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Developing Interactive Electronic Book Based on TPACK to Increase Creative Thinking Skill

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Abstract

This study aims to: (1) improve the creative thinking skills of prospective teachers, (2) measure the level of validity, practicality, and effectiveness of the developed electronic book. This type of research is research and development (R&D) by applying the ADDIE model. This research was conducted through 5 stages: (1) analysis, (2) design, (3) development, (4) implementation, and (5) evaluation. The subjects of this study were students (prospective teachers) in the 5th-semester consisting of 55 people in the IT-based learning media course. At the same time, the object of this research was an electronic book developed based on TPACK. Several instruments were used: observation sheets, questionnaires, validation sheets, and essay tests. The results of data analysis indicate that the electronic book has met the requirements of validity, practicality, and effectiveness. In addition, there was a significant increase in the ability to think creatively.

Kata kunci:
Interaktif,
Buku Elektronik,
ADDIE,
Berpikir Kreatif

Abstrak

Penelitian ini bertujuan untuk: (1) meningkatkan kemampuan berpikir kreatif calon guru, (2) mengukur tingkat validitas, kepraktisan, dan kefektifitasan buku elektronik yang dikembangkan. Jenis penelitian ini adalah penelitian dan pengembangan (R&D), dengan menerapakna model ADDIE. Penelitian ini dilakukan melalui 5 tahap: (1) analisis, (2) desain, (3) pengembangan, (4) implementasi, dan (5) evaluasi. Subjek penelitian ini adalah mahasiswa (calon guru) semester 5 yang terdiri dari 55 orang pada matakuliah media pembelajaran berbasis IT. Objek penelitian ini adalah buku elektronik yang dikembangkan berbasis TPACK. Pada penelitian ini menggunakan beberapa intrumen: lembar observasi, kuisioner, lembar validasi, dan essay tes. Hasil analisis data menunjukkan bahwa buku elektronik tersebut telah memenuhi syarat validitas, kepraktisan dan efektifitas. Selain itu, terjadi peningkatan kemampuan berpikir kreatif secara signifikan.

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INTRODUCTION

Online learning systems or blended learning are still applied during the Covid 19 pandemic. This change in the learning system challenges campus institutions and lecturers to adjust the systems and devices. Furthermore, they need to develop teaching materials and learning devices used to achieve learning goals according to the specified targets. But in fact, the ability to think creatively in solving pedagogical problems related to mathematical learning media was still relatively low. Creative and innovative solutions were needed to solve it.

Creative ability is one part of the skills of 4Cs (critical thinking, communication, collaboration, and creativity) that are needed to be able to face the challenges of the 21st century (Bialik & Fadel, 2015). Creative thinking means creating (Norris & Ennis, 1989), which is the process of creating a new product or generating a new idea (Arends &Kilcher, 2010; Krulik & Rudnick, 1999; Martin, 2009). Creating means generalizing both a new idea, a new product or a new way of looking at phenomena (Anderson & Krathwohl, 2001). Creative thinking is an imaginative thought process that allows it to develop multiple solutions and their lateral (Kusiak & Brown, 2007). Creative thinking is a person's ability to create new ideas or ideas that make him feel able to achieve a shared goal in his life (Maxwell, 2004). The ability to think creatively (analyzing and evaluating) is included at the HOTS level (Conklin, 2012; King et al., 2010). Creative thinking is one of the competencies required by prospective teachers to face increasingly dynamic challenges and problems. But in fact, the creative thinking ability of prospective teachers is still relatively low, especially in solving pedagogical problems. This is in line with PISA data, where creative thinking skills in Indonesia are still relatively low (OECD, 2016; Mullis et al., 2020). In general, creativity is a high-level ability to solve problems in original, new, and different ways.

