics related questions (Dahlkemper, Lahme, & Klein, 2023). Physics chatbot with active learning suite for first year physics students (Aguilar-Mejía, et al., 2022). Chatbot to improve the conceptual understanding of Newton's laws, integrating them into a didactic series simultaneously (Maclsaac, 2023). An AI chatbot that can solve physics problems and provide explanations and reasons behind the answers. It can solve most school physics questions and perform basic mathematical calculations (Küchemann et al., 2023). This shows the chatbot gap in physics learning which discusses the Physics Chatbot of Global Warming Concept.

Therefore, the research that will be carried out by researchers is regarding the development of AI chatbots on global warming material. In general, the results of this study are expected to be useful in the field of education, especially for physics teachers as an innovation in the application of Artificial Intelligence Chatbot in learning. This research aims to analyses the effect of the effect of Artificial Intelligent Independent Learning (AIII) with the physics chatbot of global warming concept.

## Method

This research uses the Research & Development method with ADDIE model. ADDIE model has a goal to produce a product (Kurt, 2019). The reason for choosing the ADDIE model is because this model makes it easy to create, organize, and simplify effective media learning and development programs. In addition, the ADDIE Model is simple and easy to understand, but very effective in creating learning media programs. The advantage of this model is that it is structured and integrated, and organizations often use it to design chatbot media development. ADDIE stands for Analyses, Design, Develop, Implement, and Evaluate. ADDIE is an instructional design cantered on individual learning, has direct and long-term phases, is systematic, and uses a systems approach to knowledge and human learning. Effective ADDIE instructional design focuses on executing authentic tasks, complex knowledge, and original problems. The ADDIE learning model is based on an effective and efficient system approach and an interactive process between students and teachers and the environment. The results of the evaluation of each learning step can bring learning development to the next step or phase (Spatioti et al., 2022). Each stage of this research will be described in Figure 1.

