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Innovative Trigonometry Learning: The Role of Liveworksheets-assisted Interactive Worksheets in Improving Numerical Literacy

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Abstrak

Penelitian pengembangan lembar kerja interaktif berbasis teknologi masih sangat terbatas. Penelitian bertujuan mengembangkan lembar kerja interaktif berbantuan Liveworksheets sebagai upaya meningkatkan literasi numerasi siswa yang memenuhi kriteria valid, praktis, dan efektif. Kevalidan lembar kerja interaktif dinilai oleh ahli media dan ahli materi. Kepraktisan penggunaan lembar kerja interaktif berdasarkan respon guru dan siswa. Keefektifan implementasi pembelajaran trigonometri menggunakan lembar kerja interaktif ditinjau dari hasil peningkatan pretest dan postest kemampuan literasi numerasi siswa. Penelitian pengembangan menggunakan model ADDIE, meliputi Analyze, Design, Development, Implementation, dan Evaluation. Hasil penelitian menunjukkan Lembar kerja Interaktif berbantuan Liveworksheets valid dengan skor 86% dari ahli media dan 80% dari ahli materi. Penggunaan lembar kerja interaktif berkategori sangat praktis dengan skor 94,80% dari angket respon guru dan 84,60% dari angket respon siswa. Pembelajaran menggunakan lembar kerja interaktif berbantuan Liveworksheets efektif meningkatkan literasi numerasi siswa. Bantuan scaffolding berbasis teknologi yang diterapkan pada pembelajaran menggunakan liveworksheet menjadi lebih menarik dan memotivasi siswa untuk berpikir literasi numerasi.
Kata Kunci: Lembar Kerja Interaktif; Literasi Numerasi; Pembelajaran Inovatif; Trigonometri.

Abstract

Research on the development of technology-based interactive worksheets is still minimal. The study aims to develop interactive worksheets assisted by Liveworksheets to improve students' numeracy literacy that meets the criteria of valid, practical, and effective. Media experts and material experts assess the validity of interactive worksheets. The practicality of using interactive worksheets is based on teacher and student responses. The effectiveness of implementing trigonometry learning using interactive worksheets is reviewed from the results of the pretest and posttest increase in students' numeracy literacy skills. The development research uses the ADDIE model, which consists of analysis, design, development, implementation, and evaluation. The study results showed that the Interactive Worksheet assisted by Liveworksheets was valid, with 86% validity from media experts and 80% from material experts. Interactive worksheets are categorized as very practical, with a score of 94.80% from the teacher response questionnaire and 84.60% from the student response questionnaire. Learning using interactive worksheets assisted by Liveworksheets effectively improves students' numeracy literacy. Technology-based scaffolding assistance applied to learning using liveworksheets makes it more interesting and motivates students to think about numeracy literacy.
Keywords: Interactive Worksheets; Numeracy Literacy; Innovative Learning; Trigonometry.

I. INTRODUCTION

Trigonometry is a branch of mathematics with wide applications in various fields, such as engineering, physics, astronomy, and technology. However, students' understanding of this material is often challenging in mathematics education (Maknun et al., 2022; Spangenberg, 2021; Taufiq & Agustito, 2021). This is due to the abstract nature of trigonometric concepts, such as angle ratios and trigonometric functions, and their application to contextual problems. This difficulty impacts students' low ability to apply trigonometric concepts to solve real-world problems, which is an integral part of numeracy literacy.

Numeracy literacy is one of the key competencies of the 21st century, and it's emphasized in various educational curricula (Gal et al., 2020; Masjudin et al., 2020; Nofriyandi et al., 2023; Wahyuni & Afdhila, 2024). This competency includes understanding, analyzing, and solving number-based problems in various contexts. In trigonometry learning, numeracy literacy includes the ability to interpret data in graphical form, use trigonometric ratios in everyday situations, and critically evaluate calculation results (Basir & Maharani, 2018).

The lack of numeracy literacy in trigonometry material makes it difficult for students to connect trigonometric concepts to real-world situations (Spangenberg, 2021; Jayanti & Cesaria, 2024; Qolbi & Afriansyah, 2024). Students view this material as a series of formulas and numbers without seeing its relevance. In addition, when students are given problems that require the application of trigonometry concepts, most students have difficulty identifying the right steps to solve the problem. Students tend to get stuck in the calculation stage without understanding the logic behind the concepts used. Low numeracy literacy in students often occurs due to the lack of supporting learning media to improve numeracy literacy skills (Tito, Muhtadi, & Sukirwan, 2024), such as interactive and relevant student worksheets.

