ISSN : 2549-2764 (ONLINE)
ISSN : 2337-604X (PRINT)
BERKALA ILMIAH PENDIDIKAN FISIKA
https://ppjp.ulm.ac.id/journal/index.php/bipf

Utilization of Sky Map Application in Astronomy Learning of Celestial Coordinates to Improve Students' Understanding of Concepts and Digital Literacy for Physics Education Students

Nurulia Fajriani* and Masturi
Pendidikan Fisika, Fakultas Matematika dan Ilmu Pengetahuan Alam
Universitas Negeri Semarang, Semarang, Indonesia
*nuruliafajri23@gmail.com

DOI:10.20527/bipf.v11i1.15603

Received: 13 February 2023 Accepted:13 March 2023 Published: 18 March 2023

Abstract

Using the Sky Map application in astronomy learning of celestial coordinates is intended to analyze students' level of understanding of concepts and digital literacy. Students' understanding of concepts and digital literacy was measured through tests and questionnaires. The research was focused on students who took astronomy courses in the physics department of Semarang State University, totaling 40 students. The type of research used is quantitative research. The research design carried out was pre-experimentation with one group pretest-posttest. There are two variables used, i.e. the use of Sky Map application media as the independent variable, and the improvement of the understanding of the student concept as the dependent variable. The analysis using the Wilcoxon signed rank test showed a significant increase in students' conceptual understanding after using Sky Map application media in learning with an N-Gain of 0.21, and digital literacy in the use of Sky Map application media has attained 83.47% (excellent). Therefore, it can be concluded that the use of Sky Map application media in celestial coordinates can help students understand the concept of the material as well as increase their digital literacy skills.

Keyword: Celestial Coordinates; Concept Understanding; Digital Literacy; Sky Map

How to cite: Fajriani, N. & Masturi, M (2023). Utilization of sky map application in astronomy learning of celestial coordinates to improve students' understanding of concepts and digital literacy for physics education students. *Berkala Ilmiah Pendidikan Fisika*, 11(1), 80-88.

INTRODUCTION

The rapid development of technology every second has caused changes in various fields, including education (Lestari, 2018). The information needed can flow quickly, making it easier in many job sectors. But not all these developments make it easy constant development makes life more complicated and unpredictable due to constantly changing circumstances. So that with the current technology, it must be used as well as possible by humans.

The development of technology in education also has a big impact. New Innovations are presented to facilitate all learning processes, from learning media to learning models (Umoh et al., 2020). In general, the learning process with media is more effective than without lessons media (Puspitarini & Hanif, 2019). However, the use of suboptimal

media can be detrimental to the learning process that takes place.

The use of media in the learning process helps students to understand concepts. Not only learning in high school requires media, but in higher education, when the learning process, students also need media to develop a conceptual understanding of the material presented. Depictions that are presented realistically and clearly in learning media are very supportive of students and facilitate the understanding process.

Conceptual understanding is the ability to understand a material concept given in detail and seen in improving learning outcomes. Students should not only memorize but understand the semantic content contained in it and be able to explain certain concepts, diagrams, and situations in their own words (Astiti & Yusuf, 2018).

Astronomy courses, especially the coordinate material of celestial bodies, require complex learning media to support conceptual understanding. The necessary medium should be able to present not only the required information but also the visualization of objects of various shapes that exist in space. One of the familiar celestial sphere application media is the Sky Map. The application of the celestial sphere is an innovation in science and technology that is increasingly developing and capable of displaying scientific observations of celestial bodies (Cam & Kiyici, 2017).

The selection of Sky Map application media in this study is to know whether there is an increase in understanding of concepts in students after carrying out astronomical learning of celestial body coordinate materials using Sky Map application media. Sky Map application was chosen because it is easily accessible to students, is available in web and application modes, and there is information that supports learning.

On the other hand, cutting-edge technology developments raise problems that must be faced, including low student skills to solve complex problems, less creativity to think positively, and less innovation and productivity in finding new things. Lack of ability to analyze data, collect data, and communication skills. The necessity to strengthen digital literacy is precious, so this problem must be resolved by various efforts to refract and culture of science literacy in learning. Strengthening science literacy can also be applied by learning astronomy has unique material content characteristics that arouse curiosity. The learning hoped to be able to provide an in-depth understanding of natural and space phenomena to be able to answer pry and the ability to search and analyze accurate data (Gunes & Bahcivan, 2018).