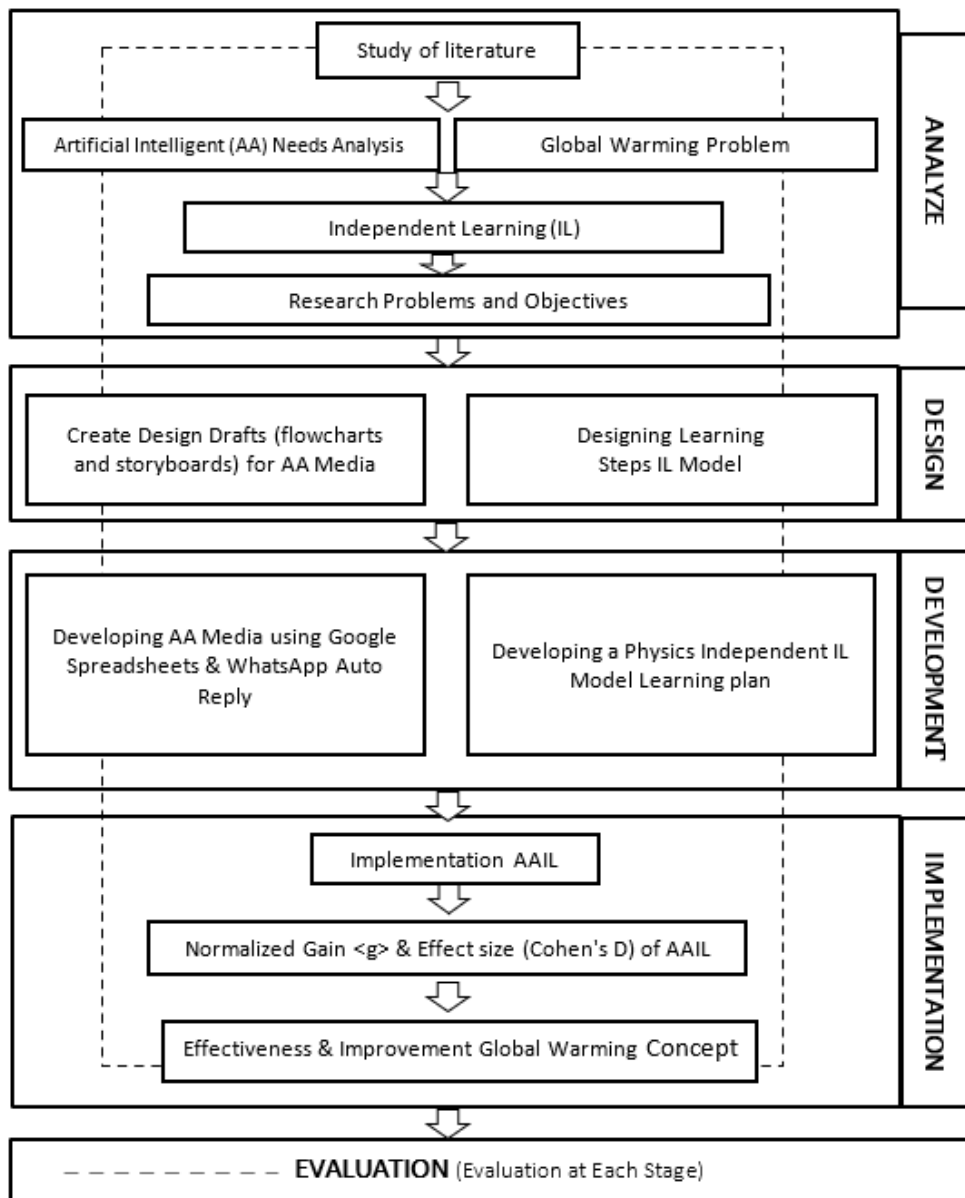


Figure 1. ADDIE Research Design of AAIL

Figure 1 describes the ADDIE Research Design of AAIL with Physics Chatbot of Global Warming Concept. The analysis phase was carried out using literature studies and field studies. Field studies in the form of observations were carried out by identifying the needs of students and teachers in the physics learning process. In contrast, literature studies analyse the curriculum and look for references to solve the specified problems. The design phase creates a storyboard design to determine learning materials based on facts, concepts, principles, and procedures, learning time allocation, indicators, and instruments. The development stage is carried out by developing AAIL media and producing and revising the media, which will later be used to achieve the learning objectives that have been designed. Technically, researchers develop AAIL Chatbot under the name "MiClima" at this development stage, which media, material, and learning experts will validate. After being validated by experts, revisions will be carried out according to the suggestions and criticisms of experts. In addition to media development test instruments leaning outcome tests were also developed, and instrument experts will also validate these two tests. Test instruments and cognitive tests will be revised according to the validator's criticisms and suggestions. The implementation stage implementing AAIL MiClima was validated by experts and revised according to the directions and suggestions from the validator; then, it will be implemented or implemented through a limited trial process and large-scale trials by high

school students in one of the cities in the centre of Jakarta, Indonesia. The evaluation stage is carried out at each stage by looking at the improvement of each ADDIE Stage.

The instrument used in this study was a student learning outcome. The objective was to determine the results of testing the effect of AI Chatbot MiClima media developed on student learning outcomes. This questionnaire is for pre-test and post-test trials of the influence of learning in 2 Group groups, the control group and the experimental group that uses chatbots. Instruments to see improvements using cognitive learning outcomes instruments on the Global Warming Concept. Cognitive aspects with the main indicator criteria regarding conception namely C1 (knowledge) and C2 (Understanding).

