



Effectiveness of Mobile Phones as Learning Aid among Senior High School Students

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Abstract:

Mobile phone usage by students is beneficial and found to have a great impact on students learning. This study assessed the effectiveness of mobile phones as a learning aid among senior high school students. The assessment is based on the dimensions using Gavriel Salomon's symbol system theory. The study used the descriptive method of research, respondents are randomly selected using the cluster sampling technique. The principal instrument used is the survey questionnaire and a face-to-face survey is conducted. The survey used the 5-point Likert scale. For inferential statistics, the independent t-test is employed to compare the means based on gender. Results yield that there is no significant difference in the scores for males and females in the dimensions such as content, connectivity, and cognitive abilities. There is a significant difference in the dimensions such as convenience and digital literacy. There is no significant difference in the scores for males and females for the overall assessment of the effectiveness of mobile phones as learning

aid across dimensions. Gender has no moderating effect. Implications for future research on capability infrastructures both for teachers and students across levels addressing gaps in institutionalizing online education portals/ applications for Filipino learners.

Keywords: *Mobile Phones, Learning Aid, Senior High School, Symbol System Theory.*

Introduction

People across the world now consider mobile phones to be both a commodity and a need, especially for the younger generation. The use of mobile devices by students is beneficial. The educational program must formally recognize mobile devices as additional learning resources (Ngesi et al., 2018). Ahmad (2018) articulated the teachers' and students' viewpoints on using a mobile device as a learning tool in the classroom.

Hassan and Yousaf (2021) stated that mobile phones have created a great impact on students' learning progress.

Further, the mobile applications developed by Farrah and Abu-Dawood (2018) have enhanced learning effects in an engaging learning environment, and boost students' creativity and problem-solving skills (Onyema, 2019). Saeed and Hassan (2020) argued that phones would be a great instrument for the learning process of



students. There is an improvement in the performance and involvement of learners (Yousaf et al., 2021).

Mohammadi et al (2020), on the other hand, found that mobile use is ineffective for learning. More difficulties and obstacles are associated with mobile learning. Alghazi and other (2021) stated that a student must meet several prerequisites to use a mobile phone. Schools better meet students' demands for sharing, communicating, and learning.

The behavioral intention was the most significant predictor of actual mobile phone usage. Age, gender, and experience had no moderating influence (Nikolopoulou et al., 2020). There were differences in how the students felt about their grades though there were no statistically significant differences in how they perceived gender and age (Mortazavi et al., 2020). Boys and girls can benefit equally from educational technologies. Women tend to be less confident about their digital skills, even though this does not indicate a difference in real competence (Allier-Gagneur & Moss Coflan, 2020).

According to Mauricio (2017), mobile phones have a beneficial effect on studying both for students and teachers. Fabito (2017) concluded that whether people use their mobile devices to access a learning management system is still not a reliable predictor of their behavioral intent. Jin et al (2018) described the effects of smartphone use on students' learning processes and further guidance and training on how to integrate mobile devices into academic activity should be acknowledged. Multidimensionality and gratifications approach to explore the applications must be included (Saeed & Hassan, 2020).

The study by Peralta et al. (2019), revealed that the Mobile Learning Application (MLA) is a practical piece of technology that enables teachers to provide lessons and other helpful resources online. High school students enrolled in government-run schools in the Philippines have a poor adoption of this technology. According to Asio and other (2021), having a mobile phone allows students to take classes

online and in other ways. Toquero and Talindong (2020) opined that the use of digital technology ensures a secure environment and mobile devices, according to Lim and Arcilla (2021), it enhances students' understanding of a variety of ideas.

However, significant digital imbalances still exist among Manila's public schools, according to Jin and Junio-Sabio (2018). The results show that mobile devices have the potential to be used in already operating public senior high schools and that regulations and curricula need to be revised to match the mobile era. According to Bombaes (2018), perceived usefulness influences students' intentions for m-learning favorably. Lim and Moneva (2018) stated that the use of mobile devices as a learning aid was ineffective due to the possibility of cheating, it serves as a "hindrance" to learning.

Hence, the purpose of this study is to assess how senior high school students at SPRCNHS-Landayan Annex use mobile phones as learning tools for School Year 2022-2023. The assessment is based on the dimensions such as enhancing connectivity, strengthening cognitive abilities, developing digital literacy, convenience, and content. Each of these dimensions is assessed based on the efficiency of mobile phones as a learning aid depending on their gender. Moreover, the study aims to further validate hypotheses.

