PERJ Vol. 4 No.1 (2022), 1-6

ISSN 2685 - 6190 (p)
ISSN 2714 - 7746 (e)

Physics Education Research Journal

Department of Physics Education
Faculty of Science and Technology
UIN Walisongo Semarang-Indonesia

Digistar 6-Based Planetarium as an Educational Media for Learning about the Sun Position Using a Horizontal Coordinate System

Irman Said Prastyo [1*], Muhammad Nurkhanif [2], M. Ihtirozun Ni'am [2], Apriana [3], and Lalu Muhammad Abdi Zamakhsyari [4]

[1] *Physics Department, Universitas Islam Negeri Walisongo Semarang, Indonesia*
[2] *Astronomy Department, Universitas Islam Negeri Walisongo Semarang, Indonesia*
[3] *Physics Department, Institut Teknologi dan Sains Nahdlatul Ulama, Bandar Lampung, Indonesia*
[4] *Physics Department, Kanazawa University, Kanazawa, Japan*

ARTICLE INFO

Article history:
Submitted : December 8th, 2021
Revised : January 17th, 2022
Accepted : February 5th, 2022

Keywords:
Digistar; educational media; horizontal coordinate system; planetarium; sun.

ABSTRACT

A good understanding of the labeling of the positions of celestial bodies, including the Sun, in a horizontal coordinate system, is absolutely necessary as a basis for understanding astronomy and astrophysics. The existence of media that can be used to provide simulations of the celestial sphere and its coordinate system is very important to support the learning process. Through this quantitative descriptive statistical research with One-Group Pretest-Posttest Design, it can be shown that the use of Digistar 6-Based Planetarium as an educational medium can improve students' understanding of the position of the Sun in a horizontal coordinate system. The increase in understanding was marked by an increase in the average percentage of correct answers from pretest to posttest by 32.89%, an increase in the percentage of minimum and maximum correct answers by 54% and 60%, respectively, and an increase in the number of passes in the PAP version by 53.34%.

Introduction

The celestial sphere is an imaginary sphere in which the entire sky is projected on its surface and is centered on the observer (Earth) (Gautama, 2010). By using the celestial sphere, all celestial bodies are considered to be on the two-dimensional surface with their respective positions. The method of labeling the positions of celestial bodies on the celestial sphere using coordinate systems is one of the basic knowledge in astronomy and astrophysics that must be understood at the beginning of learning these subjects.

A good understanding of the coordinate systems is very useful. By using coordinates, equations of motion of celestial bodies in the celestial sphere can be presented. Besides that, celestial navigation can also be used. It is because, in celestial navigation, the positions of stars, planets, the Sun, and the Moon need to be identified (Allen, 2004).

One of the coordinate systems that is often used is the horizontal coordinate system. It is a coordinate system that uses the observer's local horizon as the fundamental plane and is expressed in terms of altitude (or elevation) angle and azimuth (Zaki, 2019). With this coordinate system, the celestial bodies which can be observed are those whose altitudes are larger than 0° or above the horizon.

*Correspondence email: irmansaid@walisongo.ac.id
doi: 10.21580/perj.2022.4.1.11013

For every coordinate system, it is known what is called coordinate curves. Unfortunately, one can not draw the curves on the sky directly, so the existence of the media for doing simulations is absolutely needed. From observation in astrophysics classes, the problem that students usually face is difficulties in understanding the concept only by using their imaginations. The students need good and helpful media. Those are the media which meet the VISUAL principle (Visible, Interesting, Simple, Useful, Accurate, Legitimate) (Miftah, 2013).

There are several media which can be used to simulate the celestial sphere and its coordinates. One of them is Stellarium astronomy software that can be installed on computers and mobile phones. Several studies related to stellarium have been carried out, including research on rukyat simulation with Stellarium software (Sayehu, 2014), the use of Stellarium to improve cognitive abilities and physics learning activities (Habibi, et al., 2014), and the use of Stellarium as interactive multimedia to improve students' understanding and motivation in studying the solar system (Marina and Prima, 2019).

