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Igniting Curiosity: E-LKPD with a Scientific Twist on Circle Concepts

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Abstract

This study aims to develop and test the effectiveness of live worksheet-based E-LKPD in increasing student involvement and understanding of circle material in grade VI elementary school. The main problem faced is the low interest of students in mathematics learning, which is monotonous and less interactive, which causes difficulties in understanding material that is considered difficult. The development of this product is based on an analysis of student needs and interviews with teachers to identify challenges in mathematics learning. The research method used is the ADDIE (Analysis, Design, Development, Implementation, Evaluation) model, which includes the stages of needs analysis, product design, interactive media development, and product testing through limited and field trials. The results showed that E-LKPD based on live worksheets increased student motivation and material comprehension, significantly increasing learning outcomes between the pretest and post-test. These findings suggest that technology-based teaching media can increase the effectiveness of mathematics learning at the elementary school level, especially in materials that are considered difficult. The implication of this research is the development of interactive teaching media that can be applied in various educational contexts to improve the quality of learning.

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INTRODUCTION

In many areas, mathematics learning in elementary schools still relies on conventional methods such as textbooks and posters that are less appealing to students (Lo & Hew, 2020; Matuk et al., 2021; Zhang et al., 2023). Most elementary schools still rely on textbooks and posters as the primary medium in teaching mathematics (Bellens et al., 2020; Jäder et al., 2020; Otieno & Povey, 2023). Although this method has been used for a long time, many studies show that static teaching materials are less able to foster students' interest in learning, especially in materials that require a deeper conceptual understanding (AlGerafi et al., 2023; Chen et al., 2023; Darling-Hammond et al., 2020). A survey conducted at MI Al-Hidayah Mangli found that 75% of students found mathematics learning tedious and challenging to understand. In addition, 68% of teachers report difficulty creating engaging learning media due to time and resource constraints. This shows that there is a significant gap between the needs of students and the learning media available. Therefore, developing more interactive and technology-based teaching media is very important to increase the effectiveness of mathematics learning at the elementary school level.

Several previous studies have examined the use of interactive learning media in primary schools with mixed results. Where some previous research was to develop multimedia applications for mathematics learning that showed increased student involvement, although it has not been able to overcome the gap in technology access in remote areas (El-Sabagh, 2021; Maćkowski et al., 2022; Ullah & Anwar, 2020). In addition, studies related to testing the use of technology-based E-LKPD that increase student motivation but are limited to one type of teaching material and have not been tested in various contexts (Barrot et al., 2021; Pan & Carpenter, 2023; Sedrakyan et al., 2020). This is also reinforced by several studies that show that although technology-based methods have great potential, their implementation is still hampered by infrastructure limitations in many schools (Gkrimpizi et al., 2023; Lucas, 2020; Onyema et al., 2020). While there have been some successes, the most glaring shortcoming is the lack of learning media that can accommodate the needs of students in various areas with limited facilities. This shows the need for the development of teaching media that is more flexible and easily accessible.

Based on the needs analysis and observations conducted at MI Al-Hidayah Mangli, there is a significant gap between the existing learning media and the needs of students in learning mathematics. Although textbooks and posters are widely used, they are not considered engaging and effective enough to address students' difficulties in understanding the circle material, which is often considered complicated. Students are more likely to be interested in interactive and technology-based learning, but infrastructure limitations in many schools prevent optimal use of technology.

Therefore, the main problem that needs to be solved is the development of teaching media that is not only interesting and interactive but also accessible in various school conditions, including those with technological limitations. This research aims to develop a live worksheet-based E-LKPD that can address these problems, providing students with a more engaging and practical learning experience. This research introduces innovations in developing E-LKPD-based learning media with a live worksheet approach that integrates interactive multimedia elements, such as images, videos, and hyperlinks, in mathematics learning for elementary school students. The uniqueness of this product lies in its ability to incorporate technological elements that can be accessed through simple devices, which correspond to the conditions of schools with technological limitations. Compared to traditional learning products such as textbooks and posters, this E-LKPD offers a more attractive design and suits the learning needs of more active and technology-based students. Using the ADDIE model, this research contributes to interactive learning theory and provides practical solutions that can be applied directly in the classroom. This innovation is expected to enrich student's learning experiences and increase the effectiveness of mathematics learning at the elementary school level.