This study assessed the effectiveness of mobile phones as a learning aid among senior high school students of the SPRCNHS-Landayan Annex. Specifically, this study answers the following questions:

1. What gender-specific characteristics best define the demographic profile of the students?
2. How do the respondent-students assess the effectiveness of mobile devices as tools for learning in the following areas:
 - 2.1. improving digital literacy,
 - 2.2. convenience,
 - 2.3. improving cognitive abilities,
 - 2.4. connectivity and

2.5. content?

3. Is there a significant difference in the assessment of the student-respondents on the effectiveness of mobile phones as a learning aid when grouped according to gender and on the overall level of effectiveness of mobile phones as a learning aid when grouped according to gender?

Null Hypothesis

- There is no significant difference in the assessment of the effectiveness of mobile phones as learning aid between male and female student-respondents.
- There is no significant difference in the assessment of the overall level of effectiveness of mobile phones as learning aid between male and female student-respondents.

Gavriel Salomon's symbol system theory examines the many effects of media on learning. It claims that whether a medium may successfully support effective learning depends on how closely the symbol system aligns with the learning activities and contents of the learners. Mobile phones may be utilized as a learning aid. Various media symbol systems can affect a learner's capacity to learn (Salomon, 1994). Symbol system theory is the theoretical framework of this study.

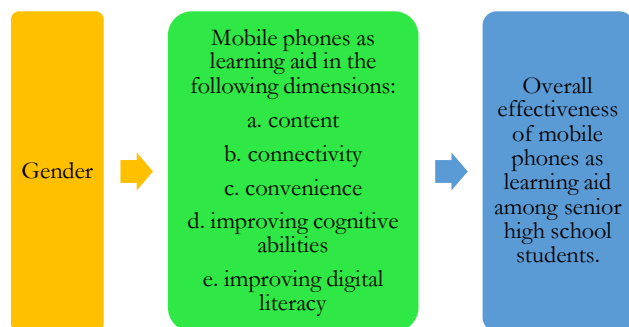


Figure 1. The Conceptual Framework of the Study focuses on the Constructs of Symbol System Theory

More recent research has expanded the framework to include cognitive processing aids, supports for intellectual performance, and mind-enriching devices. Humans work in collaboration with computers, but when these

collaborations have later cognitive spin-off impacts on learners functioning independently of machines, those benefits are felt (Salomon et al., 1991).

The conceptual framework as presented in Figure 1 demonstrates how effective mobile devices are as learning tools based on gender as demonstrated in the dimensions such as content, recoding or connectivity, mental elaboration or convenience, processing or improving cognitive abilities, and mental processes for re-coding and elaboration or improving digital literacy. Finally, how well mobile phones work overall as a learning tool for senior high school students.

Materials and Methods

The study used the descriptive method of research. According to Aggarwal and Ranganathan (2019), data are considered "descriptive" if it is studied to reveal the distribution of one or more variables. Further, Adlit et al. (2023) opined that a descriptive survey is a methodical approach to gathering and analyzing factual data. The respondents of this study are the randomly selected students totaling 120 from Grade 11 and Grade 12 of San Pedro Relocation Center National High School Landayan Annex using the cluster sampling technique (Bun et al., 2022).

In this study, the principal instrument used in gathering the necessary data and information is the survey questionnaire. The first part of the questionnaire is about the track and strand as well as gender. The second part is about the effectiveness of mobile phones as a learning aid in the dimensions such as content, connectivity, convenience, improving cognitive abilities, and improving digital literacy. The survey used the 5-point Likert scale, where statements are described in Table 1. Considerations to use the Likert scale was based on the different principles and strategies provided by Preedy (2010).

The instrument has undergone the process of development, validation, and implementation. Language teachers assisted in the development stage, while specialized and applied subject teachers validated the instrument. A revision is

made after further checking and examination before the implementation of the data-gathering procedure. A face-to-face survey is conducted by the researchers.

Table 1. 5-Point Likert Scale for Survey-Questionnaire

Score	Range	Description
1	1.00-1.80	Strongly Disagree
2	1.81-2.60	Disagree
3	2.61-3.40	Neutral
4	3.41-4.20	Agree
5	4.21-5.00	Strongly Agree

The school head and the senior high school coordinator provided formal authorization for the researchers to carry out this study. To conduct the survey, the researchers split into pairs and handed out the survey questionnaire to the participants one by one, with the assistance of teachers who handled each section. The respondents were asked to participate voluntarily in the study. All the surveys were returned and submitted completely and correctly.

Both descriptive and inferential statistics were used in the study. For inferential statistics, an independent t-test is employed to compare the means of precisely two groups (Bevans, 2022). The researchers determined whether there is a significant difference between the two groups' mean scores using an independent sample t-test (Gerald 2018). The researchers used the IBM

SPSS Statistics version 20 to perform the independent t-test.

