International Journal of Education and Teaching Zone. Vol 2 (Issue 3): 15-10 (2023)
DOI: https://10.57092/ijetz.v2i3.132

THE JOURNAL OF IJETZ
(International Journal of Education and Teaching Zone)
P-ISSN: 2963-7899 I E-ISSN: 2830-7925
jurnal.yayasannurulyakin.sch.id/index.php/ijetz

Content Accuracy and Recency of TPACK-Based Physics Textbooks on Work and Energy Materials to Improve Science Literacy of High School Students

Zidan Afidah[1]*, I Ketut Mahardika[1], Subiki[1]
[1]Faculty of Teacher Training and Education, Universitas Jember, Jember, Jawa Timur Indonesia

Article History:
Received: June 09, 2023
Revised: August 17, 2023
Accepted: August 21, 2023
Published: October 15, 2023

Keywords:
Scientific Literacy,
Textbooks,
TPACK,
Work and Energy

***Correspondence Author:**
afidahzidan7@gmail.com

Abstract: TPACK-based textbooks are reference books containing a collection of material from certain branches of knowledge that are presented comprehensively using a combination of pedagogic technologies and content that are applied according to the learning context. Scientific literacy is the scientific ability possessed by students to solve various kinds of problems and explain scientific phenomena scientifically. Work and energy are physics materials closely related to students' daily lives. The method used for this research is to use research and development research and development methods. Based on the results of the latest and contextual material validation on the suitability of the material with the latest scientific developments, validator one scores four, and validator two scores 4. The 100% percentage results that meet the criteria are very valid. From the results of the validation assessment in terms of the average rating of each validator for the two validators, an average percentage result of 87.49% is obtained with very valid criteria. This shows that the TPACK-based physics textbook on the subject matter of work and energy is appropriate to be used as an Electronic School Book aid for students in understanding and mastering material about work and energy.

INTRODUCTION

The 21st century is a century of globalization and information technology. Humans must have skills in technology, critical thinking, creativity, and the capability to find solutions. Therefore, education is expected to bridge individuals and the environment in the era of globalization so that individuals can play a role in becoming a generation of quality human resources (Defrianti & Iskandar, 2022; Riantoni & Yelianti, 2023).

Science learning, especially physics learning, especially in Indonesia, still needs to apply technology. Therefore, it is necessary to instill a sense of technological literacy in science so that today's knowledge can innovate in science, technology, and economics. This literacy to science can be called science literacy.The results of research by PISA and TIMSS on science literacy are a reference for improving the learning system in Indonesia. The results of PISA research in 2018 ranked Indonesia 70 out of 78 countries, while the effects of TIMSS research ranked 44 out of 49 countries. (Hadi & Novaliyosi, 2019 in

Suparya I. K *et al*., 2022). According to UNESCO 2012, this was motivated by the low interest in reading Indonesian.

Some other things that cause low science literacy in students are learning models, facilities, facilities, and learning resources. One of them is in teaching aids in the form of textbooks. Textbooks have an essential role in learning physics in schools. According to (Adisendjaja, 2009), existing textbooks have emphasized the content dimension compared to the process and context dimensions as recommended by PISA, the content of science literacy is still minimal in the context of science as the way of thinking. (Rahmawati *et al*., 2019).

Teachers are encouraged to use innovative learning strategies to increase science literacy in physics learning (Rachmatina *et al*., 2020). It takes teacher creativity to modify and improve quality by developing textbooks that integrate technology, materials, and effective learning methods tailored to the needs of the 21st century and the characteristics of students.

THEORETICAL SUPPORT

TPACK-Based Textbooks

Textbooks are one of the instruments in teaching and learning activities. The textbook itself is a book that discusses an aspect of study or unique science that is compiled to make it easier for teachers and students to achieve learning goals. Therefore, textbooks, as a source students use, should have an exciting presentation method and language easily understood by students, which will later be used continuously as a learning support book. In the regulations of the Ministry of National Education of Indonesia, Number 11 of 2005, it is stipulated that textbooks are mandatory reference books to be used in schools. These textbooks contain learning materials aimed at enhancing faith and piety, ethics and character, competence and mastery of science and technology, sensitivity and aesthetic abilities, physical potential, and health. They are designed based on national educational standards. According to this ministerial regulation, student textbooks should be engaging and innovative, enabling students to grasp knowledge effectively.

