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Comic strip-based Learning Module as Tool in Teaching Mathematics Among Persons Deprived of Liberty (PDL)

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Abstract

Aim: The primary objective of the study was to develop a contextualized Mathematics comic strip-based learning module titled MathComStrip to support the teaching and learning of Mathematics among Persons Deprived of Liberty (PDL) enrolled in the Secondary Program under the Alternative Learning System (ALS) in Bureau of Jail Management and Penology (BJMP) Trece Martires City, Cavite, Philippines. Specifically, the study aimed to asses the developed learning module relative to content validity, practicality, and acceptability. The study also sought to determine the effectiveness of the MathComStrip based on the performance of PDL students before and after utilizing the developed learning module.

Methodology: ADDIE (Analysis, Design, Development, Implementation and Evaluation) model was employed to develop the contextualized Mathematics comic strip-based learning module. Also, a quantitative type of research was employed to determine the validity, practicality and acceptability of the MathComStrip. A total of 41 ALS Teachers and 64 Jail Officer-Teachers from the five provinces in Region IV-A participated in the study. The study also utilized a quasi-experimental type of research specifically the pretest-posttest design to measure the effectiveness of the MathComStrip. Here, 13 PDL students enrolled in Secondary Program under the ALS were given a researcher-made test which contains lessons in Basic Mathematics and Arithmetic. Mean, weighted mean, standard deviation, dependent t-test, Hake's <g> and Cohen's d were used to analyze the data gathered.

Results: MathComStrip is a contextualized learning module in Mathematics developed as a tool in teaching PDL students. The learning module includes lessons under the ALS K-12 Basic Education Curriculum's Learning Strand 3 which covers problem solving skills. The module contains lessons in Arithmetic and Geometric sequence and series; designed in a setting familiar to PDL students with themes in real-life contexts. Lessons are organized to encouraged critical thinking and are delivered in a conversational tone, making learning of Mathematics engaging. Also, the module promotes inclusivity by involving Christian and non-Christian characters. After developing the module, it was evaluated and results showed that MathComStrip was very valid in terms of its content, aligned to ALS K-12 Curriculum; very practical as it promotes active learning; and very acceptable in terms of the language used, graphic design and clarity of instruction. Results also showed that there is significant difference on the performance of PDL students before and after utilizing the MathComStrip. Finally, it was found out that MathComStrip is effective in teaching Mathematics among PDL students and posit a very large effect size to the students' mathematics performance. .

Conclusion: MathComStrip is an effective and inclusive learning module for teaching Mathematics to PDL students. It demonstrated strong content validity, practicality, and acceptability, while significantly improving students' performance. With a medium normalized gain and a very large effect size, MathComStrip proves to be a valuable tool in alternative learning settings.

Keywords: *MathComStrip, persons deprived of liberty, alternative learning system*

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INTRODUCTION

Mathematics education plays a crucial role in developing students' critical and logical thinking skills, which are essential across all fields of study. It goes beyond enhancing test performance, equipping learners with the ability to acquire new knowledge and apply it effectively to solve real-world problems. However, most classroom instructions lack effective learning resources that will engage students into fun and meaningful learning experiences.

Effective mathematics teaching involves creating opportunities for all students to engage meaningfully with mathematical concepts, taking into account their diverse backgrounds. This includes fostering a supportive learning environment, providing high-quality instructional materials, delivering structured lessons, presenting appropriate mathematical challenges, and employing strategies that encourage active learning. However, access to these opportunities can be significantly affected by a student's circumstances, particularly for those who are incarcerated and rely on alternative modes of education, such as the Alternative Learning System (ALS). Republic Act 11510, or the Alternative Learning System Act, affirms the right of all learners, including those in marginalized, underserved, and conflict-affected communities, to equitable, flexible, and appropriate educational opportunities, as mandated by Department of Education (DepEd, 2022) and by virtue of DepEd Order No. 13, S. 2019.

The Bureau of Jail Management and Penology (BJMP), as one of the five pillars of the country's criminal justice system, is mandated not only to provide safe custody but also developmental and educational opportunities for persons deprived of liberty (PDL) through ALS. As part of the agency's initiatives, BJMP implements programs that acknowledge education as a pathway to personal transformation and reintegration into society. One such program is "*Tagapangalaga Ko, Guro Ko*" established by virtue of Standard Operating Procedure No. 2020-02 (BJMP, 2010) which brings formal education inside jails, allowing PDLs to continue their studies despite incarceration. This program supports the rehabilitation by prmoting access to basic education, enabling them to earn elementary and secondary diplomas, and helping them become reformed, law abiding, and productive members of the society.