Results and Discussion

1. Gender of Student-Respondents

Table 2 shows the gender of the respondents. Among the 120 respondent-students, 58 or 48.33% were male while 62 or 51.67% were female.

Table 2. Gender of Student-Respondents

Gender	Frequency	Percentage
Male	58	48.33%
Female	62	51.67%
TOTAL	120	100%

The result affirmed that most students decide to utilize their phones for academic purposes during class (Mortazavi et al., 2020). Moreover, educational innovations or technologies can help both males and females in equal measure (Allier-Gagneur & Moss Coflan, 2020).

2. Student-Respondents Assessment of the Effectiveness of Mobile Phones as Learning Aid Tools

The data collected in determining the effectiveness of mobile phones among senior high school students in terms of the content dimension as reported by the 120 respondents are revealed in Table 3.

Table 3. Student-Respondents' Assessment of Effectiveness of Mobile Phones in Terms of Content

Content	Male	Description	Female	Description
1. Mobile phones provide me with the necessary information I need in learning.	3.62	Agree	3.73	Agree
2. They provide me with the necessary services used to help in examining information.	3.50	Agree	3.69	Agree
3. They provide me with supporting information on lessons or topics I need in learning.	3.69	Agree	3.94	Agree
TOTAL	3.60	Agree	3.79	Agree

Male and female respondents have the highest score in statement 3 “They provide me with supporting information on lessons or topics I need in learning” with a mean of 3.69 and 3.94 or a description of “Agree”, respectively. The total mean for male respondents is 3.60 or “Agree” and 3.79 or “Agree” for female respondents. The result is related to the findings of Yu et al. (2022) who found that students read a variety of news categories because of mobile devices changing their reading habits. Walid and Omaid (2020) stated that using a mobile phone for educational purposes was a “driving factor of motivation”.

The data collected in determining the effectiveness of mobile phones among senior high school students in terms of connectivity

dimension as reported by the 120 respondents are revealed in Table 4. Male and female respondents have the highest score in statement 2 “mobile phones help me connect with people” with a mean of 3.64 and 4.13 or a description of “Agree”, respectively. The total mean for male respondents is 3.04 or “Neutral” and 3.29 or “Agree” for female respondents. The result also agreed with the findings of Shonola et al (2016) who claimed that communication is greatly facilitated by teachers and students and studying is more pleasurable. Humans act rationally when connected, and a mobile phone is an invaluable instrument that can make our life more knowledgeable (Harris & Cooper, 2019).

Table 4. Student-Respondents' Assessment of Effectiveness of Mobile Phones in terms of Connectivity

Content	Male	Description	Female	Description
1. I communicate and share information with my fellow learners / acquaintances.	2.48	Disagree	2.15	Disagree
2. Mobile phone help me contact with people.	3.64	Agree	4.13	Agree
3. They help develop myself in becoming confident in communicating with others.	3.00	Neutral	3.60	Agree
TOTAL	3.04	Neutral	3.29	Agree

The data collected in determining the effectiveness of mobile phones among senior high school students in terms of cognitive

abilities dimension as reported by the 120 respondents are revealed in Table 5.

Table 5. Student-Respondents' Assessment of Effectiveness of Mobile Phones in terms of Cognitive Abilities

Content	Male	Description	Female	Description
1. With the use of mobile phones, my decision-making skills in facing situations have improved and developed.	3.34	Neutral	3.34	Neutral
2. They help me understand situations to be more open-minded.	3.45	Agree	3.65	Agree
3. They help me to become more specific, handling things in ways that I understand both sides of the situation.	2.59	Neutral	2.66	Neutral
TOTAL	3.13	Neutral	3.22	Neutral

Male and female respondents have the highest score in the statement “They help me understand situations to be more open-minded” with a mean of 3.45 and 3.65 or “Agree”, respectively. The total mean for male respondents is 3.13 or “Neutral” and 3.22 or “Neutral” for female respondents. The results somehow agree that active learning benefits

from the promotion of higher-order cognitive abilities like critical thinking, problem-solving, and decision-making. Media, technology, and communication are essential for active learning (Harris & Bacon, 2019). Similarly, cell phones are effective and generate reliable results as a tool for aptitude and competency (Valenza et al., 2022).

