The Effects of Digital Learning on 21st Century Skills of Grade 10 Learners in Physics
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Abstract The study investigated the effects of Digital Learning on the 21st-century skills of Grade 10 Learners in Physics. This was conducted among Grade 10 learners of Bukidnon National High School, Malaybalay City, school year 2022-2023. The study used a quasi-experimental research design and a post test-only control group design. The 30-item researcher-made critical thinking test, validated by a panel of experts and has a reliability of 0.761, was used to collect data. The data gathered were analyzed and interpreted using mean, standard deviation, ANCOVA, and an independent sample t-test. Findings revealed that there is a significant difference in 21st-century skills between the two groups. Therefore, the utilization of digital learning resources in teaching physics can enhance 21st century skills, specifically the critical thinking skills, communication skills, collaboration skills, and creativity skills of learners.

Keywords — digital learning resources, conventional learning resources, 21st-century skills

I. INTRODUCTION

Twenty-first-century skills are recognized internationally as vital skills for learners for them to prepare for the challenges of this modern age and make a tangible and beneficial contribution to their life success. This age requires teachers to have a flexible mindset as the learners take on the challenges of the 21st century. Education is indispensable for giving learners the confidence to develop those skills, creating a generation ready to face the challenges of the twenty-first century (Driscoll, 2021). Thus, learners deserve an education that will empower them with the skills they need in the future.

The 21st-century skills fall into three categories: learning skills, literacy skills, and life skills (Partnership for 21st-Century Skills, 2016). The most common skills used are the learning skills, also known as the 4Cs (critical thinking, communication, collaboration, and creativity), because these abilities are prerequisites for every occupation (Stauffer, 2022). The Department of Education’s (DepEd), professional development for teachers for school year 2020–2023 emphasizes that educators should apply and develop effective teaching strategies to promote critical and creative thinking and higher-order thinking skills (DepEd Order No. 050, s. 2020).

Wrahatnolo and Munoto (2018) believe that computer technology innovation is one of the essential drivers of developing these 21st-century skills. However, others perceive it as ineffective for learning and teaching processes due to the main challenge encountered, which is the power interruption, and other factors in using new technologies (Ngonso et al., 2018). For this reason, a study on the effectiveness of digital learning resources and their relation to developing learners’ skills is necessary.

The National Science Teaching Association (NSTA) conveys that effective science instruction and 21st-century skills complement one another when utilizing varied technologies to help students develop their thinking, critical reasoning, and problem-solving skills. Moreover, Gabales (2017) cited that strategies in teaching could influence learners’ achievement.

According to the most current 2018 PISA results, the math and scientific literacy of Filipino learners are 357 points below the average 489 thresholds set by the Organization for Economic Cooperation and Development (OECD, 2018). The results of the National Achievement Test (NAT) for grade 10 students in 2018 showed that these students scored poorly in problem-solving, information literacy, and critical thinking. During the 2022 Regional Achievement Test (RAT), grade 10 science learners of region 10 earned an average score of 17.55/40 points (Pañares, 2022).

Before the COVID-19 pandemic, grade 10 learners of Bukidnon National High School, Malaybalay City, had been performing poorly in their second quarterly summative assessment in physics for the year 2020-2021. The Mean Percentage Score (MPS) belongs to “Did Not Meet Expectations” and became lesser during the
pandemic times. The least mastered competencies are electromagnetism topics in Physics. Teachers consider it a problem in their performance every year.

Through this, the need to develop the 21st-century skills of the learners challenged the researcher to look for an intervention by utilizing the digital learning resources package in Kotobee Author software as supplementary material in teaching physics lessons focused on the least mastered competencies that may enhance their learning skills, such as critical thinking skills, collaboration, communication, and creativity skills.