The problem is that astronomy learning has not been able to involve students in actively observing and optimizing digital literacy as part of the high-level thinking skills needed. This research has relevance to previous research, namely in general, the discussion has similarities with what will be studied about understanding concepts with one of the subjects being students majoring in physics, but the difference with this research is that the research focuses on the use of different application media, namely the application of Sky Maps in learning astronomy of the coordinate material of celestial coordinates to the understanding of concepts and digital literacy of students.

METHOD

The quantitative research uses a pre-experimental design with one group pretest-postest design. The data used in this study is in the form of numbers obtained from student test results with two tests: pretest and posttest. There was no control class in this research design, and there were only experiment classes that were given pretests before treatment and posttests after treatment (Arikunto, 2010). The study was carried out at

Semarang State University, Semarang City, Central Java.

The population in this study were students majoring in Physics at Semarang State University who took astronomy courses. Sampling uses purposive samples where sampling is carried out with certain considerations. This technique is used because the number of samples taken is only in the astronomy department of physics, Semarang State University, which is 40 students.

The instruments used are test instruments in the form of multiple-choice questions and questionnaires containing statements that the experts have validated. There are three stages carried out in this activity, first is to carry out a pretest to know students' understanding before being given treatment. Then online learning with Sky Map application media. Finally, the implementation of a posttest to find out the level of understanding after treatment, and given a questionnaire to see students' digital literacy skills. The sampling used purposive samples that were carried out based on certain aspects.

This technique is used because the number of samples taken is only in the astronomy department of physics, Semarang State University, which is 40 students. Two variables are used namely the independent and dependent variables. The first is using Sky Map application media, and the latter is understanding the student concept. The data analysis techniques used are prerequisite analysis tests with normality tests, using the help of SPSS, and hypothesis testing using paired sample t-tests for normal data or Wilcoxon signed rank tests for abnormal data.

The questionnaire analysis was analyzed using the Likert scale, which is divided into five scales, that is strongly agreeing with a score of 5, agreeing with a score of 4, undecided with a score of 3, disagreeing with a score of 2, and disagreeing with a score of 1, with the interpretation was carried out from the interval distribution as shown in Table 1 (Arikunto, 2010).

Table 1 Likert scale interpretation of digital literacy

Category	Interval	%
Excellent	65 – 80	81 – 100
Good	49 – 64	61 – 80
Moderate	33 – 48	41 – 60
Poor	17 – 32	21 – 40
Very Poor	0 – 16	0 – 20

RESULT AND DISCUSSION

Based on the results of the normality test analysis using IBM SPSS with the Kolmogorov-Smirnov method, the pretest significance value is sig (0.034) because the significance value is less than 0.05, the data is not normally distributed, and the posttest significance value is sig(0.002), so the significance value is smaller than 0.05, the data is not normally distributed, the following test results shown in Table 2.

Table 2 Normality test analysis results

Kolmogorov-Smirnov	Statistic	df	Sig.
Pretest	0.145	40	0.034
Posttest	0.181	40	0.002

Because the data is not normally distributed, hypothesis testing cannot be done with parametric tests. In addition, the data were analyzed using a nonparametric test, namely the Wilcoxon test. The following test results are shown in Table 3.

Table 3 Wilcoxon signed rank test analysis (2-tailed) results for concept understanding

Pretest	Postest	Sig
46	57	0.000
N-gain = 0.21		

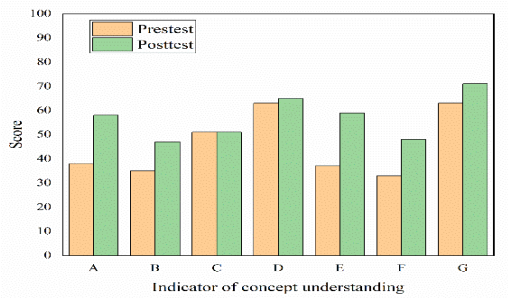
Based on the Wilcoxon test analysis results, a value of Asymp Sig (2-tailed) is 0.000. Therefore, the significance value is smaller than 0.05 (0.000 < 0.05), so the Ha hypothesis is accepted. It is stated that there is an increase in students' understanding of the concept of learning

astronomy of the coordinate material of celestial bodies with the Sky Map application media. This shows that learning astronomy of the coordinate material of celestial bodies using the Sky Map application media is well used to help improve students' understanding of concepts. The results of the N-Gain analysis showed a score of 0.21. It can be concluded that the use of the Sky Map application can improve students' understanding of concepts but is not effective. This situation shows that astronomy is difficult and demands complex understanding and abilities (Camarillo, et al., 2011). Agreeing with what Roblyer, David A Jacobsen, and colleagues said, technology can make it easier for educators to help learners understand facts and abstractions and achieve goals at a higher level of cognitive taxonomy (Jacobsen, 2009).