In Region IV-A CALABARZON, there were 64 jail institutions implementing ALS program as part of the BJMP's initiative for PDLs' rehabilitation. Each jail institution has a designated ALS Implementer, typically a Jail Officer or Co-PDL who serves as a teacher or certified Instructional Manager (IM). These implementers are qualified individuals with formal educational backgrounds or teaching degrees, who willingly dedicate their time and expertise to support the learning needs of PDL students within the facility. Programs within these jail institutions are fully supported by DepEd ALS teachers, who serve as partners of the Jail Bureau in implementing the Alternative Learning System. They provide essential learning resources for both teachers and students and also serve as additional instructional support in the delivery of classroom-based lessons.

BJMP Annual Accomplishment Report for 2020–2021, Region IV-A CALABARZON recorded a 77% combined passing rate in the ALS Accreditation and Equivalency (A&E) Test, with 889 out of 1,150 PDL students from both elementary and secondary levels passing. This rate is notably higher than the national average of 69%, or 2,091 out of 3,190 PDL ALS takers across all regions. These results suggest that ALS learners in jail settings are performing at par with their counterparts in the formal education system. Notably, elementary-level PDL students achieved an 80% passing rate (355 out of 441), outperforming secondary-level PDL students, who posted a 75% passing rate. This disparity indicates that secondary-level PDL learners may face greater challenges, particularly in core subjects like Mathematics, which remains a key focus for instructional improvement due to its conceptual difficulty (BJMP, 2021).

On a global scale, Elliott and Corrie (2015) highlighted persistent challenges related to the ineffectiveness and poor quality of instructional materials, which have long hindered student learning and negatively impacted academic performance. In the context of prison education, Rangel and De Maeyer (2019) emphasized that the daily reality of incarcerated individuals is shaped by a lack of resources and limited support from national agencies responsible for their education. As a result, education within prisons remains marginalized, with teaching often underprioritized in correctional systems worldwide. It is imperative for governments to recognize that investing in prison education allows institutions to hire qualified teachers and trainers, deliver civic and literacy education, and offer inmates a second chance at learning—especially those who are already in socially and educationally disadvantaged positions. Such initiatives not only cultivate a peaceful prison environment, but also equip inmates with essential life skills that contribute to their successful reintegration into society. Ultimately, prison education plays a crucial role in reducing recidivism and promoting long-term social rehabilitation.

Delivering education behind bars presents numerous challenges for administrators, particularly when addressing the needs of PDLs. Addae (2020) identified several obstacles reported by incarcerated learners, including insufficient administrative support, lack of qualified teachers, and irregular attendance, all of which hinder effective learning. Similarly, Evans (2018) noted that curriculum-related issues, personal challenges faced by learners, educators'

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perceptions, and broader institutional barriers significantly affect learner progression in correctional education programs, particularly from adult education levels 4 to 10. Furthermore, the limited availability of space within jail facilities to conduct educational and rehabilitative activities often results in inconsistent class schedules, further disrupting the continuity of learning and negatively impacting student outcomes.

Despite the strong desire to bring out the best in PDL students, jail institutions face significant limitations in terms of available learning resources, which are primarily provided by ALS partners from DepEd. These materials are predominantly text-based, making learning less engaging and appealing for many students. Due to the limited number of copies, resources are often shared among learners during classes, reducing the effectiveness of instruction. Although the current modular format offers some flexibility, its lack of variety and interactivity fails to stimulate student interest and motivation. Given that learning materials play a critical role in the educational process, there is a clear need to enhance instructional content to better engage learners. Learning modules have become essential tools in the teaching and learning processes within jail institutions. Hasibuan (2019) found that mathematics modules are effective in delivering content and supporting students' learning, helping both students understand concepts and teachers address learning challenges. However, Dangle (2020) pointed out several limitations of modular learning, such as the need for greater self-regulation and initiative from students, increased preparation time, and limited external motivation for both teachers and staff. Additionally, the system may result in reduced supervision and increased administrative workload, highlighting the need for more dynamic and supportive instructional approaches in correctional education settings.

In the pursuit of more engaging and effective instructional materials, comics and illustrated stories have emerged as highly influential communication tools in education. These resources combine the visual immediacy of images with the narrative power of text, making complex ideas more accessible and relatable to learners. This approach not only offers a creative way to popularize mathematics but also serves as a powerful pedagogical tool in various learning contexts (Saracco, 2019). A study by Nurfitriyanti et al. (2020) demonstrated that mathematics cartoon materials significantly improve students' learning outcomes by stimulating their interest, particularly in reading and comprehension. Similarly, Chu and Toh (2020) found that comics promote interest in mathematics through their interactive elements and simplified language, while also expanding students' critical thinking by presenting mathematical concepts within contextualized and relatable scenarios.

