JPPIPA 10(10) (2024)

Jurnal Penelitian Pendidikan IPA

Journal of Research in Science Education

http://jppipa.unram.ac.id/index.php/jppipa/index

Development of E-LKPD Based on 7E Learning Cycle to Stimulus Students' Complex Problem-Solving and Self-Efficacy

Amelia Yuni Saputri[1], Agus Suyatna[1*], Abdurrahman[1]

[1] Master of Physics Education, Lampung University, Lampung, Indonesia.

Received: April 26, 2024
Revised: July 12, 2024
Accepted: October 25, 2024
Published: October 31, 2024

Corresponding Author:
Agus Suyatna
asuyatna@yahoo.com

DOI: 10.29303/jppipa.v10i10.7506

Abstract: The research conducted aims to describe e-LKPD based on the 7E learning cycle that is valid, practical, and effective in stimulating complex problem-solving (CPS) and student self-efficacy (SE). The research method used is Design and Development Research (DDR) consisting of analysis, design, development, and evaluation. After the e-LKPD was designed based on the results of an analysis of teacher and student needs, a product feasibility test was carried out with three experts and obtained valid results in aspects of media and design, content, and construction. Furthermore, the e-LKPD was tested for practicality with aspects of learning implementation, readability tests, and student responses which obtained very practical results. Furthermore, the effectiveness test using the N-Gain test, difference test, and paired test showed that there was a significant difference in the increase in CPS and SE in the experimental class and the control class and there was a significant increase in CPS and SE in the experimental class which was categorized as quite effective. Therefore, the e-LKPD based on the 7E learning cycle that has been developed has obtained valid, practical, and effective results for stimulating students' CPS and SE.

Keywords: Complex problem solving; E-LKPD; Learning cyle 7E; Self efficacy

Introduction

In the 21st century, the world is faced with an increasingly complex environment that requires various problems to be solved (Schefer-Wenzl & Miladinovic, 2019). Minimally complex systems have been introduced in the context of the challenges of large-scale assessments, such as PISA which measures new aspects of problem-solving, namely interactive problems (Greiff & Funke, 2017). Complex problem-solving is seen as a 21st-century skill that has attracted interest in PISA (Herde et al., 2016). Complex problem-solving is one of the important competencies needed in the future including in the field of education (Eichmann et al., 2019; Häkkinen et al., 2017). Currently, students' complex problem-solving skills are still relatively low. The low level of students' complex problem-solving skills can be seen from the results of the PISA 2018 study which shows that Indonesia is ranked 67th out of 74 countries with a score of 396 (OECD, 2019). This result is a benchmark for students' complex problem-solving skills because the question items have the same characteristics as problem-solving questions (Nahdi, 2018). Complex problem-solving is an interactive process that provides empirical access to detailed investigations (Eichmann et al., 2019; Thomann et al., 2019). The dimensions of complex problem-solving are: articulating the problem, identifying the desired result, brainstorming creative options, analyzing and selecting the option that best achieves, developing a plan of action that will achieve the desired result, and enacting the plan of action and adapting as needed.

Apart from complex problem-solving skills, the most important thing in students is self-efficacy. Student self-efficacy in Indonesia is still categorized as low. This is relevant to Muslimah et al. (2021) research at Putra Juang High School that students' self-efficacy is still relatively low. This is also supported by the results of

How to Cite:
Saputri, A. Y., Suyatna, A., & Abdurrahman. (2024). Development of E-LKPD Based on 7E Learning Cycle to Stimulus Students' Complex Problem-Solving and Self-Efficacy. *Jurnal Penelitian Pendidikan IPA*, *10*(10), 7313–7321. https://doi.org/10.29303/jppipa.v10i10.7506

initial research that some of the 76 high school students in Lampung are still not confident when solving physics problems. Learning innovation can be done by choosing an innovative effective and appropriate learning model to improve self-efficacy (Amalya et al., 2021; Hasbie et al., 2023).

Increasing complex problem-solving and self-efficacy can be supported by treatment in the learning process. Increasing complex problem-solving abilities can be obtained through implementing learning models that guide in solving problems (Stadler et al., 2015). One learning model that has the potential to improve complex problem-solving and self-efficacy is the 7E learning cycle. The learning cycle is an innovative learning model that can facilitate students constructing their knowledge so that it can improve students' problem-solving abilities (Utami et al., 2022). Learning using the learning cycle can make students active in class, where students have the opportunity to analyze independently by connecting concepts, details, models, and applications to the material they study (Jack, 2017). The 7E learning cycle model can be integrated into teaching materials. One of these teaching materials is the Student Worksheet (LKPD).

Worksheets are used for learning support purposes, assisting active learning, and increasing interest in learning and assessment. It is hoped that the LKPD can support students' process of understanding the material being studied (Lee, 2014). Apart from that, LKPD is one of the materials that are relatively often used by teachers. From the results of the initial research, it is known that 54 students out of 76 students used LKPD during the learning process. Teaching materials based on the 7E learning cycle can make students active and focused on learning (Yuliana et al., 2020). Apart from that, it is supported by research by Primanda et al. (2019) that worksheets based on the 7E learning cycle can improve students' understanding of concepts and physics problem-solving abilities and research by Puspita et al. (2021) that the application of the 7E learning cycle model in Senior High School is effective in aspects of student learning achievement and self-efficacy.