We can know that the Sky Map application media has provided benefits, as Irsyan Rasyid said in his research that one of the uses of learning media is that it can improve the quality of lessons. The other benefits of learning media are: (1) The material presented becomes more uniform, (2) The learning process becomes more interesting, (3) Make learning activities two-way, (4) Saves effort and time, (5) Using learning media can be done more flexibly, (6) Media makes students towards a positive attitude toward the material and the learning process, (7) Changing the role of educators to be more positive and productive (Rasyid & Rohani, 2018). These benefits are proven by students who can use the application well and can apply it in learning. Previous research has also revealed various benefits of learning media, namely increasing student enthusiasm for learning, helping students understand lessons well, and improving learning outcomes and quality of learning (Leow & Neo, 2014; Wu & Tai, 2016).

Sky Map utilization can also improve concept understanding in astronomy because it allows students to visualize and explore the night sky, enhancing their comprehension of astronomical concepts (Shafiq et al., 2019). Sky Map also provides an interactive and engaging learning experience that can improve students' motivation and interest in astronomy. This argument can be explained as follow. In this work, Sky Map was used to support the learning process by a constructivist approach, where students are actively engaged in their learning process and construct their understanding of concepts. By allowing students to explore the night sky on their own using Sky Map, they can make their observations and draw their conclusions about astronomical phenomena, which can help them build a deeper and more meaningful understanding of astronomy concepts, especially in celestial body coordinates (Handayani et al., 2020). Additionally, SkyMap can create interactive and engaging learning experiences that can enhance student motivation and interest in the matter (Kumar & Pandey, 2021).

Figure 1 shows the achievement of each concept understanding indicator. In general, there is an improvement in each indicator, with the maximum gain being the interpretation aspect, while the classifying and summarizing aspects tend to be constant.



Description:
A = Interpreting, B = Exemplifying, C = Classifying, D = Summarizing, E = Inferring, F = Comparing, and G = Explaining

Figure 1 Achievement for concept understanding indicators

This increase can be understood as follows: Further, since its role as an augmented reality media, SkyMap can also enhance students' spatial intelligence, which is the ability to mentally manipulate and visualize objects in space (Newcombe & Shipley, 2015; Uttal, et al., 2013). SkyMap can help students develop their spatial intelligence by allowing them to explore and manipulate the night sky in a virtual environment. This can also help students develop their spatial reasoning skills, which are important for understanding and solving problems in many areas of science, including the celestial body coordinates matter (Handayani et al., 2020). Moreover, SkyMap also promotes students' cognitive engagement by encouraging them to explore and analyze astronomical phenomena. This can enhance their motivation to learn and help them develop critical thinking and problem-solving skills (Shafiq et al., 2019; Uttal, et al., 2013).

Sky Map also shows the positions of celestial objects such as stars, planets, and galaxies in real-time and the real position of the observer (Stephanie & Gilles, 2013). The use of the media can significantly improve students' understanding of celestial coordinate systems in astronomy and enhance their interpretation skills since it provides a visual representation of celestial objects and their locations in the sky. This visual aid can help students understand complex concepts related to celestial coordinates, such as right ascension, declination, and celestial sphere (Maleke et al., 2018). Sky Map also provides a way to visualize how the sky changes throughout the night and over different seasons. This helps students understand the motion of celestial objects and how to locate them at different times, especially the interpretation skill (Vishnupriva & Bharati, 2022). By observing and analyzing the image displayed by this application, students can learn how to identify different celestial objects, recognize patterns in their locations, and predict their movements over time (Kraicik & Merritt, 2012). These skills are essential for astronomers, and Sky Map provides an accessible way for students to practice them (Council, 2006).