This study aims to develop, validate, and test the effectiveness of live worksheet-based E-LKPD products in increasing student involvement and understanding of circle material in grade VI elementary school. This research follows the ADDIE model cycle, which consists of the stages of Analysis, Design, Development, Implementation, and Evaluation. In the analysis stage, data is collected through interviews and surveys to identify student needs and challenges in mathematics learning. E-LKPD products focus on interactive and multimedia elements in the design stage to support concept understanding. Development is carried out through expert validation, involving media and material experts to ensure the quality and feasibility of the product. Field trials are conducted to test the product's effectiveness through pretest and post-test. Based on user feedback and trial data, this product is expected to meet students' learning needs and positively impact their learning outcomes.

RESEARCH METHOD

This study is situated in the context of addressing the need for more engaging and effective learning materials in elementary school mathematics at MI Al Hidayah Mangli Jember, particularly focusing on teaching Circle material. Traditional teaching methods, such as textbooks and static posters, are insufficient in maintaining student interest and engagement, leading to a gap in achieving optimal learning outcomes. The ADDIE model (Analysis, Design, Development, Implementation, Evaluation), chosen for this research, provides a systematic and structured approach to address these issues (Spatioti et al., 2022; Tu et al., 2021; Wahira et al., 2023).

The model is ideal for product development in educational settings, as it emphasizes iterative development through analysis, design, and testing stages. This method ensures that the final product is tailored to the specific needs of students, validated by experts, and refined based on empirical data. The ADDIE model's iterative nature is crucial for producing a validated educational tool that can effectively enhance student engagement and learning outcomes.

The development of the live worksheet-based E-LKPD involved several stages to ensure that the product met both the educational goals and students' needs. Initially, a thorough needs analysis was conducted through interviews with teachers and students to understand the challenges faced in current mathematics lessons. The design stage included creating an initial framework for the E-LKPD, focusing on the Circle topic, and incorporating multimedia elements to engage students. Expert validation was then carried out, with media experts, material experts, and linguists providing feedback on the content, layout, and educational appropriateness of the E-LKPD. Data collection methods included qualitative and quantitative instruments, such as interviews, expert validation sheets, and student feedback questionnaires (Buschle et al., 2022; Gogo & Musonda, 2022; St. Marie et al., 2021). These methods were crucial for ensuring that the product was relevant, effective, and aligned with the needs of the students, as well as to refine the product for the following stages of testing.

The validation and testing of the E-LKPD were conducted in two key phases: expert validation and field testing. The product received an average score of 90% during expert validation, categorizing it as highly valid. This suggests that the product was well-aligned with educational standards and expert expectations. In the field testing phase, a pilot trial was conducted in Grade VI at MI Al-Hidayah Mangli Jember, with 30 students using the E-LKPD. The data collected through pretest and post-test scores and teacher and student response questionnaires indicated significant improvements in student engagement and learning outcomes. A paired sample t-test was used to analyze the pretest and post-test data, which showed a significant increase in students' understanding of the Circle material ($p < 0.05$). This validates the effectiveness of the E-LKPD in enhancing students' learning. The analysis confirms that the product meets theoretical expectations and proves practical for real-world classroom settings, contributing to both theoretical advancements and practical applications in educational technology.

At the product validation stage, the data obtained from the expert validation sheet is calculated to determine the developed product's validity level. The validation score is calculated using the following formula:

$$Validation\ (V) = \frac{Total\ Scor\ Validation}{Total\ Scor\ Maxsimum} \times 100\%$$

Table 1. Validation Result Percentage

Validity Criteria	Validity Level
85% - 100%	Highly Valid
69% - 84%	Valid
53% - 68%	Quite Valid
36% - 52%	Less Valid
20% - 35%	Invalid
0% - 19%	Highly Invalid

Source: Sugiono (2019)

The analysis of the response questionnaire data was calculated to determine the practicality of the E-LKPD teaching materials developed by the researcher in its collection using a Likert scale with the calculation below. With a percentage of ≥69%, E-LKPD teaching materials in Mathematics lessons are declared interesting and practical for students to use as a learning medium.