Table 6. Student-Respondents' Assessment of Effectiveness of Mobile Phones in terms of Convenience

Content	Male	Description	Female	Description
1. I communicate and share information with fellow learners / acquaintances.	3.36	Neutral	3.73	Agree
2. Mobile phone help me connect with people.	3.55	Agree	3.74	Agree
3. They help develop myself in becoming confident in communicating with others.	3.57	Agree	3.95	Agree
TOTAL	3.49	Agree	3.81	Agree

The data collected in determining the effectiveness of mobile phones among senior high school students in terms of convenience dimension as reported by the 120 respondents are revealed in Table 6. Male and female respondents have the highest score in statement 3 “They help develop me in becoming confident in communicating with others” with a mean of 3.57 and 3.95 or “Agree”, respectively. The total

mean for male respondents is 3.49 or “Agree” and 3.81 or “Agree” for female respondents. The results confirmed the studies such as that of Onyema et al (2019) who explored mobile phones to increase learning and said to be "vital for collaboration and creativity." Harris and Cooper (2019) said that mobile phones are a valuable tool to conduct learning effectively and efficiently.

Table 7. Student-Respondents' Assessment of Effectiveness of Mobile Phones in terms of Digital Literacy

Content	Male	Description	Female	Description
1. I communicate and share information with fellow learners / acquaintances.	3.33	Neutral	3.74	Agree
2. Mobile phone help me connect with people.	3.40	Neutral	3.71	Agree
3. They help develop myself in becoming confident in communicating with others.	3.22	Neutral	4.10	Agree
TOTAL	3.32	Neutral	3.85	Agree

The data collected in determining the effectiveness of mobile phones among senior high school students in terms of digital literacy dimension as reported by the 120 respondents are revealed in Table 7. Male respondents have the highest score in statement 2 “mobile phones

help me connect with people” with a mean of 3.40 or a description of “Neutral” while the female respondents have the highest score in statement 1 “1. I communicate and share information with my fellow learners/acquaintances” with a mean of 3.74 or

description of “Agree”. The total mean for male respondents is 3.32 or “Neutral” and 3.85 or “Agree” for female respondents. To help students develop self-control, students must be digitally literate (Peng & Yu, 2022). Developing digital literacy enhances learning and had a good effect on students' academic achievement (Naz et al., 2022).

3. Significant Difference in the Assessment of the Student-Respondents on the Effectiveness of Mobile Phones as a Learning Aid and on the Overall level of Effectiveness of Mobile Phones as a Learning Aid

Table 8. Independent Samples (Male and Female) for Content

Gender	Mean	Standard Deviation	t-Value	Sig. Value	Interpretation	Decision to Ho
Male	3.60	.09609	-1.923	.127	Not Significant	Accept
Female	3.79	.13429				
$\alpha = 0.05$ Level of Significance						

Table 9 shows the independent-samples t-test for connectivity. As gleaned from the table, there is no significant difference in the scores for males (M=3.04, SD=0.581) and females (M=3.29, SD=1.025); $t(4) = -.372$, $p = 0.728$. These results suggest that since the probability value of .728 which is more than alpha 0.05, the

Table 9. Independent Samples (Male and Female) for Connectivity

Gender	Mean	Standard Deviation	t-Value	Sig. Value	Interpretation	Decision to Ho
Male	3.04	.58103	-.372	.728	Not Significant	Accept
Female	3.29	1.02500				
$\alpha = 0.05$ Level of Significance						

Table 8 shows the independent-samples t-test for content. As gleaned from the table, there is no significant difference in the scores for males (M=3.60, SD=0.096) and females (M=3.79, SD=0.134); $t(4) = -1.923$, $p = 0.127$. These results suggest that since the probability value of .127 is more than alpha 0.05, the null hypothesis is accepted. The study affirmed Darko-Adjei (2019) who found that there is positive usefulness of the use of smartphones in students' learning activities. The development of mobile phones, according to Obiadazie and Obijiofor (2019), has allowed for more cooperation and a new pedagogical strategy (Polat et al., 2021).

null hypothesis is accepted. The result affirmed that mobile phones are rapid communication devices for social connectedness (Swamy, 2020). Connectivity impacted communication and information-gathering behaviors (De Masi & Wac, 2022). Students preferred mobile phones as a medium for connectivity (Ahmad, 2020).

Table 10. Independent Samples (Male and Female) for Cognitive Abilities

Gender	Mean	Standard Deviation	t-Value	Sig. Value	Interpretation	Decision to Ho
Male	3.13	.46801	-.226	.832	Not Significant	Accept
Female	3.22	.50639				
$\alpha = 0.05$ Level of Significance						

Table 10 shows the independent-sample t-test for cognitive abilities. As gleaned from the table, there is no significant difference in the scores for males (M=3.13, SD=0.468) and females (M=3.22, SD=0.506); $t(4) = -0.226$, $p = 0.832$.