A teacher needs a creative ability to solve pedagogical problems. Pedagogy is everything related to the process of educating. Specifically, pedagogical science is related to (1) psychology, (2) teaching strategies (3) media and teaching materials, (4) learning models, (5) learning theory (6) characteristics of learners, (7) curriculum, and teaching method. Each teacher must master this aspect well to achieve the established learning goals (Siregar, 2018). But, based on the results of diagnostic tests on prospective teachers, the results are still relatively low in solving pedagogical problems. In line with that, prospective teachers' ability is still included in the weak category in solving problems related to Education (Siregar, 2019). Thus, it is necessary to take the appropriate solution to overcome it.

The low ability of prospective teachers to solve pedagogical problems was due to thinking creatively. This is based on the results of diagnostic tests of creative thinking on pedagogical problems conducted in August 2021, where only 9 out of 52 prospective teachers are able to solve the problem well. In contrast, 35 prospective teachers were only able to solve problems at the LOTS (lower-order thinking skill) level. They did not have new ideas and original ideas that could be used to solve the problem. The roots of the problems were: (1) the unavailability of teaching materials developed to improve creative thinking skills in solving pedagogical problems, (2) book content was only compiled in the form of information and routine tasks, (3) worksheets and project sheets in the book could not stimulate the creative thinking ability of prospective teachers to solve pedagogical problems, (4) available books were not developed based on technology, and (5) there were no electronic learning devices that could be used on online systems or blended learning. This fact shows the need for alternative creative and innovative solutions.

Technological developments have had a significant impact on the learning process, whether on online, offline, or blended learning systems. Technology has become an increasingly important part of the lives of aspiring teachers inside and outside the classroom. Technology can also help improve students' understanding of complex concepts or encourage collaboration among peers (Setyowati & Kharomah, 2020; Surbekti, 2021; Siregar, 2021). Correspondingly, an electronic book is one of the teaching materials arranged using text, images, audio, video, animation, and hyperlink components that can be accessed online and offline through a computer, smartphone, or tablet (Setyowati & Kharomah, 2020). Therefore, the e-book has many advantages: (1) it can be used practically and

flexibly, (2) it is more interesting (3) it contains broad and in-depth information, (4) the learning process can take place interactively and collaboratively, (5) it is easy to revise, etc. (Siregar, 2021). Previous research (Siregar, 2021; Widyawati & Sujatmika, 2020; Setyawan et al., 2020) stated that e-book or digital teaching materials improve high-level thinking skills, including creative thinking skills. It means that the use of electronic books impacts increasing student learning outcomes.

Pedagogy, technology, content are important aspects that need to be considered to develop learning tools and teaching material. The learning approach that adopts these three components is the TPACK (Technological Pedagogical Content Knowledge) learning approach. Pierson developed it in 2001. TPACK is very well used as a reference to develop teaching material (Mishra & Koehler, 2006). A framework based on TPACK integrates between (1) technological knowledge, (2) pedagogical knowledge, and (3) knowledge of content, which can be used as an approach that applies technology in the learning process. In addition, these three elements can be united and applied in effective learning to achieve learning goals, including creative thinking skills. Previous research has shown that TPACK-based learning tools can improve students' critical thinking skills (Gunawan, D. 2020). This research adopted the concept of TPACK in the development of student activities. In another study, the integration between TPACK and the PBL model could improve students' critical thinking skills (Wardani, 2021). The researcher included the elements of TPACK in the PBL syntax. In this research, TPACK elements were used to develop interactive e-books. The book was compiled in the form of student activities and contained interactive apperception activities, interactive activities, and interactive assessments. Thus, the book functioned as a source of information and an active learning-based learning tool and can be used interactively in online and offline learning systems.

Finally, by applying interactive electronic books based on TPACK, the creative thinking skills of prospective teachers in solving pedagogical problems were expected to increase significantly. The purpose of this research was to develop TPACK-based electronic books to improve the creative thinking skills of prospective teachers.