Student worksheets consist of two forms, namely printed and electronic. The development of LKPD in this research, namely teaching materials in electronic form known as e-LKPD. This e-LKPD helps efforts in paperless activities that are starting to be implemented in Indonesia. LKPD in electronic form is easier to access. This is supported by research by Fuadi et al. (2021) that e-LKPD can make it easier for students to study anytime and anywhere. Apart from that, e-LKPD is still needed in the context of offline learning (Suryaningsih & Nurlita, 2021).

These electronic forms of LKPD encourage teachers to package them in a form that is easily accessible to students, namely one that can be accessed using mobile devices. Technological advances have encouraged teachers and researchers to use mobile devices in teaching and learning (Zydney & Warner, 2016). One application that can be accessed on mobile devices is Flip PDF Corporate. Flip PDF Corporate is a device or application software used to create e-papers, e-LKPD, digital magazines, and e-books.

The designed e-LKPD will be packaged with the help of the Flip PDF corporate application. Flip PDF Corporate is a software that can be used to open the pages of LKPD like a book. It is known that by using Flip PDF Corporate, students will be more interested in learning because the appearance of Flip PDF Corporate is attractive. Flip PDF Corporate Professional is a type of PDF file device that can be flipped (back and forth), like a real book. Using Flip PDF Corporate professional software can load videos, images, audio, hyperlinks, and multimedia objects (Syamsudin et al., 2022). According to Syahrowardi et al. (2016), the output of this software can be HTML (using online publications), ZIP (sending via e-mail), EXE (CD sending), and 3DP (can be read via Android). e-LKPD with Flip PDF Corporate Professional software can be accessed offline (Marsim et al., 2022).

It is hoped that the Flip PDF Corporate software will make it easier for teachers to convey the material to be delivered and make it easier to obtain appropriate teaching materials so that learning objectives can be achieved effectively. No one has yet developed an e-LKPD integrated with the 7E learning cycle assisted by Flip PDF Corporate, so this research will develop an e-LKPD integrated with the 7E learning cycle model assisted by Flip PDF Corporate which is expected to help students in supporting learning material, namely Physics.

Learning Physics is still considered difficult by students. One of the materials in Physics lessons that is still considered difficult is Newton's laws of motion, due to the dominant analysis of equations in several motion systems. Newton's law is one of the materials that are difficult for students to understand, so it has an impact on solving problems related to Newton's law (Asrizal et al., 2022; Nurcahyo et al., 2017; Setyani et al., 2017), so students need learning media to help them understand Newton's Law material better (Suryaningsih et al., 2021). This follows the results of initial research that 49 out of 76 students had difficulty understanding Newton's laws of motion.

The results of the initial research show that students experience difficulties with Newton's laws of motion due to too many formulas, less interesting teaching materials, and less interesting learning media. Less attractive teaching materials can be caused by the teaching materials used are not homemade and there are no supporting media in the teaching materials. This is

supported by the results of the initial research that 13 out of 22 teachers used Newton's laws of motion LKPD at school and some students revealed that there was no supporting media for Newton's laws of motion LKPD.

Several problems on the topic of Newton's laws of motion have been explained, so learning materials are needed that can stimulate complex problem-solving and foster students' self-efficacy. One of the teaching materials that is expected to meet these needs is e-LKPD based on the 7E learning cycle. Based on problems and needs, researchers have developed a learning material through research entitled "Development of e-LKPD Based on 7E Learning Cycle to Stimulate Complex Problem Solving and Student Self-Efficacy"