Further, the use of Sky Map in teaching has several benefits for students. First, it provides a visual and interactive way for students to learn, which can enhance their motivation and engagement with the material. This is particularly true for students who are visual learners or who struggle with abstract concepts. Providing a concrete representation of the night sky can make astronomy more accessible and engaging for all students. Moreover, the application can help students develop spatial reasoning skills (Council, 2006). By interpreting the 2D representation of the sky in the media, students must mentally transform the information Into a 3D model of the celestial sphere (Maleke et al., 2018). This process requires spatial visualization skills, which are essential for success in many fields, including science, technology, engineering, and mathematics (STEM). Thus, using Sky Map in astronomy education can provide several benefits for students, promoting a constructivist learning approach, enhancing spatial intelligence and reasoning skills, and promoting cognitive engagement.

The questionnaire analysis was analyzed using the Likert scale, which is divided into five scales, that is strongly agreeing with a score of 5, agreeing with a score of 4, undecided with a score of 3, disagreeing with a score of 2, and disagreeing with a score of 1, with the interpretation was carried out from the interval distribution as shown in Table 3 to obtain the digital literacy of students as shown in Table 4 (Arikunto, 2010).

Table 4 Likert scale analysis results for average digital literacy of students

Average total score	Digital literacy rate (%)
66.78	83.47 (Excellent)

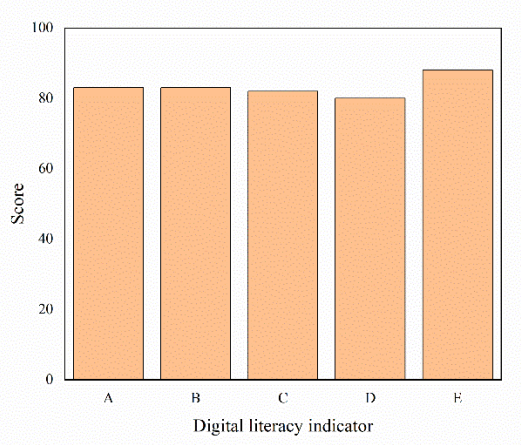
The results of the Likert scale analysis showed a percentage score of 83.47%, which is included in the excellent criteria, which means that students' digital literacy level is excellent in the coordinate material of celestial bodies using the Sky Map application media. The use of the media is very helpful for students to improve their digital literacy skills since students that require to master new media situationally can upgrade their digital literacy competence (Sagitaa, et al., 2019; Setyaningsih et al., 2019).

Good digital literacy skills are considered very reasonable because almost all students have smartphones and spend a lot of time accessing the internet (Kurniawati & Baroroh, 2016), especially the Sky Map application media can be accessed via smartphones, so its use will be very easy for students. Students' scientific abilities also are balanced by digital literacy skills such as those in the questionnaire, i.e. the ability to find data or knowledge, the ability to use data or science, the ability to evaluate knowledge or data, the ability to explore knowledge or data, and awareness of the impact of data or knowledge on society (Kateryna, et al., 2020). Digital literacy is very important for all levels of education since, in the 21st century, it must always go hand in hand with the progress of an increasingly demanding era (Trilling & Fadel, 2009). Students having good digital literacy can adapt well to e-learning because they will find it easy to learn the technology specifically for educational purposes and more efficient and effective in information management (Mohammadyari & Singh, 2015; Tang & Chaw, 2016).

Further, for digital literacy, the use of SkyMap can promote the development of digital literacy skills, such as information literacy, media literacy, and digital citizenship (Davis, 2018; Martin & Grudziecki, 2006). By using SkyMap, students can learn how to access and evaluate digital information related to astronomy and how to evaluate the accuracy and reliability of the information critically. Morever, it also helps students develop their media literacy skills, such as understanding how to interpret and analyze digital media content (Zurita et al., 2020). Additionally, using SkyMap can promote digital citizenship, by helping students develop ethical and responsible behavior when using digital technologies (Davis, 2018).

Sky Map can also enhance students' digital self-efficacy, which is the belief in one's ability to use digital technologies effectively. They can develop their confidence in using digital technologies, which can help them become more comfortable and skilled in using other digital tools and resources (Wang et al., 2020). Even the use of SkyMap can also enhance students' motivation and engagement in learning by providing a fun and interactive way to learn about astronomy. This can help students develop a positive attitude toward digital learning and promote a sense of ownership over their learning process (Martin & Grudziecki, 2006).