$$Persentase\ (P) = \frac{f}{N} \times 100\%$$

Information:

F : The total score of the overall score obtained

N : Total maximum score

Table 2. Likert Rating

Valuation	Criteria
81% - 100%	Strongly Agree
61% - 80%	Agree
41% - 60%	Simply Agree
21% - 40%	Disagree
0% - 20%	Strongly Disagree

Source: Sugiono (2019)

RESULT AND DISCUSSION

Result

The results of this research are in the form of an Electronic Student Worksheet (E-LKPD) developed using the ADDIE method, as previously stated. The ADDIE method, which stands for Analysis, Design, Development, Implementation, and Evaluation, provides a structured and systematic approach to making E-LKPD. At the analysis stage, researchers identify specific needs and learning objectives. At the design stage, they plan the content and layout of the E-LKPD. The development phase involved creating digital worksheets and incorporating multimedia elements to increase engagement and understanding. The implementation is the application of E-LKPD in a real educational environment, thereby allowing practical use and observation.

Analysis

At this stage, the researcher adjusts teaching materials to align with the curriculum and the characteristics of students' learning styles. The selection of materials is guided by analyzing students' needs and learning preferences. Observations and interviews at MI Al-Hidayah Mangli revealed that Grade VI students often find mathematics lessons monotonous and disengaging. As one student, Satria Willy, stated, he becomes bored with the material and assignments in the textbook and worksheets, preferring interactive learning experiences like those found on cell phones. The existing media, such as posters attached to the classroom walls, did not suit the students' preferred learning style, emphasizing a more playful and engaging approach. Therefore, the teaching materials were adjusted to incorporate more dynamic learning media, ensuring they match students' learning preferences and enhance engagement during mathematics lessons.

Based on interview results, the researcher developed E-LKPD teaching materials using live worksheets to reduce student boredom during the learning process. This approach was supported by an appropriate learning model designed to enhance material comprehension. The analysis of teaching materials ensured alignment with the curriculum and the student's characteristics and learning preferences. According to Grade VI teacher Mrs. Ika Irwaniati, the previous learning media consisted primarily of posters displayed on the classroom walls. These posters included multiplication, division, house diversity, and dance. While she occasionally used PowerPoint presentations, time and energy constraints limited their regular use. The development of interactive E-LKPD materials was intended to address these limitations and provide a more engaging learning experience for the students.

Interview results revealed that the teaching materials used during the learning process were mainly limited to textbooks and posters. This limitation arose from time constraints, which restricted the teachers' ability to create more diverse and interactive learning media. Traditional methods, such as these, often fail to engage students effectively and do not fully cater to the diverse learning needs in a modern classroom. Incorporating more dynamic and flexible teaching resources to address this issue is crucial. The live worksheet-based E-LKPD (Electronic Student Worksheet) presents a viable solution. It facilitates the inclusion of interactive elements, such as multimedia, images, and hyperlinks, making it particularly well-suited for complex subjects like mathematics. This approach enhances student engagement and fosters a deeper understanding of the material.

Design

In the second stage, the design process takes place prior to the development of teaching materials. During this stage, the researcher developed the general framework of the E-LKPD and analyzed the learning materials to be included. Adjustments to the materials are essential at this point, as the E-LKPD must align with the learning outcomes, students' needs, and the required content. The design phase is crucial for ensuring that the learning process and educational goals can be effectively achieved.

Based on the results of analysis and observations, the researcher selected the Circle topic from the mathematics curriculum as the focus for this E-LKPD. Live worksheet-based E-LKPD is particularly well-suited to meet students' needs. The product's name was influenced by the fact that Grade VI students are familiar with technology and enjoy characters from children's movies. This inspired the researcher to design a live worksheet-based E-LKPD that integrates these familiar elements to enhance student engagement and facilitate learning.

Development

At this stage, the researcher develops a live worksheet-based E-LKPD, utilizing a web platform that supports the creation of interactive materials. The researcher selects an appropriate application for designing the E-LKPD, ensuring it includes clear images and icons relevant to the circle material. The development process follows a structured sequence: The media design is conceptualized, outlining the layout and interactive elements. Second, the media undergoes a review process through expert validation. Finally, the media is revised based on expert feedback to improve its quality and effectiveness. This iterative process ensures that the E-LKPD meets the necessary educational standards and is engaging for students.