**Objectives**

This study ascertained the effects of Digital Learning Resources and Conventional Learning Resources in teaching Physics on the 21st-century skills of Grade 10 Learners at Bukidnon National High School, Division of Malaybalay City, during the school year 2022-2023. Specifically, it aimed to:

1. Determine the level of critical thinking skills of Grade 10 Physics learners.
2. Determine if there is a significant difference in the level of critical thinking skills of Grade 10 learners in Physics taught using digital learning resources and taught using conventional learning resources.
3. Assess the level of performance of Grade 10 Physics learners taught using digital learning resources and taught using conventional learning resources in terms of:
   a. Communication skills;
   b. Collaboration skills; and
   c. Creativity skills?
4. Investigate if there a significant difference in the following 21st century learning skills of Grade 10 learners in Physics taught using digital learning resources and taught using conventional learning resources in terms of:
   a. Communication skills;
   b. Collaboration skills; and
   c. Creativity skills.

**II. METHODS**

**A. Research Design**

The study utilized a quasi-experimental pretest - post test design in determining the level of critical thinking skills of digital learners and conventional learners. The design utilized two (2) intact classes. The group was given with pretest before the conduct of the study and a post test after the utilization of the digital learning resources and conventional learning resources. To examine the level of communication skills, collaboration skills, and creativity skills of digital learners and conventional learners, a post-test-only control group design was utilized. Both groups received the same content of lessons. However, the implementation varied as one group was exposed to Digital Learning Resources (DLRs), while the other group was exposed to Conventional Learning Resources (CLRs). The group was given post test-only using the rubric scale after the learners’ exposure to the lessons using the two different types of learning resources.

**B. Study Setting and Participants**

The participants of this study were the two intact classes of the Science, Technology, and Engineering (STE) Program of Grade 10 at Bukidnon National High School for SY 2022–2023. They were randomly assigned to either the experimental group, the digital learners, or the control group, the conventional learners. Based on their grades from the first grading period, a lottery method was used to choose 30 students from the digital learners and pair them with another 30 students from the conventional learners for the data analysis. During the study, it was intended to control any potential influencing variables.

**C. Research Instruments**

Four research instruments were used in this study to assess students’ critical thinking, communication, collaboration, and creativity in science. These instruments were subjected to reliability and validity tests by experts. The researcher tested their ability to think critically using a 30-item multiple-choice test was used to measure the participants' critical thinking skills. This instrument was used as pretest and post test. The learners' oral and written scientific communication abilities were evaluated using a communication rubric for science. The researcher used a collaboration survey questionnaire to examine how successfully students collaborate
when working on group projects. This was based on the collective impact model of collaboration. The researcher adopted and modified the rubric used by Bereña (2020) and the learner’s creativity skills were assessed using the scientific creativity skill rubric adopted and modified from Vallente (2020).

D. Procedure and Data Analysis

Before the implementation of the study, the instruments were validated by three experts from Bukidnon State University (BukSU). The issues regarding permission to conduct research, research integrity, safety and well-being of participants, particularly minors, and data confidentiality were resolved by obtaining ethical clearance on these procedural matters from the Research Ethics Committee (REC) of Bukidnon State University. Once the clearance was received, the researcher followed the proper protocol during the data gathering. An orientation was conducted for the learners of the intact classes used in the study. In the orientation, the researcher informed the participants of the purpose of the study, the source of data collection, participation risks, and benefits, voluntary participation, and withdrawal, and its confidentiality. The researcher and the participants also agreed on where and when to conduct the study.

During the actual data collection, the researcher the critical thinking skills test as a pretest and a post test to assess the digital learners and conventional learners critical thinking skills in physics. The pretest served as the co-variante for the post test of the experimental group. The researcher compared the post test results using ANCOVA at a 0.05 level of significance. Within the study, the researcher rated the participants using the rubrics for communication skills, collaboration skills, and creativity skills. The researcher then used the independent t-test and compared the results of the levels of the 3 Cs (Communication skills, Collaboration skills, and Creativity skills) at a 0.05 level of significance.