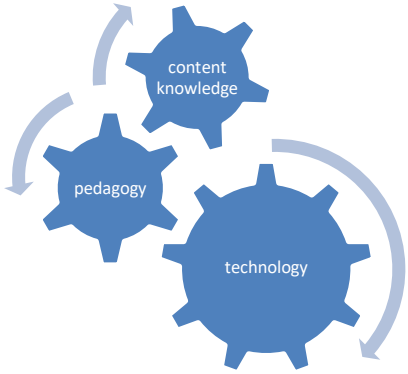

Figure 1. TPACK elements (technology, pedagogical, and content).

METHODS

This type of research is research and development (R&D). This research is a process or steps to develop a new product or improve an existing product, with measurable and guaranteed product quality (Setyosari, 2016; Sukmadinata, 2017). The product development process follows the phases of the ADDIE model. The product development process follows the phases of the ADDIE model. As the name, this model consists of five stages: (A)nalysis, (D)esain, (D)evelopment, (I)mplementation, and (E)valuation (Branch, 2009). Based on these phases, researchers will develop an electronic book based on TPACK to increase creative thinking skills in pedagogical problems. This research was conducted on IT-based learning media courses consisting of 52 teacher candidates. The research process took place by synchronous online learning system.

The data of this study were collected through observation methods, interviews, questionnaires, and tests of the creative thinking skills of prospective teachers in solving pedagogical problems. The

type of observation in this study was systematic observation. Where the factors to be observed and the categories had been determined. Observation material was limited to research objectives (Sugiyono, 2017:147). Observations were made to monitor the learning activities in the sample class. Observations focused on learning strategies, media, teaching materials, and the state of students during the learning process. In this study, the type of interview used was an unstructured interview. The guidelines used by the interviewers only outline problems related to the learning process, methods, media used, and the characteristics and abilities of students according to the teacher.

Several questions were asked based on responses to previous questions (Sugiyono, 2017:137). Questionnaires are data collection techniques given to respondents in the form of questions or written statements (Sugiyono, 2017:143). The questionnaire in this study was used before and after developing the digital book. The questionnaire used before developing the digital book was intended to determine student responses to the textbooks they had been using. This questionnaire was also used to determine what learning students enjoy as input for digital book designs. A test is a series of questions or exercises used to measure knowledge skills, intelligence, talent capabilities possessed by individuals or groups (Sugiyono, 2017). This study used tests before and after the digital book was developed. Before the digital book was developed, students were given a diagnostic test to prove that the creative thinking ability of the research subject was low. Furthermore, the test instrument also was used during product implementation in the form of pretest-posttest to measure the increase in students' creative thinking skills after using interactive digital books developed.

The instruments used were interactive electronic book materials and media validation sheets, lesson plan validation sheets, and lecturer and prospective teachers' response sheets. Each component is contained in the teaching material and then validated based on assessment criteria (Bozkurt & Bozkaya, 2015).

Table 1. Research Instruments

Variables	Data Sources	Methods	Research Instruments
Lesson Plan (RPS)	Materials expert	Questionnaire	validation sheets
TPACK-based e-book	Media expert, material expert, Lecturer, Prospective teachers	Questionnaire	validation sheets
Creative Thinking Skill	Prospective teachers	Test	1. *Pretest* 2. *Posttest*

The data analysis technique in this study consists of two. They were: (1) qualitative and (2) quantitative. Qualitative data was obtained from interviews, observations, and advice from experts and practitioners after using interactive electronic books based on TPACK, then this data was analyzed descriptively (Donald et al., 2010). In contrast, quantitative data is data in the form of numbers as a result of observation or measurement (Blaikie, 2003). Quantitative data of this study was obtained from the validation results by media experts and material experts, the results of the response of prospective teachers to digital books, and the pre-test and post-test results.

The success of this study was determined from three aspects: (1) validity, (2) practicality (3) and effectiveness (Nieveen, 2007). Analysis of the validity of a digital book, lesson plan, and teacher and student response questionnaires are carried out with the provisions: (a) Validity data analysis techniques using scores obtained based on the Likert Scale with 4 scales: excellent (4), good (3) average (2) and poor (1). (b) calculates the average score of the total fill of the instrument using the formula $\bar{x} = \frac{\sum x}{N}$. The following chart describes the process of research.