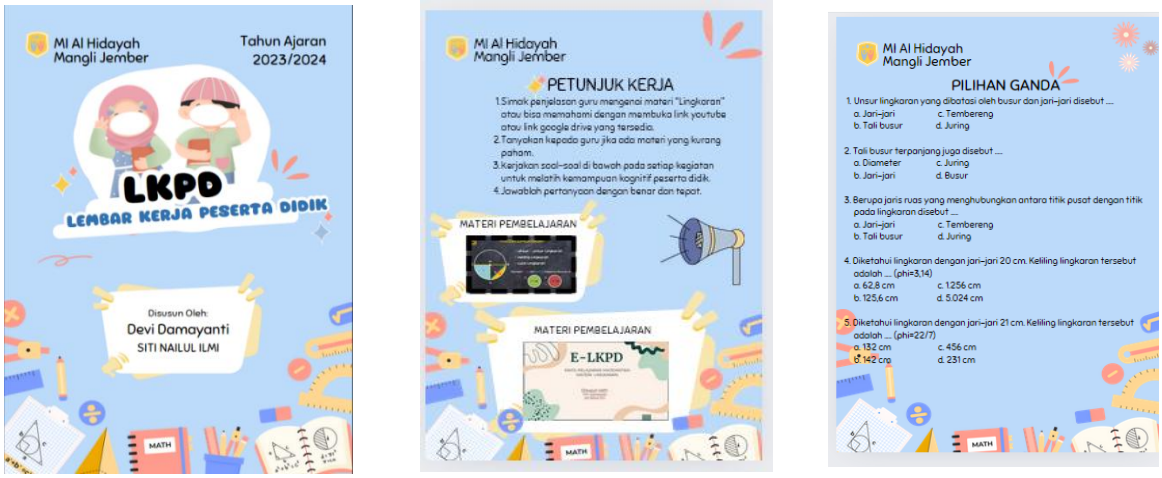

Figure 1. Initial Design of E-LKPD

At the design stage of the E-LKPD teaching materials, they are made in A4 size using Canva. The E-LKPD teaching materials are created in A4 size using Canva during the design stage. The front design of the worksheet includes a title section labeled "E-LKPD," followed by sections for instructions, materials, and evaluations. The evaluation section consists of various questions, including 10 multiple-choice questions, five fill-in-the-blank questions, five matching questions with arrows, five sliding-scale questions, five questions where students select the correct answer, and five listening comprehension questions. This design ensures that the E-LKPD is interactive and comprehensive, addressing student engagement and assessment.

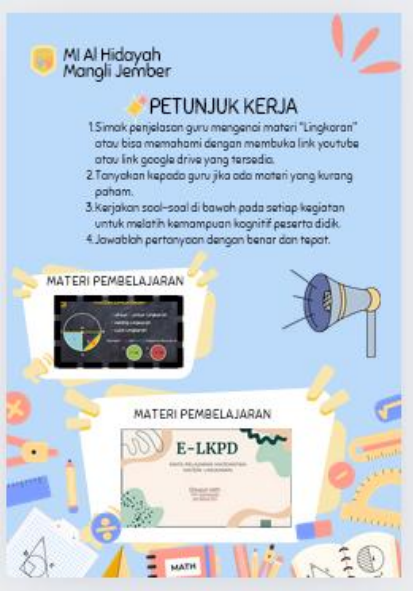

Figure 2. Instructions for E-LKPD Game based on Liveworksheet

There are material guides and work instructions in developing this E-LKPD; this is done to make it easier for students to understand when playing and the learning goals are achieved. The material work instructions are listed on the E-LKPD with a color design, pictures, and decryptions. The game instructions are designed using Canva to be most attractive and possibly to make it easier for users. At the validity test stage of developing E-LKPD teaching materials, the following scores were obtained and displayed in Table 3.