This is what underlies researchers to compile TPACK-based textbooks. TPACK (Technological Pedagogical Content Knowledge) is a learning approach combining technology, pedagogics, and content applied according to the context of learning (Amelia, Ayu *et al*., 2021). In addition, on the material of effort and energy, students often experience misconceptions related to the physical meaning of their effort and energy. Thus, TPACK-based textbooks on works and Energy materials have greater effectiveness as essential knowledge development when students learn work and energy materials and understand how technology can ease and increase opportunities and learning experiences for students while knowing the correct pedagogy to improve the content of the learning (Rasilah *et al*., 2021).

Material Accuracy and Textbook Up-to-Date

The material contained in the book includes explanations related to concepts, definitions, principles, procedures, examples, and training so that students can recognize ideas or ideas, identify statements, explain the characteristics of an image or picture, can define, and formulate formulas/formulas/rules, construct new knowledge, and apply new knowledge, and apply knowledge by the KI and KD that have been developed. Thus, the concepts used in textbooks must be clear and precise. Dim and security must be avoided so that students or readers are also clear about their understanding, understanding, and arrest (Ocvtaviani *et al*., 2019).

In addition to accuracy, textbooks must meet the up-to-date information in learning materials. The up-to-date textbooks can be known from when the literature referenced was published. By understanding the up-to-date literature, the development of publications or information in the discipline concerned will be known. Thus, textbooks can be used as material to support student learning in the digital era of the 21st century. With the presence of this research, it can provide critical evaluation and refinement of the instructional content found in the textbook, ensuring its continued relevance. Additionally, the researcher aims for the sustainability of this TPACK-based instructional material, enabling this journal to provide the necessary information.

METHOD

This research utilized the Research and Development (R&D) methodology. The research and development method is employed for designing, producing, and validating the validity of a specific product. Research and development serve as the validator and enhancer of the resulting product. The Physics Teaching Material Based on TPACK in the Topic of Work and Energy is the product generated and validated in this study (Rahmawati *et al*., 2019).

Scheme of Work

This research and development refer to the 4-D teaching material development model (four D model), which Semmel and Thiagarajan proposed in 1974. The four stages of research and plot are the defining stage (define), the design stage (design), the development stage (develop), and the distribution or dissemination stage (disseminate). However, this paper is only limited to the third stage, namely development with the end validated.

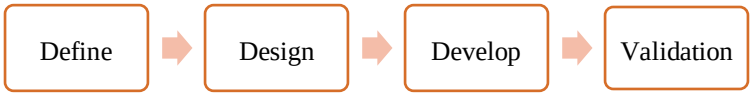

Figure 1. Research flow

Validation Instrument

The validity sheet for the TPACK-based physics teaching materials used in this research data collection tool on the topic of work and energy will be validated by two experts. The Likert scale used for this validity instrument ranges from 1 to 4. Analysis of

the expert responses' outcomes The outcomes of expert reactions were examined in two stages, with the sum of each expert's total scores for all indicators and validity scores determined using the procedure. The number of scores acquired was divided by the highest score, multiplied by 100%, and the results were then interpreted using the following criteria.

Table 1. Likert Scale validation criteria

Percentage (%)	Criteria
0-20	Invalid
21-40	Less Valid
41-60	Moderately Valid
61-80	Valid
81-100	Very Valid

From the above presentation table, it can be determined that if the instructional material has a percentage of <20, then the instructional material is considered invalid and should not be applied to prospective learners. If the validity percentage falls within the range of 21-40%, the instructional material is considered to be of low validity and if the validity percentage is within the range of 41-60%, then the instructional material is classified as moderately valid. In both cases, it is not recommended for application to prospective learners. Instructional materials that obtain a validity percentage within the range of 61-80% are considered valid and are allowed for application to prospective learners with the condition of being revised or not based on the validator's assessment. On the other hand, if the instructional material has a validity percentage of 81-100%, it falls under the category of highly valid and can be directly applied to prospective learners without revisions. This assessment is based on the accuracy of concepts and definitions, accuracy of reference sources, alignment of material with the latest developments in the field, incorporation of current images, and the up-to-dateness of references present within the instructional material.