Method

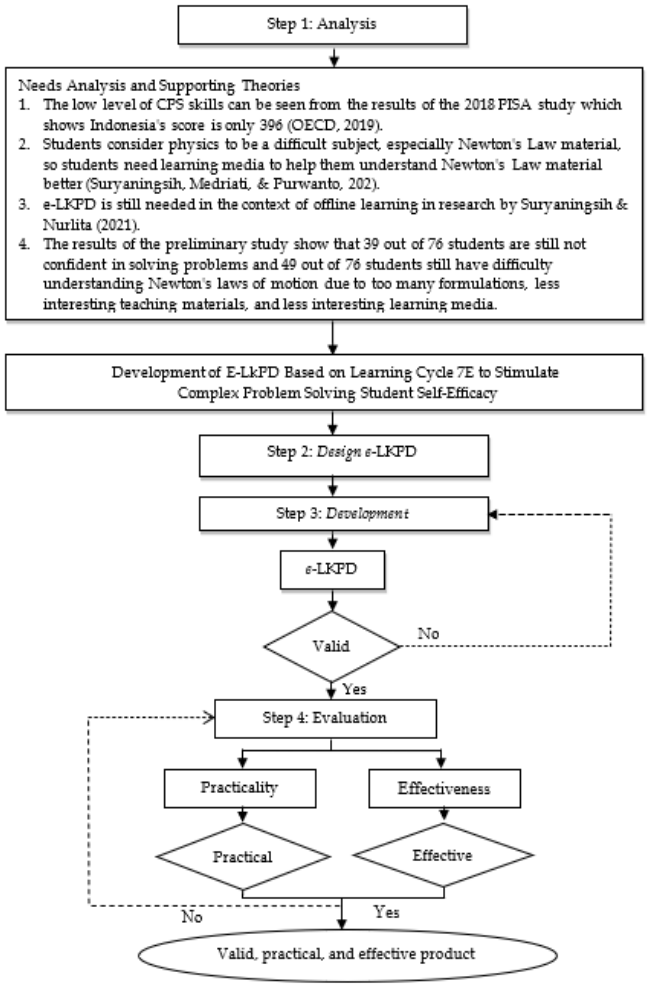

Figure 1. Product development procedures

This research developed an electronic form of LKPD based on the 7E learning cycle assisted by Flip PDF Corporate Professional to stimulate complex problem-solving and foster self-efficacy in class XI of the Merdeka Curriculum. The stages of developing e-LKPD based on the 7E learning cycle to stimulate complex problem-solving and student self-efficacy can be seen in detail in Figure 1.

The design used in this development research is Design and Development Research (DDR) which was adapted from (Richey & Klein, 2014) and consists of 4 stages, namely analysis, design, development, and evaluation. Meanwhile, the steps in research development are as follows.

Analysis Stage

The researcher conducted a needs analysis at several schools in Lampung using questionnaires given to students and teachers in classes X, XI, and XII. This needs analysis is carried out to determine the potential problems at the school. The needs analysis is related to whether the 7E learning cycle model has been implemented or not, the availability of e-LKPD regarding material on Newton's laws of motion, difficulties in learning material on Newton's laws of motion, and whether or not students have been stimulated by complex problem solving and self-efficacy in students. as well as applications used by teachers.

Design Stage

The next step is the design stage, namely designing the e-LKPD framework. The product was created based on the needs analysis that has been carried out and the indicators to be achieved, namely e-LKPD based on the 7E learning cycle to stimulate complex problem solving and grow students' self-efficacy in Newton's law material on assisted Flip PDF Corporate Edition.

Development Stage

This development stage aims to produce a revised e-LKPD based on expert input. The e-LKPD based on the 7E learning cycle that has been prepared will then be assessed by two Physics Education Masters Lecturers and one Physics Teacher who has completed the Master's Program so that it can be seen whether the e-LKPD based on the 7E learning cycle is valid or not. The results of this validation are used as material for improving the e-LKPD based on the 7E learning cycle that was developed. Product validation by reviewing three aspects, namely media, design, construction, and content.

Evaluation Stage

The evaluation stage is carried out to determine the success of the learning program product. The evaluation stage is carried out based on summative evaluation which is carried out to improve the resulting prototype. Summative evaluation is carried out to determine complex problem-solving and students' self-efficacy in using the product after field trials. e-LKPD which has been declared valid, is then carried out in a field trial to

determine the results of implementing e-LKPD based on the 7E learning cycle in classroom learning. This test was carried out to determine the practicality and effectiveness of the product being developed. Practicality data was obtained from observations of learning implementation, readability tests, and tests of student response results. validity and practicality scoring using a Likert scale.

Product effectiveness data was obtained from students' pretest and posttest scores regarding complex problem-solving on Newton's Laws of Motion material which was adopted by Weisdiyanti et al. (2023) consisting of five essay questions and a self-efficacy scale developed by Jerusalem et al. (2014) which consists of 10 statement items using a Likert scale. The research was carried out at SMAN 1 Padang Cermin in Class XI using two classes an experimental class and a control class. Data obtained from the research results were processed using SPSS by carrying out independent sample t-tests and paired sample t-tests. The stages of developing e-LKPD based on the 7E learning cycle to stimulate complex problem-solving and student self-efficacy can be seen in detail in Figure 1.

Result and Discussion

The author prepares the e-LKPD according to a predetermined design. The e-LKPD that has been developed consists of three parts. The introductory section consists of a cover, foreword, table of contents, learning outcomes, learning objectives, and study instructions. The cover contains an illustration of the material consisting of the title of the material, a picture of the application of Newton's laws of motion in everyday life, the name of the developer, the name of the supervisor, and the level and level of school. Meanwhile, the foreword, table of contents, learning outcomes, learning objectives, and study instructions are written according to the general guidelines for Indonesian spelling.

The content is grouped into three sub-materials, namely Newton's first law, Newton's second law, and Newton's third law. Each sub-material consists of 7E learning cycle activities, namely elicit, engage, explore, explain, elaborate, evaluate, and extend. 7E learning cycle leads to constructivist learning theory, where the center of the constructivist learning process according to Bada et al. (2015) is problems and collaboration. Students are directed to use their strategies in learning, while teachers guide students to a higher level of knowledge (Masgumelar & Mustafa, 2021). Therefore, the 7E learning cycle learning activities in e-LKPD can stimulate complex problem-solving and grow students' self-efficacy. An example of the content coverage in e-LKPD can be seen in Figure 2.