Worksheets are learning aids to help students understand, practice, and apply concepts taught by teachers (Muskita et al., 2020; Yurtyapan & Kandemir, 2021). Good worksheets are designed to meet student needs, are relevant to learning objectives, and are interactive, interesting, flexible, and adaptive (Murod et al., 2020). In the digital era, worksheets are developed in interactive formats, such as using digital platforms to increase student engagement. However, existing studies often do not utilize the potential of interactive platforms to address gaps in student understanding of trigonometry material. In addition, most studies focus more on cognitive outcomes, while aspects of numeracy literacy, including critical, reflective, and contextual thinking skills, are still lacking.

Along with technology development, various interactive learning media have begun to be used in mathematics education to improve student understanding (Ramadoni, Aima, & Mardiyah, 2024). One platform that is starting to gain attention is Liveworksheets. This online platform allows teachers to transform static worksheets into interactive worksheets that students can access and work on digitally (Ismaniar,

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Sumarni, & Riyadi, 2024). With features such as automatic evaluation, immediate feedback, and multimedia integration, this platform has become popular for supporting interactive and technology-based learning in the digital era (Oktaviyanthi & Sholahudin, 2023). This platform also provides opportunities to create more dynamic learning experiences and support active student engagement (Widiantho et al., 2023).

Liveworksheets is one alternative complete package that can be used in learning (Ghaisani & Setyasto, 2023). These liveworksheets not only focus on how to solve problems but can also be varied by creating interactive learning resources. Even more interesting, Liveworksheets provides features that can be used for listening and speaking, and users can add images, audio, YouTube videos, PowerPoint files, and other links. Trigonometry learning materials become more interesting and allow students to learn in a more interactive way than just using printed materials. Using Liveworksheets to develop interactive worksheets for trigonometry materials provides a more modern learning approach and helps students understand and master the material better and improve their numeracy literacy.

This research is important because it combines a technology-based learning approach with a focus on strengthening numeracy literacy, an urgent need in 21st-century education. By developing and evaluating interactive worksheets assisted by Liveworksheets, this research contributes to developing innovative learning media and answers the challenges in improving students' numeracy literacy (Husna & Kurniasih, 2023). The results of this study are expected to provide new insights for educators, researchers, and policymakers to integrate technology in mathematics learning, especially trigonometry, effectively.

II. METHOD

This research design uses the Research and Development approach that used to produce a particular product and test its validity, practicality, and effectiveness (Adeoye et al., 2024). Many development models can be used, including the ADDIE development model.

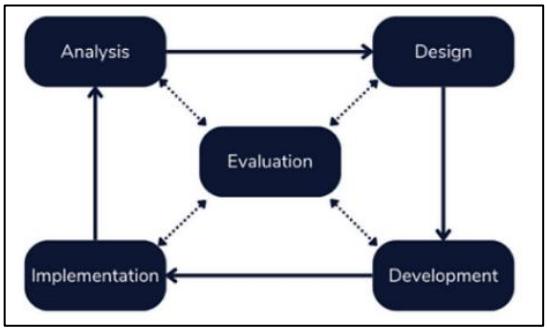

Figure 1. The ADDIE Model of Instructional Design.

Figure 1 shows that the ADDIE Model is a systematic framework used in development research to create learning products (Adri et al., 2020; Boyman et al., 2020). The ADDIE model is a systematic and structured approach to producing effective learning products according to needs (Ramly et al., 2022; Sahaat et al., 2020; Spatioti et al., 2023).

The ADDIE Model uses five stages, namely Analysis, Design, Development, Implementation, and Evaluation (Basir et al., 2020; Nofriyandi et al., 2023; Wahyuni & Afdhila, 2024). This model is often used

in education to ensure that the products produced are valid, practical, and effective.

The first stage of the ADDIE model is analysis. The Analysis stage focuses on identifying learning needs, analyzing problems, and understanding numeracy literacy in trigonometry material. The analysis results are the basis for designing learning products through appropriate interactive worksheets. The second stage is design. The product design is based on the results of the analysis at this stage. This includes the preparation of learning objectives, materials, learning strategies, and appropriate visual designs. Next is the development stage, where learning products are developed based on the designs. Product prototypes are made, tested, and revised to produce a final product ready to use. At the implementation stage, the product that has been developed is implemented on students. This stage involves testing the product in real situations to ensure its effectiveness and practicality. Finally, in the evaluation stage, the success of the learning product is assessed. This evaluation is carried out after the product has been implemented.