Similar to the challenges encountered in other jail institutions, Trece Martires City Jail in Cavite has faced significant difficulties in delivering quality education through the ALS since its implementation three years ago. In line with the BJMP's mandate, the institution firmly believes that education is a remedy for ignorance and a vital opportunity to transform the lives of PDL. However, to fully realize this transformative potential, there is an urgent need to enhance instructional materials by integrating high-quality and engaging learning resources that support the academic success of every learner. These resources not only assist teachers in delivering more effective instruction but also provide enriching learning experiences that help PDLs reach their full potential, foster a love for learning regardless of age or background, and ultimately improve academic performance.

Motivated by this pressing need and inspired by a deep sense of duty, the researchers, both a Jail Officer and an educator, conceptualized the development of a contextualized Mathematics comic strip-based learning module, called MathComStrip. This module aims to serve as an innovative instructional tool for teaching mathematics to PDL students and to help raise the overall quality of mathematics education within the correctional setting. The initiative aligns with the broader goal of ensuring that the jail institution not only safeguards individuals humanely but also supports their intellectual and personal development. With these objectives in mind, this study was undertaken.

Theoretical Framework

The study is anchored in the ADDIE model: Analysis, Design, Development, Implementation and Evaluation. This instructional design model offers a structured and cyclical approach to identifying learning requirements, creating educational content, executing training plans, and assessing their overall impact (Gagne et al., 2005). Muruganantham (2015) emphasizes that the analysis phase serves as the cornerstone of all stages within instructional design models like ADDIE. During this phase, instructional goals are clarified, potential learning challenges are examined, and learners' prior knowledge and skill levels are assessed to tailor appropriate instruction. Additionally, Muruganantham (2015) explains that this phase may involve various research methods, including needs analysis, goal analysis, and task analysis. For example, conducting a needs analysis allows instructional designers to identify the necessary resources and anticipate possible limitations in their implementation strategies.

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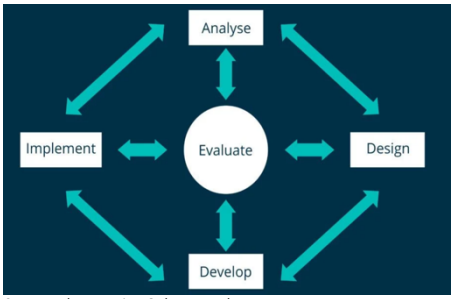
During the design phase of the ADDIE model, instructional designers plan the structure by which learners will attain specific educational outcomes. Kurt (2017) emphasizes the importance of carrying out this phase in a structured and rule-based manner. Information gathered in the earlier analysis phase guides the design decisions, allowing designers to select the most suitable instructional methods and materials for the target audience. This stage also includes setting timelines for activities and determining how learner feedback will be collected and used.



Source: *The Learning Oak, research.com*

Figure 1. The ADDIE Model

In the development stage of the ADDIE model, instructional designers begin producing the materials and content planned during the design phase. These instructional components may include lesson plans, activities, simulations, and other training tools. At this point, testing procedures are also conducted to detect and correct flaws in the instructional design strategies. Following the creation of course materials, designers often conduct pilot testing to trial the instructional approach and content delivery (Davis, 2013). Insights gained from these tests are used to refine and strengthen the learning program prior to full implementation. The implementation stage of the ADDIE model involves delivering the instructional content to the learners. As students engage with the materials developed in earlier phases, teachers play a key role in facilitating understanding and guiding learners toward achieving the intended outcomes. According to Yeh and Tseng (2019), it is also crucial for instructors to monitor and record learners' academic performance, attitudes, and behaviors during this stage. These observations provide essential feedback that informs the next phase – the evaluation phase. On the evaluation phase, the effectiveness of the developed instructional materials is measured.

Objectives

The primary objective of this study was to develop a contextualized Mathematics comic strip-based learning module (MathComStrip) to be used in teaching PDL students who are enrolled in Secondary Program under ALS.

Specifically, this study aimed to;

1.) develop a comic strip-based learning module in Mathematics;
2.) asses the learning module relative to content validity, practicality, and acceptability;
3.) determine the performance of PDL students before and after utilizing the learning module; and
4.) determine the effectiveness of the leanring module.

