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The Effectiveness of Virtual Laboratory Assisted Online Science Learning On the Scientific Character of Elementary School Teachers Candidate

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Abstrak

Penelitian ini bertujuan untuk menganalisis keefektivan pembelajaran IPA daring berbantuan *virtual laboratory* terhadap karakter ilmiah mahasiswa calon guru sekolah dasar. Karakter ilmiah ini sangat diperlukan oleh calon guru sekolah dasar untuk mencetak generasi penerus bangsa yang menguasai ilmu pengetahuan alam dan memiliki karakter ilmiah yang baik. Metode penelitian ini adalah eksperimen dengan jenis *quasi exsperimental design*. Subjek penelitian ini adalah mahasiswa kelas A7 dan A8 yang berjumlah 80 orang. Teknik pengumpulan data menggunakan observasi, angket dan tes. Teknik analisis data menggunakan persentase, uji-t, dan N-gain. Hasil penelitian menunjukkan bahwa terjadi peningkatan rata rata kemunculan karakter ilmiah dari setiap pertemuan dari level sedang (54,55) pada pertemuan pertama meningkat menjadi tinggi (74,96) pada pertemuan ke enam. Hasil uji-t pada skor post test diperoleh nilai t hitung = 2,798 > t tabel = 1,998 berarti bahwa terdapat perbedaan yang signifikan pada prestasi belajar antara mahasiswa yang mengikuti pembelajaran IPA daring berbantuan *virtual laboratory* dengan mahasiswa yang mengikuti pembelajaran IPA daring biasa. Berdasarkan uji N-Gain diketahui bahwa kelompok eksperiman memiliki peningkatan dengan kriteria sedang (0,62) yang lebih baik dari kelompok kontrol dengan kriteria peningkatan rendah (0,26).
Kata kunci : Pembelajaran IPA Daring, *Virtual Laboratory*, Karakter Ilmiah.

Abstract

This study aims to analyze the effectiveness of online science learning assisted by a virtual laboratory on the scientific character of prospective elementary school teacher students. This scientific character is very much needed by prospective elementary school teachers to produce the next generation of the nation who master natural science and have good scientific character. This research method is an experiment with a quasi-experimental design type. The subjects of this study were students of classes A7 and A8, totaling 80 people. Data collection techniques using observation, questionnaires and tests. The data analysis technique used percentage, t-test, and N-gain. The results showed that there was an increase in the average appearance of scientific characters from each meeting from the medium level (54.55) at the first meeting to high (74.96) at the sixth meeting. The results of the t-test on the post-test score obtained that the t value = 2.798 > t table = 1.998 means that there is a significant difference in learning achievement between students who take online science learning assisted by virtual laboratories and students who take regular online science lessons. Based on the N-Gain test, it is known that the experimental group has an improvement with moderate criteria (0.62) which is better than the control group with low improvement criteria (0.26).
Keywords: *Online Science Learning, Virtual Laboratory, Scientific Character.*

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INTRODUCTION

The Covid-19 pandemic, which has not subsided, has caused abnormalities in various human activities, including educational activities. Education that originally took place face-to-face was suddenly changed to online, making some activities impossible. One of the activities that can no longer be done directly is practicum activities in science learning. Practicum in science learning is very important in building scientific character (Agustina, P., Saputra, A., Anif, S., Rayana, A., & Probowati, 2021);(C. E. Sari, 2020). Scientific character is part of attitudes in general, and attitudes are part of values, namely the value of life (V. K. Sari et al., 2021);(Auliyairrahmah et al., 2021). This scientific character becomes an important part in the behavior of individual activities in everyday life in society. This scientific character is very important for prospective elementary school teacher students where later this elementary school teacher candidate will produce students of the nation's future generation who not only have broad knowledge but also have scientific character as a provision to live and compete in the global era.To be able to instill knowledge and scientific character to elementary school students, prospective elementary school teachers who have broad knowledge and good scientific character are needed One of the courses that can be used to instill scientific character in prospective elementary school teachers is science courses.

Scientific character is one of the important components in everyday life in the era of the industrial revolution 4.0 that must be mastered by prospective teacher students. Natural Sciences courses are directed at conducting experiments or practicums so that they can help students gain a deeper understanding of the natural sciences. The application of science learning in the classroom with appropriate methods has been proven to improve students' knowledge and skills (Mutanaffisah et al., 2021); (Ali & Sukmawati, 2022). Teachers have started to use various methods to teach science in the classroom, but often teachers fail to train the scientific character in students because the learning model used is still not appropriate and without consideration of students' intellectual abilities. The teacher's lack of understanding of the use of appropriate learning methods in science learning has an impact on the lack of development of students' scientific characters. Therefore we need an appropriate way to teach science in the classroom, especially in elementary schools in order to instill the scientific character of students well. To be able to instill good scientific character in elementary school students, it is necessary to have prospective elementary school teachers who have good scientific knowledge and character. One of the courses that can be used to instill scientific character in prospective elementary school teacher students is the Natural Sciences course.