In the ADDIE model development research, the population and sample are determined based on the research context and the product being developed. The population includes all individuals who are the target of the learning product being developed (Yeh et al., 2019). In this study, the population was all students of class X of SMA Islam Sultan Agung 3 Semarang. The sample is part of the population selected to participate in the study (Zhong & Xia, 2020). The sample selection was carried out purposively, namely students of class X-1. The sample selection considered representation so that the research results could be generalized.

The data collection method in the ADDIE model development research aims to collect relevant information at each stage of the development process. The methods used include interviews with teachers to understand learning needs, interviews with students to determine difficulties in understanding trigonometry material, teacher and student responses to determine the level of satisfaction in using the developed product, pretest and posttest of numeracy literacy to determine the increased in student learning outcomes after using interactive worksheets assisted by Liveworksheets.

The data that has been collected is then analyzed using qualitative and quantitative approaches. Qualitative data is analyzed using thematic analysis techniques, including organizing data, reading and understanding data, identifying patterns, and providing conclusions about findings. This data helps understand learning needs, teacher and student responses, and expert input on interactive worksheets assisted by liveworksheets. Data from expert validation were analyzed to assess the feasibility of the product. Data from student and teacher questionnaires were analyzed to assess the extent to which the product was easy to use and implement.

Quantitative data were analyzed using descriptive and inferential statistics. Descriptive statistics were used to describe the percentage of data. Inferential statistics were used to determine the increase in

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students' numeracy literacy pretest and posttest results.

III. RESULT AND DISCUSSION

A. Result

The study's analysis stage results showed that, based on the identification of needs, students often have difficulty understanding the concept of trigonometry; the learning media currently used is less varied and has not utilized interactive technology. Teachers need innovative teaching materials that support numeracy literacy-based learning.

The target users are students of class X-1 SMA Islam Sultan Agung 03 Semarang, with the characteristics that most students have access to digital devices such as cell phones and laptops, thus enabling interactive media. Student learning motivation is higher when using interesting technology-based media that allows independent practice. Students' numeracy literacy is still in the moderate category, with weaknesses in solving contextual problems involving data interpretation and understanding concepts.

The results of the curriculum analysis refer to the learning achievements of the independent curriculum for grade X mathematics. The competencies developed through this worksheet are understanding the basic concepts of trigonometry, using trigonometry concepts to solve contextual problems, and improving students' abilities in reading, analyzing, and solving problems based on numerical and graphical data.

Based on the diagnostic test results, students had difficulty interpreting the relationship between trigonometric concepts and trigonometric function graphs, solving story problems involving trigonometry in the context of measuring angles or lengths, and effectively using numeracy-based problem-solving strategies. The needs analysis results, student characteristics analysis, curriculum and competency analysis, and identification of numeracy literacy problems became the basis for designing interactive worksheets that combine trigonometry material with numeracy literacy-based questions implemented through the Liveworksheets platform.

The Design stage aims to design the framework and main components of interactive worksheets assisted by Liveworksheets on trigonometry material. Design results include material structure, question design containing numeracy literacy, and design of learning media interactivity. Learning objectives are based on learning achievements in the independent curriculum and focus on improving students' numeracy literacy. The objectives expected to be achieved are that students understand and apply basic trigonometry concepts in various contexts, solve numeracy literacy-based problems that utilize numerical data, graphs, and visual models, and use digital learning media independently to support conceptual understanding.

The mapping of materials and competencies consists of several main topics. The trigonometry material designed is the basic concept of trigonometry (trigonometric ratios in right triangles and arbitrary triangles), trigonometric function graphs (sine, cosine, and tangent), and the

application of trigonometry in contextual problems (measuring height, distance, and elevation angles).

The interactive worksheet design is based on Liveworksheets technology with the following elements: interactive instructions (student guidance in working on the worksheet accompanied by instructions for using the platform), numeracy literacy questions (contextual questions such as calculating building height using elevation angles that display data in the form of tables, graphs and diagrams), interactive features (drag-and-drop to match trigonometric concepts with visualizations, fill-in-the-blank to calculate trigonometric ratios, use of trigonometric function graph simulations that can be manipulated). The worksheet is designed with a flow that makes it easy for students to learn gradually, including the introduction, basic exercises, advanced exercises, and feedback. The introduction explains the concept of trigonometry with animations and illustrations. Basic exercises relate to questions to understand the concept of trigonometric ratios. Advanced exercises relate to numeracy literacy questions that require data interpretation and problem-solving. Feedback contains each answer that gets automatic feedback from Liveworksheets so students can discover the mistakes and their discussions. The design of evaluation and assessment based on automatic question results in Liveworksheets. Score categories to measure students' understanding of trigonometric concepts and numeracy literacy skills.