However, the Stellarium software cannot be used to simulate the sky in a true three-dimensional (3D) view. In contrast to that, a Planetarium, a theater room with a dome-shaped roof, can be used to display sky simulations in 3D by using one or more projectors. The dome of the planetarium represents the shape of the celestial sphere. With a such software, the position of the celestial bodies at any time can be accurately displayed there. One of the Planetarium's softwares that can display good visualizations is Digistar-6. The interface of Digistar 6 can be seen in Figure 1.

Figure 1
Digistar 6 interface

Several studies related to Planetarium also have been carried out, including research on the effect of Planetarium trip (Bozdoğan, 2016), survey of the academic use of Planetariums for undergraduate education (Everding and Keller, 2020) and learning about the scale of the solar system using digital planetarium visualizations (Sahami and Dove, 2017).

One of the celestial bodies that is very important for us is the Sun. Even, for Muslims, its position at the celestial sphere also determines the time of prayer. A study about positions of the Sun at the celestial sphere has been carried out by H. Abbas Padil (Padil, 2013). However, in his article, he only described the position of the sun on the celestial sphere in various coordinate systems without any simulation in the Planetarium. To see one of the benefits of using a Planetarium, in this article the authors specifically want to show one of the effects of using a Digistar 6-based Planetarium on the level of students' understanding about the position of the Sun on the celestial sphere using the horizontal coordinate system.

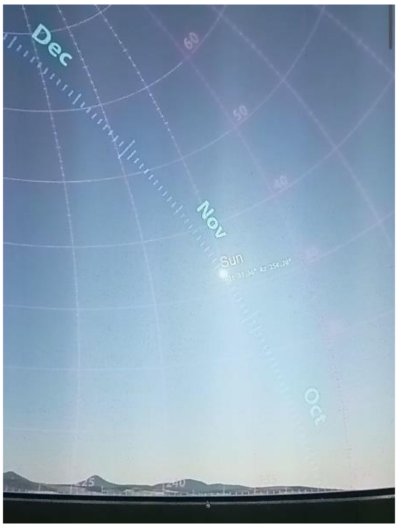
Methods

This research is a descriptive statistical quantitative research with a quasi-experimental research design. Quasi-experimentation is the use of methods and procedures to conduct observations in a structured study similar to an experiment but the conditions and experiences of the participants are less controlled because the research is limited to random assignment, including comparisons or control groups (Privitera and Delzell, 2019). The quasi-experimental used in this study is One-Group Pretest-Posttest Design which is a quasi-experimental in which a group is measured and observed before and after being given treatment (Fraenkel et al., 2012).

Figure 2
A show/simulation in the Planetarium

Figure 2 shows a simulation in the Planetarium. The subjects of this research were 15 physics students of UIN Walisongo Semarang who had been given material about the celestial sphere and the position of the Sun expressed in the horizontal coordinate system without any simulation in the Planetarium. They were given pretest questions which consisted of 15 multiple choice questions. After that, they were given a show/simulation and an explanation of the same material using Digistar 6-based Planetarium media at the planetarium building of UIN Walisongo Semarang. After that, they were asked to work on the posttest questions, which were the same questions that were used during the pretest. A view of the sun on the dome of the Planetarium can be seen in Figure 3.

Figure 3
A view of the Sun on the dome of the Planetarium



The pretest and posttest scores were then converted into letter scores and standard grades of 4 using the PAP (*Penilaian Acuan Patokan*) assessment method. There are two score conversion rules (PAP I and PAP II) that can be seen in Table 1 (Nurbayani, 2012). In this research, PAP II is chosen to be used. According to the PAP, a student is said to pass if he or she gets a minimum grade of the letter C.