The learning process for science courses that aims to instill scientific character must of course be different from the learning process for ordinary subjects. Because the Covid-19 pandemic has not subsided, the design of this science lecture is carried out online with the help of a virtual laboratory to instill the scientific character of prospective elementary school teacher students. A virtual laboratory is a laboratory where computer-operated software is used to observe or carry out experimental activities (Rosdianti, V. I., & Paidi, 2021). Several studies on virtual laboratories have been carried out, including by (Khairuna et al., 2021) which state that the use of a Virtual Laboratory with a discovery learning model can improve Science Process Skills and Student Learning Outcomes on Excretion System Material. Rokhim et al., (2020) developed a virtual laboratory for a smartphone integrated chemical separation practicum. Furthermore, (Zaturrahmi et al., 2020) research stated that The variable that is most affected by the use of virtual laboratories is student achievement. In addition, the use of virtual laboratories has also been studied by (H. K. Sari et al., 2020) which states that there is a virtual laboratory contribution to acid-base titration learning with predict-observe-explain on learning outcomes and critical thinking skills. In line with various studies on virtual laboratories that have been carried out by previous researchers, this study also examines the use of virtual laboratories. The difference between this study and several previous studies is that in this study the application of virtual laboratories was used and implemented on prospective elementary school teacher students, whereas in

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previous studies it was mostly carried out on high school students. In addition, the novelty of this research is the purpose of utilizing virtual laboratories whereas previous studies have focused more on mastering knowledge and skills in a practicum in secondary schools. Meanwhile, in this study, the use of a virtual laboratory aims to instill scientific character in prospective elementary school teacher students.

Based on various previous research studies, it is known that the use of virtual laboratories is proven to be able to have a positive impact on the learning process and results. Furthermore, regarding the importance of scientific character to be mastered as a provision for life and to compete in the global era, it is very important to instill scientific character in prospective elementary school teacher students. One of the efforts that can be made to instill the scientific character of prospective elementary school teacher students during the Covid-19 pandemic is through online learning assisted by a virtual laboratory. So, through this research, we will analyze the effectiveness of online science learning assisted by a virtual laboratory on the scientific character of prospective elementary school teacher students.

RESEARCH METHOD

This research is experimental research with a quasi-experimental design type. This research was conducted in January 2022 – April 2022 in the Elementary School Teacher Education Study Program, Faculty of Teacher Training and Education, Universitas PGRI Yogyakarta. The subjects of this study were students of the PGSD study program in classes A7-21 and A8-21, totaling 80 people who were taking Science 1 courses. Where A7-21 was the control group and A8-21 was the experimental group. Types of data, data collection techniques, instruments, and data analysis techniques in this study can be seen in Table 1.

Table 1. Types of Data, Data Collection Techniques, Instruments, and Data Analysis Techniques

Types of Data	Data Collection Techniques	Instruments	Data Analysis Techniques
Scientific Character	Observation	Scientific Character Observation Sheet	Percentage
Activities in virtual practicum	Observation	Activity Observation Sheet in virtual practicum	Percentage
Science Learning Achievement	Test	Pre-Test and Post-Test Questions for Science learning achievement	t-test N-gain

RESULTS AND DISCUSSION

The results of the analysis of scientific character data were made based on the observation scores of students' scientific characters in online science learning assisted by virtual laboratories in classes A7-21 and A8-21. The results of data analysis on observing scientific characters of prospective elementary school teaching students in online science learning assisted by virtual laboratories can be seen in Table 2.