Statistical testing showed increased learning outcomes using normalized gain <g>. In general, data processing is done using a very statistical approach. Data on student test results on the pre-test and post-test were analysed by comparing the pre-test and post-test scores. The increase in learning outcome that occurs before and after learning is calculated using the Gain factor <g> formula developed by Hake (2002) with the formula:

$$\langle g \rangle = \frac{\langle S_{post} \rangle - \langle S_{pre} \rangle}{\langle S_{maks} \rangle - \langle S_{pre} \rangle} \tag{1}$$

**Information:**

- <S<sub>post</sub>> = average final test score
- <S<sub>Pre</sub>> = average pre-test score
- <S<sub>max</sub>> = average maximum score

**Table 1. Criteria <g>**

<g>	Criteria
$g \geq 0,7$	High
$0,3 \leq g < 0,7$	Medium
$g < 0,3$	Low

Effectiveness test of AAIL MiClima Learning on Learning Outcomes using the Cohen's D Test. Cohen's D is a measure of effect size often used in statistics and calculated as the difference between the two means (Experimental Group and Control group), divided by the combined standard deviation(s) of the two groups. A small effect size is generally considered d 0.2 or less, a medium effect size is between 0.5 and 0.8, and a large effect size is 0.8 or greater. The following is the general process (formula) for calculating Cohen's D expressed Goulet-Pelletier & Cousineau, (2018).

$$d = (\bar{x}_1 - \bar{x}_2)/s \tag{2}$$

**Information:**

- $\bar{x}_1$  = Average Experiment Group
- $\bar{x}_2$  = Average Control Group
- s = the combined standard deviation of the two groups by the formula:

$$\sqrt{\frac{(s_1^2 + s_2^2)}{2}}$$

**Table 2. Criteria Cohen's D**

Effect Size (ES)	Criteria
ES < 0.20	Ignored
0.20 < ES < 0.50	Low
0.50 < ES < 0.80	Currently
0.80 < ES < 1.30	Large
$1,30 \leq ES$	Very large



Results and Discussion

Chatbot Development

The resulting Artificial Intelligence is the development of AAIL MiClima Chatbot to improve student learning outcomes on Global Warming material. Global Warming material in the Merdeka Indonesia curriculum is part of physics lessons in grade ten at high school, so this research was conducted on physics learning. This Artificial Intelligence Chatbot can be accessed online using social media platforms such as WhatsApp, Telegram, and Messages. The development of Artificial Intelligence Chatbot is equipped with teaching materials that can help students to understand Global Warming material briefly. The development of the Artificial Intelligence Chatbot is also equipped with a usage module. The appearance of the usage module is arranged to facilitate the use of Artificial Intelligence Chatbot MiClima. This module aims to make it easier for users to find the keywords they want to ask. There are main keywords and sub-keywords. It contains some material content along with a comprehension test.