These results suggest that since the probability value of .832 which is more than alpha 0.05, the null hypothesis is accepted. The result agreed with the following, for instance, cognitive ability, as defined by Shi and Qu (2021), is the capacity

of the human brain to process, retain, and retrieve information. Students' ability to learn may be improved, and learning can be made more efficient (Jamil et al., 2022). Mobile phones are becoming increasingly prevalent and are powerful and adaptable tools that boost human intelligence (Wilmer et al., 2017). Table 11 shows the independent-samples t-test for convenience. As revealed from the table, there is a significant difference in the scores for males (M=3.49, SD=0.581) and females (M=3.80, SD=1.025); $t(4)=-3.194$, $p = 0.033$. These results suggest that

since the probability value of 0.033 is less than alpha 0.05, the null hypothesis is rejected. The results affirmed that students access essential information anywhere, anytime, and make knowledge accessible with ease and speed (Sharma & Madhusudhan, 2017). According to Ifeanyi and Chukwuere (2018), the ability to access media conveniently is one of the benefits of using cell phones effectively. Sambo et al (2021) stated that Web 2.0 increased communication, research development, and information sharing.

Table 11. Independent Samples (Male and Female) for Convenience

Gender	Mean	Standard Deviation	t-Value	Sig. Value	Interpretation	Decision to Ho
Male	3.49	.58103	-3.194	.033	Significant	Reject
Female	3.80	1.02500				
$\alpha = 0.05$ Level of Significance						

Table 12 shows the independent-samples t-test for digital literacy. As gleaned from the table, there is a significant difference in the scores for males (M=3.32, SD=0.091) and females (M=3.85, SD=0.217); $t(4)=-3.927$, $p = 0.017$. These results suggest that since the probability value of 0.017 which is less than alpha 0.05, the null hypothesis is rejected. The results are

consistent with the study of Wijaya et al (2021) who asserted that the advancement of mobile learning media can improve students' learning results in digital literacy. Digital literacy helps with using contemporary technologies and is better equipped to contribute to the development of the country (Reddy et al., 2020).

Table 12. Independent Samples (Male and Female) for Digital Literacy

Gender	Mean	Standard Deviation	t-Value	Sig. Value	Interpretation	Decision to Ho
Male	3.32	.09074	-3.927	.017	Significant	Reject
Female	3.85	.21703				
$\alpha = 0.05$ Level of Significance						

Table 13 shows the assessment of student-respondents on the effectiveness of mobile phones across dimensions and it is revealed that for males it is the content dimension with a score of 3.60 and description of "Agree" while females

scored high in digital literacy with 3.85 and description of "Agree". Overall males scored 3.32 or "Neutral" while females scored 3.85 or "Agree".

Table 13. Assessment of Student-Respondent Effectiveness of Mobile Phones Across Dimensions

Content	Male	Description	Female	Description
Content	3.60	Agree	3.79	Agree
Connectivity	3.04	Neutral	3.29	Neutral
Cognitive Abilities	3.13	Neutral	3.22	Neutral
Convenience	3.49	Agree	3.80	Agree
Digital Literacy	3.32	Neutral	3.85	Agree

TOTAL	3.32	Neutral	3.59	Agree
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Table 14. Assessment of Student-Respondent Effectiveness of Mobile Phones Across Dimensions

Gender	Mean	Standard Deviation	t-Value	Sig. Value	Interpretation	Decision to Ho
Male	3.32	.23544	-1.582	.152	Not Significant	Accept
Female	3.59	.30765				
$\alpha = 0.05$ Level of Significance						

Table 14 shows the independent-samples t-test of the overall assessment of the effectiveness of mobile phones as learning aid across dimensions such as content, connectivity, cognitive abilities, convenience, and digital literacy. As presented in the table, there is no significant difference in the scores for males ($M=3.32$, $SD=0.235$) and females ($M=3.59$, $SD=0.308$); $t(8) = -1.582$, $p = 0.152$. These results suggest that since the probability value of 0.152 which is more than alpha 0.05, the null hypothesis is accepted. According to Hassan and Yousaf (2021), mobile phones have a significant influence on students' learning. Fabito (2017) determined the most important predictor of actual mobile phone usage was the behavioral intention. Experience, age, and gender exhibited no moderating effects (Nikolopoulou et al., 2020).

Conclusion

The study assessed the effectiveness of mobile devices as learning tools based on gender as demonstrated in the dimensions such as content, recoding or connectivity, mental elaboration or convenience, processing or improving cognitive abilities, and mental processes for re-coding and elaboration or improving digital literacy using Gavriel Salomon's symbol system theory. Results yield that there is no significant difference in the scores for males and females in the dimensions such as content, connectivity, and cognitive abilities. Hence, both genders agreed that smartphones are in the student's learning activities, and it paved the path for a new pedagogical strategy. Further, mobile phones greatly increased social connectedness, communication, and information-gathering behaviors are impacted by as a medium of connectivity. Lastly, learning becomes efficient

and acknowledged that mobile phones are powerful and adaptable tools for increasing intelligence.