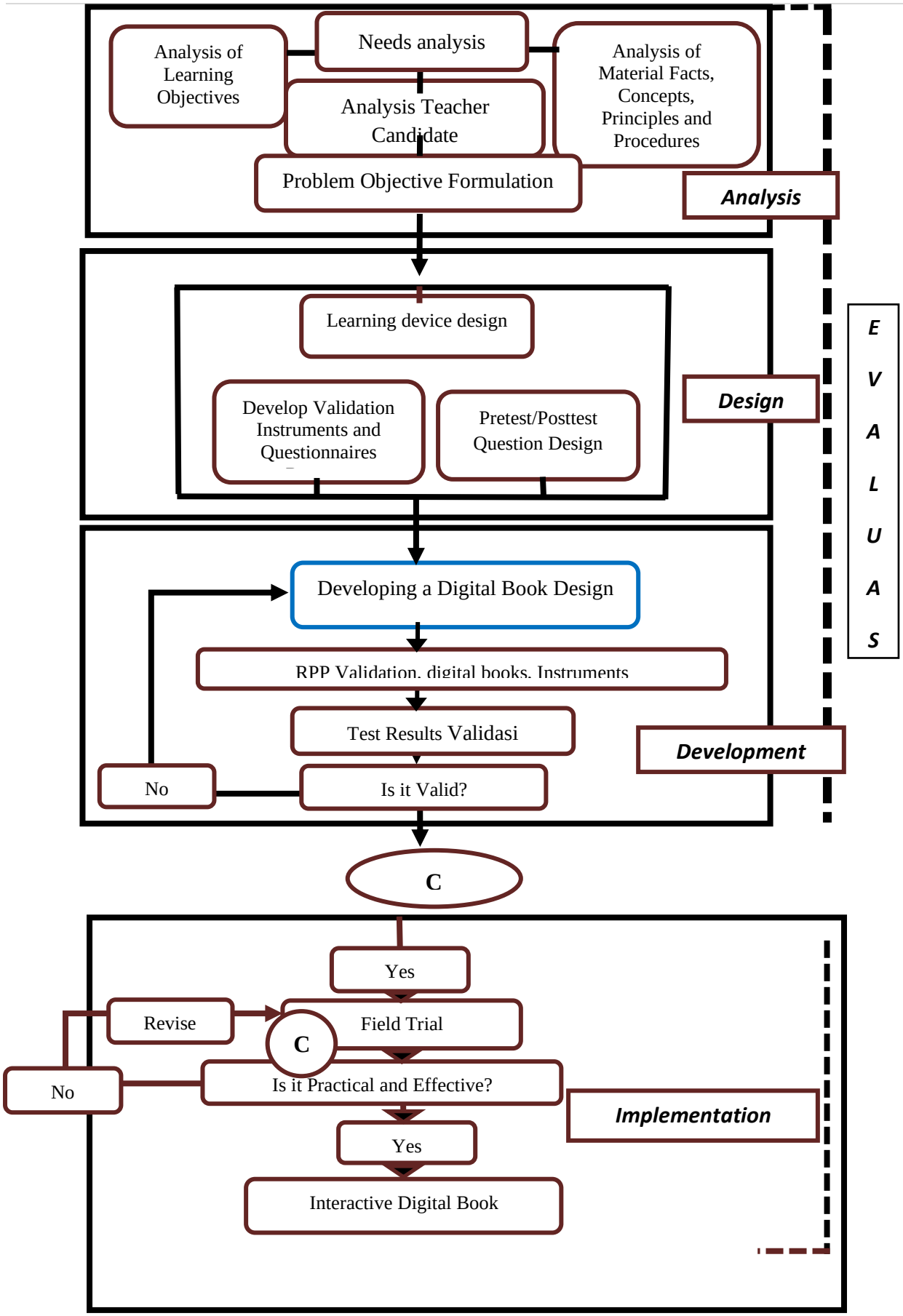

Figure 2. ADDIE Model Development Chart

FINDINGS AND DISCUSSION

After analyzing the data, the results of the study were obtained as follows:

