

## **Advanced Chatbot Development to Improve Student Literacy and Numeracy Skills**

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### **Abstract**

The literacy and numeracy skills of prospective teacher students are still in the very low category. This is an indication that the opportunity to increase students' literacy and numeracy skills is still very high. The purpose of this study was to measure the increase in literacy and numeracy in science learning using the Advanced Chatbot media. This type of research is an experimental research with a pretest-posttest group design technique. The research was conducted at the students of Elementary School Teacher Education, Walisongo State Islamic University, Semarang and University of Sarjanawiyata Tamansiswa Yogyakarta, with a total of 57 students. The data acquisition technique used a test instrument. The literacy and numeracy indicators used are based on the achievements developed by PISA 2015 namely knowledge and skills to 1) use various numbers and symbols related to basic mathematical concepts to solve practical problems in various contexts of everyday life; and 2) analyze the information displayed in the form of graphs, tables, and charts. Then use the interpretation of these results to predict and make decisions. The test instrument was declared valid as seen from the level of difficulty and the suitability of the items. The results of the analysis show the mean value of n-Gain is 0.32 in the medium category. This means that there is an increase in student literacy and numeracy in science learning assisted by advanced chatbot media. In conclusion, advanced chatbots can be used as an alternative media for science learning which can effectively improve students' literacy and numeracy skills.

**Keywords:** literacy, numeracy, advance chatbot

## **Pengembangan Advanced Chatbot untuk Meningkatkan Kemampuan Literasi dan Numerasi Mahasiswa**

Kemampuan literasi dan numerasi mahasiswa calon guru masih dalam kategori sangat rendah. Hal ini menjadi indikasi bahwa peluang peningkatan kemampuan literasi dan numerasi mahasiswa masih sangat tinggi. Tujuan penelitian ini adalah untuk mengukur peningkatan literasi dan numerasi pada pembelajaran IPA dengan menggunakan media *advanced chatbot*. Jenis penelitian ini adalah penelitian eksperimen dengan teknik *pretest-posttest*

*group design*. Penelitian dilakukan pada mahasiswa Pendidikan Guru Sekolah Dasar Universitas Islam Negeri Walisongo Semarang dan Universitas Sarjanawiyata Tamansiswa Yogyakarta yang berjumlah 57 orang. Teknik perolehan data menggunakan instrumen tes. Indikator literasi dan numerasi yang digunakan didasarkan pada capaian yang dikembangkan PISA 2015 yaitu pengetahuan dan keterampilan 1) menggunakan berbagai bilangan dan simbol yang berkaitan dengan konsep dasar matematika untuk menyelesaikan soal-soal praktis dalam berbagai konteks kehidupan sehari-hari; dan 2) menganalisis informasi yang ditampilkan dalam bentuk grafik, tabel, dan bagan. Kemudian digunakan interpretasi dari hasil tersebut untuk memprediksi dan mengambil keputusan. Instrumen tes dinyatakan valid dilihat dari tingkat kesukaran dan kesesuaian butir soal. Hasil analisis menunjukkan nilai rata-rata *n-Gain* sebesar 0,32 dalam kategori sedang. Artinya ada peningkatan literasi dan numerasi siswa pada pembelajaran IPA berbantuan media *advanced chatbot*. Kesimpulannya, *advanced chatbot* dapat digunakan sebagai media alternatif pembelajaran IPA yang secara efektif dapat meningkatkan kemampuan literasi dan numerasi mahasiswa.

Kata kunci: literasi, numerasi, advance chatbot

## INTRODUCTION

Surveys of various national and international institutions show that the literacy and numeracy index of students in Indonesia is still in the low category. The low literacy rating has an impact on the quality of a country's human resources. Newer interpretations of literacy skills are understanding, assessing, using and also engaging with written messages to participate in culture, to achieve individual goals and aspirations and to create understanding and potential. Literacy is the capacity to see, create, listen and speak in a way that will enable us to communicate as well as to understand the world (Allum et.al, 2018). Writing and reviewing, when combined with speaking, paying attention as well as seeing and critical thinking, comprise skill elements that are valuable in modern life. Literacy is an essential element to ensure all students have the most effective opportunity to succeed in research as well as in everyday life.