METHODS

Research Design

ADDIE model was employed to develop the contextualized Mathematics comic strip-based learning module. This model is a systematic instructional design framework involving five phases; Analysis, Design, Development, Implementation and Evaluation. Also, a quantitative type of research was employed to determine the validity, practicality and acceptability of the MathComStrip. The study also utilized a quasi-experimental type of research specifically the pretest-posttest design to measure the effectiveness of the MathComStrip.

Population and Sampling

The study involed 41 ALS teachers and 64 Jail Officer-teachers from the five provinces in Region IV-A. This comprised the entire population of ALS teachers assigned in jail facilities across the region. As part of the research

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process, the participants were asked to assess the developed learning module in terms of its content validity, practicality, and acceptability. For the experimental phase of the study, out of the 468 PDLs residing at Trece Martires City Jail, only 13 learners enrolled in the Secondary ALS program for the School Year 2022–2023 participated. These 13 PDLs represent the entire population of enrolled students who voluntarily agreed to take part in the study.

Instruments

A survey questionnaire consisting of 45 items was utilized in the study. This was used to assess the module's content validity, practicality and acceptability. The instrument underwent face validation by a panel of experts in the fields of education and correctional instruction to ensure that the items were clear, appropriate, and relevant to the objectives of the study. After face validation, the instrument underwent pilot testing. Here, 20 ALS implementers and teachers respondended to the questionnaire, and the internal consistency and reliability was computed. With Cronbach alpha values of .78 for content validity, .82 for practicality and .87 for acceptability, the instrument was found to be internally consistent and acceptable.

Also, a 30-item test was constructed to determine the students' performance in Mathematics. This consists of problems in arithmetic. It also underwent face validation by experts in the field of Mathematics, pilot testing with 20 students and reliability using KR 20. With a KR-20 value of .87, the test is found to be reliable and appropriate for the study.

Data Collection

The data gathering process began after the development of the learning module. Following the data gathering protocols, collection of data was done using both online and face-to-face modalities, from June 1 to September 31, 2023. This includes gathering of data from ALS impelemters and teachers who assessed the learning module, actual implementation of the learning module to PDL students and the administration of pre-test and post-test.

Data Analysis

The gathered data were organized, cleaned and analyzed employing appropriate statistical treatment. Descriptive statistics such as mean, weighted mean and standard deviation were utilized. Dependent t-test was used to determine whether there is significant difference on the students' performance before and after implementing the module. Meanwhile, Hake's <g> and Cohen's d were used to determine the normalized gain in students' scores and the effect size and how effective the module was.

Ethical Considerations

The researchers ensured ethical standards as prescribed by DepEd, CHED, and BJMP research protocols and by virtue of the Data Privacy Act of 2012. Prior to the conduct of the study, informed consent was obtained from all participants, especially the PDL students. The informed consent process, during which the study's purpose, procedures, potential risks and benefits, and participants' rights, including the option to withdraw at any time without consequence, were clearly communicated to the the respondents. Special consideration was given to the voluntary nature of their participation, emphasizing that their involvement would not affect their status, privileges, or standing within the facility. Confidentiality and anonymity were strictly observed, and all responses and performance data were handled with utmost care to protect the privacy and dignity of the participants throughout the study.

RESULTS and DISCUSSION

This section presents the analysis and interpretation of data. Here, the respondents' assessment on the comic strip-based learning module relative to content validity, practicality and reliability were highlighted. Also, PDL students' performance were analyzed and the effectiveness of the learning module was determined.

1. Development of the Comic strip-based Learning Module

The comic strip-based learning module, titled MathComStrip, was developed using ADDIE Model (Analysis, Design, Development, Implementation, and Evaluation). This is a systematic instructional design framework aimed at ensuring effective and learner-centered material development (Alismail & Alshumaimeri, 2021). In the Analysis Phase, the researchers examined the PDLs' level of engagement, learning difficulties in Mathematics, and their prior academic performance. These inputs served as the basis for identifying learners' needs, setting appropriate learning

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objectives, and designing relevant instructional strategies for the development of the MathComStrip module. After careful observation and analysis, the researchers identified the need to develop a contextualized learning module that would address the specific challenges faced by PDL students in learning Mathematics, particularly terms of engagement, comprehension, and application of concepts and problem solving within their unique learning environment.

In the Design Phase, the content of the module was identified based on the ALS K to 12 Curriculum Guide. The researchers selected Learning Strand 3: Mathematical and Problem-Solving Skills as the focus of the module. This particular strand was chosen because, during the period of the study, its lessons were actively being taught to PDL students. Aligning the module with ongoing instruction ensured relevance, continuity, and immediate applicability in the learners' current academic context. Comic setting was also identified to make it relevant to the unique environment of PDLs. Also, the module features inclusivity as it includes Christian and non-Christian characters. Inclusion of learning exercises at the end of each lesson was a good feature of the module.