Table 3. Results of the validation questionnaire

No	Validators	Percentage	Criteria
1.	Media Members	92%	Highly Valid
2.	Material Expert	89%	Highly Valid
3.	Linguist	90%	Highly Valid
Average Score		90%	Highly Valid

The data presented above were obtained from expert validation, with media experts assigning a score of 92%, material experts scoring 89%, and learning experts scoring 90%. The overall average score of 90% places the E-LKPD in the "very valid" category, indicating that it is suitable for field testing. This suggests that the live worksheet-based E-LKPD is feasible in educational settings. Further development of the media will be informed by the feedback and suggestions from the validator lecturers, which will serve as a basis for revising and refining the media product.

Implementation

During the implementation stage, a trial was conducted after the E-LKPD teaching materials had been validated and revised by a team of media and material experts. This trial took place in Grade VI at MI Al Hidayah Mangli Jember, involving 30 students. The purpose of the trial was to assess the responses of both teachers and students regarding the live worksheet-based E-LKPD. The results of these responses are presented in Table 4.

Table 4. Results of Teacher and Student Response Questionnaire

No	Response Questionnaire	Percentage	Criterion
1.	Teacher's Response	90%	Highly Valid
2.	Student Response	91%	Highly Valid
Average Score		90%	Highly Valid

The teacher and student response questionnaire analysis reveals that the teacher's responses scored 90%, indicating strong agreement. In comparison, the students' responses averaged 91%, also falling into the category of strongly agreeing. The combined average score of 90% further confirms the strong support for the live worksheet-based E-LKPD. These results demonstrate that the E-LKPD is highly engaging, particularly for teaching Circle material. Additionally, the E-LKPD's accessibility, as anyone with the link can access it, makes it a practical tool for learning, available anytime and anywhere.

Evaluation

In the final stage of the ADDIE research model, the researcher evaluated to assess the quality of the developed E-LKPD. The results from the trial, conducted with Grade VI students at MI Al Hidayah Mangli Jember, showed positive outcomes based on student and teacher responses. These results indicate that developing the E-LKPD, using a scientific approach to teaching Circle materials, effectively increased student interest in learning. The findings suggest that the media significantly impacted the learning process, particularly in engaging students with the Circle material.

Table 5. Results of Revision of E-LKPD Teaching Materials

No	Revised Point	Before Revision	After Revision
1	Use images that have Islamic nuances		

Several suggestions were gathered from teachers and students during the evaluation stage. These inputs were used to refine and enhance the product. The high student interest reflects the positive evaluation of the live worksheet-based E-LKPD. Based on feedback from Grade VI students, one suggestion was to enlarge the size of the game instructions to improve readability. Media experts recommended adjusting the images to make them more visually appealing and engaging for users. Additionally, the size of the product was increased for better clarity, and lamination was added to improve its durability. The image above illustrates the changes made to the image section of the E-LKPD, where images with Islamic nuances were used to better align with the cultural context of the content. These revisions are summarized in Table 5.

Table 6. Results of Revision of E-LKPD Teaching Materials

No.	Revised Point	Before Revision	After Revision
1.	Use colors that do not clash with the writing.		

Table 6. presents the results of revisions made to the E-LKPD teaching materials, specifically focusing on color adjustments. The revised point, "Use colors that do not clash with the writing," is illustrated by the before-and-after images of the teaching material. Before the revision, the colors used in the material did not align well with the text, potentially causing readability issues. After the revision, the color scheme was changed to one that better complements the writing, with more visually appealing colors appropriate for the target audience. This change was made based on feedback that the research institute is predominantly populated by women, prompting the use of colors that are more popular and culturally appropriate for them. This adaptation enhances readability and makes the E-LKPD more engaging for its intended users, aligning with their preferences and the context of use.

Discussion

This research aims to develop *a live worksheet-based E-LKPD* product using the Research and Development (R&D) approach. This product is expected to increase student engagement in mathematics learning, especially circle material, with a more interactive approach to student needs. This discussion will discuss the results of each stage of product development and how these products meet the research objectives. In the initial development stage, the E-LKPD product is designed with the needs of students and the applicable curriculum in mind. The design process involves creating materials tailored to students' learning characteristics based on interviews with teachers and students at MI Al-Hidayah Mangli. The results of the interviews revealed that students felt bored with monotonous learning methods, such as the use of posters and textbooks. Therefore, the developed E-LKPD integrates multimedia elements to increase student engagement.