On the other hand, result yield that there is a significant difference in the dimensions such as convenience and digital literacy. Hence, both genders agreed that mobile phones make knowledge accessible with ease and speed, convenient access is a benefit, and Web 2.0 increased communication, research, and information. Likewise, it improves students' learning results in digital literacy and may help them become more knowledgeable.

The results for the overall assessment of the effectiveness of mobile phones as learning aid across dimensions reveal that there is no significant difference in the scores for males and females. This means that both genders agreed that it influences learning, behavioral intention is a fundamental predictor and gender has no moderating effect.

Recommendations

It is recommended by the researchers to conduct both qualitative and quantitative research on the capability infrastructures, technologies, and manpower on institutionalizing a learning resource and teaching and learning applications at the national, regional, division, and school levels. Assess the effectiveness, efficacy, and efficiency of virtual capabilities both for teachers and students across levels further focusing on limitations to address gaps in institutionalizing online education portals or educational applications for Filipino learners.

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Conflict of interests

No conflict of interest.

References

- Adlit, M.F., Adlit, M.F., Rama, J. M., Dineros, M. J. & Lim-Barrozo, D. (2023). Effects of Learning Action Cells among Elementary Teachers' Level of Awareness on Climate Change Education. *Puissant*, 4, 1113-1134.
- Aggarwal, R. & Ranganathan, P. (2019). Study designs: Part 2 – Descriptive studies. *Perspectives in Clinical Research*, 10(1), 34-36. https://doi.org/10.4103/picr.PICR_154_18
- Ahmad, T. (2020). Student perceptions on using cell phones as learning tools: Implications for mobile technology usage in Caribbean higher education institutions. *PSU Research Review*, 4(1), 25-43. <https://doi.org/10.1108/PRR-03-2018-0007>
- Alghazi, S.S., Wong, S.Y., Kamsin, A., Yadegaridehkordi, E. & Shuib, L. (2020). Towards sustainable mobile learning: A brief review of the factors influencing acceptance of the use of mobile phones as learning tools. *Sustainability*, 12(24), 10527. <https://doi.org/10.3390/su122410527>
- Allier-Gagneur, Z. & Moss Coflan, C. (2020). *Your questions answered: Using technology to support gender equity, social inclusion and out-of-school learning* (No. 14). EdTech Hub. <https://doi.org/10.53832/edtechhub.0025>
- Asio, J. M. R., Gadia, E., Abarintos, E., Paguio, D. & Balce, M. (2021). Internet connection and learning device availability of college students: Basis for institutionalizing flexible learning in the new normal. *Studies in Humanities and Education*, 2(1), 56-69. <https://doi.org/10.48185/she.v2i1.224>
- Bevans, R. (2022). Choosing the Right Statistical Test | Types & Examples. Scribbr. Retrieved from <https://www.scribbr.com/statistics/statistical-tests/>
- Bombaes, A. (2018). Student's Intentions to Use M-Learning: An Empirical Perspective from the Philippines. *Learning*, 8(1). <https://doi.org/10.5296/ber.v8i1.12305>
- Bun, M., Drechsler, J., Gaboardi, M., McMillan, A. & Sarathy, J. (2022). In 3rd Symposium on Foundations of Responsible Computing (FORC 2022): *Controlling privacy loss in sampling schemes: An analysis of stratified and cluster sampling*. <https://doi.org/10.4230/LIPIcs.FORC.2022.1>
- Darko-Adjei, N. (2019). The Use And Effect Of Smartphones In Students' learning Activities: Evidence From The University Of Ghana, Legon. *Library Philosophy and Practice*, 1-37.
- De Masi, A. & Wac, K. (2022). *The Importance of Smartphone Connectivity in Quality of Life*. In: Wac, K., Wulfovich, S. (eds) *Quantifying Quality of Life*. Health Informatics. Springer, Cham. https://doi.org/10.1007/978-3-030-94212-0_23
- Farrah, M., & Abu-Dawood, A. (2018). Using mobile phone applications in teaching and learning process. *International Journal of Research in English Education*, 3(2), 48-68. <http://dx.doi.org/10.29252/ijree.3.2.48>
- Fabito, B.S., Trillanes, A.O. & Sarmiento, J.R. (2020). Barriers and challenges of computing students in an online learning environment: Insights from one private university in the Philippines. *International Journal of Computing Sciences Research*, 5(1), 441-448. <https://doi.org/10.25147/ijcsr.2017.001.1.51>
- Gerald, B. (2018). A brief review of independent, dependent and one sample t-test. *International journal of applied mathematics and theoretical physics*, 4(2), 50-54. <https://doi.org/10.11648/j.ijamtp.20180402.13>