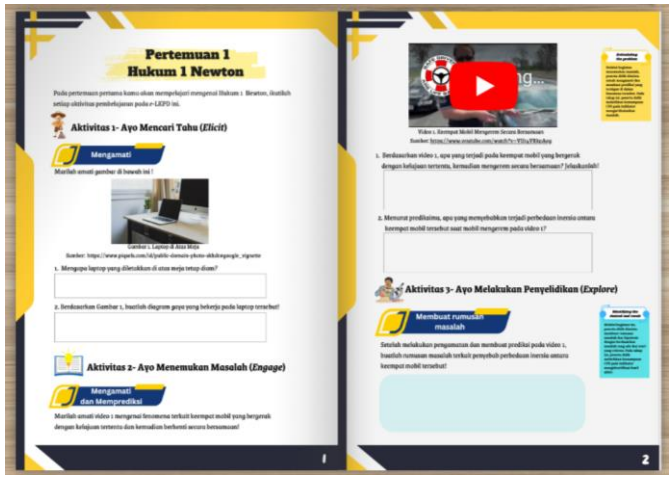

Figure 2. E-LKPD with 7E learning cycle activities

The closing part of the e-LKPD consists of a reflection that includes complex problem-solving questions about Newton's laws of motion and a self-efficacy scale. The e-LKPD that has been developed and packaged using Flip PDF media is then tested for product validity. At the validation stage, an assessment was carried out by experts consisting of two master's lecturers in physics education and one teacher who had completed a master's degree in physics education. Validation tests include validation of design and media, construct, and content. The data from the validation test results from the three experts can be seen in Table 1.

Table 1. Validity Test Results

Evaluation	Aspect	Score (%)	Average Score (%)
Design and Media	Usability	80.00	78.98
	Legibility	80.00	
	Display quality	79.92	
	Quality of e-LKPD management	76.00	
Content	Syntax	78.67	81.96
	social systems	83.33	
	Reaction principles	81.67	
	Support system	81.67	
	Companion instructional impact	84.44	
Construct	Originality	78.67	79.87
	Language	84.45	
	Design	76.48	

Based on Table 1, the average score for media and design validation is 78.98% in the valid criteria. This shows that the development of e-LKPD based on the 7E learning cycle is suitable for use in terms of media and design aspects. Based on the results of this assessment,

the e-LKPD is feasible and can be tested on students, because the appearance of the e-LKPD in terms of images and videos, as well as readability can attract students' enthusiasm for learning. This is supported by research that teaching materials can attract students' attention if the presentation of teaching materials is equipped with attractive colors and images and arouses students' interest in learning (Frisilla & Hardeli, 2022; Jayanti et al., 2015). Therefore, it is supported by Nurhidayah et al. (2021) that the selection of colors for video displays, fonts, and background colors have criteria that are easy to see.

Then, observing the content validation, the average score was 81.96% with very valid criteria. This shows that the development of e-LKPD based on the 7E learning cycle is suitable for use in terms of content aspects. The validity value of the e-LKPD obtained in the content aspect is based on several reasons, namely that the e-LKPD developed is appropriate based on student needs, such as the breadth and depth of the material, so that the e-LKPD can be used as teaching material that helps students understand Newton's Law material about motion. The LKPD is packaged with the help of Flip PDF Corporate so that it makes it easier for students to understand the lesson. These results are supported by research by Lestari et al. (2021) that almost all students like learning using the learning cycle model and Hikmawati et al. (2020) that the learning cycle model allows students to be active. Students can solve problems with their concepts.

Then, observing the construct validation, the average score was 79.87% with valid criteria. This shows that the development of e-LKPD based on the 7E learning cycle is suitable for use in terms of construct aspects. Based on the results of this assessment, the e-LKPD is feasible and can be tested on students, because the e-LKPD based on the 7E learning cycle that was developed contains several contents that make learning very interactive and interesting for students, including discussion columns and practical activities. uses stage simulation, video, animation, colors, and an attractive appearance, so that students do not get bored easily while learning. This can also create a sense of enjoyment in students during the learning process which will ultimately influence the level of complex problem solving and student self-efficacy. Apart from language rules, the most important part is creating open material. This is by research with Chatri et al. (2023) regarding language rules so that the interpretation does not create false (ambiguous) meanings and is easy for students to understand.

The practicality test was carried out through an e-LKPD readability test by providing a rating scale given to students, a learning implementation test through observations made by observers while the researcher was teaching, and a student response test by providing a rating scale given to students. The results of the practicality test data can be seen in Table 2.

Table 2. Practicality Test Results

Evaluation	Aspect	Score (%)	Average Score (%)
Test readability	e-LKPD readability	79.35	80.24
	convenience of e-LKPD	81.14	
Implement ability test	Implementation of learning	84.00	83.00
	Implementation of the social systems	85.00	
	Implementation of the reaction principle	80.00	
Test student responses	Effective	80.08	80.81
	Attractiveness	81.88	
	Efficient	79,71	
	Convenience	81.57	

Based on Table 2, the results of the analysis of the readability test results by students, a percentage result of 80.24% was obtained with the readability category being very good, meaning that this e-LKPD can be used in the learning process on Newton's Law of Gera material. The product developed is considered practical because the e-LKPD is easy to use and helps improve students' complex problem-solving and self-efficacy.