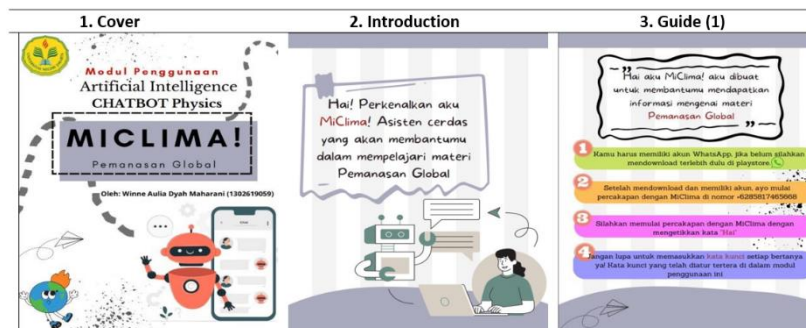


Figure 2. Cover, Introduction & Guide of Chatbot MiClima

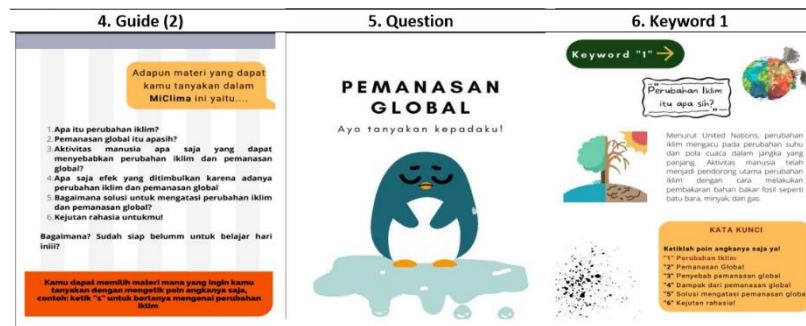


Figure 3. Guide (2), Question & Keyword 1 of Chatbot MiClima

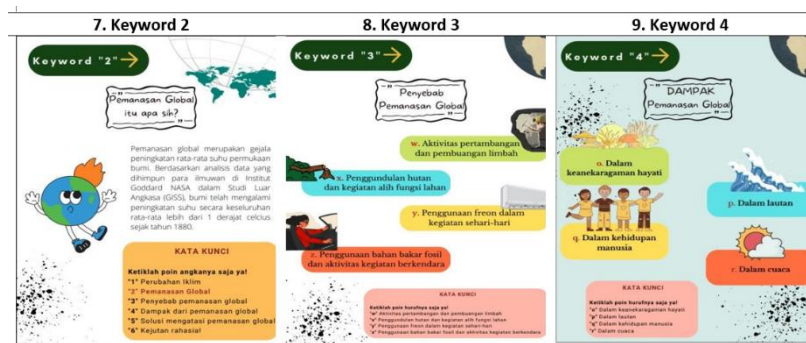


Figure 4. Keyword 2-4 of Chatbot MiClima



Figure 5. Keyword 5, Task & Start of Chatbot MiClima

Figure 2-5 the description of AAIL physics learning is implemented using Google Spreadsheets, which is connected directly to WhatsApp Auto Reply. The data loaded in the Spreadsheet will immediately sync with the social media application you want to use. In this study, the authors used the WhatsApp application as the medium.

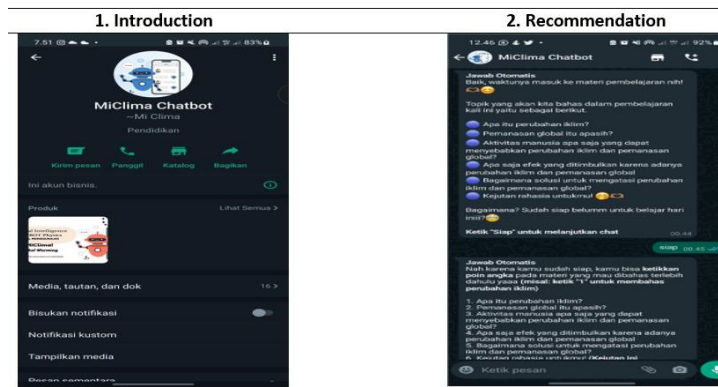


Figure 6. Implementation of Chatbot MiClima in WhatsApp's

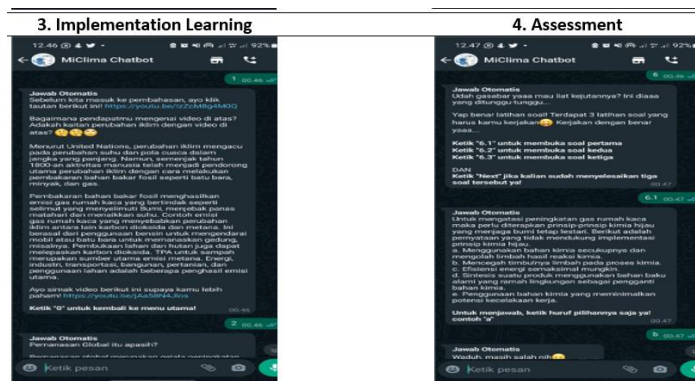


Figure 7. Implementation learn to be independent of Chatbot MiClima in WhatsApp's

Figure 6-7 illustrates that The AAIL MiClima product was developed based on micro-learning, which contains four sections: introduction, recommendations for sub-learning materials, learning, and assessment. AAIL contains a brief catalogue of prefix keywords and sub-materials to be discussed. AAIL is equipped with a usage module embedded in Google Drive.