- Harris, N. & Bacon, C.E.W. (2019). Developing cognitive skills through active learning: a systematic review of health care professions. *Athletic Training Education Journal*, 14(2), 135-148. <https://doi.org/10.4085/1402135>
- Ifeanyi, I.P. & Chukwuere, J.E. (2018). The impact of using smartphones on the academic performance of undergraduate students. *Knowledge Management & E-Learning*, 10(3), 290-308.
- Jamil, N., Belkacem, A. N. & Lakas, A. (2022). On enhancing students' cognitive abilities in online learning using brain activity and eye movements. *Education and Information Technologies*, 1-35. <https://doi.org/10.1007/s10639-022-11372-2>
- Jin, W. & Junio-Sabio, C. (2018). Potential use of mobile devices in selected public senior high schools in the city of Manila Philippines. *International Journal of Learning, Teaching and Educational Research*, 17(4), 102-114. <https://doi.org/10.26803/ijlter.17.4.7>
- Jin, W., Prudente, M. S. & Aguja, S. E. (2018). Students' experiences and perceptions on the use of mobile devices for learning. *Advanced Science Letters*, 24(11), 8507-8510. <https://doi.org/10.1166/asl.2018.12600>
- Lim, M. & Moneva, J.C. (2018). Cellular Phone Utilization and the Student Academic Performance. *TIJ's Research Journal of Social Science & Management*, 7.
- Lim, R.A. & Arcilla Jr, F.E. (2021). Mobile assisted language learning: Perspectives from senior high school students. *International Research Journal of Science, Technology, Education, and Management*, 1(2), 108-118. <https://doi.org/10.5281/zenodo.5726387>
- Mauricio, M. (2017). In ASSHIS-17: *Mobile phone-assisted instruction (Mpai): Exploring the perceptions of students and teachers of Taal junior and senior high school*.
- Mohammadi, M., Sarvestani, M. S. & Nouroozi, S. (2020). Mobile phone use in education and learning by faculty members of technical-engineering groups: Concurrent mixed methods design. *In Frontiers in Education*, 5, 16. <https://doi.org/10.3389/feduc.2020.00016>
- Mortazavi, M., Tansu Hocanın, F. & Davarpanah, A. (2020). Application of quantitative computer-based analysis for student's learning tendency on the efficient utilization of mobile phones during lecture hours. *Sustainability*, 12(20), 8345. <https://doi.org/10.3390/su12208345>
- Naz, F. L., Raheem, A., Khan, F. U. & Muhammad, W. (2022). An Effect of Digital Literacy on the Academic Performance of University-Level Students. *Journal of Positive School Psychology*, 6(8), 10720-10732. [https://doi.org/10.31703/gssr.2019\(iv-i\).1](https://doi.org/10.31703/gssr.2019(iv-i).1)
- Ngesi, N., Landa, N., Madikiza, N., Cekiso, M. P., Tshotsho, B. & Walters, L. M. (2018). Use of mobile phones as supplementary teaching and learning tools to learners in South Africa. *Reading & Writing-Journal of the Reading Association of South Africa*, 9(1), 1-12. <http://dx.doi.org/10.4102/rw.v9i1.190>
- Nikolopoulou, K., Gialamas, V. & Lavidas, K. (2020). Acceptance of mobile phone by university students for their studies: An investigation applying UTAUT2 model. *Education and Information Technologies*, 25, 4139-4155. <https://doi.org/10.1007/s10639-020-10157-9>
- Obiadazie, R. E. & Obijiofor, V. U. (2015). Use of mobile phone technology in education for easy accessibility of information: challenges and prospects. *AFRREV IJAH: An International Journal of Arts and Humanities*, 4(2), 164-178. <https://doi.org/10.4314/ijah.v4i2.12>
- Onyema, E. M. (2019). Opportunities and challenges of the use of mobile phone technology in teaching and learning in Nigeria—a review. *International Journal of Research in Engineering and Innovation*, 3(6), 352-358. <http://doi.org/10.36037/IJREI.2019.3601>
- Onyema, E.M., Ogechukwu, U., Anthonia, E.C. D. & Deborah, E.C. (2019). Potentials of mobile technologies in enhancing the effectiveness of inquiry-based learning approach. *International Journal of Education*, 2(1), 1-22. <http://dx.doi.org/10.5121/IJE.2019.1421>

