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Analysis of STEAM-Based TPACK Integrated Activities in Elementary School Thematic Books

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Abstract. Technological, Pedagogical, and Content Knowledge (TPACK) can collaborate with the Science Technology Engineering Art Mathematics (STEAM) approach. STEAM is also essential for students to improve their ability and skills to operate and produce science and technology-based products, supported by the TPACK abilities of educators to develop quality technology-based learning. In this study, there were 26 items of integrated TPACK and STEAM activities, with the most findings being content knowledge, as much as 27.50% for science. The second-highest finding was the integration of pedagogical knowledge, as much as 24%. Furthermore, the third most common finding, 17.40%, was the integration of technological knowledge with art and pedagogical content knowledge with art, while 10% of activities integrated content knowledge with art. The last finding found the integration of pedagogical knowledge with science of 3.4%. However, all indicators did not appear mathematical. In addition, the most common finding was the integration of art and pedagogical content knowledge, as much as 34.60%. The percentage of activities integrating engineering and content knowledge was 27%, which was the highest finding. In this case, one activity allows more than one integration.

Keywords: integrated activity, TPACK, technology, thematic book, STEAM

1. Introduction

Science and technology are currently growing swiftly in various fields, one of which is in the field of education. On the other hand, the importance of mastering 21st-century skills is because, at this time, students are required to develop life skills and soft skills, including the ability to think critically and solve problems, develop creativity, communicate, and collaborate (Nabilah & Nana, 2020). Therefore, educators need to have the ability to collaborate between learning activities and the environmental conditions of students through activities that link technology. However, many educators in Indonesia still have not fully utilized technology maximally (Kemendikbud, 2015). Based on a survey from the Center for Information and Communication Technology Education and Culture (Pustekkom, *Pusat Teknologi Komunikasi dan Informasi Pendidikan dan Kebudayaan*), Ministry of Education and Culture, 60% of educators in Indonesia were still technologically stuttering, with the primary cause being the age of educators over 45 years of age until retirement age, lack of technology content education, and inadequate facilities for each region. Given these facts, educators require special abilities to integrate technology with every learning activity. In addition, technology has several capabilities; for example, it can provide interactive content, provide rapid learning feedback, diagnose student learning needs, provide effective ways to remediate student learning difficulties, assess student learning processes and outcomes, or store examples of student work, which will be used in improving learning outcomes (Cover et al., 2011).

In this case, Technological, Pedagogical, Content, and Knowledge (TPACK) can collaborate with the Science Technology Engineering Art Mathematics (STEAM) Approach.STEAM can be utilized in direct learning activities, particularly in elementary schools, because STEAM combines aspects of science, technology, engineering, art, and mathematics with prioritizing new products with creative and problem-solving abilities (Katz-Buonincontro, 2018). Moreover, the whole learning process is basically an activity (Sardiman, 2013). In Indonesia, the 2013 curriculum uses thematic books as one of the various learning resources for activity-based learning. Through activities in thematic books, the STEAM approach, assisted by the teacher's TPACK, can be integrated to form effective learning.

Furthermore, activity has an essential role in student learning interactions because it is one of the factors for students' desire to learn (Tara, 2019). In addition, the 2013 curriculum applies a scientific approach, including several scientific activities, such as observing, asking, reasoning, trying, processing, presenting, concluding, and communicating (Mulyasa, 2013). For this reason, the indicators in each material need to be studied to determine how strong the integration between the TPACK components is in the STEAM element: science, technology, engineering, art, and mathematics. Moreover, there is technology in the TPACK and STEAM components that link technology-based learning. STEAM-based learning is also known as experiential learning and offers problem-solving skills based on the opinion that science, technology, engineering, art, and mathematics have an interrelated relationship. Thus, STEAM learning is vital for students to improve their abilities and skills to operate and produce science and technology-based products, supported by the educators' TPACK to develop quality technology-based learning (Ishartono et al., 2021).