Analysis

Creative thinking skills are competencies needed by prospective teachers to solve pedagogical problems. A good teacher is able to master the content and in pedagogical and technological aspects. However, the ability of prospective teachers was still relatively low. This is can be seen from the results of the diagnostic test, where there are only 4 students in very high categories, 5 in high categories, 23 in moderate categories, and others in low and very low categories. The root of the problems: (1) the learning process was not yet constructivism-based, (2) the book was used only as a source of information and could not be used to stimulate the creative thinking skills of prospective teachers, (3) books did not contain projects or worksheets to stimulate the creative thinking skills of prospective teachers, (4) there were no electronic books that could be used flexibly and effectively to improve the creative thinking of prospective teachers, (5) there were no interactive digital books that could be used online, offline or blended learning system that could be used to stimulate creative thinking skills. 6) the books were not integrated with animation, video, audio, interactive evaluation designed to enhance creative thinking skills. Thus, it was necessary to develop interactive digital books based on TPACK to improve this capability where the process of developing this book by adopting 3 elements in TPACK: (a) technological elements in the form of video animation, interactive evaluation, (b) pedagogical aspects that were by paying attention to cognitive level, learning style, interest of prospective teachers, etc. (c) elements of content, where the material was composed based on constructivism and problems.

In the past learning process only used hardcopy books. The book's content consisted of definitions, theories related to media, phases of interactive media development, and several application tutorials. In addition, this book was equipped with several evaluation questions at the LOT level (routine problems). Based on the analysis of materials and needs, it was necessary to design an electronic book that could be accessed online and offline. Each chapter had images, animations, videos, interactive evaluations. The material described definitions, theories, and steps. It was structured based on projects, worksheets, and interactive evaluations based on TPACK and oriented to improve the creative thinking skills of prospective teachers in solving pedagogical problems.

Designing

The design phase is the resolution of problems that have been identified in the analysis phase. Based on the analysis stage, the solution needed to overcome the problem of prospective teachers is to develop interactive electronic books based on TPACK that are oriented towards improving creative thinking skills.

Research instructions were lesson plans, worksheets, electronic books, and interactive evaluations, validation instruments and response questionnaires. Where the development of electronic books and instruments considers aspects of TPACK and the creative thinking skills of prospective teachers. The material on electronic books consists of: interactive multimedia based on constructivism, learning theory, 21st-century learning, development of learning devices, types of media required based on learning style and cognitive level, designing graphic info media, motion graphics, animation, video, etc. This content was written in 9 chapters, and each chapter comes with images, animations, videos, hyperlinks, worksheets, and interactive evaluations. In addition, the art aspect was a consideration in the development of electronic books. This book used an interesting full color so that it had an appeal to readers.

Development

The development is realizing what has been done at the design stage. There were two phases: (1) developing instruments such as questionnaires, evaluation questions, and learning plans, and media elements that are then put together into a complete interactive teaching material, (2) assessment or validation by experts.

Development of electronic books and instruments Based on TPACK.

At this stage was developing a learning plan (RPS) and an evaluation problem. Worksheets and teaching materials were developed according to the concept of TPACK and were oriented towards improving the creative thinking skills of prospective teachers. Furthermore, developed the content of the book and the necessary elements such as animation, video, images, interactive evaluation, hyperlinks, then put together into an electronic.