In the Development Phase, the researchers began writing the script of the module, focusing on Arithmetic and Geometric sequence and series. The script was written using a narrative and approachable comic format, which facilitated effective communication of mathematical concepts in an engaging and relatable manner. The storyline featured a jail officer and male and female, Christian and non-Christian, PDLs as the main characters, with content deliberately contextualized to reflect the realities and environment of jail settings. Language used in the script was composed of simple and accessible sentences, designed to personally engage the learners while subtly integrating values aligned with the rehabilitation and reintegration programs of the BJMP. This approach aimed to promote not only academic learning but also the development of life skills essential for the PDL students' reintegration into mainstream society.

The development of the script for the comic strip-based learning module took approximately two months to complete. It underwent multiple revisions based on the feedback of the mathematics expert and grammar expert to ensure clarity, coherence, and language accuracy. To bring the narrative to life visually, the researcher collaborated with a professional graphic artist and a former comic strip illustrator. The illustrations were digitally created by the layout artist using a pen tablet and Adobe Photoshop. The final arrangement and visual elements were carefully designed to capture the learners' interest and effectively convey the intended messages and mathematical concepts of the storyline. More specifically, the MathComStrip learning module was developed using the comic format structure proposed by Collver and Weitkamp (2018) as a guiding framework. Their model provided structural elements that helped shape the narrative flow, visual layout, and integration of educational content within the comic medium. This approach aligns with Thompson's (2017) discussion on the phases of scriptwriting and comic book illustration, highlighting the interdisciplinary nature of comic creation as both a literary and visual process. Thompson emphasizes that writing comics draws from diverse fields such as visual design, art, rhetoric, and new media studies, offering not only a creative platform for storytelling but also a pedagogical tool for enhancing engagement and comprehension in academic contexts.

The module includes several essential components: a cover page, preface, user's guide, table of contents, lesson objectives, and three core lessons—Lesson 1: Summing It Up (Arithmetic Sequence and Series), Lesson 2: Multiply It Continuously (Geometric Sequence and Series), and Lesson 3: Applying Sequence and Series. The structure was designed to ensure clarity, coherence, and progressive learning for the target learners. The shift toward the use of contextualized and modular learning resources aligns with current educational trends, particularly in correctional and alternative learning systems. This approach is supported by the findings of Hamora et al. (2021) and Ramdani and Haryanto (2020), who reported that instructional modules developed through systematic methods were positively received by both students and teachers, enhancing learning engagement and comprehension.

2. Assessment of the MathComStrip Learning Module

Following the development phase, the module underwent a comprehensive assessment to assess its content validity, practicality, and reliability. Forty-one ALS teachers and 64 Jail Officer-teachers from the five provinces in Region IV-A participated in the study. Results are presented on the next tables.

Table 1 shows that the developed comic strip-based learning module was highly valid as far as the depth, clarity and alignment to the most essential learning competencies is concerned, with an overall mean of 3.66 and standard deviation of .407. Further, it can be seen from the table that the module is highly valid in terms of its alignment to the learning competencies set in the K to 12 Basic Education Curriculum for ALS (WM=3.73; SD=.483). Also, there is a high level of validity when it comes to the examples and illustration relevnt to real – life situations (WM=3.70;

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SD=.477) and are appropriate to each topics (WM=3.67; SD=.490); use of proper font style, size and line spacing making it easy to read and comprehend (WM=3.69; SD=.515). Instructions are also clear and easy to follow (WM=3.69; SD=.501) and it includes adequate presentation and discussion of the lessons (WM=3.68; SD=.487). The module also contains activities based on the learning objectives (WM=3.68; SD=.469) that enable positive students and teachers interaction (WM=3.67; SD=.490).