III. RESULTS AND DISCUSSION

A. Level of Critical Thinking Skills of Grade 10 Physics Learners

The researcher used the results from the pretest and post test given to the participants to gauge their critical thinking abilities. The Physics instructions was on magnets and magnetic fields, electric field, magnetic induction, and Oersted’s and Faraday’s discovery.

| TABLE I  |
| Critical Thinking Skills of Grade 10 Physics Learners |

<table>
<thead>
<tr>
<th>Level</th>
<th>Range Of Scores</th>
<th>Digital Learners</th>
<th>Conventional Learners</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Pretest</td>
<td>Pretest</td>
</tr>
<tr>
<td></td>
<td></td>
<td>F</td>
<td>%</td>
</tr>
<tr>
<td>Outstanding</td>
<td>26-30</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Very Satisfactory</td>
<td>23-25</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Satisfactory</td>
<td>21-22</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>Fairly Satisfactory</td>
<td>18-20</td>
<td>12</td>
<td>40</td>
</tr>
<tr>
<td>Did Not Meet Expectations</td>
<td>0-17</td>
<td>17</td>
<td>57</td>
</tr>
<tr>
<td>Mean</td>
<td>16.90</td>
<td>28.00</td>
<td>17.53</td>
</tr>
<tr>
<td>Qualitative Description</td>
<td>DNME</td>
<td>O</td>
<td>FS</td>
</tr>
<tr>
<td>sd</td>
<td>2.55</td>
<td>1.44</td>
<td>2.50</td>
</tr>
</tbody>
</table>


The critical thinking skills of Grade 10 Physics learners taught using digital learning resources are outstanding, while learners taught using conventional learning resources are very satisfactory. The digital learners have mastered and exceeded the core requirements in terms of knowledge, skills, and understanding of physics; they can transmit this knowledge through real-world performance problems, while the conventional learners have developed the fundamental skills and core understanding of physics with little guidance from the teacher and some assistance from peers.

The results of the study support the claims of Dwyer and Walsh (2019) believe that students engaged in DLR outperform traditional students in problem-solving and decision-making, which are essential components of
critical thinking. Moreover, this observation correlates to the discovery of Sinaga et al. (2022) that using electronic interactive teaching materials (EITMs) improved the critical thinking skills of learners in the experimental class with high criteria compared to the control group, and learners responded favorably to the EITMs stored and used on their mobile phones.

B. Significant Difference in the Critical Thinking Skills Between the Digital Learners and Conventional Learners

Table 2 presents the test for significant differences in critical thinking, between digital learners and conventional learners. At the 0.05 level of significance, analysis of covariance (ANCOVA) was utilized. Based on the data, the group received a p-value less than the significance level of 0.05. This means that the null hypothesis is rejected. Therefore, there is a significant difference in the critical thinking skills between digital and conventional learners in favor of digital learners.

<table>
<thead>
<tr>
<th>21st - century Skill</th>
<th>p-value</th>
<th>Significance</th>
<th>Decision</th>
</tr>
</thead>
<tbody>
<tr>
<td>Critical thinking</td>
<td>0.00</td>
<td>Significant</td>
<td>Reject the null hypothesis</td>
</tr>
</tbody>
</table>

From the data, this study concludes that learners who used digital resources for science have better critical thinking skills than those who used conventional resources. Due to the presentation’s feature, which includes visuals, words, and symbols in sequential order, the learner can devote greater attention to it. Consequently, learners become more motivated to learn as you engage them more. The implementation of digital learning resources for teaching science improves learners’ performance in critical thinking skills.

This statement reinforces the finding of Djamas et al. (2021) which is that multimedia learning resources in teaching physics could enhance learners’ critical thinking skills. The study’s findings demonstrated the validity, applicability, and effectiveness of interactive multimedia learning tools, soundly suggesting that interactive multimedia learning materials can help students develop their critical thinking skills.

C. Performance of Grade 10 Science Learners in Communication Skills

Table 3 shows the communication skills of the digital and conventional learners. Based on the results, the digital learners had better communication skills in physics than the conventional learners.

<table>
<thead>
<tr>
<th>Communication 21st-Century Skill</th>
<th>Digital Learners</th>
<th>Conventional Learners</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>sd</td>
<td>QD</td>
</tr>
<tr>
<td>Articulate thoughts and ideas effectively using written communication skills in a variety of forms and contexts</td>
<td>4.77</td>
<td>0.430</td>
</tr>
<tr>
<td>Utilize acquired knowledge and know how to judge their effectiveness as well as assess their impact</td>
<td>4.80</td>
<td>0.407</td>
</tr>
<tr>
<td>Communicate effectively to interpret meaning, including values, attitudes and intentions</td>
<td>4.87</td>
<td>0.346</td>
</tr>
<tr>
<td>Overall</td>
<td>4.81</td>
<td>0.209</td>
</tr>
</tbody>
</table>

Legend:

Although both groups exceeded standard levels of communication skills, the digital learners had a higher mean score than conventional learners. It also indicates that digital learners use communication very effectively
to inform, instruct, motivate, and persuade them on various occasions with a thorough presentation and explanation of the subject.