At the expert validation stage, E-LKPD products are tested by media experts, subject matter experts, and linguists. Based on the validation results, the product obtained an average score of 90%, which is very valid. This shows that this product has met the expected standards and meets mathematics learning needs, especially circle material. This validation aligns with the findings noted by Moktadir et al. (2020), who stated that expert validation is a crucial step in ensuring the quality of R&D products. In addition, the size of the in-game instructions has also been enlarged to improve readability. These changes are based on expert advice and feedback from students who suggest that colors and images be more attractive and in line with their preferences. This is in line with research by Kestin and Miller (2022), which shows that engaging visual elements can increase student engagement in learning materials.

The product was tested in class VI of MI Al-Hidayah Mangli Jember at the limited trial stage, involving 30 students. The trial results showed that 90% of students responded positively to the live worksheet-based E-LKPD. These results show that the product successfully engages students and provides a more interactive learning experience than traditional learning methods. This data supports the findings of Winarno et al. (2021), who state that multimedia-based teaching materials are more effective in improving student engagement and learning outcomes. Field trials show that using live worksheet-based E-LKPD has successfully improved student learning outcomes. The test results showed a significant increase in pretest and post-test scores, with the average post-test score being 15% higher than the pretest. The t-paired samples showed that this difference was significant ($p < 0.05$), with a large size effect (Cohen's $d = 0.8$). These results indicate that the E-LKPD product increases student engagement and contributes to an improved understanding of math material, especially circle material.

Compared to existing products or approaches, live worksheet-based E-LKPD offers innovation by integrating engaging multimedia elements like images, videos, and hyperlinks. This approach is more dynamic, flexible, and in line with the characteristics of students who prefer technology-based learning. The R&D approach allows for the development of products that are more suited to the needs of users, which is reflected in the success of these products in meeting the needs of students who prefer interactive methods (McDonagh et al., 2021; Zhan et al., 2020; Zheng et al., 2020).

This research makes a significant contribution to mathematics learning innovation by developing an interactive live worksheet-based E-LKPD product according to the needs of students. The findings show that this product successfully increases student engagement in the learning process and improves their learning outcomes, particularly in the circle material. Product trials show that live worksheet-based E-LKPD improves student understanding through engaging and interactive multimedia elements. These results align with constructivist theories that emphasize the importance of students' active involvement in learning. The advantage of this product lies in its ability to adapt to the learning preferences of students who prefer technology-based methods. In the future, this product can be further developed to reach a wider audience and improve its accessibility, especially in areas with limited technology infrastructure. This development is expected to impact educational practices in the future positively.

CONCLUSION

This study addressed the challenge of improving student engagement and learning outcomes in mathematics, particularly in teaching Circle materials. Developing and implementing an E-LKPD based on live worksheets showed promising results in increasing student interest and enhancing their understanding of the topic. Key findings indicate that incorporating multimedia and interactive elements effectively captured students' attention, providing a dynamic learning experience. The feedback from teachers and students highlighted the engaging nature of the product, confirming its relevance and practical application in contemporary classrooms. These results suggest integrating interactive learning tools can significantly improve student participation, particularly in traditionally perceived complex subjects. Future research could explore the long-term impact of such tools on academic performance across different subjects and educational levels. Further development of these tools, focusing on accessibility and scalability, could expand their use in diverse educational settings, ultimately enriching the learning experience.