If we look in detail at each indicator, the achievement of digital literacy occurs for all indicators at a similar excellent rate (Figure 2). The good achievement shows that the students have used Sky Map for concept understanding enhancement and digital literacy encouragement.



Description:
A = ability to find data/knowledge,
B = ability to use data/knowledge,
C = ability to evaluate data/knowledge,
D = ability to explore knowledge/data,
E = awareness of the impact of data or knowledge on oneself and society

Figure 2 Achievement for concept understanding indicators

As known, Sky Map uses augmented reality technology to overlay labels and information onto the user's view of the sky. The Sky Map application can increase people's ability to find, use, evaluate, and explore knowledge and data related to astronomy and space science (Dzeroski et al., 2020). For example, it can help users identify different constellations, stars, and planets and provide information about their characteristics and properties. This can increase students' awareness and understanding of the cosmos and the impact of space science on society (Dimitriadou et al., 2020). In conclusion, Sky Map in astronomy education can provide several benefits for improving students' digital literacy by promoting the development of digital literacy skills, enhancing digital self-efficacy, and enhancing motivation and engagement in learning.

CONCLUSION

The results showed that the use of the Sky Map application media had been proven to significantly increase students' understanding of concepts in learning astronomy of celestial material coordinates; this is evidenced by an increase in the value of student test results that have been analyzed using Wilcoxon signed rank test, with an N-Gain value of 0.21. The use of the Sky Map application media has also encouraged students to improve digital literacy skills, i.e. the ability to search for data or knowledge, the ability to use data or science, the ability to evaluate knowledge or data, the ability to explore knowledge or data, and awareness of the impact of data or knowledge on society, as evidenced by an excellent achievement (83.47%).

ACKNOWLEDGEMENT

The authors thank the Research and Community Service Institute (LPPM) of Universitas Negeri Semarang for funding this work.

REFERENCES

Arikunto, S. (2010). *Prosedur penelitian suatu pendekatan praktik.* Jakarta: Rineka Cipta.

Astiti, K. A., & Yusuf, Y. H. (2018). Pengaruh penggunaan bahan ajar berbasis kontekstual terhadap peningkatan pemahaman konsep fisika siswa materi suhu dan kalor. *Jurnal Fisika Sains dan Aplikasinya*, 91-192.

Cam, E., & Kiyici, M. (2017). Perceptions of prospective teachers on digital literacy. *Malaysian Online Journal of Education Technology*, 29-44.

Camarillo, C., Coble, K., Hayes, V., Nickerson, M., Cochran, G. L., Bailey, J. M., . . . Cominsky, L. R. (2011). Investigating student understanding of the universe: Perceptions of astronomical sizes and distances. *American Astronomical Society*, (43).

Council, N. R. (2006). *Learning to think spatially: GIS as a support system in the K-12 curriculum.* National Academies Press.

Dahar, R. W. (2011). *Teori - teori belajar dan pembelajaran.* Jakarta: Erlangga.

Davis, K. (2018). Digital Literacy and the future of work: Challenges and opportunities. *International Journal of Information Management*, 156-160.

Dimitriadou, E., Kostaris, C., & Paraskeva, F. (2020). Mobile learning of astronomy: A case study on students' engagement, satisfaction, and learning outcomes. *Education and Information Technologies*, 1499-1519.
https://doi.org/10.1007/s10639-020-10166-2

Dzeroski, S., Korosec, P., & Jereb, E. (2020). Impact of an augmented reality mobile app on students' attitudes towards astronomy. *Journal of Science Education and Technology*, 492-503.
https://doi.org/10.1007/s10956-020-09857-6

Gunes, E., & Bahcivan, E. (2018). A mixed research-based model for pre-service science teachers' digital literacy: Responses to "which beliefs" and "how and why they interact" questions. *Computers & Education*, 96-106.

Handayani, L., Zulkardi, & Darmawijoyo, D. (2020). The effect of sky map application on students' understanding of astronomy concepts. *Journal of Physics: Conference Series*, 15-21.

Jacobsen, D. A. (2009). *Methods for teaching*. Yogyakarta: Pustaka Pelajar.

Kateryna, A., Oleksandr, R., Mariia, T., Iryna, S., Evgen, K., & Anastasiia, L. (2020). Digital literacy development trends in the professional environment. *International Journal of Learning, Teaching and Educational Research*, 55-79.