Learning implementation test carried out by one observer who is a Physics teacher who already has teaching experience. Every aspect of implementing the use of e-LKPD based on the 7E learning cycle can be implemented with an average score of 83.00% in the very good category. This means that the e-LKPD based on the 7E learning cycle used has activity steps, a question system, and reaction principles that can stimulate complex problem-solving abilities and grow students' self-efficacy. Each activity in the 7E learning cycle consisting of elicit, engage, explore, explain, elaborate, evaluate, and extend is related to each other so that learning is carried out in the order of these activities. This research found that the cycle learning model was able to increase students' activeness in analyzing and solving problems (Ardi et al., 2021).

Learning activities using e-LKPD based on the 7E learning cycle received a positive response from students. Based on Table 2, the student response scale consists of aspects of effectiveness, overall attractiveness, efficiency, and convenience obtained an average score of 80.81% and was categorized as very good. The response of students to the use of e-LKPD based on the 7E learning cycle is considered very practical, this is because, in the e-LKPD based on the 7E learning cycle, there are learning videos related to the

material or practical activities so that students more easily understand the material on Newton's Laws of motion. Students also feel comfortable using e-LKPD based on the 7E learning cycle, this can be seen from the attractive appearance of the e-LKPD, each page can be turned, there are videos of phenomena and learning, then virtual practicum activities using PhET simulation, apart from that Access to use e-LKPD based on the 7E learning cycle is very easy, namely only accessed via a link, so students are more motivated to learn. It is known that teachers with an educational background in physics and natural sciences also consider that PhET simulations are suitable for their application in science learning and that PhET simulations improve students' concepts (Primanda et al., 2019; Rahmat et al., 2023).

The effectiveness of the e-LKPD based on the learning cycle as a result of the development is seen from aspects, namely the increase in complex problem-solving abilities and students' self-efficacy before and after using the e-LKPD. The effectiveness test used two classes consisting of a control class (conventional learning) and an experimental class (7E learning cycle learning) which was carried out at SMA Negeri 1 Padang Cermin. The results of N-Gain complex problem-solving and self-efficacy in the experimental and control classes can be seen in Table 3.

Table 3. Results of N-Gain

Variable	Class	N-gain
Complex problem solving	Control class	42.00%
	Experimental class	56.00%
Self-efficacy	Control class	46.00%
	Experimental class	60.00%

The results of the students' N-Gain complex problem-solving test showed a higher increase in the experimental class compared to the control class with a difference of 14.00% and students' N-Gain self-efficacy showed a higher increase in the experimental class compared to the control class with a difference of 14.00%. Based on Table 3, it is known that the experimental class obtained N-Gain complex problem solving of 56.00% which was categorized as effective and self-efficacy of 60.00% which was categorized as effective. The results of increasing complex problem-solving and student self-efficacy can be seen from the results of paired tests with normal data, namely the paired sample t-test. The results of the paired tests can be seen in Table 4.

Table 4. Paired Test Results

Variable	Sig.
Complex problem solving	0.000
Self-efficacy	0.000

Based on the results in Table 4, it is known that students' complex problem-solving has a significant difference between the pretest and posttest with the sig value < 0.05. The complex problem-solving results were followed by significant self-efficacy results between self-efficacy before and after learning with a sig value < 0.05. Learning innovation can be done by choosing an innovative effective and appropriate learning model to improve self-efficacy (Amalya et al., 2021; Hasbie et al., 2023).The results of this research show that the 7E learning cycle can increase self-efficacy.

The learning that has been implemented is based on the 7E learning cycle, where students find and investigate problems with application activities, making students challenged and growing students self-efficacy in solving problems with Newton's laws of motion. This is supported by research by Sritresna (2018) and Yuliana et al. (2020) that the learning cycle learning model makes students active in learning so that students can develop knowledge optimally in learning.

The 7E learning cycle learning model which is integrated into electronic LKPD makes it easier for students to access the available videos. This is to research by Diani et al. (2023) and Utami (2021) that e-LKPD will make learning easier for students because it is practical and presented in an interesting way which can increase enthusiasm for learning. One of the learning activities in the 7E learning cycle, namely exploring, can be seen in Figure 3.

Figure 3. 7E Learning cycle activities

Data on N-Gain complex problem-solving and self-efficacy in the experimental and control classes were normally distributed, so the N-Gain difference test was carried out using a parametric test, namely the independent sample t-test. The 2-tailed sig results on the different tests of complex problem-solving and self-efficacy can be seen in Table 5.

Table 5. Test The Difference Between Two Groups

Variable	Sig.
Complex problem solving	0.000
Self-efficacy	0.001

The statistical test results obtained in Table 5 show that there is a difference in the average N-Gain complex problem-solving and self-efficacy of students in the experimental and control classes. This means that the e-LKPD based on the 7E learning cycle that was developed is effective in stimulating complex problem-solving and fostering student self-efficacy. The results of this research are supported by the results of research conducted by Primanda et al. (2019) and Fatih et al. (2020) that a worksheet based on the 7E learning cycle is effective and practical in increasing students' problem-solving abilities and Puspita & Fardillah (2021) that the 7E learning cycle learning model is effective in improving students' self-efficacy.

