JIPF (JURNAL ILMU PENDIDIKAN FISIKA)
p-ISSN: 2477-5959 | e-ISSN: 2477-8451 *Vol. 7 No. 1, January 2022, Page 18-29*

Pre-Service Physics Teacher Conceptions and Visual Literacy to Observe Sky Maps throught Heaven View Media

Susilawati [1*)], Dadi Rusdiana [2], Ida Kaniawati [3], Taufik Ramlan Ramalis [4]
Universitas Pendidikan Indonesia, Indonesia[1,2,3,4], Universitas Islam Negeri Walisongo Semarang, Indonesia[1]
[*)]Corresponding E-mail: susilawati@walisongo.ac.id

Received: January 24th, 2021. Revised: May 3rd, 2021. Accepted: June 2nd, 2021

Keywords *:*
Observe Sky Maps; The Heaven View Media; Visual Literacy

ABSTRACT
Learning science, especially learning astronomy subjects, is still very limited in activities carried out by students. The observation of the sky map provided is adequate as a learning media that can support student curiosity and concept understanding of stars for students. The research aims to explore the relationship between students 'conceptions of the stars using a sky map application, students' perceptions of Heaven Above media and visual literacy in the implementation of learning astronomy courses. Research participants involved 72 students who took astronomy lessons. The instrument consisted of a observation sheet and a questionnaire that had gone through the construct and content validation process. Data analysis using quantitative analysis factor analysis and determines normalized gain to descripe an increase in student visual literacy of stargazing. In addition, the calculation of the proportion questionnaire for students 'conceptions of learning and students' perceptions of the heaven view application then analyzes the factors to show the correlation. The result of this research is understanding that a deeper understanding of the concept and experience of maps is a need of students who can support the learning community in learning to observe more interesting stars. Visual literacy has increased between twice observation.

INTRODUCTION

The technology in learning leads visual literate students to strengthen visual argumentation, give meaning to the process and add interesting combinations of picture presentation. Students' visual literacy is aimed at reconstructing current and new information based on cutting-edge data and scientific concepts. This literacy requires the ability to manipulate, apply, build critical visual representations to construct an understanding of the conceptual results of new knowledge and interpretation of knowledge and data. Visual literacy is included in the realm of dynamic, complex and comprehensive.

The urgency of visual literacy is closely related to the ability to analyze, interpret, and create images with an important purpose for student understanding [1] [2] [3]. Scientific ideas about certain phenomena and conceptual problems emphasize scientific facts and procedures. The learning difficulties associated with understanding concepts can be best illustrated by a combination of additional writing and explanation. For example, the image shown illustrates and describes a star. If students are less able to pay attention and understand the visualization of stars, it means that students do not understand object illustrations. How to understand object illustration can be done by identifying celestial bodies and lunar orbits.

Visual literacy has a definition in accordance with the context related to the competency categories obtained for the interpretation of observations. A visually literate person is able to describe and make objects appear as visual acuity; visible objects look static and dynamic effectively; and perfects objects. Visual literacy is concerned with the competency cluster of the larger information literacy framework. The idea of visual literacy contains three concepts, namely visual learning, visual thinking and communication principles. Visual learning involves visual experience, visual thinking to organize information based on image composition and visual communication using symbols that express meaning. This includes changing the information processing paradigm.

As a visual literacy process, it reveals images that are constructed, arranged, and expressed to communicate meaning [4] [5]. The scientific conception of science learning in the laboratory related to visual literacy obtains manipulative skills to achieve deeper experiences that have a relationship with student perceptions of science learning in the laboratory consisting of group investigative skills, various rules and discussion [6] [7]. The model level identifies and analyzes visual views: (1) visual as a denotative system, (2) visual as a style-semiotic system, (3) visual as a connotative system and (4) visual as an ideological representation. These four levels are defined and the process of identifying the frames at each level is explained. The proposed system can be applied to analyze all types of visual media content or the audience's perceptions of that content [8] [9] [10].

These skill can interpret and build visual abilities with awareness of various visual elements, namely color, shape and position. Determination of visualization options relevant to a specific context. This is very helpful for independent learning ability, flexibility, deep understanding and interaction skills in the learning team. These skills can also have an influence on the personal and professional character of student [11] [12]. The use of android can play a role and function in the classroom in accessing learning resources and certain learning facilities [13] [14].

Visual literacy skills are very important as basic literacy communication skills through images with different perspectives and skills to receive messages from images, simulations, animation and others. Basic visual skills include indicators of distinguishing images, identifying images, being able to interpret hidden objects in images, reading images, examining images, describing visual material, and answering questions about visual material [3] [15] [16]. Use of images to provide in-depth physical explanations including pictures, symbols, photographs and visual images. Visual perception is important to build to have a positive influence on behavior. Students are able to provide responses to visual texts through the ability to retell, compile summaries, provide interpretations. This is evidence of understanding concepts and meaningful experiences in effective visual interpretation.