RESULT AND DISCUSSION

Characteristics of Textbooks

The textbook entitled "TPACK-Based Physics Textbook: Work and Energy" is printed using A4 paper size, with paper length specifications of 29.7 cm and a width of 21 cm. The typography of the writing uses Times New Roman font with a size of 12 points. The works and energy materials for grade X high school in the textbook are arranged based on the core competencies and basic competencies of the 2013 curriculum

This textbook consists of 44 pages because it includes various materials and there are practice questions that allow the number of pages to be able to facilitate students in understanding the book. The making of this book integrates Technological Pedagogical Content Knowledge (TPACK), which combines aspects of knowledge, ways of learning, and mastery of learning materials by utilizing information and communication technology. In this book, TPACK aspects are presented in barcode form. Barcodes will go to materials links, quizzes, and interactive worksheets. So learning requires technological devices to access it. On the other hand, when students use technological devices to access, there must

be direct supervision from a teacher and parents for the sake of safe, effective and efficient learning. The TPACK-based physics textbook is structured into three parts, namely introduction, content, and closing.

The first section is the Introduction section, where in the introduction section there are several components, namely the cover page, foreword, table of contents, concept map, core competencies, basic competencies, learning objectives, and material details. The textbook cover design is shown in Figure 2.

Figure 2. Textbook cover design

In the introductory section, a concept map is provided which includes a network of material from the textbook as well as learning material covered in the textbook. Concept maps are made in the form of flow diagrams or images. then there is another content section called let's hypothesize like figure 3

Figure 3. Let's Hypothesize desing

In the Let's Hypothesize feature, readers are invited to provide opinions to solve a problem in real life. Readers will be given several choices so that readers can reason by being given real examples that occur in everyday life. then there is also a design section with the title Let's Observe which has been designed as shown in figure 4.

Figure 4. Let's Observe design

The Let's Observe section is a form where readers can increase understanding by observing the video. In Let's Observe there is a barcode that readers can scan and will take the reader to watch a video on the appropriate topic. Then there is also the design section, do you know, to provide reinforcement and increase students' interest in learning, like Figure 5.

Figure 5. Did you know design

In the known feature, you are given knowledge accompanied by images that readers need to know. This feature provides interesting facts accompanied by illustrations so that readers can find points that are not explained in the material. then continued with the let's experiment section, as a forum for students to carry out the process of investigating the material being discussed as in Figure 6.

Figure 6. Let's Experiment design

In the Let's Experiment section, there is a feature that provides readers with a link to do practicums using a virtual laboratory. This feature offers scannable barcodes and will take readers to the web, which provides a virtual laboratory so readers can conduct independent experiments. After students experiment, there is also a special practice section, where in the practice section there are example questions which are features of applying concepts that are already known. In this feature there are examples of questions that readers can do to improve their ability to understand what they have read. The last section is the closing section, where the closing section includes a summary, evaluation and bibliography. The summary presents important concepts more concisely than the material description, then continues with the evaluation which includes practice questions used by teachers and students to measure understanding and scientific literacy after learning. This is done to find out the extent to which the learning objectives have been achieved and can be used as a reference for improvements in the next textbook.

In this textbook, students are directed to acquire the skills of seeking information, analyzing data, obtaining and presenting data in various forms, and drawing conclusions from observations. After using the textbook, students are expected to be able to communicate the results of their analysis in the form of experimental conclusions, fostering a sense of responsibility for the results obtained. In addition, apart from increasing mastery of concepts, this textbook aims to develop students' character and improve their learning achievement. Students at the high school level (SMA) need character development when viewed in general, which is related to students' initial abilities as well as intellectual abilities, on the other hand there are characteristics related to differences in student personality, for example there are differences in attitudes or behavior and students' interest in improving Achievements, of course, have different ways.

The author strives to enable students to think critically and independently seek out data. The book provides exercises and self-guided experiments using PhET simulations. Students have the opportunity to gather data to input into the designated experimental variables, thereby engaging in hands-on experimentation that hones their skills in information retrieval, data analysis, and drawing independent conclusions.