Table 1. Content validity of the comic strip-based learning module

The MathComStrip…	WM	SD	Interpretation
is aligned to the learning competencies set in the K to 12 Basic Education Curriculum for the Alternative learning System (ALS-K to 12).	3.73	.483	Strongly Agree
includes examples that is relevant to the real-life situations.	3.70	.477	Strongly Agree
uses proper font style, size, and line spacing that makes reading easier.	3.69	.515	Strongly Agree
has instructions that are clear and easy to follow.	3.69	.501	Strongly Agree
has adequate presentation/discussion of the lesson content.	3.68	.487	Strongly Agree
contains activities based on the learning objectives.	3.68	.469	Strongly Agree
provides activities that enable positive students and teacher interactions.	3.67	.490	Strongly Agree
includes illustrations that are appropriate for each lesson topic.	3.67	.490	Strongly Agree
presents well-explained ideas, concepts, and points.	3.66	.510	Strongly Agree
covers the lesson indicated in the learning strand 3: Mathematical and Problem-solving skills of the ALS-K to 12.	3.64	.550	Strongly Agree
has learning objectives which are specific, measurable, attainable, realistic, and time bound.	3.64	.534	Strongly Agree
contains lessons that is based on the learning competencies.	3.64	.498	Strongly Agree
provides substantial coverage of the key concepts indicated in the ALS-K to 12.	3.63	.567	Strongly Agree
has contents that are suited to the cognitive capacities of the students.	3.59	.527	Strongly Agree
contains supplementary activities that enhance the students' understanding of the lesson content.	3.58	.512	Strongly Agree
OVERALL	**3.66**	**.407**	**Strongly Agree/ Highly Valid**

The consistently high validity ratings across all components affirm that the developed comic strip-based module is appropriate, relevant, and effective for its intended learning outcomes; and can cater the diverse age and needs of PDL students. This supports the results of the study by Lestari and Chandra (2018), Saputri and Qohar (2020), and Saputra and Pasha (2021), which demonstrated that the mathematics content embedded in comic strip-based learning materials significantly enhances students' ability to learn and understand mathematical concepts. Integarting mathematical content into engaging visuals was found to make abstract concepts more concrete and relatable, thereby increasing student comprehension and interest. The validated module was rated as highly effective in presenting content in a clear and structured manner, which contributed to improved student performance in social arithmetic. In addition, mathematical comic-strip application provided content that was accurate, age-appropriate, and aligned with the learning goals, making it easier for students to follow and absorb complex ideas. Both studies highlight that when mathematical content is presented through well-designed comic strips, it reduces cognitive load, sustains attention, and supports a more interactive and enjoyable learning experience, especially for students who may struggle with traditional instructional methods.

Another domain that was assessed in the developed module was its practicality defined as the ease of use of the comic strip-based module. Table 2 shows that MathComStrip module is highly practical (Overall Mean=3.61; SD=.431) with strong agreement across all parameters.

The module assessed with high level of practicality creates active learning (WM=3.68; SD=.487) among students, making learning mathematics enjoyable (WM=3.67; SD=.507) and more interesting (WM=3.62; SD=.505) and can generate students' interest in learning (WM=3.65; SD=.496). Because it is user friendly (WM=3.59; SD=.543), students understand the mathematical concepts easier (WM=3.64; SD=.501); and allows reflection and review of previously learned concepts (WM=3.53; SD=.609).

As assessed by ALS teachers and Jail Officer – teachers, the module was found to promote active learning, make mathematics more enjoyable and engaging, and help students understand mathematical concepts more easily. It also supports motivation, self-learning, and alignment with the needs of ALS learners. Furthermore, it is designed

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to be user-friendly, time-efficient, and uses clear, accessible language. These findings affirm that MathComStrip is a well-designed instructional material that caters effectively to diverse learner needs and supports independent, reflective, and meaningful mathematics learning. This concurs with the findings of Van Wyk (2011) stating that integrating cartoons in teaching enhances constructive, cooperative and collaborative learning.

Table 2. Practicality of the comic strip-based learning module

The MathComStrip…	WM	SD	Interpretation
creates active learning.	3.68	.487	Strongly Agree
makes learning mathematics enjoyable.	3.67	.507	Strongly Agree
can generate student interest in learning.	3.65	.496	Strongly Agree
can help students understand the mathematical concepts easier.	3.64	.501	Strongly Agree
can motivate students to learn mathematics.	3.64	.531	Strongly Agree
motivates student learning.	3.64	.501	Strongly Agree
can make learning more interesting.	3.62	.505	Strongly Agree
helps students understand the concepts being discussed more quickly.	3.61	.490	Strongly Agree
can be used by the students for self-learning.	3.61	.507	Strongly Agree
is designed based on the learning needs of the students.	3.60	.492	Strongly Agree
is user-friendly.	3.59	.543	Strongly Agree
is designed according to the standard learning material used for ALS learners.	3.58	.575	Strongly Agree
can save the time and energy in learning the subject.	3.53	.609	Strongly Agree
allows for reflection and review of the previously learned concepts.	3.53	.595	Strongly Agree
uses language that is easy to understand.	3.51	.637	Strongly Agree
OVERALL	**3.61**	**.431**	**Strongly Agree/ Highly Practical**

Another criteria that was assessed in the developed comic strip-based learning module was its acceptability. This is the attribute of being able to satisfy the PDl students' needs when it comes to learning mathematics through the use of the developed MathComStrip. Result is presented in Table 3. With an overall mean of 3.60 and standard deviation of .424, the module was found to be highly acceptable in terms of its instructional quality and overall design. It can also be seen from the table that respondents strongly agreed in all indicators of its acceptability.