Table 2. Scientific Character Of Students in Online Science Learning Assisted By Virtual Laboratory

Aspects of Scientific Character	Occurrence Frequency (%)					
	Meeting-1	Meeting -2	Meeting -3	Meeting -4	Meeting -5	Meeting -6
Discipline	56,75	61,25	65,50	72,25	74,75	76,25
Honest	57,25	63,50	67,25	70,50	72,25	74,75
Curiosity	53,75	62,25	66,50	71,25	72,75	75,25

Creative	55,50	64,75	68,25	71,50	73,75	74,50
Responsibility	51,75	61,25	64,75	70,25	71,25	73,25
Work together in groups	52,25	62,50	66,75	71,75	73,50	75,75
Total	327,25	375,50	399,00	427,50	438,25	449,75
Average (%)	54,55	62,58	66,50	71,25	73,05	74,96
Category	medium	medium	medium	high	high	high

Based on Table 2, it is known that there is an increase in the average appearance of scientific characters from each meeting. At meetings 1 to 3, the average scientific character of students was in the medium category, while at meetings 4 to 6 were in the high category. The aspect of a scientific character that has the highest percentage of occurrences is discipline. Discipline is an attitude of a person obeying, accepting, or obeying all applicable norms or rules with full awareness (Yuliyanto et al., 2018). In this study, student discipline was observed during the implementation of online science learning assisted by a virtual laboratory. The character of this discipline is very necessary for prospective elementary school teacher students, who later will set an example for elementary school students. The character of this discipline plays an important role in life in the era of the industrial revolution 4.0 so it must be instilled from an early age starting from elementary school age, one of which is through a practicum in science learning. Practicum in science learning can be an alternative to instilling character because science practicum it contains character values, one of which is the character of discipline (Dinatha & Dek Ngurah Laba Laksana, 2018).

The second character that appears in this science practicum is an honest character. This medium character increased from medium to high category at the sixth meeting. This honest character is very much needed in everyday life because students who are smart in terms of cognitive (knowledge) but do not have honest character, good personality, or noble character will actually cause harm, either to themselves or to others (Juwantara, 2019). The third aspect of a scientific character is curiosity. Curiosity is an attitude and action that always seeks to find out more deeply and widely from something that is learned, seen, and heard (Fadilah, I., & Kartini, 2019). Through science learning, one's curiosity will develop because in science learning there are always problems and oddities that can be proven through a practicum. Science practicum can be a means of proving or finding new things that arouse someone's curiosity.

The next character is creative. Creativity is an ability (creative thinking) to produce a new way or something in dealing with a problem or situation (R. T. Sari & Angreni, 2018). Creativity is a person's ability to express ideas or ideas through a creative thinking process to create something that demands concentration, attention, willingness, hard work, and perseverance (Herak & Lamanepa, 2019). Through science learning, students plan practicums to prove concepts or experiments to prove an event or natural phenomenon encountered in everyday life. The planning, implementation, and reporting of this practicum will train prospective elementary teacher students to come up with creative ideas. This is in line with (Herak & Lamanepa, 2019) who stated that the implementation of science learning through the STEM approach to class VIII students of SMP Negeri 11 Kupang with an excretory system could increase student creativity. In accordance with this statement, it is known that one's creativity can be formed through science learning by using certain methods and followed by science practicum.

The fifth character that appears in online science learning assisted by virtual laboratories is responsibility. Responsibility means carrying out every job or task in the family, at school, and at work to the best according to ability (Widiyasanti et al., 2018). This responsibility must be owned by every individual in daily life. One must have a sense of responsibility as a consequence of what has been done. The character of responsibility can also be observed in the actions of students in doing and completing school assignments (S. P. Sari & Bermuli, 2021). In this study, the character of responsibility was observed in prospective elementary

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school teaching students in doing and completing a practicum in online science learning. assisted by a virtual laboratory.

The sixth character that appears in online science learning assisted by virtual laboratories is working together in groups. Working together in groups is the attitude of individuals who want to do a job together regardless of the background of the people who are invited to work together to achieve the same goal (Agustini, 2020). This collaboration is very important in realizing the achievement of science learning objectives. Through good group collaboration, it will produce a practicum that is in accordance with the procedures and objectives of the practicum which will have an impact on the science learning achievement of prospective elementary school teacher students. Based on the results of the analysis, it is known that in this study the character of cooperation obtained a high category. This is because solving problems in the science practicum requires in-depth thinking and study so it requires good cooperation between each individual in a group.

In addition to the six scientific characters, this study also conducted observations on student activities during online science learning assisted by a virtual laboratory. The results of the data analysis on student activity observations can be seen in Table 3.