Students' needs in studying astronomy are the need to master concepts, be able to understand astronomical calculations, visualize and be able to interpret the meaning of images, graphs and diagrams. In addition, astronomy practicum has not been carried out in real terms or at least simulated observations are relevant to essential concepts. Students are still limited in getting practice to use problem-solving approaches according to classroom learning. Hope in learning astronomy, students can pay more attention to student learning behavior and pay attention to natural phenomena, direct experience, understand concepts, understand procedural and carry out experiments related to measurement. Direct observation and visualization contribute to realizing meaningful learning. The success of learning through observation activities in the astronomy laboratory or in the open field must be supported by observation facilities in the astronomy laboratory or at least assisted by aids in the form of learning applications about sky maps. Visualization in the application based on the official astrology website in the form of images, photos, simulations, animations, and additional text for information.

Differences in learning styles and certain ways of accessing information and data can be analyzed in terms of active, reflective, general and visual variations. There is a clear relationship between motivation, information technology ability and willingness to learn [17] [18]. Prospective teachers need critical thinking skills and reflective processes. The inquiry learning model is a more effective application of reflective processes for cognitive processes. The learning process of astronomy does not only consider the part of the learning outcome, but also the learning process and outcomes are strived to improve. The factors reviewed to be identified include strategic, conditional, and practical reflective factors. The learning environment provides a willingness related to theoretical knowledge, desires, characteristics and attitudes [19] [20].

Concept construction from strategy implementation, reflection and specific programs that focus on assessment. The learning environment, the availability of theoretical knowledge, desires, characteristics, and attitudes are determinants of students' concept construction [15] [21]. Abilities and skills that are deeper than literacy can meet one of the competency criteria of someone who has programmer ability, namely visual literacy which can then develop into digital literacy. The learning process needs to be studied to evaluate the results of learning objectives so that graduates can be accepted by the industrial world [22] [23].

Information technology-based application support is not sufficient to facilitate astronomy learning so that it is more effective in implementing innovative learning models, for example when implementing a problem-based learning model, project-based learning model and discovery learning model. Direct observation through visualization is tried to help learning more effectively to instill a meaningful understanding of concepts. Information technology is needed to support independent learning resources. Application support as an effective communication medium to support innovative learning strategies. Students need various learning resources, one of which is in the form of effective Information and Communication Technology to support learning in class or outside the classroom as well as online and offline learning.

The use of smartphones, androids or tablets as a medium for learning science provides the opportunity to gain authentic experiences in the form of scientific investigations. This is part of the activity that supports asking questions, preparing, planning and carrying out scientific investigations for data collection, observation, analysis, data interpretation, discussion, making explanations and providing arguments using evidence. Learning that is integrated with cellular technology to support the scientific investigation process with the ability to access media, data collection, communication, representation, share information, transfer knowledge, connect, reference, analyze and draw conclusions [12] [24]. Cellular technology has not been optimally utilized as a learning resource and learning media, especially in exploring real phenomena in the real world.

METHOD

Instruments

The research instruments were tests and questionnaires. The measured visual literacy test consists of indicators: (1) determining the quality and level of visuals required; (2) find and access the required visuals effectively and efficiently; (3) interpret and analyze the visual evaluation of the visual and its sources; (4) use visuals effectively; (5) designing and creating visuals that achieve. The visual literacy of observation sheet is in the form of multiple choices of 10 questions with 5 answer choices. The questionnaire has 5 items that measure the response to the concept of astronomy learning through observations of celestial bodies. The questionnaire has 5 items that measure students' perceptions using heaven above media. The questionnaire has 5 items that measure students' discussion in team work. The questionnaire has 6 items that measure students' presentation, discussion and obsercvation skill in group. The questionnaire was arranged using a Likert scale ranging from 1 to 5, namely strongly disagree, disagree, quite agree, agree to strongly agree. The questionnaire for the conception of astronomy learning through observations of celestial bodies and the student perception questionnaire used heaven above media through expert validation. Indicators of the conception of astronomy learning include learning experience, mastery of concepts and student learning supplements.

Participants

There are 55 physics education students who have been actively participating in science practice for 4 semesters in the form of fundamental physics practicum, wave practicum, optics practicum, basic electronics practicum. Furthermore, in this study, science practice was carried out in a preliminary astronomy course.

Procedure

This research begins with a preliminary study to identify problems in learning astronomy. Problem identification is focused on formulating problems. Literature review is conducted to explore the sky map media, look for media advantages, limit media weaknesses and review the results of previous research on the use of sky map media in astronomy learning. The literature review was continued by designing this quasi-experimental research to facilitate research implementation. The research instrument was designed to reveal students 'conceptions of learning and students' perceptions using sky map media. The research procedure from the initial stage to the final stage is as shown in Figure 1.