Table 3. Acceptability of the comic strip-based learning module

The MathComStrip is acceptable in terms of . . .	WM	SD	Interpretation
readability.	3.73	.517	Strongly Agree
the graphic design.	3.68	.487	Strongly Agree
the presentation of the module content.	3.64	.501	Strongly Agree
the module structures.	3.62	.553	Strongly Agree
clarity of instructions.	3.59	.527	Strongly Agree
adequacy of the content.	3.58	.530	Strongly Agree
application of appropriate teaching-learning material.	3.58	.544	Strongly Agree
compatibility of the teaching-learning material to the intended learning outcomes.	3.58	.561	Strongly Agree
the clarity of how of the rationale of the module is presented.	3.57	.562	Strongly Agree
compatibility of the lessons to the allotted time frame.	3.44	.621	Agree
OVERALL	3.60	.424	**Strongly Agree/ Highly Acceptable**

Respondents' assessment showed that the module is highly acceptable in terms of readability (WM=3.73; SD=.517), graphic design (WM=3.68; SD=.487), and presentation of content (WM=3.64; SD=.501). Based on this result, the module is found to be visually engaging and easy to understand. Other areas such as clarity of instructions (WM=3.59; SD=.527), adequacy and appropriateness of content (WM=3.58; SD=.530), and alignment with the

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intended learning outcomes (WM=3.58; SD=.561) and time frame (WM=3.44; SD=.621) were also rated with a very strong agreement indicating that the module is higly acceptable. Results of the study support the study of Shahrill et al. (2022) indicating that factors that affect students' learning and interest in the subject are the significant use of colors, structure, and shape of the images and illustrations in comic-based module. According to Ervanti (2022), pictures and illustrations allow students to infer and create meaningful ideas in learning mathematics.

3. PDL students' Performance

The previous section showed that MathComStrip was found to be highly valid, practical and acceptable with astrong agreement across all criterias set for these three domains. Because of the module's good characteristics and features, it was then implemented in teaching PDL students in Trece Martires City Jail in Cavite, Philippines. One of the researchers, as ALS implementer and Jail Officer-teacher took charge of the implementation of the module in ALS classes. Here, 13 PDL students enrolled in the DepEd-ALS Secondary Program participated in the study, representing the entire population of PDL learners enrolled in the said program at the time of data collection. During this phase it is ensured that the data gathered were treated with utmost care and privacy. Before utilization, PDL students were given a 30-item test. After the administration of the pre-test, the module was then utilized in the teaching and learning process. After two months of utilization, feedbacks from the students were obtained. Also, post-test was given to students to measure the effect of the comic strip-based module to their mathematical performance. Results are presented in Table 4.

Table 4. Students' performance before and after the implementation of MathComStrip

	Pre-test			Post-test		
	Score	Percentage	Descriptor	Score	Percentage	Descriptor
Student 1	14	46.67	Did Not Meet Expectation	25	83.33	Satisfactory
Student 2	18	60.00	Did Not Meet Expectation	27	90.00	Outstanding
Student 3	6	20.00	Did Not Meet Expectation	18	60.00	Did Not Meet Expectation
Student 4	11	36.67	Did Not Meet Expectation	15	50.00	Did Not Meet Expectation
Student 5	9	30.00	Did Not Meet Expectation	23	76.67	Fairly Satisfactory
Student 6	18	60.00	Did Not Meet Expectation	22	73.33	Did Not Meet Expectation
Student 7	8	26.67	Did Not Meet Expectation	17	56.67	Did Not Meet Expectation
Student 8	11	36.67	Did Not Meet Expectation	14	46.67	Did Not Meet Expectation
Student 9	13	43.33	Did Not Meet Expectation	23	76.67	Fairly Satisfactory
Student 10	9	30.00	Did Not Meet Expectation	11	36.67	Did Not Meet Expectation
Student 11	9	30.00	Did Not Meet Expectation	13	43.33	Did Not Meet Expectation
Student 12	11	36.67	Did Not Meet Expectation	23	76.67	Fairly Satisfactory
Student 13	9	30.00	Did Not Meet Expectation	21	70.00	Did Not Meet Expectation

Pre-test: Mean=37.44 (Did Not Meet Expectation); SD=12.183; Min=20 (Did Not Meet Expectation); Max=60 (Did Not Meet Expectation)
Post-test: Mean=64.62 (Did Not Meet Expectation); SD=16.807; Min=36.67 (Did Not Meet Expectation); Max=90.00 (Outstanding)