Table 1
Score conversion rules with PAP

Percentage of correct answers (%)		Converted score	
PAP I	PAP II	Letter Score	Standard grade of 4
90-100	81-100	A	4
80-89	66-80	B	3
65-79	56-65	C	2
55-64	46-55	D	1
< 55	< 46	E	0

Result and Discussions

From the pretest and posttest that have been carried out, the number of correct answers and the percentage of correct answers for each student are shown in Table 2. The percentage of correct answers was calculated using Equation 1.

$$\textit{Percentage of correct answers} = \frac{\textit{The number of correct answers} \times 100\%}{15} \qquad (1)$$

The percentage of correct answers was rounded to an integer (without decimals) to comply with the score conversion rules in Table 1.

Table 2
Pretest and posttest results

Student	Pretest		Posttest	
	The number of correct answers	Percentage of correct answers	The number of correct answers	Percentage of correct answers
1	10	67	13	87
2	5	33	13	87
3	6	40	14	93
4	2	13	10	67
5	2	13	9	60
6	6	40	8	53
7	6	40	6	40
8	7	47	13	87
9	9	60	12	80
10	10	67	12	80
11	9	60	12	80
12	4	27	6	40
13	8	53	14	93
14	8	53	12	80
15	3	20	15	100

Based on the data from the pretest and posttest results, statistical calculations can be carried out which include determining the minimum and maximum values, calculating the mean and standard deviation. The statistical data are shown in Table 3.

Table 3
Statistical data

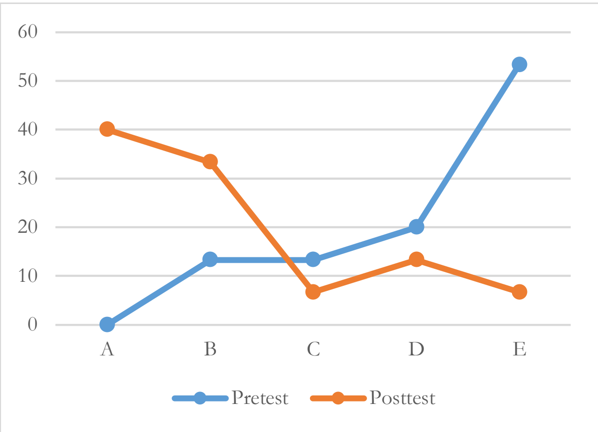
Statistics	Percentage of correct answers	Percentage of correct answers
	Pretest	Pretest
Min	13	13
Max	67	67
Mean	42.22	42.22
Standard Deviation	18.11	18.93

The distribution of pretest and posttest (letter) scores is then presented in Table 4. In accordance with Table 4, the difference in the results of the pretest and posttest is more clearly shown through the graph in Figure 4.

Table 4
Distribution of pretest and posttest scores

Letter score	Pretest		Posttest	
	Number of students	Percentage	Number of students	Percentage
A	0	0	6	40
B	2	13.33	5	33.33
C	2	13.33	1	6.67
D	3	20	2	13.33
E	8	53.33	1	6.67

Figure 4
Percentage of pretest and posttest scores



From the data that has been obtained, it can be seen that there is a clear difference between the results of the pretest and posttest. Table 3 shows that there is a difference in the mean of the percentage of correct answers of 32.89%, which is an increase from 42.22% to 75.11% with almost the same level of data distribution (as seen from the small difference in standard deviation). The percentage of the minimum and maximum correct answers also experienced a large increase, namely 54% and 60% respectively.

In addition, the passing rate of the PAP version has also increased. As already mentioned that the minimum letter score to be said to be passed is C, from Table 4 it can be seen that the difference in the percentage of passing between the pretest and posttest is 53.34%, which is an increase from 26.66% to 80%.

The graph in Figure 4 also shows that the pretest scores are dominated by low scores (D and E) while the posttest results are dominated by high scores (A and B). In fact, there was not one student who got an A in the pretest but in the posttest the A score was the score that most students got.