**Improved Student Learning Outcomes**

Implementation of AAIL for students is carried out pre-test and post-test to see how student learning outcomes increase after learning with AAIL. This Gain test was carried out to determine the conception and effectiveness of the product developed on student learning outcomes after learning

was carried out using Artificial Intelligence Chatbot MiClima media. This N-Gain has the objective of measuring the effectiveness of the media in increasing students' knowledge and skills and measuring the extent to which student learning outcomes have improved. In this study, data were obtained, which were the results of the pre-test and post-test carried out by 64 students from 2 different groups, namely the experimental and the control groups. Pre-test activities are carried out before students use Artificial Intelligence Chatbot MiClima in learning, and post-test activities are carried out after students use Artificial Intelligence Chatbot MiClima, which has been developed. The results of increasing learning outcomes through calculating the average N-Gain score of Figure 8.

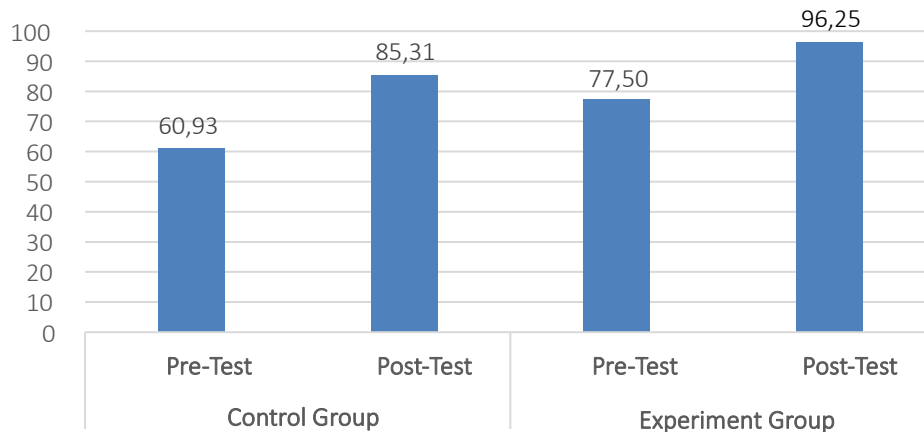


Figure 8. Average Pre-Test dan Post-Test Learning Outcome Student

Based on Figure 8 obtained from the calculation, the average value of the experimental Group in the pre-test was 77.5 and the average value of the experimental Group in the post-test was 96.25 with an ideal value of 100. The average value of the control Group in the pre-test was 60.938 and the average value of the control Group in the post-test was 85.313 with an ideal value of 100.