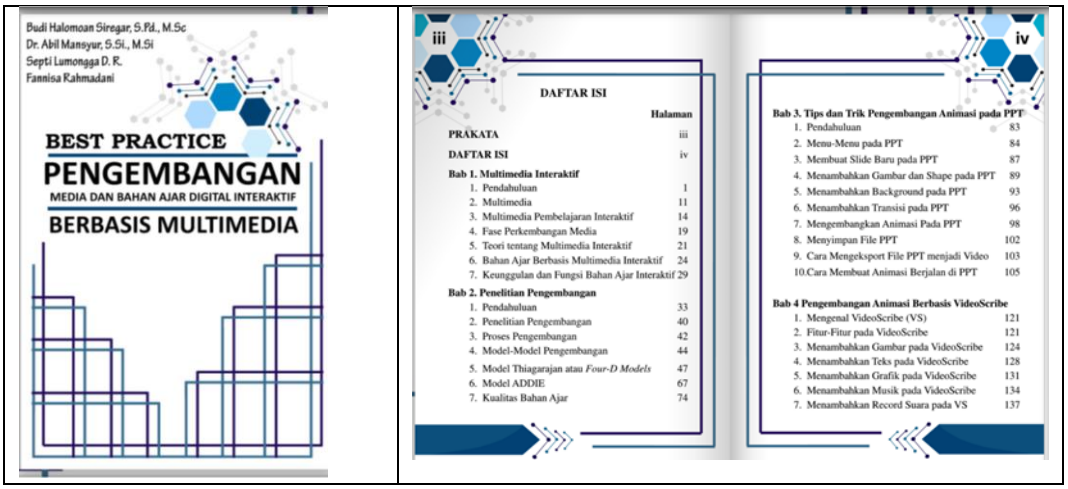

Figure 3. Cover and Content

The cover was designed using simple features and soft colors to make it more attractive. Then, the table of contents is connected to their respective pages to make it easier to use. For example, if a user wanted to open subchapter 3 on page 42, it could be done by clicking on that page number on the table of contents.

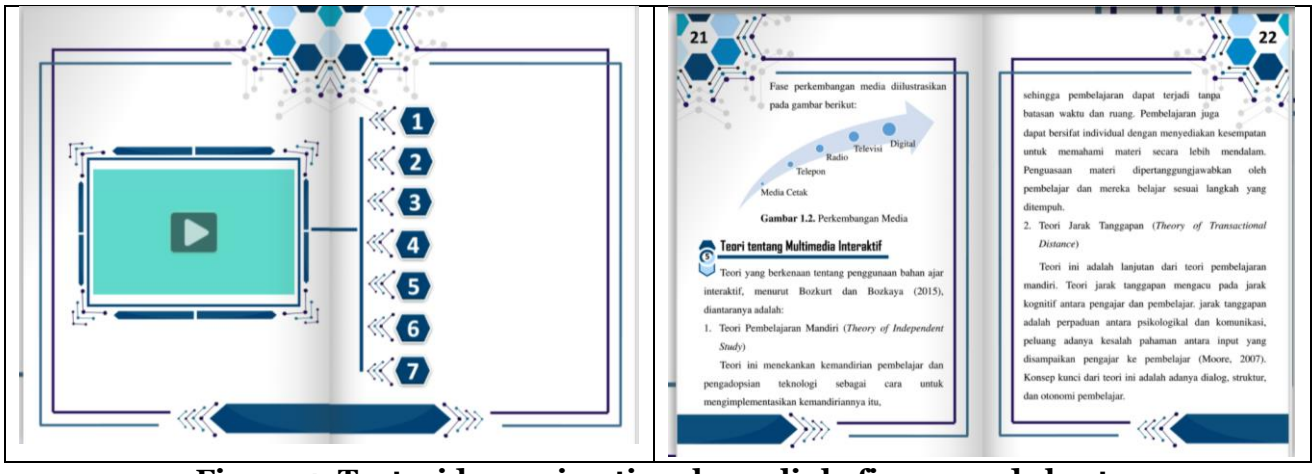

Figure 4. Text, video, animation, hyperlink, figure, and chart.