Conclusion

Based on the results and discussions related to the development of e-LKPD based on the 7E learning cycle that has been carried out, it can be concluded that the e-LKPD that has been designed according to the results of the analysis has been tested for validity in terms of media and design, content and construct aspects. Valid results were obtained from the three experts. Furthermore, the e-LKPD was tested for practicality in terms of learning implementation, readability, and student responses, and obtained very practical results. Apart from that, the results of effectiveness tests have been carried out at SMAN 1 Padang Cermin using the N-Gain test, difference test, and paired test. The test results showed a significant difference in the increase in complex problem-solving and student self-efficacy between the experimental class and the control class and there was a significant difference in the increase in complex problem-solving and self-efficacy in the experimental class which was categorized as quite effective. Therefore, these three test results show that the e-LKPD based on the 7E learning cycle that has been developed is valid, practical, and effective for stimulating complex problem-solving and student self-efficacy.

Acknowledgments
The researcher would like to thank all parties who participated in this research, validators, heads of SMAN 1 Padang Cermin, and peers of the master program of physics education at Lampung State University who assisted in completing this research until this article was fixed.

Author Contributions
Conceptualization, A. Y. S, A. S, A. A.; methodology, A. Y. S, A. S, A. A.; investigation, A. Y. S.; writing-original draft preparation, A. Y. S.; writing-review and editing, A. S, A. A.; All authors have read and agreed to the published version of the manuscript.

Funding
This research received no external funding.

Conflicts of Interest
The authors declare no conflict of interest.

References

Amalya, C. P., Artika, W., Safrida, S., Nurmaliah, C., Muhibbuddin, M., & Syukri, M. (2021). Implementation of the problem base learning model combined with e-stem based student worksheets on learning outcomes and self efficacy on environmental pollution materials. *Jurnal Penelitian Pendidikan IPA*, *7*(SpecialIssue), 37–38. https://doi.org/10.29303/jppipa.v7iSpecialIssue.962.

Ardi, Y. M., Vauzia, V., Razak, A., & Syamsurizal. (2021). The Effect of using the student academic ability-problem solving and 5E cycle learning models on the student learning outcomes. *Jurnal Penelitian Pendidikan IPA*, *7*(4), 607–611. https://doi.org/10.29303/jppipa.v7i4.77.

Asrizal, A., Ayu, D. F., Mardian, V., & Festiyed, F. (2022). Electronic learning material of newton's laws with kvisoft flipbook maker to improve learning outcomes of students. *Jurnal Penelitian Pendidikan IPA*, *8*(2), 489–498. https://doi.org/10.29303/jppipa.v8i2.1222.

Bada, & Olusegun, S. (2015). Constructivism learning theory: A paradigm for teaching and learning. journal of research & method in education. *Journal of Research & Method in Education*, *5*(6), 66–70. https://doi.org/10.9790/7388-05616670.

Chatri, M., Zalni, T. Y., Zalni, I., & Fajrina, S. (2023). Development of discovery learning based e-modules on animalia and ecosystem materials for class x high school students. *Jurnal Penelitian Pendidikan IPA*, *9*(11), 9729–9737. https://doi.org/10.29303/jppipa.v9i11.4789

Diani, D. R., Nurhayati, N., & Suhendi, D. (2023). Pengembangan lembar kerja peserta didik (LKPD) menulis cerpen berbasis aplikasi android. *Jurnal Bahasa, Sastra, dan Pengajarannya*, *7*(2), 1–13. https://doi.org/10.20961/basastra.v7i2.37800.

Eichmann, B., Goldhammer, F., Greiff, S., Pucite, L., & Naumann, J. (2019). The role of planning in complex problem solving. *Computers & Education*,

128, 1–12. https://doi.org/10.1016/j.compedu.2018.08.004.

Fatih, F. D., Suharini, E., & Sanjoto, T. B. (2020). Self-regulation and problem solving ability on geography basic knowledge materials using the 7e-learning cycle model. *Proceedings of the International Conference on Science and Education and Technology (ISET 2019)*, *443*. https://doi.org/10.2991/assehr.k.200620.045.

Frisilla, S., & Hardeli, H. (2022). Validity and practicality of chemical equilibrium electronic student worksheets based on guided discovery learning to increase the critical thinking ability. *Jurnal Penelitian Pendidikan IPA*, *8*(3), 1191–1198. https://doi.org/10.29303/jppipa.v8i3.1481.

Fuadi, H., Melita, A. S., Siswadi, S., Jamaluddin, J., & Syukur, A. (2021). Inovasi LKPD dengan desains digital sebagai media pembelajaran ipa di smpn 7 mataram pada masa pandemi covid-19. *Jurnal Ilmiah Profesi Pendidikan*, *6*(2), 167–174. https://doi.org/10.29303/jipp.v6i2.184.

Greiff, S., & Funke, J. (2017). Interactive problem solving: Exploring the potential of minimal complex systems. In *The Nature of Problem Solving: Using Research to Inspire 21st Century Learning* (pp.93-105). Paris: OECD Publishing.