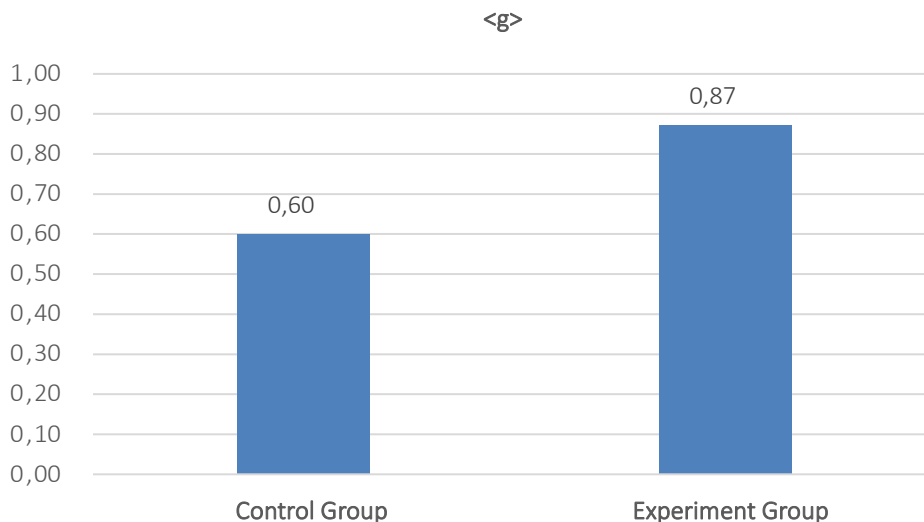


Figure 9. Average Score <g> Learning outcome student

Figure 9 illustrates the results of the average value of <g> from 2 different groups. For the experimental Group, the results of the main score were 0.871 in the high category. And for the control Group, the results of the N-Gain score were 0.600 in the moderate category. These two results show a significant difference between the two Groups in measuring students' conceptual construction abilities.



### *Effectiveness of AAIL for Learning*

The D'Cohen test was carried out to measure the effectiveness used to show the magnitude of the difference between the two Group averages. In this study, the D'Cohen test was calculated to determine how much influence or impact the student's learning outcomes had after learning Global Warming using the Artificial Intelligence Chatbot MiClima product. After conducting the research, data obtained from the pre-test and post-test results were carried out in 2 groups, namely the experiment and control. Pre-test activities were carried out before learning with 25 learning outcomes indicator items and ten learning outcomes concept items based on a cognitive questionnaire with C1 (knowledge) and C2 (understanding) indicators. And post-test activities are carried out after learning with the number of items with indicators of learning outcomes, as many as 25 questions, and as many as ten questions about the concept of conception construction based on cognitive questionnaires with these indicators. The following are the results of calculations using Ms. Excel and SPSS 25 in Table 3.

**Table 3. Effectiveness of AAIL MiClima Media based on D'Cohen Calculations**

Group	n	x	S	S2	D'Cohen
Control	32	0,600	0,318	0,101	0,93
Experiment	32	0,871	0,262	0,068	

Based on the data in Table 3, information is obtained that the magnitude of the effectiveness of AAIL MiClima influences the formation of the conceptual construction of the Global Warming concept of student learning outcomes in student learning in the two Group groups is 0.92 with the results of the large category where the criterion  $0.80 \leq ES < 1.30$  is included in the large category. Based on the results of the AAIL effectiveness test on student learning outcomes during the learning that has been carried out, the use of AAIL scores is in the moderate category. In this case, the authors conclude that learning using Artificial Intelligence Chatbot needs to be accompanied by selecting appropriate learning models and strategies (Chakrabortt et al., 2023). The learning method using chatbots is more suitable for students with higher initial perceptions (Yin et al., 2021). The use of an Artificial Intelligence Chatbot requires collaboration that emphasizes group work and joint tasks that encourage interaction between people, where in learning, knowledge is obtained and built through active dialogue that allows the exchange of ideas and information and supports knowledge construction even from a distance. Learning that is open and intended for individual learning causes students to feel unmotivated.

Chatbots have an important role in physics learning, including that chatbots can be used as formative test assistants to provide feedback on temperature and heat material in physics learning (Nikolic et al., 2023). Chatbots can help students understand physics concepts in an interactive and interesting way. Chatbots can increase student activity in learning physics (Mai, 2022). Chatbots can become virtual assistants for teachers in physics learning (David, Chalon, & Zhang, 2022). Chatbots can help in solving pictorial physics problems on resistor material (P dos Santos, 2023). By using chatbots in physics, students can get a more interactive, interesting, and personalized learning experience.

Future research needs to develop a comprehensive longitudinal evaluation framework in addition to learning motivation that can be used as a benchmark to understand how chatbot-based learning can complement current teaching to create more effective learning that can be done anywhere (Mageira et al., 2022). In addition, it is hoped that in the future, chatbots can increase familiarity with technology in learning (Gudala et al., 2022) or use chatbot technology collaboratively (Sloan, 2015) to maintain interest, value, and use in the learning process and of course increase student motivation and performance. In the previous Artificial Intelligence Chatbot development research, various Artificial Intelligence Chatbots were developed in various aspects such as health, economy, business, education, and many more. Chatbot Development as a Digital Learning Tool to Increase Students' Research Knowledge, shows the results of using Artificial Intelligence Chatbot technology in education to provide personalized learning support in increasing students' conceptual and construction knowledge and providing positive learning outcomes (Vanichvasin, 2021). In this study, the chatbot version used is still inflexible and limited because it cannot handle undetected text or keywords (outside of the regulated

keywords), and this study also uses a relatively small sample. Therefore, in future research, chatbots can be developed that are more flexible and broader to produce more precise responses and can further enhance conceptual and construction knowledge and more significant learning outcomes through chatbot digital media with personalized learning.