The results of the design stage become the basis for the development stage, where interactive worksheets are developed technically by the established design. The visual design uses Canvas assistance. Figure 2 covers the results of the development of the interactive student worksheet.

Figure 2. Interactive Worksheet Assisted by Liveworksheets.

The Development stage is the implementation stage of the previously designed design. At this stage, the creation and initial testing of interactive worksheets assisted by Liveworksheets for trigonometry material is carried out. The research results at this stage include creating worksheets, testing functionality, and initial evaluation of the developed learning media. Interactive worksheets assisted by Liveworksheets were developed using the features designed at the design stage. The development process includes creating interactive questions and adding automatic feedback. The display design is simple but attractive, with contrasting colors to distinguish important elements. The navigation between questions is arranged with an easy-to-follow flow so students do not feel confused. As shown in Figure 3.

Media experts and material experts conducted product validation tests. Product validation was conducted to determine the validity of the product used

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as a learning resource. This product validation test also aims to ensure that the features in Liveworksheets function as designed.

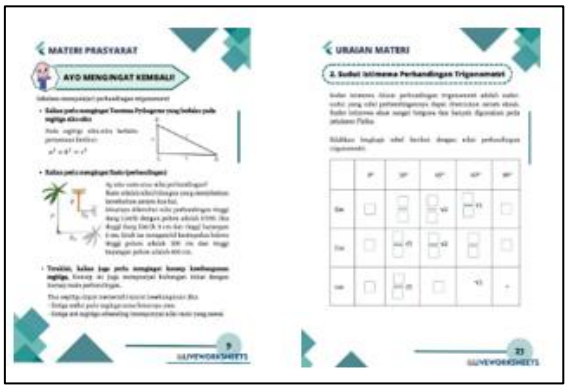

Figure 3. Content of the Material on the Interactive Worksheet Assisted by Liveworksheets.

The results of the media expert assessment showed that the appearance of the interactive worksheet design assisted by Liveworksheets was attractive; the graphic aspects at the level of color accuracy, size, font type, and clarity of the image illustration also need to be considered because if the combination of color, size, font type and clarity of the image illustration is not appropriate, then students are not interested in the media. All interactive questions can be answered correctly, and automatic feedback works well. Trigonometric function graphs can be manipulated smoothly. The system can provide evaluation results that match student answers.

Validation by material experts showed that the material was based on learning outcomes, indicator problems in improving numeracy literacy, the truth and accuracy of the material, the suitability of the images, and the language in the Worksheet. Slight revisions were made to the writing of mathematical symbols using math equations. The results of the interactive worksheet validation test assisted by Liveworksheets can be seen in Figure 4.

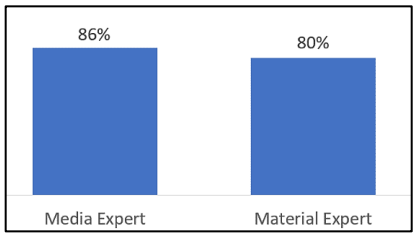

Figure 4. Results of the Interactive Worksheet Validation Test by Experts.

In Figure 4, the percentage of validation test results by media experts was 86%, and by material experts was 80%, so it can be said that the interactive worksheet assisted by Liveworksheets is included in the very valid category.

The interactive worksheet assisted by Liveworksheets can be used as a learning resource because it has met the validity criteria. Furthermore, this interactive worksheet was tested on students who had been taught trigonometry material before. This test aims to determine the practicality of using the product, both from the perspective of teachers and students as users. This is to determine the teacher's response to utilizing interactive worksheets as a learning resource, determine the extent to which students interact with learning media, and determine whether students have difficulty using Liveworksheets. The results of the practicality test show that students can access and use the worksheets easily, most students show increased motivation in solving technology-based trigonometry problems, and some students need time to understand the concept of operating

graphs in interactive worksheets assisted by Liveworksheets. The results of the teacher response questionnaire on Interactive worksheets with Liveworksheets are shown in Figure 5.