Häkkinen, P., Järvelä, S., Mäkitalo-Siegl, K., Ahonen, A., Näykki, P., & Valtonen, T. (2017). Preparing teacher-students for twenty-first-century learning practices (PREP 21): A framework for enhancing collaborative problem-solving and strategic learning skills. *Teachers and Teaching*, *23*(1), 25–41. https://doi.org/10.1080/13540602.2016.1203772.

Hasbie, M., Abdullah, A., Rusmansyah, R., Aufa, M. N., Fitri, M. A., Saputra, M. A., & Hairunnisa, H. (2023). Development of science module on the topic of interaction of living things and the environment using the scientific critical thinking (sct) model to improve critical thinking ability and self-efficacy. *Jurnal Penelitian Pendidikan IPA*, *9*(3), 1348–1351. https://doi.org/10.29303/jppipa.v9i3.2458.

Herde, C. N., Wüstenberg, S., & Greiff, S. (2016). Assessment of complex problem solving: What we know and what we don't know. *Applied Measurement in Education*, *29*(4), 265–277. https://doi.org/10.1080/08957347.2016.1209208.

Hikmawati, H., Suastra, I. W., & Pujani, N. M. (2020). Ethnoscience-based science learning model to develop critical thinking ability and local cultural concern for junior high school students in lombok. *Jurnal Penelitian Pendidikan IPA*, *7*(1), 60–66. https://doi.org/10.29303/jppipa.v7i1.530.

Jack, G. U. (2017). The effect of learning cycle constructivist-based approach on students' academic achievement and attitude towards chemistry in secondary schools in north-eastern part of nigeria. *Educational Research and Reviews*, *12*(7), 456–466. https://doi.org/10.5897/ERR2016.3095.

Jayanti, M. I., Jufri, A. W., & Ramdani, A. (2015). Pengembangan perangkat model pembelajaran kuantum berbasis masalah dengan pendekatan saintifik. *Jurnal Penelitian Pendidikan IPA*, *1*(2). https://doi.org/10.29303/jppipa.v1i2.15.

Jerusalem, M., & Schwarzer, R. (2014). Self-efficacy as a resource factor in stress appraisal processes. *In Self-Efficacy* (pp. 195-214). Taylor & Francis.

Lee, C.-D. (2014). Worksheet usage, reading achievement, classes' lack of readiness, and science achievement: A cross-country comparison. *International Journal of Education in Mathematics, Science and Technology*, *2*(2). https://doi.org/10.18404/ijemst.38331.

Lestari, H., Rahmawati, I., Siskandar, R., & Dafenta, H. (2021). Implementation of blended learning with a stem approach to improve student scientific literacy skills during the covid-19 pandemic. *Jurnal Penelitian Pendidikan IPA*, *7*(2), 224–231. https://doi.org/10.29303/jppipa.v7i2.654.

Marsim, F., Danial, M., & Syahrir, M. (2022). Pengembangan e-LKPD berbasis problem solving pada materi titrasi asam basa untuk meningkatkan motivasi dan hasil belajar peserta didik. *Chemistry Education Review (CER)*, *5*(2), 120. https://doi.org/10.26858/cer.v5i2.32718.

Masgumelar, N. K., & Mustafa, P. S. (2021). Teori belajar konstruktivisme dan implikasinya dalam pendidikan dan pembelajaran. *Ghaitsa*, *2*(1), 49–57. https://doi.org/10.621 59/ghaitsa.v2i1.188.

Muslimah, N., Putra, R. W. Y., & Masykur, R. (2021). Pengaruh model pembelajaran student facilitator and explaining (SFAE) untuk meningkatkan kemampuan pemahaman konsep matematis dan self-confidence siswa. *Maju: Jurnal Ilmiah Guruan Matematika*, *8*(1), 49–59. https://doi.org/10.30998/fjjk.v9i3.14504.

Nahdi, D. S. (2018). Eksperimentasi model problem based learning dan model duided discovery learning terhadap kemampuan pemecahan masalah matematis ditinjau dari self efficacy siswa. *Jurnal Cakrawala Pendas*, *4*(1), 50–56. http://dx.doi.org/10.31949/jcp.v4i1.711.

Nurcahyo, A. W., Wartono, W., & Yuliati, L. (2017). Kemampuan pemecahan masalah hukum gerak newton mahasiswa melalui pembelajaran cooperative problem solving. *Jurnal Pendidikan: Teori, Penelitian, Dan Pengembangan*, *2*(7), 963–970. https://doi.org/10.17977/jptpp.v2i7.9686.

Nurhidayah, N., Jumaeri, J., & Susilaningsih, E. (2021). Development of video based on pop up questions integrated religious character human digestive system materials. *Jurnal Penelitian Pendidikan IPA*, *7*(SpecialIssue), 250–255. https://doi.org/10.29303/jppipa.v7iSpecialIssue.1055.

OECD. (2019). *PISA 2018 Result: What Students Know And Can Do*. Paris: OECD Publishing.

Primanda, A., Distrik, I. W., & Abdurrahman, A. (2019). The impact of 7E learning cycle-based worksheets toward student's conceptual understanding and problem-solving ability on newton's Law of motion. *Journal of Science Education*, *19*(2), 95–106. https://doi.org/10.12691/education-8-6-1.