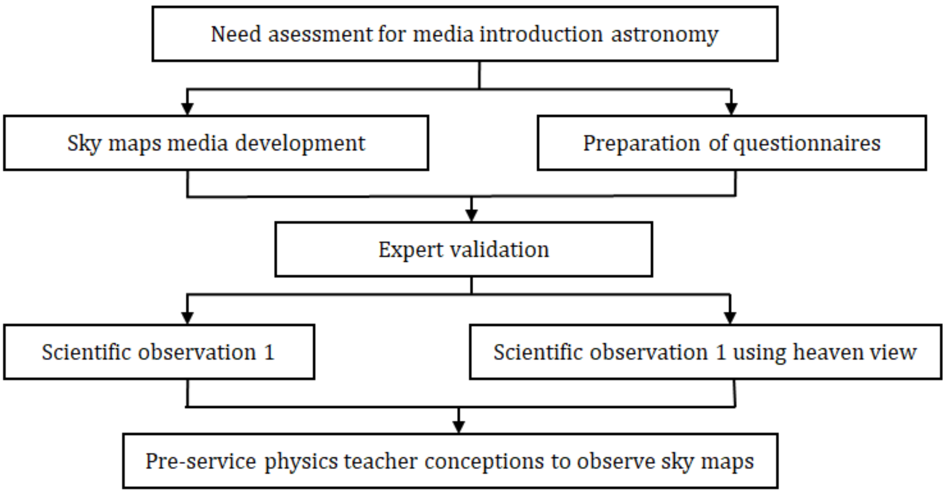

Fig 1. *Research Prosedure of Conceptions to Observe Sky Maps*

Data Analysis

Students take a visual literacy test and fill out two types of questionnaires related to the concept of astronomy learning and students' perceptions of the use of the heaven above media. Both questionnaires were filled out by participants online. The data from the conception of astronomy learning and student perceptions were analyzed using a quantitative approach by calculating the percentage of each questionnaire rubric. The student's conception questionnaire observed the sky map and the questionnaire on students' perceptions of the use of heaven above media was carried out by factor analysis by SPSS to explain the correlation between the research variables [19] [25]. Visual literacy skills are analyzed using normalized gain.

RESULTS AND DISCUSSIONS

Students' prior knowledge can be reviewed based on astronomy learning activities that students have previously studied or general knowledge gained in everyday life based on curiosity about the universe that can be observed directly through observations of the sun, moon and stars. In astronomy lectures, manipulative skills and assessing student skills as prospective physics teachers show students' perceptions that as additional information through learning astronomy adds practical science skills to manipulate direct observation or assisted simulation to obtain better data information. The learning environment is needed to provide an understanding of scientific concepts from observation and to assess skills in exploring experiences through the laboratory in order to improve conceptual understanding. Follow-up activities in the form of learning enrichment and assignments to support meaningful independent learning.

Students' perceptions of using heaven view media include a questionnaire containing questions to reveal student responses in the astronomy learning process related to science practices and the use of sky map simulations. Questions to reveal student perceptions [6] [20] [26] include:
1) Student collaboration skills, investigating cooperatively student collaboration activities in a compact work team.
2) Open and independent, investigating students' ability to explore using an experimental approach in problems solving and decisions making.
3) Integration, investigating the integration between scientific theory and practice that affects the way scientific observations and results are observed.
4) Clarity of rules, investigating student behavior in accordance with scientific procedures, observing and using simulations according to procedures that seek to approach the standards used by scientists.
5) Student learning environment, investigating and considering the tools and materials used by students in science practice and the conditions of the learning environment as a place to conduct observations and discussions.

Table 1. The Confirmatory for Pre-service Physics Teacher Conceptions to Observe Sky Maps

Items	SD	Mean	Factor loadings	AVE	CR	Alpha value
Custom skill of star	0.50	3.53		0.43	0.37	0.75
(CSS)			0.62			
CSS1			0.21			
CSS2						
Prior Knowledge (PK)	0.55	3.69		0.72	0.46	0.77
PK1			0.63			
PK2			0.57			
Depth Conceptual Mastery (DCM)	0.67	3.84		1.05	0.54	0.73
DCM1			0.79			
DCM2			0.65			
Student Motivation & Curiosity (SMC)	0.58	3.75		1.17	0.56	0.77
SMC1			0.81			
SMC2			0.72			
Using Heaven View	0.62	3.78		0.49	-	0.81
(UHV)			0.54			
UHV1			0.45			
UHV2						

Comfirmatory Factor Analysis (CFA) for verify the construct validity of the conceptions of pre-service teacher observe the sky map and media perceptions of heaven view. Descriptive data stated mean, deviation standard, faktor loadings, average variance extracted (AVE), composite reliability (CR) anda Alpha coeficient are shown in the Table 1.