1.1. Problem Statement

Currently, Indonesia has entered the industrial revolution 4.0, which requires educators to be technology literate to instill critical skills in students. Based on a survey from Pustekkom and the Ministry of Education and Culture (Kemendikbud, *Kementerian Pendidkan dan Kebudayaan*), many educators in Indonesia are still not optimal in utilizing technology. On the other hand, applying the three main components of TPACK can result in effective learning by utilizing technology to explain the material. There is technology in the TPACK and STEAM components, which link technology-based learning. STEAM-based learning is also known as experiential learning and offers problem-solving skills based on the opinion that science, technology, engineering, art, and mathematics have an interrelated relationship. Theoretically and practically, the interaction between TPACK and the STEAM approach needs to be carried out, resulting in the type of flexible knowledge needed to integrate technology into learning.

Each subject is taught at the elementary school level based on a theme related to students' daily activities. Each theme can contain several concepts of scientific studies, including mathematics, natural sciences, social sciences, Indonesian language, civic education, Physical education, sports, health, and cultural arts. Moreover, the 2013 curriculum uses thematic books as one of the various learning resources. The thematic books used in the 2013 curriculum are identical to the content presented in the form of activities by directing students to play an active role in learning activities through various activities that can be carried out, both in the school environment and outside the school. Therefore, this study needs to be done because, currently, thematic books are the main companion of 2013 curriculum learning in all elementary schools in Indonesia. The thematic books show how far the writing team involves technological elements in learning.

1.2. Related Research

This study refers to Starzinski (2017), which examined how much influence the STEAM approach had on learning activities at elementary school age. The researchers wanted to see how far students knew about what they could and experienced directly. Subsequent research was carried out by Kamienski & Radziwill (2018), who found that the STEAM learning approach could foster a new ability model that demonstrated empathy and increased student curiosity. Further relevant research was performed by Firdaus & Rahayu (2019), who concluded that TPACK is the knowledge needed to integrate technology into learning. Three components of teacher knowledge were produced: pedagogical content knowledge, technological content knowledge, and technological pedagogical knowledge. Another research revealed that the STEAM approach responds well to student learning (Becker & Park, 2011; Septiani & Yuliarto, 2016). Meanwhile, the novelty of this study is that the researchers combine the three previous studies, thus forming a STEAM-based TPACK integration, which is believed to improve the quality of student learning and is supported by the ability of teachers to create effective learning.

1.3. Research Objectives

Based on the previous problem background and formulation, this study aims at finding out the analysis results of the activities integrated with STEAM-based TPACK in elementary school thematic books.

2. Theoretical Framework

Thematic books must be used by the students and teacher during the learning process, distributed free of charge according to each class. Following technological developments, there is a need for continued research on technology-based learning that integrates the TPACK of educators and the STEAM learning model in integrated thematic books. In this case, a direct practice system is needed to face the challenges. Learning through direct practice follows the demands of 21st-century technology, where students must have the skills to learn and innovate. Learning with a direct practice system can also be obtained through the STEAM approach, supported by the TPACK of educators. Here, educators must have a TPACK that can be used as the basis for the effectiveness of learning activities. TPACK can collaborate with STEAM because they both focus on technology-based learning. In addition, the STEAM approach can be applied in natural science subjects since it combines various aspects, such as science, technology, technical, arts, and mathematics, which emphasize problem-solving skills. Thus, using the STEAM approach, the learning objectives will be achieved per the TPACK possessed by the educators. Basically, thematic learning is an integrated learning model using themes to link several subjects, thus providing a meaningful learning experience for students. For this reason, the STEAM-based TPACK integration activity in the fifth-grade elementary school thematic book on theme 1, regarding animal and human motion organs, could be analyzed in order to find a detailed description of the aspects, characteristics, and indicators.