The technological aspects can be seen in the integration between text, images, videos, hyperlinks, interactive evaluations, and animations. These components were structured in a related manner to support the concept of a TPACK approach oriented towards improving the creative thinking skills of prospective teachers. The animations and videos in this book can help to describe abstract and complex material into more real and simple. This book was equipped with several hyperlinks containing perceptions, worksheets, and videos connected to a youtube channel. Apperception contains supporting materials presented in the form of interactive quizzes. Prospective teachers can access the perception in a simulation. Worksheets were developed based on issues and projects that could be accessed interactively and connected on the lecturer's google drive. The lecturer and prospective teachers could find out the results of perceptions and worksheets through their own Google drive. Lecturers could also provide input and criticism of the work of prospective teachers online.

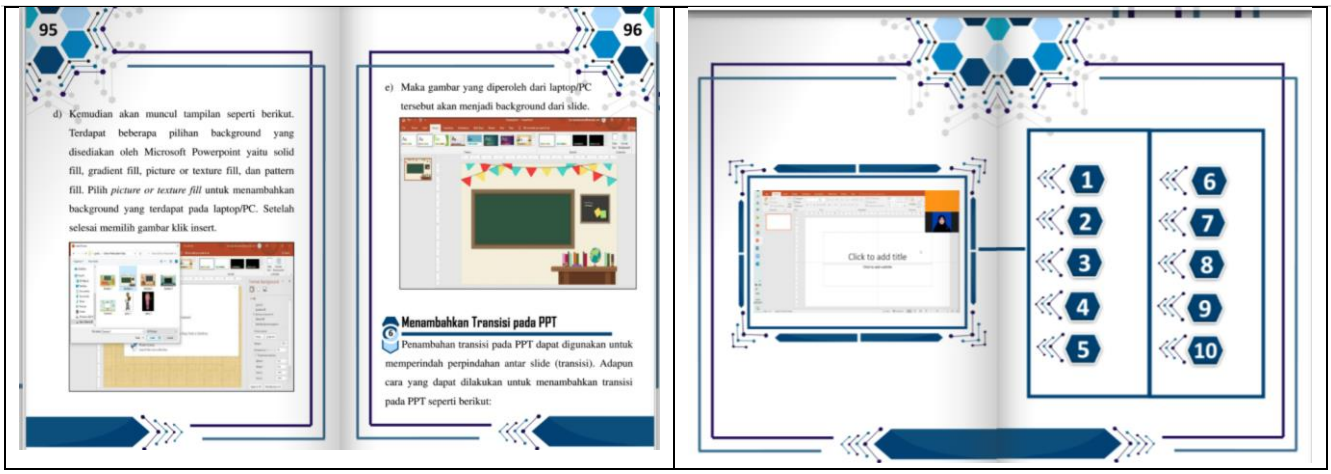

Figure 5. Evaluation and hyperlink

This book contains evaluations with interactive systems that can be accessed online or offline. The exam results will appear on the screen after completing it. Then the test results score will be revealed on lecturer's and prospective teachers' google drive. There are two types of evaluation questions provided: (1) multiple-choice, (2) essay tests. Both types of evaluation were developed based on indicators of creative thinking skills: (1) fluency (2) originality, (3) elaboration. To complete this evaluation, new original ideas were needed to be able to solve original and contextual problems.

Expert Appraisal.

After becoming draft I consisted of a questionnaire instrument, lesson plan (RPS), an interactive electronic book based on TPACK, then all these draft experts.

Table 2. Validation of research instruments

No.	Type of Instrument	Validator	Average Value	Average Validator Value	Category
1.	Validation sheet of material expert	VAM 1	3,4	3,30	very Feasible
		VAM 2	3,2		
2.	Validation sheet of media expert	VAE 1	3,1	3,15	very Feasible
		VAE 2	3,2		
3.	Questionnaire of lecturer response	ARD 1	3,2	3,20	very Feasible
		ARD 2	3,2		
4.	Questionnaire of prospective teachers' responses	ARC 1	3,3	3,4	very Feasible
		ARC 2	3,5		

Based on table 2, all instruments, learning devices, and e-books are in a very feasible category. After revising draft-I according to the advice of experts, it is further called draft II.