Scientific literacy is an individual's scientific ability to use their knowledge in the process of identifying problems, gaining new knowledge, explaining scientific phenomena, and drawing conclusions based on evidence related to scientific issues (Drummond & Fischhoff. 2017). Klucevsek (2017) to achieve higher scientific literacy, students and the public need information literacy specifically for scientific disciplines in science. Scientific information literacy is a core component of the scientific process. In addition to teaching how to find and evaluate resources, scientific information literacy

should include teaching and publishing processes in science.

Scientific literacy can be defined as scientific knowledge and skills to be able to identify questions, acquire new knowledge, explain scientific phenomena, and draw conclusions based on facts, understand the characteristics of science, awareness of how science and technology shape the natural, intellectual and cultural environment, and willingness to be involved. and care about science-related issues (OECD, 2015)

Literacy and numeracy skills as knowledge and skills are closely related to understanding numbers, symbols, and analysis of quantitative information such as the use of graphs, tables, charts and so on (Chen Yu, et al. 2020). Important components of numeracy literacy are mastered such as: numbers, operations and calculations, geometry and measurement, data processing, statistical interpretation, spatial reasoning and patterns (Tegeh, et.al. 2021). Bucchi & Saracino (2016) researched literacy and numeracy, the results show that respondents are generally better at recognizing pictures, diagrams and charts related to science than just responding to textual questions.

Numeration can be defined as the ability to apply number concepts and arithmetic operations skills in everyday life. Literacy and numeracy are also the ability to translate quantitative information from the problems around us. Numeration includes skills in applying mathematical concepts and rules in real situations (Won Han & Borgonovi, 2020). Numeration requires mathematical knowledge that is learned in the curriculum, but learning mathematics itself does not necessarily foster literacy skills. Wolf & McCOy (2019) Numerical literacy is the ability or skill to develop knowledge and skills to use mathematics with confidence in all aspects of life.

Based on the results of the initial test, students' literacy and numeracy skills on science material are still in the low category. Students are not accustomed to in-depth analysis of the reading material in the material, as a result they have difficulty solving problems in the form of reading texts or story questions. Students are less skilled in using mathematical calculations to solve problems in everyday life. Based on the results of interviews with several students, it was obtained data on the low literacy of students because they rarely read, lacked skills and were accustomed to analyzing problems in the form of graphs, tables and charts. In addition, students have difficulty in applying mathematical analogies when working on problems.

Enrichment and strengthening of numeracy literacy skills can be done through

various activities, one of which is through reading sources that are fun and challenging for students. Literacy and numeracy can be learned through habituation that is integrated into learning. The development of scientific literacy is basically to attract the involvement of students in the learning process and create a pleasant learning atmosphere. Media can be an idea in bridging students' thinking processes through design thinking, applying mathematical understanding and applied science in solving problems (Flores, 2018). The process of learning science is carried out in an effort to understand the concept, meaning, and relationships through an intuitive process to finally arrive at a conclusion. The process of developing scientific literacy is done through observation, classification, measurement, prediction, determination, and inference. Based on the above problems, it is necessary to develop a digital-based learning media that can help improve students' literacy and numeracy skills.

Artificial intelligence (AI) and machine learning (ML) can help students in the form of advanced chatbots from the collaboration of dialogflow and communicate platforms. Chatbots are rarely used in education (Ross, S. 2018). Chatbots can solve individual student support problems but have not been used to their full potential (Winkler, R. & Söllner, M., 2018). The advantage of using this advanced chatbot is time and place efficiency (Botwe, et. al., 2015; Faraon, M., Rönkkö, K., Wiberg, M. et al., 2020). Chatbots in education have not been carried out to facilitate learning.