2.1 STEAM (Science, Technology, Engineering, Art, Mathematics)

STEAM is an integrated approach that combines science, technology, engineering, art, and mathematics to develop students' inquiry, communication, and critical thinking during learning (Starzinski, 2017). STEAM is also an adaptation of STEM, highlighting the relationship between two or more content or discussion, guiding instructions through observation, investigation, and problem-solving. This explanation is in line with Maeda(2013) who added art to STEM to become STEAM. Following the 21st century, design and art will provide changes to economic development, as science and technology have played a role in the previous century. In addition, STEAM encourages students to further develop knowledge around them through observing, asking, and investigating. STEAM's steps are followed (Syukri et al., 2013). (1) In the observation step, students are invited to observe various phenomena or issues in daily life related to the science concept in the learning discussed. (2) In the new idea step, students observe and seek additional information about various phenomena or issues related to the scientific topic discussed. (3) In the innovation step, students are asked to describe what has to be done to apply the ideas generated in the previous new idea step. (4) In the creativity step, all suggestions and opinions are implemented, resulting from discussions regarding ideas that can be applied. Finally, (5) the value step (society) is the final step that students must possess from the resulting idea in the form of beneficial values for social life. STEAM can also be carried out in several stages, including (1) identifying the main activities, (2) identifying sub-activities, (3) identifying specific benefits that can be obtained, (4) selecting a matrix or developing data collection, (5) exploring aspects social involvement involved, and (6) the acquisition of benefits (Kamienski & Radziwill, 2018).

The STEAM approach focuses on students' interests, talents, and skills in science, technology, engineering, art, and mathematics (Quigley et al., 2017). The STEAM approach can be used in direct learning activities, especially in elementary schools, because STEAM combines science, technology, engineering, art, and mathematics, prioritizing producing new products with creativity and problem-solving abilities (Katz-Buonincontro, 2018). In the learning process, students' understanding of natural science is revealed through their observations and experiments with various objects. Science learning accompanied by the STEAM approach will significantly impact increasing students' creativity (Cho & Lee, 2013; Kim et al., 2014). Students are also allowed to apply knowledge in solving problems.

2.1.1 Natural Science

Natural science learning in elementary school is done by solving problems around. Natural science discusses phenomena that occur in nature (STEM Task Force Report, 2014)'. Natural science is also a way to study certain aspects in a structured and systematic way through various standardized scientific methods (Gunawan et al., 2020). In addition, natural science can train students' abilities to recognize events around them by utilizing the senses.

The public can accept natural science as a product found through a series of structured research in the scientific process, and its success is determined by its scientific attitude. Here, elementary schools teach natural science as a process, product, attitude, and technology so that it becomes a means to develop science process skills, cognitive aspects, and psychomotor aspects. Natural science can also stimulate students to increase curiosity, develop interest, and solve problems. It is consistent with the rules of the 2013 curriculum, which aims at shaping students through the integration of strengthening attitudes, knowledge, and skills. Learning activities that can be applied in implementing the natural science approach include inviting students to study outside the classroom, such as studying in the garden to observe pets so that they get used to and have the skills to live in the open.

Based on these definitions, natural science is defined as the study of nature, which is obtained through observation, thought processes, and experiencing events directly. The application of natural science can be supported by a person's high curiosity about the world around him. The scope of natural science includes everything that can be obtained and proven through the activities of the senses, i.e., seeing, touching, hearing, touching, and tasting.

2.1.2 Technology

Technology is a development and application aimed at solving problems (Huda, 2020). According to Law No. 11 of 2019 concerning the National System of Science and Technology, technology is a method, system, or process of applying and utilizing various scientific disciplines, which are useful in meeting the needs, continuity, and improvement of human quality. Based on STEM Task Force Report (2014), technology links environmental settings, designing, and using tools to support human activities. In addition, technology must be interpreted as an effort to increase effectiveness and efficiency because it is developed to deal with and solve problems encountered during human activities(Suryadi, 2019). Several models can guide pedagogical and learning designs supported by simple technology (Kartini & Widodo, 2020).

Moreover, all human activities can run easily and quickly with the help of technology. Likewise, some activities in schools can run with the help of technology. Thus, increasing understanding of the importance of using technology in schools can be done by explaining the Industrial Revolution 4.0 so that students have a relatively high literacy level about technology. In addition to understanding the scientific basis of modern technology, but students can produce something new, which can be used as a problem-solving tool in everyday life, both at school and outside school.

2.1.3 Engineering

Engineering is a trick, tactic, or invention used to complete and perfect a direct goal (Iskandar & Sunendar, 2008). Engineering in STEAM leads to applying knowledge and skills in creating a useful method or procedure (Gunawan et al., 2020). Engineering aims to solve a problem by involving knowledge and creativity according to the imagination of students. Students can develop hands-on project-based learning by understanding the engineering design process integrated with STEAM aspects, which are widely used in the real world. According to Selly (2017), children naturally tend to be involved in engineering activities and practice them according to existing procedures. Students can also follow the activity procedure by assembling and building a certain form using various media. For example, students experience the process of figuring out how to arrange a block framework so that it becomes a complete block shape.