The standard deviation confirms that the ideas of the digital learners were more concentrated compared to the conventional learners. It was probably because digital learners have the same levels of communication skills. They articulate thoughts and ideas effectively using written communication skills in different forms and contexts, utilize acquired knowledge and know how to judge their effectiveness and assess their impact, and communicate effectively to interpret meaning, including values, attitudes, and intentions. The results favor digital learners over conventional learners. It infers that utilizing DLRs in teaching physics can improve learners’ communication skills in the said subject rather than using CLRs.

The responses propose that the DLRs developed their ability to participate more in the activities. It challenged them to learn better since they understood the lessons thoroughly and systematically through communication. A researcher claimed that DLRs play a crucial role in improving communication skills and may also have contributed to attaining a higher level of communication skills in the experimental group. The online lessons, simulation software, and oral feedback aided by video appear to be at least as effective as conventional learning and possibly even more so (Hussain Al-Qahtani, 2019; Kyaw et al., 2019).

The learners could explain the electric field directions and patterns of charges, and they could explain the electric field strength E to distance quantitatively and qualitatively. They could also describe the different ways of inducing magnetism. As observed, learning becomes more significant when there is a group discussion and experiencing a close-to-real scenario of the imaginable concept leading them to clarify vague and fragmented ideas.

These findings support the study of Pardede (2020) that digital learning resources, such as multimedia, have significantly transformed communication in the 21st century. Thus, using digital learning resources is much better than conventional learning resources in enhancing the communication skills of physics learners.

D. Performance of Grade 10 Science Learners in Collaboration Skills

Table 4 presents the comparison of the collaboration skills of digital learners and conventional learners. Digital learners have the highest overall mean score, which is in the Exceed Standard range on a scale of 1 to 5. The data denote that all members of the group are aware of collaborative activities at all times. Conventional learners’ scores, on the other hand, have a lower overall mean that is within the Met Standard range.

Furthermore, digital learners have the highest mean score in indicators 13 and 14, indicating that they outperformed the conventional level of collaborative skills. That means that everyone is free to voice their thoughts and observations. When someone speaks, the entire group listens. It is because learners are motivated to complete the work during the group and partnered activities.

Meanwhile, digital learners got the lowest mean score in criterion two. It demonstrates that group plans and designs are meticulously produced and thoroughly reviewed with each group member. During the group planning and designing, the group was unable to carefully design and create their output with detailed discussions, possibly due to a lack of time. As a result, they were unable to carefully design and discuss the task with each member. But, once the DLRs were in place, they were able to manage and discover strategies for organizing, creating, and discussing their group output. Despite having the lowest mean score, this collaboration skill is at the Exceed Standard level. It demonstrates that all members of the group consistently collaborate.
Nonetheless, students exposed to CLRs in science classes demonstrate a Meet Standard level of collaborative skills, indicating that certain group members frequently observed group efforts. During the group activity, learners were tasked with using a discovery technique to discuss the concepts in groups. The students were in charge of exploring the Phet simulation; they were given a guide question to respond to, carried out the practical exercise, and presented a project based on the concepts learned in class as a whole. The tasks were the same for both groups, but because conventional learners were focused on using traditional learning materials, the Phet simulation activities were presented as still images.

The data also revealed the conventional learners' highest and lowest mean. In indicator 12, they have the highest mean score. It describes how the group works even after class hours on activities that were not completed during class and has an Exceed Standard degree of cooperation skill. The students were in charge of exploring the Phet simulation; they were given a guide question to respond to, carried out the practical exercise, and presented a project based on the concepts learned in class as a whole. The tasks were the same for both groups, but because conventional learners were focused on using traditional learning materials, the Phet simulation activities were presented as still images.