Implementation

After becoming draft II, all teaching materials and electronic books were used in field trials. This stage aimed to determine the level of practicality and effectiveness of the product.

Device Readability

The readability of all devices was tested on 10 prospective teachers. Based on the test results, it could be concluded that electronic books and tests were classified as mostly readable and understandable. However, some sentence structures and word usage need to be improved, for example, on pages 92, 108, and 112. After revising them, this draft was used in field trials.

Field Trial

After the electronic book had passed the readability test, the practicality data (response of prospective teachers and lecturers) and effectiveness data (pre-test, post-test, percentage of learning completeness, and N-Gain score) were shown as follows.

Table 3. The results of the response analysis of prospective teachers and lecturers.

Information	Teacher Candidate Response	Lecturer Response
Total	52 prospective teachers	1 lecturer
Practicality percentage	93,1%	94,3%
Category	very practical	very practical

Table 3 shows that the responses of prospective teachers and lecturers to electronic books are in the very practical category, with a value of 93.1% and 94.3%, respectively. Thus, the practical aspect has been met. Furthermore, the results of the effectiveness analysis in the percentage of completeness and the acquisition of n-gain scores are given as follows.

Table 4. Complete learning based on institutional rules

Interval	Grade	*Pre-test of Creative Thinking*		*Post-test of Creative Thinking*	
		Number of Prospective Teacher	Percent. Of Prospective Teacher	Number of Prospective Teacher	Percent. Of Prospective Teacher
90 - 100	A	4	8%	19	37%
80 - 89	B	5	10%	23	44%
70 - 79	C	23	44%	9	17%
00 - 69	E	20	38%	1	2%
Total of		52	100%	52	100%

Table 4 describes that 18% of prospective teachers scored A and B on the pre-test, then there is a significant increase to 81% on the post-test.

Table 5. The level of creative thinking ability of prospective teachers

Interval	Category	*Pretest of Creative Thinking*		*Posttest of Creative Thinking*	
		Number of Prospective Teacher	Percent. Of Prospective Teacher	Number of Prospective Teacher	Percent. Of Prospective Teacher
90 – 100	very high	4	8%	19	37%
80 – 89	high	5	10%	23	44%
65 – 79	moderate	23	44%	9	17%
55 – 64	low	18	35%	1	2%
0 – 54	very low	2	4%	0	0%
Total of		52	100%	52	100%

Table 5 reveals that there are only 9 teacher candidates who are included in the high and very high categories. There is a dramatic increase to 41 people after using the TPACK-based electronic book. Furthermore, to determine the effectiveness of the e-book, it is necessary to determine the N-Gain score.

Table 6. Achievement of creative thinking skills based on the N-gain score

N-Gain	Category	Number of Prospective Teacher	Percentage	Average of gain
g > 0,7	high	37	71%	0.72
0,3 ≤ g ≤ 0,7	moderate	14	27%	
g < 0,3	low	1	2%	
Total		52	100%	

Table 6 indicates 37, 14, and 1 prospective teacher in the high, medium, and low categories, respectively, with an average N-gain of 0.72 (high category). Therefore, it can be concluded that draft-III has met the requirements for effectiveness.

Evaluation

The evaluation stage was carried out in a formative and summative manner. At this stage, there were only minor errors, which were considered not to affect the study results. For example, the duration of the implementation time was more than 7 minutes from the specified time, numbering errors in an electronic book, and interrupted videos.

CONCLUSION

The study results indicate that the validity and practicality requirements have been met (very feasible and very practical category). Then, the creative thinking ability of prospective teachers increased dramatically after using TPACK-based interactive e-books. Finally, it was highly recommended for lecturers and trainers to use this e-book in the learning process either on an online or blended learning system in order to improve creative thinking skills. The researchers suggest continuing this study by considering the variables of digital literacy and numeracy literacy.

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