It can be gleaned from the above table that 100% of the PDL students did not meet expectation (M=37.44; SD=12.183) and have poor performance in mathematics under the ALS as reflected on their pre-test scores. This could be attributed to factors like limited access to quality instructional materials and minimal exposure to engaging or contextualized learning materials appropriate to their unique environment. Also, the constrained learning environment within the correctional facility, coupled with potential gaps in foundational knowledge and low academic self-confidence, may have further contributed to their underperformance. These findings underscore the urgent need for innovative, learner-centered interventions—such as the use of comic strip-based modules, that can help simplify abstract mathematical concepts, sustain learner interest, and improve academic outcomes in alternative learning settings.

A significant increase on the students' scores were reflected on their post-test scores. Despite, the mean score (M=64.62; SD=16.807) suggesting a poor students' performance, it can also be noted that five out of thirteen students (38.46%) obtained a passing mark with one student on the outstanding level. Disregarding other factors, this result is a good indication that the developed comic strip-based module contributed to the students' attainment of learning outcomes in mathematics. This supports the study of Musa et.al (2022), Azamain et.al (2020) and Pinili (2022) indicating that the use of comics and colors provides engaging learning experience among students. They

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could easily learn with visuals appealing to their critical thinking mind. This further affirms the findings of the Azizi and Fauzan (2020) and Rasiman and Pramasdyahsari (2014) showing that cartoons that teach math, based on flipbook machines can promote mathematical content knowledge

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4. Effectiveness of the MathComStrip Learning Module

To measure the effectiveness of the module, students' scores before and after the implementation of MathComStrip were compared. Here, dependent t-test was employed to determine whether there is significant difference on the students' pre-test and post-test scores. See Table 5.

Table 5. Difference on the performance of PDL students before and after the implementation of the comic stri-based learning module

	Mean	*SD*	*t-value*	*p-value*	*Interpretation*
Pre-test	37.44	12.183	7.067	<.001	Significant
Post-test	64.62	16.807			

Table 5 shows that there is significant difference on the students' scores before (M=37.44; SD=12.183) and after (M=64.62; SD=16.807) the implementation of the module with t(13)=7.067; p<.001. This result suggests that the use of MathComStrip had a substantial positive effect on learners' performance in mathematics. This improvement can be attributed to the module's engaging format, contextualized presentation of concepts, and learner-friendly design, which helped simplify complex mathematical ideas and sustain the students' interest and motivation. The visual and narrative elements of the comic strips likely enhanced understanding and retention, making the learning experience more accessible and effective for PDL students under the ALS program.

Table 6. Normalized gain on students' scores and effect size

	Mean	*Mean Difference*	*<g>*	*N-gain*	*d*	*Effect Size*
Pre-test	37.44	27.18	.446	Medium	1.852	Very Large
Post-test	64.62					

Disregarding other factors that may affect students' performance, Table 6 shows that the utilization of comic strip-based learning module has a very large effect size, d=1.852, to the PDL students' mathematics performance with a medium normalized gain, <g>=.446, on students' scores.This reflect a marked improvement in the students' post-test scores, indicating that the module effectively supported the attainment of learning objectives. Also, this further conclude that the structured, visually engaging, and contextualized approach of the module played a key role in enhancing learners' comprehension and interest in the subject, even within the limitations of an alternative learning environment.

Conclusions

Based on the findings of the study, it can be concluded that the comic strip-based learning module is an effective instructional tool in improving the mathematics performance of PDL students under ALS. The module's engaging format, contextualized content, and learner-friendly design contributed to improved students' learning engagement and increased learners motivation. Despite initial low performance, the significant gains observed after the intervention indicate that the module supported better understanding and retention of mathematical concepts. Overall, the comic strip-based module proved to be a practical and meaningful approach to addressing the diverse learning needs of students in non-traditional educational settings.

Recommendations

Based on the findings of this study it is recommended that the developed MathComStrip module should undergo additional assessment and evaluation involving a broader range of experts and learners to ensure its effectiveness, accuracy, and applicability prior to large-scale implementation. It is also recommended that the Bureau of Alternative Education (BAE) under the Department of Education may explore the use of contextualized learning modules integrated with comic strip, such as MathComStrip, in teaching mathematics to PDL in wider scope and context. And finally, it is recommended that parallel studies in other subject areas beyond mathematics, should be conducted to explore the potential of comic strip-based contextualized modules as an innovative instructional approach in different learning domains within the ALS and similar educational settings.

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