Literacy and numeracy skills will be improved by combining the learning process using advanced chatbot media. The implication is that they will become quality outputs that are ready to compete in the world with computer technology. Therefore, this study aims to measure the increase in literacy and numeracy with Advanced Chatbot media.

## **METHODS**

The research was conducted on elementary school teacher education students with 57 research subjects. This type of research is an experimental study with a pre-experimental design approach using a one group pretest-posttest design. This design can be described as in Table 1.

Table 1. Experimental Design

Pre-test	Treatment	Post-test
Y1	X	Y2

The media used in the treatment is a chatbot application that has been developed by researchers in the form of a digital application that facilitates students to learn independently with various features that can display pictures, charts, tables and learning videos. Students can also consult with lecturers in the form of text or audio when experiencing difficulties in searching using the chatbot application. The data acquisition technique used literacy and numeracy tests. Data analysis used t-test to determine the significance level and differences in numeracy literacy results after and before using chatbot media. Followed by the n-gain test to determine the improvement of students' literacy and numeracy skills. The n-gain calculation was obtained from the pretest and posttest scores with the scoring criteria in Table 2.

Table 2. Criteria for scoring n-gain

Range	Category
$g > 0,7$	High
$0,3 \leq g \leq 0,7$	Medium
$g < 0,3$	Low

Literacy and numeracy indicator in this study are knowledge and skills to 1) use various kinds of numbers and symbols related to basic mathematical concepts to solve practical problems in various contexts of everyday life; 2) analyze the information displayed in the form of graphs, tables, and charts. Then use the interpretation of these results to predict and make decisions.

## RESULTS AND DISCUSSION

Mastery of six basic literacy, namely literacy, numeracy, scientific literacy, digital literacy, financial literacy and cultural literacy are part of the 21st Century competencies that students need to master. Literacy and numeracy skills are very useful in everyday life. Numeration functions effectively in learning, working, and interacting throughout life (Gunn & Wyatt-Smith. 2010). Susongko (2021) with good literacy and numeracy, students will be skilled in applying mathematical knowledge in solving problems. McMaster et al (2021) explain that the curriculum needs to be designed to develop reasoning and mathematical abilities to support various scientific aspects. In addition, the concept of science also needs to be taught clearly so that it does not occur through various stages of scientific thinking.

Literacy and numeracy help a person acquire the basic skills needed to achieve

success in life. As they are used in many aspects of our lives, literacy as well as numeracy skills are important for accessing the wider curriculum. Coffey & Sharpe (2019) one needs to consider and differentiate between math and numeracy. Mathematics is not only the ability to count but also reason and use logic to solve problems. The ability to reason with numbers can lead to more accurate processing of statistical information (Hutmacher, Reichardt, & Appel, 2022). Numerical skills in the work environment, employability and proficiency are often used in conjunction with one another.

Dichev & Dicheva (2017) reveal that scientific literacy is demonstrated through the activities of collecting, processing, analyzing, and using data. The goal is to prepare students in the early stages of their education for change in a data-driven society and to provide them with the skills to navigate proficiently in today's data-rich world. The ability to use scientific knowledge and principles to understand the environment and test hypotheses is also a form of scientific literacy (Sulistiyowati., Abdurrahman., & Jalmo, 2018). Fakhriyah, et al (2017) the functions of scientific literacy include understanding the environment, health, economy, and other problems faced by modern societies that depend on technology and scientific developments.

The hypothesis in this study is H0: there is no significant difference in students' numeracy literacy skills before and after using chatbot media. Ha: there is a significant difference in students' literacy and numeracy skills before and after using chatbot media. To test this hypothesis, the results of the paired sample t-test analysis are presented in Tables 3 and 4 below.

Table 3. Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	Pre Test	41.9298	57	18.89242	2.50236
	Post Test	58.2456	57	18.72001	2.47953

The results of the t-test in Table 3 show that the average value of the pretest is 41.93 and the average value of the posttest is 58.25, it shows that there is an increase in the average value of literacy and numeracy skills after using chatbot media. The data shows that there are differences in the average literacy and numeracy abilities of students at the pretest and posttest.