2.1.4 Art

STEAM combines "arts" with STEM learning to increase students' involvement, creativity, innovation, problem-solving skills, and other cognitive benefits in learning activities (Liao, 2016). Art is the result of human work or expressions in the human soul, deliberately created to be recognized and appreciated by the wider community (Rondhi, 2017). Art and science can positively impact students if they go hand in hand. According to Swaminathan & Schellenberg (2015), art learning can improve cognitive skills, such as reasoning, abstract thinking, divergent thinking, self-creativity, openness to experience, and curiosity. In this respect, school facilities for students to be creative, think critically and solve problems help improve artistic skills. In elementary school, students' artistic skills can be produced from a series of learning activities, such as singing, telling stories, dancing, and being creative with objects that can be used to produce works of art. Apart from entertainment, art has an affective value so that students have good self-control and character.

2.1.5 Mathematics

The nature of mathematics is absolute, meaning it cannot be improved and updated because mathematics is based on pure evidence formed in a unit (Tarigan, 2021). Mathematics has a vital role in technological activities, both in applying other fields of science and mathematics itself (Siagian, 2016). The key role of mathematics is recognized in Shadiq (2014) that it would not be possible without the use of mathematics. The main problem in implementing mathematics learning in Indonesia at the elementary school level is students' low mathematical problem-solving skills (Lubis et al., 2019). In fact, solving mathematical problems can be done in diverse ways, relying on the ability to understand, reason, and think critically and creatively so that students can produce their solutions to solve mathematical problems according to their abilities. Therefore, improving the quality of mathematics education can be used to develop human resources.

2.2. TPACK (Technological, Pedagogical, and Content Knowledge)

TPACK is a form of integration of comprehensive knowledge and skills with the principle of collaborating content or material applied in a context according to technological developments. TPACK is also the basis for effective teaching using technology and requires an understanding of conceptual representation by using technology, with pedagogical techniques constructively utilizing technology, to convey content and realize new knowledge based on existing knowledge in students. TPACK was proposed by Shulman (1987) and developed by Koehler & Mishra (2009). TPACK is considered a potential framework that can convey new directions for educators in solving problems related to integrating ICT into learning activities in and outside the classroom.

TPACK can also be used as a basis for effective teaching utilizing technology. Understanding TPACK requires a discourse representation of concepts composed using technology. TPACK also makes teachers' knowledge in integrating technology with learning more effective. Thus, professional educators have superior TPACK competencies because TPACK covers four teacher competencies: pedagogy, personality, social, and professional. In this case, TPACK seeks to provide motivation to increase understanding, stimulate students' interest in subjects, and improve student learning.

The types of basic knowledge possessed by educators are technological knowledge (TK), pedagogical knowledge (PK), and content knowledge (CK). The integration results between the three basic knowledge were developed and produced four new knowledge: pedagogical content knowledge (PCK), technological content knowledge (TCK), and technological and pedagogical knowledge (TPK), and refined into technological pedagogical content knowledge (TPACK) (Oster & Peled, 2014; Rahmadi, 2019). Koehler et al. (2013) stated that based on the interaction type, TPACK is divided into seven:

a) Technology knowledge (TK) includes the ability to operate software and hardware and create educational content through technology-based presentation documents. Some of the main considerations for technology-supported learning include the ability to communicate, audio or video media, which can support the course of learning activities (Wang, 2019).

b) Content knowledge (CK) covers special abilities and skills in scientific disciplines or learning materials.

c) Pedagogical knowledge (PK) generally explains knowledge components for teaching supplies. This knowledge comprises class organization, motivation, lesson plans, and learning assessments.

d) Pedagogical content knowledge (PCK): the provision of different content in each lesson is needed to create effective learning activities because each content will suit different learning methods.

e) Technological content knowledge (TCK) describes reciprocal knowledge between knowledge and content (material).

f) Technological pedagogical knowledge (TPK) explains the interrelated relationship between technology and pedagogy. Knowledge may help teachers give the necessary tools based on using a pedagogical approach, as well as understand how to use appropriate technology to achieve pedagogical goals.

g) Technological pedagogical and content knowledge (TPACK) explains knowledge that each field of study has conveyed. TPACK is also a complement to the previous fields, including technological knowledge, content knowledge, pedagogical knowledge, pedagogical content knowledge, technological content knowledge, and technological pedagogical knowledge, which focuses on developing technology applied to the pedagogical needs to present content.