Table 1 show that results of analysis each indicator for custom skills of star, prior knowledge, depth conceptual mastery, student motivation and curiosity, using heaven view have mean each of indikator are 3.53; 3.69; 3.84; 3.75 and 3.78 while the standard deviation are 0.50; 0.55; 0.67; 0.58 and 0.62. the mean of each questionnaire indicator for the pre-service physics teacher > 0.3 was categorized as good and the standard deviation obtained <1.0 was in the good category. The loading factor for each indicator of the pre-service physics teacher's conception is > 0.6. Each questionnaire indicator is categorized as reliable. The average variance extracted in the conceptions of pre-service teachers is higher than 0.5 on indicator of CSS1; PK1; PK2; DCM1; DCM2; SMC1; SMC2 and UHV1. Composite reliability value ranges from 0.37 to 0.56. Alpha values range from 0.73 to 0.81. The results of analysis indicate that the item validity for the questionnaire scale for the conceptions of pre-service teachers to observe sky maps is quite adequate. This shows the pre-service physics teacher's conception of the use of applications is very helpful in triggering conceptual understanding and learning motivation. In line with the results of previous research regarding visual skills related to visual literacy which are expressed from the results of the analysis and interpretation of observational data [2] [5].

Table 2 The Confirmatory Factor Analysis for Perceptions Heaven View

Items	SD	Mean	Factor loadings	AVE	CR	Alpha value
Content Presentation (CP)	0.66	3.54		1.006	0.57	0.86
CP1			0.50			
CP2			0.87			
Demonstration Activities (DA)	0.63	3.67		1.059	0.78	0.84
DA1			0.79			
DA2			0.66			
Phase of Task (PoT)	0.61	3.83		1.070	0.67	0.86
PoT1			0.56			
PoT2			0.87			
Scientific Observation (SO)	0.69	4.02		1.264	0.86	0.84
SO1			0.80			
SO2			0.79			
Fun Learning (FL)	0.58	3.76		1.073	0.86	0.84
FL1			0.83			
FL2			0.62			

Table 2 show that results of the analysis students' perceptions using the heaven view application show that the results of the analysis of each indicator of content presentations, demonstration activities, phase of tasks, scientific observation and fun learning have a mean of each indicator was 3.54; 3.67; 3.83; 4.02 and 3.76 while the standard deviation was 0.66; 0.63; 0.61; 0.69 and 0.58. The mean of each indicator of the pre-service physics teacher's questionnaire using Heaven View score > 3.0 was categorized as good and the standard deviation obtained value < 1.0 was categorized as good. The loading factor for each indicator of pre-service physics teacher's conception was > 0.6, meaning that each questionnaire indicator is categorized as reliable. The average variance extracted of the pre-service teacher's conceptions reaches higher than 0.5 on each indicator of the pre-service physics teacher's perception. Composite reliability value ranges from 0.57 to 0.86. Alpha values range from 0.84 to 0.86. The results of the above analysis indicate that validity item for the questionnaire scale for the perception of pre-service physics teacher using the Heaven View application reaches a proper and adequate level. This shows student responses are able to use applications according to their needs and creativity in carrying out demonstration activities, collecting data or to add to the experience of making observations. The relevant research results state that various applications of technology application are related to visual literacy and conceptual understanding of content presentation in a meaningful way [6] [8].

Table 3 The confirmatory factor analysis for discussion and observation of heaven view

Items	SD	Mean	Factor loadings	AVE	CR	Alpha value
Collaboration Skill (CS)	0.57	3.49		0.92	0.69	0.82
CS1			0.73			
CS2			0.62			
Distribution of Task (DoT)	0.45	3.53		1.081	0.77	0.81
DoT1			0.74			
DoT2			0.73			
Asking Skill (AS)	0.65	3.33		0.92	0.68	0.78
AS1			0.74			
AS2			0.61			
Brainstorming Skill (BS)	0.53	4.10		1.023	0.71	0.82
BS1			0.71			
BS2			0.72			
Scientific Answer (SA)	0.62	4.26		0.92	0.72	0.83
SA1			0.72			
SA2			0.63			
Presentation Skill (PS)	0.58	3.88		1.003	0.78	0.77
PS1			0.64			
PS2			0.77			