Puspita, W. R., & Fardillah, F. (2021). The effectiveness of the learning cycle model (5e and 7e) in learning to build flat side sides viewed from student self-eficacy. *Journal of Physics: Conference Series*, *1764*(1), 012110. https://doi.org/10.1088/17426596/1764/1/012110.

Rahmat, A. D., Kuswanto, H., & Wilujeng, I. (2023). Integrating technology into science learning in junior high school: perspective of teachers. *Jurnal Penelitian Pendidikan IPA*, *9*(5), 2391–2396. https://doi.org/10.29303/jppipa.v9i5.2922.

Richey, R. C., & Klein, J. D. (2014). Design and development research. In Handbook of Research, *Educational Communications and Technology* (pp. 141-150). New York, NY: Springer.

Schefer-Wenzl, S., & Miladinovic, I. (2019). Developing Complex problem-solving skills: an engineering perspective. *International Journal of Advanced Corporate Learning (iJAC)*, *12*(3), 82. https://doi.org/10.3991/ijac.v12i3.11067.

Setyani, N. D., Cari, C., Suparmi, S., & Handhika, J. (2017). Student's concept ability of Newton's law based on verbal and visual test. *International Journal of Science and Applied Science: Conference Series*, *1*(2), 162. https://doi.org/10.20961/ijsascs.v1i2.5144.

Sritresna, T. (2018). Meningkatkan kemampuan komunikasi matematis dan self-confidence siswa melalui model pembelajaran Cycle 7E. *Mosharafa: Jurnal Pendidikan Matematika*, *6*(3), 419–430. https://doi.org/10.31980/mosharafa.v6i3.330.

Stadler, M., Becker, N., Gödker, M., Leutner, D., & Greiff, S. (2015). Complex problem solving and intelligence: A meta-analysis. *Intelligence*, *53*, 92–101. https://doi.org/10.1016/j.intell.2015.09.005.

Suryaningsih, H., Medriati, R., & Purwanto, A. (2021). Pengembangan lembar kerja peserta didik (LKPD) berbasis scaffolding berorientasi berpikir kritis pada materi Hukum Newton di SMA Negeri kota Bengkulu. *Amplitudo: Jurnal Ilmu dan Pembelajaran Fisika*, *1*(1), 44–52. https://doi.org/10.33369/ajipf.1.1. 44-52.

Suryaningsih, S., & Nurlita, R. (2021). Pentingnya lembar kerja peserta didik elektronik (e-LKPD) inovatif dalam proses pembelajaran abad 21. *Jurnal Pendidikan Indonesia*, *2*(7), 1256–1268. https://doi.org/10.59141/japendi.v2i07.233.

Syahrowardi, S., & Permana, A. H. (2016). Desain handout multimedia menggunakan 3d pageflip professional untuk media pembelajaran pada sistem android. *Jurnal Penelitian & Pengembangan Pendidikan Fisika*, *2*(1), 89–96. https://doi.org/10.21009/1.02113.

Syamsudin, F. K., Sudirman, S., Lalang, A. C., & Lestarani, D. (2022). Pengembangan bahan ajar digital berbasis software flip pdf corporate professional pada materi pokok larutan elektrolit dan non elektrolit untuk SMA/MA Kelas X. *Jurnal Beta Kimia*, *2*(1), 8–16. https://doi.org/10.201185/jbk.v2i1.7327.

Thomann, E., Trein, P., & Maggetti, M. (2019). What's the problem? multilevel governance and problem-solving. *European Policy Analysis*, *5*(1), 37–57. https://doi.org/10.1002/epa2.1062.

Utami, N. P., Eliza, R., & Warahma, S. (2022). Kemampuan pemecahan masalah matematis dan self-regulated learning dengan model pembelajaran learning cycle 7E. *Jurnal Cendekia : Jurnal Pendidikan Matematika*, *6*(1), 1025–1038. https://doi.org/10.31004/cendekia.v6i1.1330.

Utami, R. P. (2021). Desain dan uji coba lembar kerja peserta didik berbasis learning cycle 5e pada materi larutan penyangga. *Journal of Education and Teaching*, *2*(1), 94. https://doi.org/10.24014/jete.v2i1.8231.

Weisdiyanti, N., Sahyar, S., & Juliani, R. (2023). Development of complex problem solving tests in Newton's dynamic for high school. *Jurnal Pendidikan Fisika*, *12*(2), 178–183. https://doi.org/10.24114/jpf. 12i2.48639.

Yuliana, T., Sari, M., & Meria, A. (2020). Pengembangan modul berbasis learning cycle 7E berbantuan video pada materi teori kinetik gas dan termodinamika. *Jurnal Penelitian Bidang IPA Dan Pendidikan IPA*, *6*(1), 7–21. https://doi.org/10.15548/nsc.v6i1.1552.

Zydney, J. M., & Warner, Z. (2016). Mobile apps for science learning: Review of research. *Computers & Education*, *94*, 1–17. https://doi.org/10/1016/j.compedu.2015.11.001.