The integration of the TPACK approach is not the only way to innovate learning, but it can be an alternative for developing technology-based learning methods that are more effective (Dayanti & Hamid, 2021). Some aspects of TPACK contained in the textbook are as follows, The first is Technology Knowledge *(TK)*. Technology knowledge encompasses the fundamental understanding of technology utilized to enhance the learning process. For instance, it includes the use of software, internet access, animation programs, molecular models, virtual laboratories, and other tools (Purnawati et al., 2020). In this textbook, various technologies are employed, such as the utilization of barcodes that link to YouTube videos for material comprehension, the integration of PhET Simulations as virtual laboratories, the implementation of Life Worksheet as an interactive worksheet, and the incorporation of Quizizz for practice problems. The second is Pedagogy Knowledge (PK), Pedagogical knowledge encompasses the implementation process and learning methods employed. Textbooks developed with science literacy as a reference incorporate various aspects, including the body of science, science as a means of investigation, science as a way of thinking, and the interplay between science, technology, and society (Rahmawati et al., 2019). Then the third is Content Knowledge (CK), Content knowledge refers to the understanding of the subject matter being studied. In this textbook, the content focuses on the topics of work and Energy specifically designed for high school students in the tenth grade. the fourth is Technology Pedagogy Knowledge (TPK), Technology Pedagogy Knowledge encompasses an understanding of the changes in learning that occur and the utilization of technology to facilitate student-centered learning. This textbook combines the elements of science literacy in its implementation. The fifth is Technology Content Knowledge (TCK), where Technology Content Knowledge refers to how technology facilitates the creation of representations of material, enabling students to explore new ways of understanding concepts within the subject matter through the use of technology. and finally the sixth is Pedagogical Content Knowledge (PCK), where Pedagogical Content Knowledge encompasses the understanding of how to effectively combine subject matter with pedagogical strategies in the learning process. In textbooks, the integration of effort and energy materials with the TPACK (Technological Pedagogical Content Knowledge) approach is employed to enhance students' science literacy.

Textbook Validity

Material Accuracy

Test the accuracy of TPACK-based physics textbook material using validation instruments with assessment indicator items including 1) accuracy of concepts and definitions, and 2) accuracy of library references.

Table 2. Table of material accuracy

Point	Precentage	Criteria
Accuracy of concepts and definitions	87,5%	Very valid
Accuracy of library references	100%	Very valid
Average	93,75%	Very valid

Based on the assessment of the accuracy of concepts and definitions, a result of 87.5% was obtained, which falls within the "very valid" criteria. This indicates that TPACK-based physics textbooks successfully meet the accuracy requirements for concepts and definitions. The presented material aligns with the basic competencies and learning objectives. The topics of matter, work, and energy are covered extensively, as indicated by the inclusion of numerous sub-materials for study. Furthermore, the textbooks are supplemented with activities such as "let's think," "let's hypothesize," and "let's observe," which aim to enhance students' critical thinking and process skills.

The variation in percentages arises due to the presentation of certain concepts and definitions being somewhat incomplete, thus necessitating the teacher's role to provide further explanation to prevent misconceptions. The incompleteness of definitions is attributed to the book's emphasis on offering everyday examples, enhancing the learning process with meaningful context.

Test the validity of TPACK-based physics textbooks using validation instrument sheets in terms of the content of science literacy material and its integration with the TPACK approach. The assessment is carried out by material expert validators, namely lecturers of Physics Education, at Jember University. The validation instrument sheet used consists of material accuracy and is up-to-date and contextual. The description of these aspects is as follows.

Material and Contextual Updates

Test the up-to-date material and contextual TPACK-based physics textbooks using validation instruments with assessment indicator items including 1) material conformity with the latest scientific developments, 2) image actualization, and 3) library up-to-date.