Table 3 shows the acquisition of the mean, standard deviation, factor loading, AVE, CR and alpha value of each discussion and observation indicator, namely collaboration skills, distribution of tasks, asking skills, brainstorming skills, scientific answer and presentation skills. All loading factors score above 0.60. AVE values were all higher than 0.5 and ranged from 0.92 to 1.081, CR values were all higher than 0.6 and ranged from 0.68 to 0.78, and alpha values ranged from 0.77 to 0.83 with an overall alpha value of 0.81. This shows the validity of the questionnaire items to construct the results of observations during discussion and observations which are stated to be more than adequate. The achievement of visual literacy between activity 1 and activity 2 was shown in Figure 1.The achievement of each visual literacy indicator between activity 1 and activity 2 in Group A and Group B was shown in Figure 2. The normalized gain of scientific literacy in Group A and Group B were shown in Figure 3 and 4. The results of the analysis of group discussions and observations using heaven view have better abilities because collaborative skills are trained, distribute tasks, ask questions critically, give each other suggestions and provide scientific answers. Based on the results of the study, it is stated that visual literacy skills require process and experience, the more variations in the observation are made, the sharpness of visualization, visual literacy skills and the application of digital technology also increases [12] [27].

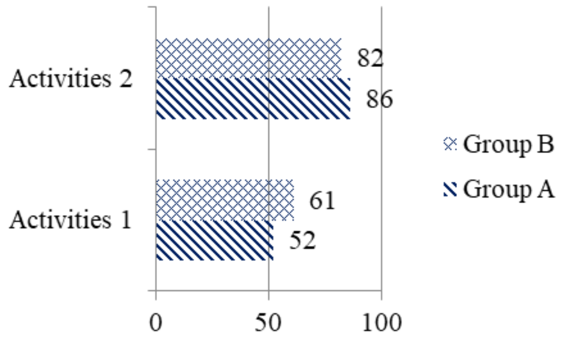

Fig 1. *Activities score*

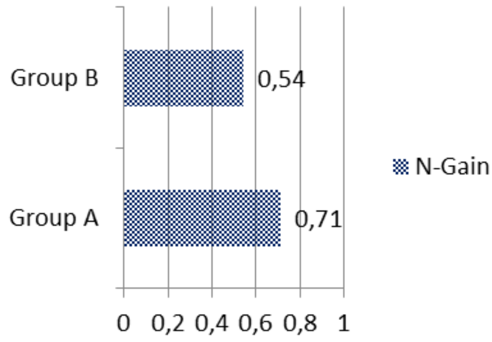

Fig 2. *N-Gain of visual Literacy*

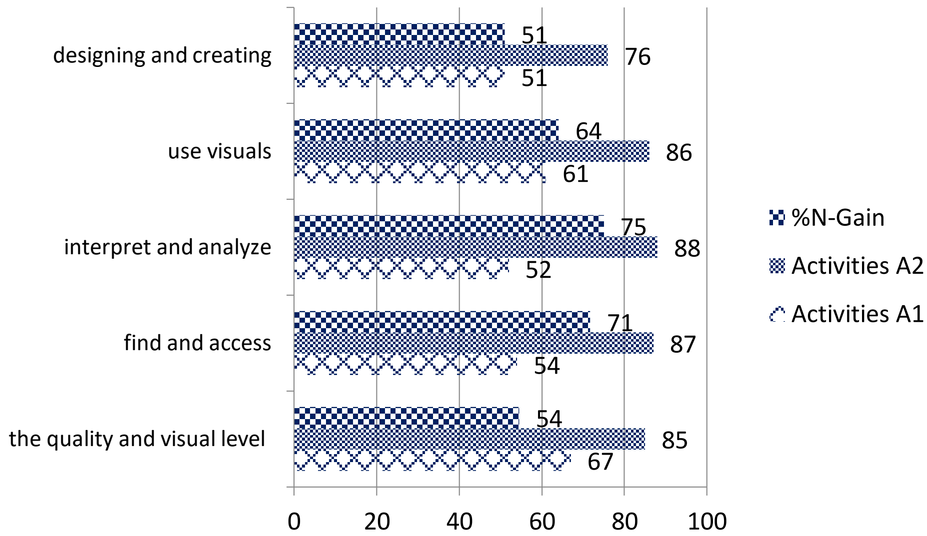

Fig 3. *Normalized gain visual literacy on Group A*

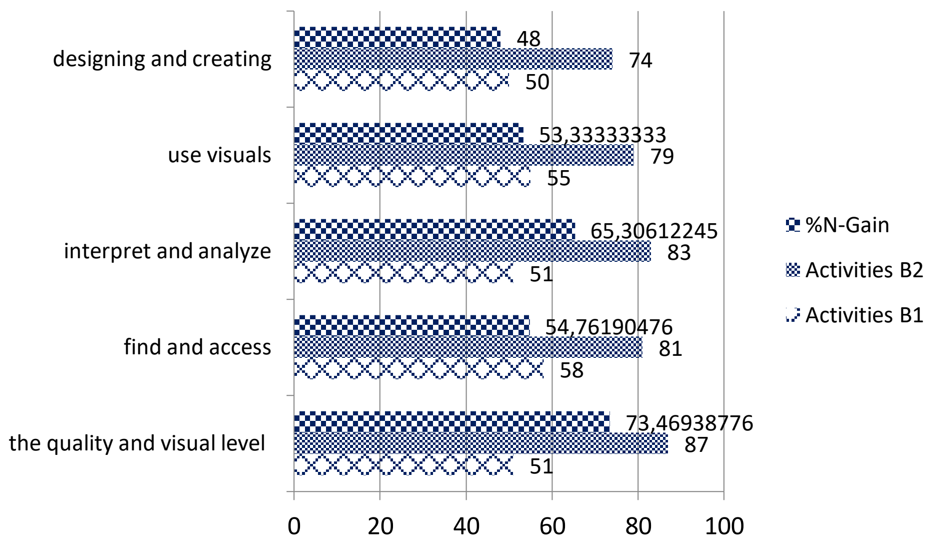

Fig 4. *Normalized gain visual literacy on Group B*

Figure 1 shows the difference in the achievement of activity 1 and activity between Group A and Group B. Group A got a score of activity 1 was 52 and activity 2 was 86, Group B got a score of activity 1 was 61 and activity 2 was 82. Figure 2 shows N-Gain of visual literacy between Group A and Group B, Group A's acquisition was 0.71 on the high category and Group B's acquisition was 0.54 on the middle category. Figure 3 shows the Normalized gain visual literacy on Group A, each visual literacy indicator gets the highest gain was 75% on the interpretation and analyze indicator. Lowest gain was 51% on indicators of designing and creating. The learning process using the Heaven View application, it provides direct experience of data retrieval, describes experience data, analyzes data and compares analysis results to interpretation. However, this media is still interested in designing and creating something new. Data interpretation comes from a large number of data variations and the results of data analysis are obtained to be compared and conclusions drawn [14] [28]. Figure 4 shows the Normalized gain of visual literacy on Group B for each indicator of visual literacy to get the highest gain was 73% on the indicators of the quality and visual level. Lowest return was 48% on indicators of designing and creating.