The data also revealed the conventional learners' highest and lowest mean. In indicator 12, they have the highest mean score. It describes how the group works even after class hours on activities that were not completed during class and has an Exceed Standard degree of cooperation skill. During the group activity, learners were listening attentively to each member's ideas, as observed during the session employing DLRs in teaching grade 10 science. Learners in the control group, on the other hand, had the lowest mean in indicator number 7. It defines how each group member takes a consistent, systematic approach to address the themes of the lesson, with a Meet Standard level of cooperation skill. Systemic instruction was not observed among the group, most likely because the learners limited their discussion to what was given to them; they did not follow a single approach in discussing the topic.
The standard deviation of the learners after the intervention is also shown in the table. Digital learners' scores are clustered, as opposed to conventional learners' scores, which are more evenly distributed. It indicates that digital learners' collaboration skills are consistent when compared to conventional learners, meaning, equal learning opportunities were observed throughout the study. This finding may be supported by the features of the DLRs and CLRs used in both groups using collaborative group work.

This observation corroborates Hammar Chiriac’s (2014) claim that group work can help students learn, gain academic knowledge, develop collaborative skills, or both. They learn more or different things when they work in groups than when they work alone. Rather than working alone, the participants learn varied perspectives by debating and questioning each other's points of view, as well as listening to the contributions of their fellow students. When students collaborate with others in an interactive setting, they gain the ability to question, share ideas, elucidate differences, solve problems, and develop new understandings. As a result, the learning experience becomes more academic.

Based on the data provided, this study concludes that students who are exposed to digital learning resources have higher collaboration skills than those who use conventional learning resources. Hence, the usage of DLRs in science instruction is credited with this improvement in performance in collaborative skills.

E. Performance of Grade 10 Science Learners in Creativity Skills

Table 5 displays the outcomes of grade 10 students' creativity skills performance. The post test means and standard deviations were evaluated and compared. The findings suggest that the aggregate mean scores of digital learners and traditional learners are somewhat similar. Both groups show above-average levels of creativity.

| TABLE V | COMPARISON IN THE CREATIVITY SKILLS OF THE DIGITAL LEARNERS AND CONVENTIONAL LEARNERS |
|---------------------------------|---------------------------------|---------------------------------|---------------------------------|
| Creativity 21st-century Skills  | Digital Learners                | Conventional Learners           |
| Mean   | sd    | QD    | Mean   | sd    | QD    |
| Use a wide range of idea creation techniques (brainstorming, etc.). | 3.63 | 0.490 | ES | 3.27 | 0.450 | ES |
| Creates new and worthwhile ideas using both incremental and radical concepts. | 3.57 | 0.504 | ES | 3.23 | 0.430 | ES |
| Elaborates, refines, analyses and evaluate their own ideas in order to improve and maximize creative efforts. | 3.60 | 0.498 | ES | 3.23 | 0.430 | ES |
| Demonstrate originality and inventiveness in work and adopting new ideas. | 3.60 | 0.498 | ES | 3.20 | 0.407 | ES |
| Overall | 3.60 | 0.326 | ES | 3.23 | 0.328 | ES |

Legend:

Although both groups used a broad concept creation technique, fully incorporated changes in creative efforts, displayed innovation, and were realistic about the constraints of the circumstance in a range of situations, digital learners outperformed traditional learners. When completing the exercises during the lesson's portion on developing mastery, the digital learners demonstrated creativity. Creating an "Electromagnet" and an "improved electric motor or generator" were two of them. They learned at their own pace and rarely offered to clarify questions. They were eager to produce ideas to achieve the best results. The DLR-facilitated discussion prompted the students to create projects that would assist them in developing strong levels of creativity.

This validates the study of Sandang et al. (2022) that interactive multimedia as a whole is genuine, usable, and fairly effective in increasing students' critical and creative thinking abilities. The table also shows the digital learners' and conventional learners' highest and lowest mean scores for each of the indicators. The group outputs from both groups were used to gauge the learners' creativity skills throughout the study. These learners had the lowest mean score in indicator number 2. The learners are said to create new and worthwhile ideas using both incremental and radical concepts, and this is defined as having an Exceed Standard level of creative skill. The time limits on the creation of the product may be the cause of this. Whereas, the conventional learners obtained
the lowest mean score in indicator number four, which defines demonstrating originality and inventiveness in work and adopting new ideas. As observed, the outputs of the conventional learners were only modified based on the learner’s material. The learners failed to demonstrate originality in making their outputs and presenting their ideas. They relied heavily on the sample illustrations from the learner’s material.