Table 3. Table of Material and Contextual Updates

Point	Precentage	Criteria
Compatibility of the material with the latest scientific developments	100%	Very Valid
Image actualization	75%	Valid
Library updates	87,5%	Very Valid
Avarage	87,5 %	VeryValid

Based on Table-3, the results of the validation of the material are up-to-date and contextual, the item of conformity of the material with the latest scientific developments is 100% which meets the criteria of being very valid. This shows that the teaching materials presented in TPACK-based physics textbooks meet the indicators of material suitability with the latest scientific developments. The material presented about work and energy in accordance with the latest scientific developments is supported by existing libraries.

In this instructional book, several material examples are presented with visualized images. The provided images employ straightforward visualizations depicting scenarios commonly encountered in the present, thereby aiding in enhancing student comprehension.

However, these images do not encompass the contemporary application of work and energy concepts in current technology, thus failing to depict more intricate occurrences.

In the image actualization item, the validation results are 75% that meet the valid criteria. The material presented has actual illustrative images in accordance with physical phenomena in everyday life. However, this percentage yield is the lowest compared to other indicator items. That is, the TPACK-based physics textbook meets the indicators of image actualization but still needs improvement for the image to be more actual following the latest developments by applying the cases discussed today. In the literature update item, the percentage result obtained is 87.5% which meets the very valid criteria. This shows that TPACK-based physics textbooks meet the latest items in the library. The library used is a reference source for 10 years, so the information obtained still follows the development of science today.

Based on the results of the assessment of each validation item, an average percentage of 87.5% fulfilled the "very valid" criteria. This shows that the TPACK-based physics textbook is effective in fulfilling current and contextual aspects. Learning that is currently developing with the help of technology that is useful for supporting continuity in the teaching and learning process. Learning is a process of interaction between students and teachers and involves the existence of learning resources in a learning environment, the sources used in textbooks include materials from textbooks, the internet, and the surrounding environment, such as real-life phenomena. This allows content to be adapted to advances in science and technology. According to Tupsai et al. (2015), linking physics learning with everyday life can encourage students to actively discuss, ask questions, and express their opinions and suggestions. This supports the idea that incorporating real-life applications in physics education increases student participation and engagement. The existence of learning using technology can facilitate interaction between teachers and students with material, students can exchange information and can access learning materials at any time and repeatedly. With this situation students can further explore or master the learning material.

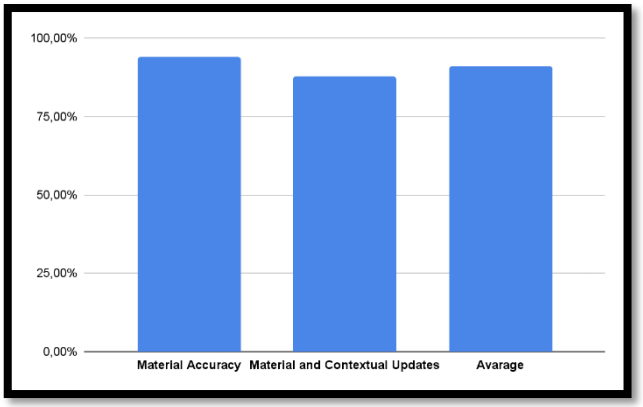

Figure 7. Graphs of Conclusion

The validation results of the accuracy of the material and the up-to-date material and conceptual presented in the textbook obtained a percentage of 90.625% with very valid

criteria. This is supported by features that support the development of TPACK-based textbooks. The integration of technology in the presentation of material makes it easier for students to access learning materials. So it is expected that students can increase their knowledge. In addition, the activities designed in the textbook also stimulate students to develop science literacy including 1) facts presented with illustrations of daily events, 2) concepts presented with narration, video visualization, and mathematical equations, 3) principles presented with drawing, 4) theories presented with visualizations in the form of pictures and graphs about the laws that apply in the subject of work and energy·

CONCLUSION

Based on the validation assessment results from each validator, namely, the accuracy of concepts and definitions at 87.5%, accuracy of reference sources at 100%, alignment of material with the latest developments in the field at 100%, incorporation of current images at 75%, and up-to-dateness of references at 87.5%, the average percentage for the indicators of material accuracy and currency obtained from both validators is 87.49%, indicating a highly valid criterion. This demonstrates that the Physics teaching material based on TPACK in the topic of work and energy is suitable for use as a supportive tool for Textbook (BTP) or Electronic School Book for students to comprehend and master the subject matter of work and energy. The researcher hopes that this article can serve as a reference for future researchers to further develop the material up to the distribution or implementation phase of the instructional material in the targeted schools.