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REFERENCES

AlGerafi, M. A. M., Zhou, Y., Oubibi, M., & Wijaya, T. T. (2023). Unlocking the Potential: A Comprehensive Evaluation of Augmented Reality and Virtual Reality in Education. *Electronics (Switzerland), 12*(18), 3953. https://doi.org/10.3390/electronics12183953

Barrot, J. S., Llenares, I. I., & Del Rosario, L. S. (2021). Students' Online Learning Challenges During the Pandemic and How They Cope with Them: The Case of the Philippines. *Education and Information Technologies, 26*(6), 7321–7338. https://doi.org/10.1007/s10639-021-10589-x

Bellens, K., Van Den Noortgate, W., & Van Damme, J. (2020). The Informed Choice: Mathematics Textbook Assessment in Light of Educational Freedom, Effectiveness, and Improvement in Primary Education. *School Effectiveness and School Improvement, 31*(2), 192–211. https://doi.org/10.1080/09243453.2019.1642215

Buschle, C., Reiter, H., & Bethmann, A. (2022). The Qualitative Pretest Interview for Questionnaire Development: Outline of Programme and Practice. *Quality and Quantity, 56*(2), 823–842. https://doi.org/10.1007/s11135-021-01156-0

Chen, Y., Jensen, S., Albert, L. J., Gupta, S., & Lee, T. (2023). Artificial Intelligence (AI) Student Assistants in the Classroom: Designing Chatbots to Support Student Success. *Information Systems Frontiers, 25*(1), 161–182. https://doi.org/10.1007/s10796-022-10291-4

Darling-Hammond, L., Flook, L., Cook-Harvey, C., Barron, B., & Osher, D. (2020). Implications for Educational Practice of the Science of Learning and Development. *Applied Developmental Science, 24*(2), 97–140. https://doi.org/10.1080/10888691.2018.1537791

El-Sabagh, H. A. (2021). Adaptive E-Learning Environment Based on Learning Styles and Its Impact on Development Students' Engagement. *International Journal of Educational Technology in Higher Education, 18*(1), 53. https://doi.org/10.1186/s41239-021-00289-4

Gkrimpizi, T., Peristeras, V., & Magnisalis, I. (2023). Classification of Barriers to Digital Transformation in Higher Education Institutions: Systematic Literature Review. *Education Sciences, 13*(7), 746. https://doi.org/10.3390/educsci13070746

Gogo, S., & Musonda, I. (2022). The Use of the Exploratory Sequential Approach in Mixed-Method Research: A Case of Contextual Top Leadership Interventions in Construction H&S. *International Journal of Environmental Research and Public Health, 19*(12), 7276. https://doi.org/10.3390/ijerph19127276

Jäder, J., Lithner, J., & Sidenvall, J. (2020). Mathematical Problem Solving in Textbooks from Twelve Countries. *International Journal of Mathematical Education in Science and Technology, 51*(7), 1120–1136. https://doi.org/10.1080/0020739X.2019.1656826

Kestin, G., & Miller, K. (2022). Harnessing Active Engagement in Educational Videos: Enhanced Visuals and Embedded Questions. *Physical Review Physics Education Research, 18*(1), 10148. https://doi.org/10.1103/PhysRevPhysEducRes.18.010148

Lo, C. K., & Hew, K. F. (2020). A Comparison of Flipped Learning with Gamification, Traditional Learning, and Online Independent Study: The Effects on Students' Mathematics Achievement and Cognitive Engagement. *Interactive Learning Environments, 28*(4), 464–481. https://doi.org/10.1080/10494820.2018.1541910

Lucas, M. (2020). External Barriers Affecting the Successful Implementation of Mobile Educational Interventions. *Computers in Human Behavior, 107*, 105509. https://doi.org/10.1016/j.chb.2018.05.001

Maćkowski, M., Żabka, M., Kempa, W., Rojewska, K., & Spinczyk, D. (2022). Computer Aided Math Learning as a Tool to Assess and Increase Motivation in Learning Math by Visually Impaired Students. *Disability and Rehabilitation: Assistive Technology, 17*(5), 559–569. https://doi.org/10.1080/17483107.2020.1800116

Matuk, C., Hurwich, T., Spiegel, A., & Diamond, J. (2021). How Do Teachers Use Comics to Promote Engagement, Equity, and Diversity in Science Classrooms? *Research in Science Education, 51*(3), 685–732. https://doi.org/10.1007/s11165-018-9814-8

McDonagh, J. L., Swope, W. C., Anderson, R. L., Johnston, M. A., & Bray, D. J. (2021). What Can Digitisation Do for Formulated Product Innovation and Development? *Polymer International, 70*(3), 248–255. https://doi.org/10.1002/pi.6056