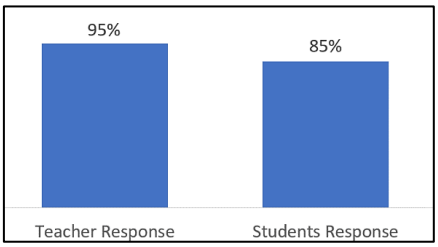

Figure 5. Percentage of Teacher and Student Response Questionnaire Results on the Use of Interactive Worksheets.

Based on Figure 5, the average percentage of teacher response questionnaire results of 95% is included in the very practical category, and the average percentage of student response questionnaire results of 85% is categorized as very practical. Interactive worksheets with Liveworksheets received a very good response from teachers and students. Therefore, the response percentage is more than 80%; it can be said that using interactive worksheets is very practical in trigonometry learning to improve students' mathematical literacy skills.

Based on the questionnaire filled out after limited learning, most students felt that using Liveworksheets was very helpful in understanding trigonometry material. Students easily understood concepts such as trigonometric function graphs.

Based on the results of the student trial evaluation and feedback from the practicality test, several improvements were made, including (1) increasing the compatibility of Liveworksheets with other devices and improving the display to be more responsive; (2) adding more detailed instructions on the use of interactive features, such as graph manipulation and filling in answers; (3) expanding the explanation of the feedback for each question that includes solution steps to help students correct mistakes.

At the Development stage, interactive worksheets are produced that are ready to be applied more widely with improvements and refinements that have been made. Further testing will be carried out at the implementation stage to determine the effectiveness of the worksheets in classroom learning situations.

At the Implementation stage. Interactive worksheets assisted by Liveworksheets on trigonometry material were tested on 30 students of class X-1 of SMA Islam Sultan Agung 03 Semarang. This stage aims to apply the worksheets to students directly and evaluate their effectiveness in improving students' numeracy literacy skills before and after learning using interactive worksheets assisted by Liveworksheets. Learning was carried out for two weeks with a time allocation of 90 minutes for each meeting. During learning activities, students were more enthusiastic and involved in working on trigonometry problems. Students actively used interactive features that honed their understanding of concepts independently.

The evaluation results before and after the implementation of learning showed a significant increase in students' abilities to interpret numerical data and graphs related to trigonometry material. The average pre-test score for students on trigonometry material was 44.5. After using Interactive Worksheets with liveworksheets, the average post-test score

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increased to 78.5. The N-Gain test results showed a mean score of 0.78, categorized as a high increase. Thus, trigonometry learning using interactive worksheets assisted by liveworksheets effectively improves numeracy literacy skills.

The evaluation stage is the last in the ADDIE development model. It aims to assess the effectiveness, efficiency, and success of interactive worksheets assisted by Liveworksheets in improving students' numeracy literacy skills. The assessment is carried out on various aspects, including the achievement of learning objectives, media quality, and user experience.

Based on the results of the post-test conducted after the implementation of the interactive worksheet, it was found that students achieved learning objectives very well; 90% of students managed to understand the basic concepts of trigonometry and were able to apply them in the context of everyday problems, and 85% of students showed good abilities in solving numeracy literacy-based problems, such as interpreting trigonometric graphs and calculating with numerical data. Both teachers and students responded that the interactive worksheets were very helpful in understanding the relationship between trigonometric concepts and their practical applications. Most students felt more confident in solving problems after being given clear and direct automatic feedback. The evaluation results showed a significant increase in numeracy literacy skills. The average score on the posttest increased by 74% compared to the pretest, indicating a positive effect of using interactive worksheets. Based on the satisfaction survey, 88% of students stated they were satisfied with this interactive worksheet and wanted to use similar media in the next material. Students also felt that the feedback given after answering the questions was very helpful in improving student understanding.

B. Discussion

The development of interactive worksheets assisted by Liveworksheets to improve numeracy literacy skills in trigonometry material is an innovation that uses technology to support mathematics learning, especially trigonometry, to improve students' numeracy literacy skills. Interactive worksheets assisted by Liveworksheets function to improve numeracy literacy with the support of technology-based scaffolding.

Technology-based scaffolding is using technology to temporarily support students in completing more complex or difficult tasks they cannot achieve independently without assistance (Abboud & Rogalski, 2021; Kamalodeen et al., 2021). Scaffolding functions to help students understand and complete more difficult tasks by providing gradual assistance until they can complete the task independently (Boonmoh & Jumpakate, 2019).