REFERENCES

Amelia, A., Nurfalah, E., & Mulhayatiah, D. (2021). Peningkatan Tpack Guru Fisika Melalui Media Pembelajaran Berbasis Google Apps. *Journal of Teaching and Learning Physics*, *6*(2), 69–76. https://doi.org/10.15575/jotalp.v6i2.10298

Riantoni, C., & Yelianti, U. (2023). Analysis of Student Problem Solving Processes in Physics. *International Journal of Education and Teaching Zone*, *2*(1), 1–2.

Dayanti, F., & Hamid, A. (2021). *Integrasi Technological Pedagogical Content Knowledge (TPACK) Dengan Information Communation and Technology (ICT) Pada Masa Pandemi Covid 19 di SMA Gema 45 Surabaya*. *13*(2), 303–313. https://doi.org/10.30596/intiqad.v13i2.7481

Defrianti, D., & Iskandar, I. (2022). The Mastery of Teacher Emotional Intelligence Facing 21st Century Learning. *International Journal of Educationa and Teaching Zone*, *1*(1), 50–59.

Huda, C., Karimah, L., & Kurniawan, W. (2022). Pengembangan Bahan Ajar Fisika Berbasis Kontekstual dengan Memasukan Literasi Sains Pada Materi Termodinamika Kelas XI Siswa SMA / MA. *Jurnal Lontar Physics Today*, *1*(2), 103–112. https://doi.org/10.26877/lpt.v1i2.12019

Ichsan, Suhaimi, Amalia Nur Kodzijah, Santosa Tomi Apra, & Yulianti Sisi. (2022). Pengaruh Model Pembelajaran Problem Based Learning Berbasis TPACK Terhadap

Ketrampilan Literasi Sains Dalam Pembelajaran IPA Siswa Tingkat SD Sampai SMA: Sebuah Meta-Analisis. *Jurnal Pendidikan Dan Konseling*, *4*(5), 2173–2181.

Irmita, L. U., & Atun, S. (2017). Pengembangan Perangkat Pembelajaran Menggunakan Pendekatan Tpack Untuk Meningkatkan Literasi Sains. *JTK (Jurnal Tadris Kimiya)*, *2*(1), 84–90. https://doi.org/10.15575/jta.v2i1.1363

Magdalena, I., Sundari, T., Nurkamilah, S., Ayu Amalia, D., & Muhammadiyah Tangerang, U. (2020). Analisis Bahan Ajar. *Jurnal Pendidikan Dan Ilmu Sosial*, *2*(2), 311–326. https://ejournal.stitpn.ac.id/index.php/nusantara

Ocvtaviani, P., & Rahmawati, L. E. (2019). *Keakuratan materi teks anekdot dalam buku teks bahasa indonesia sma kelas x*. *7*(2), 149–169.

Purnawati, W., Maison, M., & Haryanto, H. (2020). *E-LKPD Berbasis Technological Pedagogical Content Knowledge (TPACK): Sebuah Pengembangan Sumber Belajar Pembelajaran*. *16*(2), 126–133.

Rahmawati, A. R., Sarwi, S., & Darsono, T. (2019). Unnes Physics Education Journal Penyusunan Bahan Ajar IPA Fisika sebagai Upaya Peningkatan Literasi Sains Peserta. *Unnes Physics Education*, *8*(2).

Rasilah, Dahlan, J. A., & Sudirman, S. (2021). Technological, Pedagogical and Content Knowledge untuk Guru Matematika di Era Digital: Literature Review. *Gema Wiralodra*, *12*(1), 84–93.

Suparya, I. K., I Wayan Suastra, & Putu Arnyana, I. B. (2022). Rendahnya Literasi Sains: Faktor Penyebab Dan Alternatif Solusinya. *Jurnal Ilmiah Pendidikan Citra Bakti*, *9*(1), 153–166. https://doi.org/10.38048/jipcb.v9i1.580