The increase in the percentage of correct answers as well as the increase in scores and the number of passes generally reflect an increase in the level of students' understanding. This is because the pretest and posttest questions were made by considering indicators of understanding.

From what has been described, it can be seen that the use of Digistar-6-Based Planetarium as a learning medium can help students to improve their understanding of the position of the Sun on the celestial sphere in the horizontal coordinate system. The fact that the concept of the celestial sphere and the Horizontal coordinate system are basic concepts in astronomy and astrophysics (which are the foundation for understanding other concepts), the Digistar-6-Based Planetarium can also assist students in preparing supplies to learn other, more difficult concepts or more complex discussions.

Conclusions

It can be concluded that the use of Digistar 6-Based Planetarium as an educational media in this study can help students to improve their understanding of the position of the Sun in the horizontal coordinate system which is characterized by an increase in the average value of the percentage of correct answers, an increase in the percentage of minimum and maximum correct answers and an increase in the number of passes.

References

Allen, J. A. V. (2004). Basic Principles of Celestial Navigation. *American Journal of Physics*, *72*(11), 1418–1424. https://doi.org/10.1119/1.1778391

Bozdoğan, A. E. (2016). The Effect Of Planetarium Trip On Pre-Service Science Teachers ' Metaphorical Perceptions About Planetariums. *Malaysian Online Journal of Educational Sciences*, *4*(4), 70–84.

Everding, D. J., & Keller, J. M. (2020). Survey of the Academic Use of Planetariums for Undergraduate Education. *Physical Review Physics*

Education Research, *16*(2). https://doi.org/10.1103/PhysRevPhysEducRes.16.020128

Fraenkel, J. R., Wallen, N. E., & Hyun, H. H. (2012). *How to Design and Evaluate Research In Education, 8th ed.* New York: Mc Graw Hill.

Gautama, S. E. (2010). *Astronomi dan Astrofisika*. Makassar: SMA Negeri 1 Makassar.

Habibi, M., Waskito, S., & Masithoh, D. F. (2014). Penggunaan Media Stellarium untuk Meningkatkan Kemampuan Kognitif dan Aktivitas Belajar IPA Fisika Siswa Kelas IXB SMP N 14 Surakarta pada Materi Sistem Tata Surya. *Prosiding Seminar Nasional Fisika Dan Pendidikan Fisika (SNFPF) Ke-5*, *5*(1), 165–172.

Marina, R., & Prima, E. C. (2019). Stellarium as An Interactive Multimedia to Enchance Students' Understanding and Motivation in Learning Solar System. *Proceedings of The 7th MSCEIS 2019*.

Miftah, M. (2013). Fungsi dan Peran Media Pembelajaran sebagai Upaya Peningkatan Kemampuan Belajar Siswa. *Jurnal KWANGSAN*, *1*(2), 95–105.

Nurbayani, E. (2012). Penilaian Acuan Patokan (PAP) di Perguruan Tinggi: Prinsip dan Operasionalnya. *Din. Ilmu*, *12*(1).

Padil, H. A. (2013). Dasar-dasar Ilmu falak dan Tataordinat: Bola Langit dan Peredaran Matahari. *Al Daulah*, *2*(195–214).

Privitera, G. J., & Delzell, L. A. (2019). *Research Methods for Education*. SAGE Publications.

Sahami, K. C. Y., & Dove, J. (2017). Learning About the Scale of the Solar System Using Digital Planetarium Visualizations. *American Journal of Physics*, *85*(7), 550–556. https://doi.org/10.1119/1.4984812

Sayehu. (2014). Simulasi Hisab Rukyat Menggunakan Aplikasi Software Stellarium. *Al Ahkam*, *10*(2), 161–178.

Zaki, W. H. A. (2019). *The Astrophysics for 4th Class*. Department of Physics/ College of Science/ University of Kirkuk.