Table 3. Student Activities In Online Science Learning Assisted By Virtual Laboratory

Aspect	**Percentage**						**Average**	**Category**
	Meeting -1	**Meeting -2**	**Meeting -3**	**Meeting -4**	**Meeting -5**	**Meeting -6**		
Grouping	64,75	67,25	68,75	70,75	73,75	75,25	70,08	medium
Predict	67,70	69,75	70,25	71,75	73,25	74,75	71,24	medium
Communicating	66,50	68,75	69,50	70,75	72,70	73,50	70,28	high
Submitting a Hypothesis	67,50	68,70	70,75	71,50	72,75	74,75	70,99	high
Planning an Experiment	68,50	70,75	71,50	73,75	76,50	78,75	73,29	high
Using tools/materials/sources	68,75	69,50	72,75	75,25	78,50	80,25	74,16	high
Average							71,67	high

Based on Table 3, it is known that there are six aspects observed during learning. The six aspects experienced an increase from the measurement at the first meeting to the measurement at the sixth meeting. Each based on the results of the analysis obtained an average score of > 70.00 which is in the high category while for the overall average, a score of 71.67 is obtained which is in the high category. Activities in online science learning assisted by virtual laboratories contribute positively to increasing the activities of prospective elementary school teacher students. The results of this study are in line with (Rahayu, 2021) who stated that virtual practicum can improve scientific attitudes and student activities. The difference between this research and the research of (Rahayu, 2021) is in the subjects and research subjects, wherein the previous research the subjects were students of the chemistry education study program in the basic chemistry practicum course, while in this study the research subjects were students of the elementary school teacher education study program. in Science 1 courses related to the concept of biology. The IPA 1 practicum assisted by a virtual laboratory can increase student activity during the learning process. Student activities during the learning process will have an impact on student learning outcomes (Kusuma, 2020).

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Activities during learning strongly support the improvement of student achievement (Daniati et al., 2020);(Kismiati et al., 2022). that the average student activity from all aspects and all meetings are 71.67 which is in the high category. The high student activity affects student learning achievement. In this study, student learning achievement was measured using tests. Based on the results of the t-test on post-test scores it is known that there is a difference between the control group and conventional science learning and the learning achievement of the experimental group who learns to use a virtual laboratory.

Data on increasing science learning achievement was taken using an instrument in the form of test questions which contained indicators of science learning competence for prospective elementary school teacher students. Due to the Covid-19 pandemic, the test was carried out online based on a google form. The results of the calculation of the science learning achievement test show that there is a difference between students who take online science learning assisted by a virtual laboratory and students who take regular online learning. The results of the t-test of the scores obtained by students during the pre-test showed that students' initial science learning achievement was obtained t count = 1.827 < t table = 1.998 which means that there is no difference in student achievement before implementing online science with the help of virtual laboratories. While the t-test on the post-test results obtained the value of t count = 2.798 > t table = 1.998 and (p) count = 0 <0.05 which means that HO is rejected, so the conclusion obtained is that there is a significant difference in learning achievement between students who take part in online science learning assisted by a virtual laboratory with students who take regular online science lessons. In addition to differences in science learning achievement, the impact of online science learning assisted by a virtual laboratory is also an increase in students' science learning achievement before and after learning. The magnitude of the increase in science learning achievement in class A8-21 who implements online science learning assisted by a virtual laboratory and class A7-21 which carries out ordinary online science learning can be seen in Table 4.

Table 4. Comparison of Learning Achievement Between Control Group and Experiment Group

Class	Pre Test	Post Test	Gain	N gain	Criteria
Experiment (A8-21)	64,75	86,75	22,00	0,62	Medium
Control (A7-21)	65,25	74,50	12,25	0,26	Low

Based on Table 4, it can be seen that there are differences in the increase in science learning achievement. Class A8-21 which implements online science learning assisted by a virtual laboratory has an improvement with moderate criteria which is better than Class A7-21 which uses ordinary online science learning with low improvement criteria. This happened because of the online science learning process assisted by a virtual laboratory that was able to explain abstract concepts to be visualized (Vergara, D., Fernández-Arias, P., Extremera, J., Dávila, L. P., & Rubio, 2022). Online science learning assisted by this virtual laboratory, apart from improving learning achievement is also able to improve the scientific character and activities of students. These improvements indicate that online science learning assisted by virtual laboratories is effective in improving the scientific character, activity, and science learning achievement of prospective elementary school teacher students.

CONCLUSION

Based on the results of the study, it can be concluded that there was an increase in the average appearance of scientific characters from each meeting from the medium level (54.55) at the first meeting to high (74.96) at the sixth meeting. The results of the t-test on the post-test score obtained that the value of t count = 2.798 > t table = 1.998 means that there is a significant difference in learning achievement between students who take online science learning assisted by virtual laboratories and students who take regular online

science lessons. Based on the N-Gain test, it is known that students who take online science learning assisted by virtual laboratories have an improvement with moderate criteria (0.62) which is better than students who take ordinary online science learning with low improvement criteria (0.26). With these various improvements, it can be concluded that online science learning assisted by virtual laboratories is effective in improving the scientific character, activities, and science learning achievements of prospective elementary school teacher students.

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