Moktadir, M. A., Kumar, A., Ali, S. M., Paul, S. K., Sultana, R., & Rezaei, J. (2020). Critical Success Factors for a Circular Economy: Implications for Business Strategy and the Environment. *Business Strategy and the Environment, 29*(8), 3611–3635. https://doi.org/10.1002/bse.2600

Onyema, E. M., Eucheria, N. C., Obafemi, F. A., Sen, S., Atonye, F. G., Sharma, A., & Alsayed, A. O. (2020). Impact of Coronavirus Pandemic on Education. *Journal of Education and Practice, 11*(13), 108–121. https://doi.org/10.7176/jep/11-13-12

Otieno, H., & Povey, H. (2023). Mathematics Textbooks and Self-Regulated Learning: Responses from Students in Three Kenyan Secondary Schools. *Research in Mathematics Education, 25*(3), 342–358. https://doi.org/10.1080/14794802.2022.2089907

Pan, S. C., & Carpenter, S. K. (2023). Prequestioning and Pretesting Effects: A Review of Empirical Research, Theoretical Perspectives, and Implications for Educational Practice. *Educational Psychology Review, 35*(4), 97. https://doi.org/10.1007/s10648-023-09814-5

Sedrakyan, G., Malmberg, J., Verbert, K., Järvelä, S., & Kirschner, P. A. (2020). Linking Learning Behavior Analytics and Learning Science Concepts: Designing a Learning Analytics Dashboard for Feedback to Support Learning Regulation. *Computers in Human Behavior, 107*, 105512. https://doi.org/10.1016/j.chb.2018.05.004

Spatioti, A. G., Kazanidis, I., & Pange, J. (2022). A Comparative Study of the ADDIE Instructional Design Model in Distance Education. *Information (Switzerland), 13*(9), 402. https://doi.org/10.3390/info13090402

St. Marie, B., Jimmerson, A., Perkhounkova, Y., & Herr, K. (2021). Developing and Establishing Content Validity of Vignettes for Health Care Education and Research. *Western Journal of Nursing Research, 43*(7), 677–685. https://doi.org/10.1177/0193945920969693

Tu, J. C., Zhang, X., & Zhang, X. Y. (2021). Basic Courses of Design Major Based on the ADDIE Model: Shed Light on Response to Social Trends and Needs. *Sustainability (Switzerland), 13*(8), 4414. https://doi.org/10.3390/su13084414

Ullah, A., & Anwar, S. (2020). The Effective Use of Information Technology and Interactive Activities to Improve Learner Engagement. *Education Sciences, 10*(12), 1–20. https://doi.org/10.3390/educsci10120349

Wahira, Ansar, & Tolla, I. (2023). Analysis of the Needs for Developing the Competence of Elementary School Supervisors Through Analysis Design Development Implementation Evaluation (ADDIE) Model. *Kasetsart Journal of Social Sciences, 44*(4), 1303–1312. https://doi.org/10.34044/j.kjss.2023.44.4.34

Winarno, S., Andono, P. N., Muthu, K. S., & Ling, L. S. (2021). The Effectiveness of mDPBL as a Multimedia-Based Learning Approach. *Cypriot Journal of Educational Sciences, 16*(6), 2946–2955. https://doi.org/10.18844/cjes.v16i6.6479

Zhan, Y., Tan, K. H., Chung, L., Chen, L., & Xing, X. (2020). Leveraging Social Media in New Product Development: Organisational Learning Processes, Mechanisms and Evidence from China. *International Journal of Operations and Production Management, 40*(5), 671–695. https://doi.org/10.1108/IJOPM-04-2019-0318

Zhang, Q., Sun, J., & Yeung, W. Ying. (2023). Effects of Using Picture Books in Mathematics Teaching and Learning: A Systematic Literature Review from 2000–2022. *Review of Education, 11*(1), e3383. https://doi.org/10.1002/rev3.3383

Zheng, P., Xu, X., & Chen, C. H. (2020). A Data-Driven Cyber-Physical Approach for Personalised Smart, Connected Product Co-Development in a Cloud-Based Environment. *Journal of Intelligent Manufacturing, 31*(1), 3–18. https://doi.org/10.1007/s10845-018-1430-y