Conversely, both groups obtained the highest mean score in indicator number 1 in favor of the digital learners, which describes that the learners use a wide range of idea-creation techniques that are notably advanced to exceed standard levels of creative skill. Both groups engage in a wide idea creation technique, fully incorporate changes in creative efforts, demonstrate creativity, and are realistic about the limits of the situation in a variety of situations. Digital learners worked creatively because each of them was given the chance to discuss and master the lesson content.

This observation substantiates Li et al. (2022) investigations that the interactivity that films, simulations, and wearable technology provide is advantageous for encouraging creativity. Dynamic education video games and simulation worlds are shown with a high degree of interaction that continuously responds to student participation, and inputs. New technologies significantly enhance learners’ creative thinking.

F. Significant Difference in the Communication, Collaboration and Creativity Skills

Table 6 presents the test for significant differences in the critical thinking, communication, collaboration, and creativity skills between digital learners and conventional learners. Analysis of covariance (ANCOVA) and independent sample t-test was used at 0.05 level of significance.

<table>
<thead>
<tr>
<th>TABLE VI</th>
<th>COMPARISON IN THE CREATIVITY SKILLS OF THE DIGITAL LEARNERS AND CONVENTIONAL LEARNERS</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>21st-century Skills</strong></td>
<td><strong>p-value</strong></td>
</tr>
<tr>
<td>Communication</td>
<td>0.000</td>
</tr>
<tr>
<td>Collaboration</td>
<td>0.000</td>
</tr>
<tr>
<td>Creativity</td>
<td>0.000</td>
</tr>
</tbody>
</table>

The data indicate that the group’s p-value is below the 0.05 level of significance. This means that the null hypothesis is rejected. Digital learners outperformed conventional learners in terms of 21st-century skills, therefore there is a considerable difference between the two groups.

Based on the information provided, this study concludes that students who receive DLRs in Science exhibit superior communication, teamwork, and creativity skills than students who receive CLRs. The usage of digital learning resources in science instruction is credited with this improvement in the learner’s performance.

The recommendations made by Glaze (2018) are corroborated by the aforementioned finding. It asserts that making use of a variety of resources available on interactive websites can assist teachers in turning passive learning into active learning, resulting in the creation of a capable student who is well-equipped with 21st-century abilities.

The study investigated the effects of Digital Learning on the 21st-century skills of Grade 10 learners in Physics. There is a significant difference in the 21st-century skills of those grade 10 learners taught with the use of digital learning resources and those assigned with the use of conventional learning resources. Hence, the usage of digital learning resources could help improve the 21st-century skills of physics learners in terms of critical thinking skills, collaboration skills, communication skills, and creativity skills.

IV. CONCLUSION

Digital Learning Resources enabled the learners to exceed the core requirements in knowledge, skills, and understanding in physics and transfer this understanding automatically and flexibly through authentic performance tasks. Critical thinking skills of learners taught using digital learning resources are substantially different than conventional learning resources using statistical testing. Learners taught using digital learning resources exhibit very effective communication to inform and persuade a comprehensive presentation and explanation of the concept. Group members collaborate at all times and engage in idea creation technique, fully incorporate changes in creative works, demonstrates creativity, and are realistic about the limits of different
situations. Using digital learning resources in teaching can develop the 3Cs of Grade 10 learners in physics and is reliably different from the conventional learning resources using statistical testing.

It is further recommended that teachers may encourage to use Digital Learning Resources as supplemental material in teaching to help develop learners’ 21st-century skills. Teachers may also encourage to employ digital learning resources in other programs or groups of learners, such as Special Education (SPED) and Enhanced Basic Education Program (EBEP) learners. Researcher may design a workshop on integrating digital learning resources in teaching science subjects during LAC Session. Future researchers may conduct similar studies on Digital Learning Resources and their effect on the learner’s 21st-century skills in other schools with larger sample sizes, different subject areas, different grade levels, and different research designs.

REFERENCES