The relationship between the indicators of the conception of pre-service physics teachers in astronomy learning and the perceptions of pre-service physics teachers using Heaven View media to get significant and positive factors in explaining each indicator of the pre-service physics teacher's conception and their perceptions using the Heaven view media. In short, the pre-service teacher's conception of astronomy learning is directly related to their perception of using media and making observations. The conception of pre-service physics teachers in physics learning is influenced by Custom Skill of Star (CSS), Prior Knowledge (PK), Depth Conceptual Mastery (DCM), Student Motivation and Curiosity (SMC) and Using Heaven View (UHV). In addition, the concept of pre-service teachers is related to the perception of pre-service physics teachers in using learning media related to several skills, namely Content Presentation (CP), Demonstration Activities (DA), Phase of Tasks (PoT), Scientific Observation (SO) and Fun Learning (FL). This linkage of conceptions and perceptions of pre-service physics teachers provides a positive relationship and achieves adequate criteria. Improved visual literacy using Heaven View's media assistance is very adequate, including in the medium and high categories. Learning media is very helpful in meeting the needs of curiosity, motivation and learning progress of pre-service physics teachers.

This study provides a discussion related to introductory astronomy learning that shows the construct model provides an acceptable fit for the data. The third measurement of the questionnaire adapted and implemented for this study has good reliability and convergent validity. In this study, the results of the model structure have determined the relationship between conceptions in astronomy learning, perceptions of the use of instructional media and discussion activities of pre-service physics teachers. Physics teacher's conception of physics learning made a significant contribution to the perception of the use of learning media. Collaborative skills of pre-service physics teachers, the use of learning media in experiments that integrate theory into practice assisted by the Heaven View application [29].

The conceptions possessed by pre-service physics teachers can guide the growth of collaboration in the observation and discussion process, integrate in laboratory activities and study literature. The conception of pre-service physics teacher about introductory astronomy learning correlates with the perception of the use of instructional media. As a result, it is proven that the data obtained in this study have statistical suitability. Prospective physics teachers acquire manipulative skills and facilitate sophisticated skills which tend to train learning in science environments and laboratories that are actually much more open and to achieve learning goals. Learning progress is related to performance in learning activities which provides an explanation of the relationship between environmental perceptions and motivation to learn to be independent in learning. The conception of science laboratory learning is formed by a person's experience in discussion, observation and presentation activities [30] [31]. For students who highlight the cognitive aspects of activities, such as developing practical skills and inquiry in learning, they need a practice-related approach to achieve learning goals and learning achievement.