Table 4. Pair samples correlation

		N	Correlation	Sig.
Pair 1	Pre Test & Post Test	57	.916	.000

The test results in Table 4 show that the significance value is 0.000, where the sig value > 0.00 this indicates that there is a significant relationship between pretest and posttest. The results of the pair sample test to determine the difference in abilities before and after treatment can be seen in Table 5.

Table 5. Pair samples test

	Pair	Pre Test	Paired Differences				t	f	d	Sig. (2-tailed)	
			Mean	Std. Deviation	Std. Error	95% Confidence Interval of the Difference					
						Lower					Upper
1	Test	Post Test	-16.31579704	7.70	1.02082	-18.36074	14.27084	15.9836	-	5	.000

Table 5 shows the results of a significance value of 0.000 meaning less than 0.05 meaning H0 is rejected. This means that there is a significant difference between literacy and numeracy skills before and after receiving learning treatment with chatbot media. The effect of media on students' literacy and numeracy skills is  $0.9162 = 0.839$ . This means that 83.9% is influenced by chatbot media while the rest is caused by other factors. Based on the results of hypothesis testing, it can be concluded that there is an increase in students' literacy and numeracy skills after using chatbot media. Based on the n-gain calculation, the conclusions of the pretest and posttest results are shown in Table 6.

Table 6. Results of n-gain literacy and numeracy skills using advanced chatbot media

Score	n-Gain	Category
Pretest		
41	0,32	Medium
Posttest		
58		

The results of the n-gain test in table 6 obtained an increase in students' literacy and numeracy skills after using chatbot media in the medium category. This can be influenced by various factors, one of which is because the learning process takes place online so it is possible to influence the results of measuring literacy and numeracy abilities. As revealed by Putra, Widodo, & Jatmiko (2016), the inquiry learning model that is scientific in nature accompanied by good planning can improve student literacy. Supported by the statement of Rubini, Permanasari & Yuningsih (2018) that the use of multimedia can improve scientific literacy, especially in the realm of scientific content and attitudes. Other studies reveal that there are differences in the scientific literacy abilities of students who learn to use information technology media and teaching aids (Kelana, 2018). Therefore, if the use of chatbot media is supported by good learning models and methods in the classroom, it

is hoped that the increase in students' literacy and numeracy skills can be more optimal.

Chatbot media can help students learn independently through analysis in the form of text, images, charts, and tables. These media help to grow students' literacy and numeracy skills while studying. Sharon & Tsabari (2020) revealed that literacy needs to be taught related to various aspects including 1) Understanding of scientific practice; 2) Identify and assess appropriate scientific skills, and 3) thinking habits such as curiosity and an open mind. The chatbot media facilitates these various aspects, whether it is providing an understanding of practice, identifying scientific activities and stimulating students' curiosity to think broadly and deeply.

The use of chatbots will be more effective if they are combined with various learning models and methods. The function of the chatbot media is to help students learn independently, thus students' literacy and numeracy will increase because they are trained by independent learning through chatbots. Patterns and benefits of learning in self-study rooms can be designed for constructionism, meaning that students are given an open space to solve problems. Students will get used to looking deeper if they find difficulties in various ways, one of which is by utilizing technology (Flores, 2018). However, lecturers cannot be separated from their responsibility in the student learning process. Lecturers can monitor student activities through chatbot applications, student activity in exploring material in depth can be known. If students have difficulty in the search process, the chatbot will automatically provide direct consultation directions to the lecturer.

## **CONCLUSION**

Based on the results of the study, it was shown that the advance chatbot media developed had a significant influence on students' literacy and numeracy skills. It can be concluded that there is a significant difference between literacy and numeracy skills after using chatbot media in the learning process. In addition, based on the n-gain test, it shows that chatbot media can effectively improve students' literacy and numeracy skills.

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