Technology-based scaffolding is vital in improving students' numeracy literacy, especially in modern learning that integrates digital technology (Saparbayeva et al., 2024; Timotheou et al., 2023; Widajati & Mahmudah, 2023). Scaffolding becomes more effective and flexible when integrated with technology, such as adaptive learning platforms, interactive

simulations, or educational software. Technology allows teachers to provide personalized assistance based on students' needs, such as additional explanations, tailored exercises, or immediate feedback (Ayeni et al., 2024; Major et al., 2021; Qushem et al., 2021). This helps students understand numeracy concepts, from basic operations to complex problem-solving.

Technology-based scaffolding can increase student motivation through liveworksheets, gamification, and other interactive tools that make learning more engaging (Deda et al., 2023; Rusdan & Mulya, 2023; Wijaya et al., 2021). This approach trains students to understand numbers, interpret data, and apply numeracy skills in real life. Technology also facilitates students' learning at their own pace, which is crucial to addressing the ability gap in the classroom. Thus, technology-based scaffolding provides a great opportunity to reduce learning barriers, increase student engagement, and accelerate numeracy literacy achievement (Budakoğlu et al., 2023; Kazak et al., 2015; Kim et al., 2019). However, its success is highly dependent on the selection of appropriate technology and the ability of teachers to design structured learning. This makes technology-based scaffolding a relevant strategy for education in the digital era.

In trigonometry learning using Liveworksheets, technology-based scaffolding can be implemented in various ways. One of the most prominent methods is automatic feedback and tiered instructions. Liveworksheets enable direct feedback-based teaching, which allows students to improve their answers in real time. For example, suppose a student enters a trigonometric calculation incorrectly. In that case, the system can provide a hint or reference to the correct formula, allowing the student to try again until they get the correct answer. This is a very effective form of scaffolding because it provides support tailored to individual students' needs.

In addition, Liveworksheets can also facilitate scaffolding in the form of gradual explanations of trigonometric concepts. For example, students can be given a simple introduction to trigonometric concepts, such as the introduction of the sine, cosine, and tangent functions through easy problems, then gradually move on to more complex problems, such as applying trigonometric formulas in various situations. In this way, students can follow a structured learning path, where each part of the learning is tailored to the student's ability and understanding.

One important element of technology-based scaffolding offered by Liveworksheets is automated feedback. This feedback is crucial because it allows students to recognize and correct mistakes. The feedback provided by the system can include relevant warnings or hints if the student makes a mistake in calculating a trigonometric value or applying a formula incorrectly.

The technology-based scaffolding implemented in Liveworksheets allows students to develop gradually. With the support of this technology, students can feel more confident working on math problems that initially seem difficult. This, in turn, can increase students' confidence in facing bigger math challenges.

Developing interactive worksheets assisted by Liveworksheets in trigonometry learning offers a huge opportunity to improve students' numeracy literacy skills. By utilizing this technology, students can learn more interestingly and dynamically and receive support through technology-based scaffolding that helps them understand and master the material more effectively. Automatic feedback, problem repetition, and materials tailored to students' abilities are important components in helping them improve their understanding and enhance their math skills. As technology advances, platforms such as Liveworksheets can continue to evolve to offer more effective solutions for improving students' numeracy literacy.

IV. CONCLUSION

Developing interactive worksheets assisted by Liveworksheets on trigonometry material significantly improves students' numeracy literacy. In terms of validity, the developed product has met the criteria for scientificity and content relevance based on the results of expert validation. This worksheet is designed by considering the principles of interactivity and conceptual clarity to support an in-depth understanding of the material. In terms of practicality, this interactive worksheet shows a level of ease of use, both by teachers and students, as reflected in the results of limited trials in the classroom. In terms of effectiveness, this worksheet has been proven to improve students' numeracy literacy skills, as shown by the results of the pretest and posttest, which have increased significantly. The learning process also becomes more interesting and motivates students to think critically when solving contextual problems.

This study suggests that the development of interactive worksheets assisted by Liveworksheets be extended to other materials in mathematics, such as geometry or algebra, to improve numeracy literacy more comprehensively. Future researchers can also add data analytics features to learning media to monitor student progress in real-time. In addition, research can involve broader trials with various levels of student ability to obtain more accurate generalization of results. Integration with other learning applications can also be explored to create a more dynamic and adaptive learning ecosystem.

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