Pre-service physics teachers who view astronomy learning as a profound achievement in understanding physics learning. If learning activities and the use of learning media are guided by clear rules, it will have an impact on the learning progress of pre-service physics teachers. In addition, prospective physics teachers can improve the learning activities of pre-service physics teachers to involve a real understanding of scientific theory and an understanding of the meaning of doing science practice and provide clear guidance on learning activities [24] [31] [32]. Relevant to the results of previous research, the practical use of Heaven View media allows making learning more practical, open and in terms of the surrounding environment [16] [33]. The guided inquiry model provides facilities for pre-service physics teachers to carry out science practices and inquiry activities and then students design and plan independently with the help of heaven view applications such as customizing stars and making observations. In technology-assisted astronomy learning, involving a science-related environment and conducting online inquiry activities can promote students' conceptions of astronomy learning which can shape the learning experience of pre-service physics teachers. Therefore, environmental involvement and inquiry activities have the potential to achieve learning progress and independence of pre-service physics teachers.

CONCLUSION AND SUGGESTION

The findings suggest that building learning experiences through direct observation and using sky map applications requires a systematic, concept understanding and procedures for observation. This contributes to the creation of an astronomy learning and learning community study with open ended investigation activity and clearer guiding rules. Open ended investigation activities are more directed to students towards scientific inquiry skills. Besides, procedures investigation becomes a suggestion to apply student understanding to observation practice. The results of questionnaires and observations of this study can help further research in observing sky maps for learning astronomy. Students' conceptions about science practice and the use of sky map applications are important things that must be creatively designed to familiarize themselves with scientific observations in astronomy learning. This inspires independent learning and student-centered learning so as to create an engaging, fun and scientific learning environment in collaborative and advanced study groups. This study shows a positive relationship between scientific activities through investigating scientific observations and the independence of students in demonstration of scientific conception in the practice of observing celestial bodies either directly or through sky map applications. Student perceptions in controlling understanding of content and learning activities so that student experience grows. Assistance from student activity sheets determines the content and processes that shape student experiences to observe variations in the learning community.

ACKNOWLEDGMENTS

Thank you for the permits and research facilities to Science Education Department, School of Postgraduate Studies Universitas Pendidikan Indonesia; Physics Education Department, Universitas Islam Negeri Walisongo Semarang and Physics Education Department, Universitas Negeri Semarang.

REFERENCES

[1] Bowen, T. (2017). Assessing visual literacy: a case study of developing a rubric for identifying and applying criteria to undergraduate student learning. *Teaching in Higher Education*, *22*(6): 705-719.

[2] Tian, W., & Louw, S. (2020). It's a win-win situation: implementing Appreciative Advising in a pre-service teacher training programme. *Reflective Practice*, *21*(3): 384-399.

[3] Ruffinelli, A., de la Hoz, S., & Álvarez, C. (2020). Practicum tutorials in initial teacher training: conditions, strategies, and effects of reflective practice. *Reflective Practice*, *21*(1): 54-67.