- Peng, D. & Yu, Z. (2022). A literature review of digital literacy over two decades. *Education Research International*, 2022, ID 2533413. <https://doi.org/10.1155/2022/2533413>
- Peralta, V.B., Del Mundo, J.R., Palma, P.J.M., Santiago, B.R.S., Sims, C.V., Sulit, F.I. & Kurata, Y.B. (2019). Proceedings of the International Conference on Industrial Engineering and Operations Management: *AMBHigh: A User Ergonomic Mobile Learning Application Intended for Business Management Secondary Students in the Philippines*. Bangkok, Thailand.
- Preedy, V.R. (2010). *Handbook of disease burdens and quality of life measures* (Vol. 4). R. R. Watson (Ed.). New York: Springer.
- Polat, S. Ö., Petekkaya, E. & Göker, P. (2021). A literature review on the effects of the smartphone use from anatomy point of view. *Arsiv Kaynak Tarama Dergisi*, 30(4), 236-242. <https://doi.org/10.17827/aktd.966354>
- Reddy, P., Sharma, B., & Chaudhary, K. (2020). Digital literacy: A review of literature. *International Journal of Technoethics*, 11(2), 65-94. <https://doi.org/10.4018/ijt.20200701.oa1>
- Saeed, R., & Hassan, T.U. (2020). Meta analysis of smartphone usage for gratifications obtained (2016-2019). *Journal of Media Studies*, 35(2), 165-191.
- Salomon, G. (1994). Interaction of media, cognition, and learning. Psychology Press. Retrieved from <https://eric.ed.gov/?id=ED387087>
- Salomon, G., Perkins, D.N. & Globerson, T. (1991). Partners in cognition: Extending human intelligence with intelligent technologies. *Educational researcher*, 20(3), 2-9. <https://doi.org/10.3102/0013189X020003002>
- Sambo, A.S., Lawal, A. M. & Helen, K. (2021). The use of smart phones for information seeking by undergraduate students in Nigerian specialised university. *Library Philosophy and Practice*, 1-17.
- Sharma, R. & Madhusudhan, M. (2017). Use of Mobile Devices by Library and Information Science Students in Central Universities of Uttar Pradesh. *DESIDOC Journal of Library & Information Technology*, 37(4), 287-296. <https://doi.org/10.14429/djlit.37.4.11505>
- Shi, Y. & Qu, S. (2021). Cognitive ability and self-control's influence on high school students' comprehensive academic performance. *Frontiers in psychology*, 12, 5761. <https://doi.org/10.3389/fpsyg.2021.783673>
- Shonola, S.A., Joy, M.S., Oyelere, S.S. & Suhonen, J. (2016) The Impact of Mobile Devices for Learning in Higher Education Institutions: Nigerian Universities Case Study. *I.J. Modern Education and Computer Science*, 8, 43-50. <https://doi.org/10.5815/ijmecs.2016.08.06>
- Swamy, R. K. (2020). Mobiles have changed the way we communicate. *International Journal of English Research*, 6(6), 40-43.
- Toquero, C.M.D. & Talidong, K.J.B. (2021). Socio-educational implications of technology use during COVID-19: A case study in General Santos City, Philippines. *Human Behavior and Emerging Technologies*, 3(1), 194-198. <https://doi.org/10.1002/hbe2.214>
- Valenza, M., Dreesen, T. & Kan, S. (2022). *On Call: Using Mobile Technologies to Measure Learning in Emergencies*. UNICEF Office of Research-Innocenti.
- 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*, 15(16), 238-247.
- Wijaya, R.E., Mustaji, M. & Sugiharto, H. (2021). Development of Mobile Learning in Learning Media to Improve Digital Literacy and Student Learning Outcomes in Physics Subjects: Systematic Literature Review. *Humanities and Social Sciences*, 4(2), 3087-3098. <http://dx.doi.org/10.33258/birci.v4i2.2027>
- Wilmer, H.H., Sherman, L.E., & Chein, J.M. (2017). Smartphones and cognition: A review of research exploring the links between mobile technology habits and cognitive functioning. *Frontiers in psychology*, 8, 605. <https://doi.org/10.3389/fpsyg.2017.00605>
- Yousaf, Y., Shoaib, M., Hassan, M. A. & Habiba, U. (2021). An intelligent content provider based

on students learning style to increase their engagement level and performance. *Interactive Learning Environments*, 1-14. <https://doi.org/10.1080/10494820.2021.1900875>

Yu, H.Y., Tsoi, Y.Y., Rhim, A.H.R., Chiu, D.K. & Lung, M.M.W. (2022). Changes in habits of

electronic news usage on mobile devices in university students: a comparative survey. *Library Hi Tech*, 40(5), 1322-1336. <https://doi.org/10.1108/LHT-03-2021-0085>