Learning on Students' Learning Motivation and Performance" showed no significant difference in learning motivation between the two study groups. The chatbot-based learning group achieved a lower standard deviation in learning performance than the group that received traditional learning. These results can be attributed to the design of chatbot-based learning systems that allow students to learn at their own pace, receive timely feedback, and provide options to repeat learning content, all of which facilitate their learning motivation. The group with chatbot learning experienced less pressure and tension from the learning conditions than the traditional learning group. According to research conducted by the traditional learning group Artificial Intelligence (AI) Chatbot as Language Learning Medium: An Inquiry shows the results that the chatbot developed under the name Gengobot has three types of languages, namely Indonesian, English, and Japanese, and has advantages and disadvantages (Haristian, 2019). The advantages of the Gengobot chatbot are students tend to feel more relaxed talking with computers than with teachers; The developed chatbot can provide repeated repetition of the same material; Chatbot was developed and equipped with several menus such as a grammar database index, practice features, and information on basic Japanese knowledge; this allows students to practice their listening skills and become new enjoyable learning for students. The benefit of chatbot:

1. Students can use various language structures and vocabulary that they would not usually use.
2. The developed chatbot provides fast and effective student spelling and grammar feedback.
3. The weakness of the AAIL chatbot development is regarding the content and additional features such as audio features and learning kanji to maximize its function to support students' self-learning environment.
4. The advantages of the Artificial Intelligence Chatbot MiClima product being developed are:
5. Students feel happy and relaxed in learning by using Artificial Intelligence Chatbot MiClima because of lower stress pressure.
6. Artificial Intelligence Chatbot MiClima has a fast response in answering questions from students.

Artificial Intelligence Chatbot MiClima is developed and equipped with complete learning content, practice questions, and discussions, as well as project assignments, which allow students to practice independent learning skills anywhere and anytime and become new learning that is interesting for students. The Artificial Intelligence Chatbot MiClima that has been developed also has limitations, cannot respond to the keywords set by the developer and cannot embed photos, videos, and sound in conversations because you do not use a premium account. In the future, researchers hope that the development of Artificial Intelligence Chatbots can be further developed in technology and its features..

### Conclusion

The developed AAIL MiClima has good characteristics because it is equipped with complete learning material content, practice questions and discussions, and project assignments that can train students' ability to learn independently. Physics learning that uses Artificial Intelligence Chatbot MiClima as the medium is proven to have high effectiveness in improving students' conceptual construction skills on Global Warming physics material. It can be seen from the results of this study which were obtained by carrying out the normalized gain  $\langle g \rangle$  test of 0.60 (medium category) for the control group and 0.87 (high category) for the experimental group. As for the Cohen's D effect-size test results, the result was 0.93 with a high category AAIL for increasing learning outcomes. Thus, the developed AAIL chatbot has high effectiveness in increasing learning outcomes. Artificial Intelligence Chatbot MiClima has several advantages, including providing a sense of fun and comfort in learning with low-stress levels, the response given by Artificial Intelligence Chatbot MiClima is fast and effective, and Artificial Intelligence Chatbot MiClima is also equipped with complete learning content, practice questions and discussion, as well as project assignments that students can work on. The weakness of the Artificial Intelligence Chatbot MiClima is that it cannot provide responses outside of the keywords

set by the developer and cannot embed photos, videos, and sound in conversations because it is limited to non-premium accounts.

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