[4] Nelson, N. (2004). Visual literacy and library instruction: A critical analysis. *Education Libraries*, *27*(1): 5-10.
[5] Villamizar, A. G. (2018). Examining intersections between visual literacy and digital technologies in English language programs for higher education. *Journal of Visual Literacy*, *37*(4): 276-293.
[6] Lee, M. H., Liang, J. C., Wu, Y. T., Chiou, G. L., Hsu, C. Y., Wang, C. Y., ... & Tsai, C. C. (2020). High school students' conceptions of science laboratory learning, perceptions of the science laboratory environment, and academic self-efficacy in science learning. *International Journal of Science and Mathematics Education*, *18*(1): 1-18.
[7] Susilawati, Kaniawati, I., Ramalis, T. R., & Rusdiana, D. (2020). Investigating Scientific Reasoning through Observation and Astronomy Practices on Student and Pre-service Physics Teacher. *International Journal of Advanced Science and Technology*, *29*(3): 4857 – 4865.
[8] Rodriguez, L., & Dimitrova, D. V. (2011). The levels of visual framing. *Journal of visual literacy*, *30*(1): 48-65.
[9] Fischer, F., Kollar, I., Ufer, S., Sodian, B., Hussmann, H., Pekrun, R., ... & Eberle, J. (2014). Scientific reasoning and argumentation: advancing an interdisciplinary research agenda in education. *Frontline Learning Research*, *2*(3): 28-45.
[10] Penuel, W. R. (2017). Research–practice partnerships as a strategy for promoting equitable science teaching and learning through leveraging everyday science. *Science Education*, *101*(4): 520-525.
[11] Nguyen, P. V. (2020). TT-SET augmented with POT: a potential framework for academics' pedagogical reasoning. *Reflective Practice*, *21*(1): 14-27.
[12] Suwanjinda, D., Visavateeranon, S., & Phadungphatthanakoon, S. (2020). The Impact of Mobile Technologies-integrated Cooperative Instruction Workshop for In-service Science Teachers. *Universal Journal of Educational Research*, *8*(9): 4287-4293.
[13] Wali, A., & Omaid, M. (2020). The Use of Smartphones as an Educational Tool in the Classroom: Lecturers' Perceptions. *International Journal Of Emerging Technologies In Learning (IJET)*, *15*(16): 238-247.
[14] Dusadee, N., & Piriyasurawong, P. (2020). Virtual Professional Training Community Model for Developing Digital Teacher Competencies. *Universal Journal of Educational Research*, *8*(9): 4234-4241.
[15] Ismail, M. E., Amin Nur Yunus, F., Sulaiman, J., Nordin, N., & Sa'adan, N. (2020). The Implication of Employing Magnetic Test Kit on Students' Interest, Teachers' Teaching Method and Students' Visualization Ability. *Universal Journal of Educational Research*, *8*(9): 3858-3863.
[16] Kurosh, S., Yousefi, M. H., & Kashef, S. H. (2020). Iranian teachers' reflective teaching practice in relation to self-efficacy perceptions: investigating teachers' discipline. *Reflective Practice*, *21*(3): 356-370.
[17] Navarro, O., Sanchez-Verdejo, F., Anguita, J., & Gonzalez, A. (2020). Motivation of university students towards the use of information and communication technologies and their relation to learning styles. *International Journal of Emerging Technologies in Learning (iJET)*, *15*(15): 202-218.
[18] Mutlu, A. (2020). Evaluation of students' scientific process skills through reflective worksheets in the inquiry-based learning environments. *Reflective Practice*, *21*(2): 271-286.
[19] Hahs-Vaughn, D. L. (2016). *Applied multivariate statistical concepts*. Taylor & Francis.
[20] Chiu, Y. L., Lin, T. J., & Tsai, C. C. (2016). The conceptions of learning science by laboratory among university science-major students: qualitative and quantitative analyses. *Research in Science & Technological Education*, *34*(3): 359-377.
[21] Greenberger, S. W. (2020). Creating a guide for reflective practice: applying Dewey's reflective thinking to document faculty scholarly engagement. *Reflective Practice*, *21*(4): 458-472.
[22] Istiyowati, L. S., Syahrial, Z., & Muslim, S. (2020). Programmer's Competencies between Industry and Education. *Universal Journal of Educational Research*, *8*(9A): 10-15.
[23] Bahar, B., Wibawa, B., & Situmorang, R. (2019). Using Problem-Based Learning To Teach Software Modeling In Information Technology Colleges In Indonesia. *Unnes Science Education Journal*, *8*(2).

[24] Al Husna, I. Y., Masykuri, M., & Muzzazinah, M. (2021). Development of Instructional Module Based on Inquiry-Interactive Demonstration to Improve Students' Critical Thinking Skill. *JIPF (Jurnal Ilmu Pendidikan Fisika)*, *6*(1): 66-75.
[25] Sharma, S.. (1996). *Applied Multivariate Techniques*. Canada: John Wiley & Sons. Inc.
[26] Lee, H., & Schneider, S. E. (2015). Using astronomical photographs to investigate misconceptions about galaxies and spectra: Question development for clicker use. *Physical Review Special Topics-Physics Education Research*, *11*(2): 020101.
[27] Zion, M., & Mendelovici, R. (2012). Moving from structured to open inquiry: Challenges and limits. *Science Education International*, *23*(4): 383-399.
[28] Guo, D., Zimmer, W., Matthews, S. D., & McTigue, E. M. (2019). Critical analysis of research on the impact of visual literacy for learning: strengths, weaknesses and recommendations for improvement. *Journal of Visual Literacy, 38*(3): 181-198.
[29] Verawati, N., Hikmawati, H., & Prayogi, S. (2020). The Effectiveness of Inquiry Learning Models Intervened by Reflective Processes to Promote Critical Thinking Ability in Terms of Cognitive Style. *International Journal of Emerging Technologies in Learning (iJET)*, *15*(16): 212-220.
[30] Yuliani, K., & Saragih, S. (2015). The Development of Learning Devices Based Guided Discovery Model to Improve Understanding Concept and Critical Thinking Mathematically Ability of Students at Islamic Junior High School of Medan. *Journal of education and practice*, *6*(24): 116-128.
[31] Blummer, B. (2015). Some visual literacy initiatives in academic institutions: A literature review from 1999 to the present. *Journal of Visual Literacy*, *34*(1): 1-34.
[32] Tompo, B., Ahmad, A., & Muris, M. (2016). The Development of Discovery-Inquiry Learning Model to Reduce the Science Misconceptions of Junior High School Students. *International Journal of Environmental and Science Education*, *11*(12): 5676-5686.
[33] Waldrip, B., & Prain, V. (2017). Engaging students in learning science through promoting creative reasoning. *International Journal of Science Education*, *39*(15): 2052-2072.