Kraicik, J. S., & Merritt, J. (2012). Engaging students in scientific practices: What does constructing and revising models look like in the science classroom? . *Science Scope*, 32-37.

Kumar, A., & Pandey, P. (2021). Exploring the possibilities of online education in astronomy. *International Journal of Emerging Technologies in Learning*, 16-29.

Kurniawati, J., & Baroroh, S. (2016). Literasi media digital mahasiswa universitas muhammadiyah bengkulu. *Jurnal Komunikator*, 51-66.

Leow, F., & Neo, M. (2014). Interactive Multimedia Learning: Innovating Classroom Education in a Malaysian University. *Turkish Online Journal of Educational Technology-TOJET*, 99-110.

Maleke, D., Paseru, D., & Padang, R. (2018). Learning Application of Astronomy Based Augmented Reality using Android Platform. *IOP Conf. Ser.: Mater. Sci. Eng.*, 306 012018.

Martin, A., & Grudziecki, J. (2006). DigEuLit: Concepts and tools for digital literacy development. *Innovation in Teaching and Learning in Information and Computer Sciences*, 249-267.

Mohammadyari, S., & Singh, H. (2015). Understanding the effects of e-learning on individual performance: the role of digital literacy. *Computers & Education*, 11-25.

Newcombe, N. S., & Shipley, T. F. (2015). Thinking about spatial thinking: New typology, new assesment. Dalam N. S. Newcombe, & T. F. Shipley, *Thinking about spatial thinking: New typology, new assesment. In Emerging trends in the social and behavioral sciense* (hal. 1-15). John Wiley & Sons, Inc.

Puspitarini, Y. D., & Hanif, M. (2019). Using learning media to increase learning motivation in elementary school. *Anatolian Journal of Education*, 53-60.

Rasyid, I., & Rohani, R. (2018). Manfaat media dalam pembelajaran. *Jurnal Pendidikan dan Matematika*, 1778-4412.

Sagitaa, D. D., Asni, Nofriza, F., Fitniwilis, Adrin B. F. C., & Siswanto, R. D. (2019). Students' digital literacy skill to solve learning problems. *International Journal of Innovation, Creativity and Change*, 112-122.

Setyaningsih, R., Abdullah, A., Prihantoro, E., & Hustinawaty, H. (2019). Model penguatan literasi digital melalui pemanfaatan e-learning. *Jurnal Aspikom*, 1200-1214.

Shafiq, M. A., Aslam, M., & Tahir, M. H. (2019). Role of sky map smartphone application in astronomy theaching: A study on high school students. *World Journal of Education*, 11-21.

Stephanie, F., & Gilles, S. (2013). An augmented reality environtment for astronomy learning in elementary grades: An exploratory study. *Actes de la 25ieme Conference Francophone sur I'Interaction Homme-Machine*, 10.1145/2534903.2534907.

Tang, C. M., & Chaw, L. Y. (2016). Digital literacy: A prerequiisite for effective learning in a blended learning environment? *The Electronic Journal of e-learning* , 54-65.

Trilling, B., & Fadel, C. (2009). *21st Century Skills: Learning for Live in Our Times.* San Fransisco: Jossey-Bass.

Umoh J., D. M., Sheik, I., & Bassey, I. M. (2020). Teaching and learning with media technology. *International Journal of Innovation in Engineering Research and Technology*, 296-300.

Uttal, D. H., Meadow, N. G., Tipton, E., Hand, L. L., Alden, A. R., Warren, C., & Newcombe, N. S. (2013). The malleability of spatial skills: A meta-analysis of training studies. *Psychological Bulletin*, 352-402.

Vishnupriva, S., & Bharati, R. (2022). The impact of audio visual aids in teaching. *International Journal of Health Sciences*, 7847-7859.

Wang, L., Chen, Y., & Li, C. (2020). Study on the relationship between digital literacy and learning performance of college students. *Journal of Physics: Conference Series*, 1651(1).

Wu, T. J., & Tai, Y. N. (2016). Effects of multimedia information technology integrated multi-sensory instruction on students' learning motivation and outcome. *Eurasia Journal of Mathematics, Science and Technology Education*, 1065-1074.

Zurita, O. F., Castro, S. M., Chacon, C. R., & Gonzalez, V. G. (2020). Analysis of the influence of digital competence on the use of digital resources in the university context. *Sustainbility*, 12(10).