TPACK can be used as a framework to form an appropriate educational curriculum according to the era and demands of learning in the 21st century (Oster & Peled, 2014). The advantages of TPACK can be seen from its use as a reference in teaching activities for educators through mastery of the material to be taught (content knowledge), procedures for providing direction in learning activities (pedagogical knowledge), and knowledge of the content and teaching materials presented and collaborated with technological capabilities (technological knowledge). Every educator must master these three abilities by utilizing the suitable technology according to the needs in teaching and showing an interrelated relationship between knowledge, producing four collaborative knowledge. In addition to advantages, TPACK has weaknesses, including lacking research on TPACK. The development of TPACK is also still dependent on content or material, so if it is combined with other content, it will be less than optimal. Thus, it is necessary to research TPACK on an ongoing basis, tailored to each context and purpose (Rahmadi, 2019).

2.3 Student Thematic Book

The 2013 curriculum implements several principles, including graduate competency standards (SKL, *Standar Kompetensi Lulusan)* derived from needs; content standards from graduate competency standards through subject-free core competencies; the contribution of all subjects to the formation of attitudes, skills, and knowledge of students; subjects derived from the competencies to be achieved; subjects that are bound to core competencies; the similarity of demands graduate competence, content, learning process, and assessment. In this regard, thematic books are student and teacher books that must be used during the learning process, distributed free of charge according to each class. Thematic books are developed based on KD (basic competencies) and KI (core competencies) in the 2013 curriculum. According to Warahmah (2022), student books describe how students must make a minimal effort to achieve the desired competencies. The student book was developed from the aspect of the feasibility of the content in the "very good" category, the linguistic aspect in the "very good" category, the presentation aspect in the "very good" category, and the graphic aspect in the "very good" category (Sari & Syamsi, 2015).

3. Method

3.1. Research Design

This study used a descriptive research method with a qualitative approach. The considerations in this study were essentially in the form of an in-depth understanding according to the researchers' language by describing STEAM-based TPACK integration activities. In this study, the researchers collected data, which were then analyzed critically and concluded based on the research's facts. STEAM was separated into S-T-E-A-M in analyzing the occurrence rate of STEAM, which was integrated with TPACK on each indicator.

Further, this type of content analysis research used a descriptive qualitative approach. Content analysis is a technique used in analyzing texts to find out the content of communication by paying attention to the context, such as book analysis (Ahmad, 2018; Krippendorff, 2013; Nasella et al., 2019). Meanwhile, the qualitative approach is a research approach that understands phenomena or observes an object inductively and interprets them so that the results emphasize meaning rather than generalization (Moleong, 1989; Raihan, 2017; Sidiq & Choiri, 2019). Furthermore, the descriptive method explains or describes a phenomenon problem by finding facts and not testing hypotheses (Pratama, 2013; Samsu, 2021; Setiawan, 2013).

Content analysis in this study used descriptive qualitative because it is essentially an in-depth understanding. According to the language of the researchers, it was done by describing the activity of STEAM-based TPACK integration. In this study, the researchers collected data, which were then analyzed critically and concluded based on the facts at the research time. STEAM was broken down into S-T-E-A-M in analyzing the occurrence rate of STEAM integrated with TPACK on each indicator. Then, the data were described in the form of a narrative to get a clearer meaning.

3.2. Data Collection

The data collection technique used was a documentation study technique in the form of thematic books for teachers and fifth-grade students on the theme of animal and human motion organs. Documentation techniques were employed to investigate written objects, such as books, documents, or student assignments. The researchers analyzed content with five dimensions of STEAM-based TPACK in thematic books. STEAM was broken down into S-T-E-A-M in analyzing the occurrence rate of STEAM, integrated with TPACK on each indicator. Considerations could be made based on the needs of the research conducted.

The researchers have ensured that the books used are student and teacher books published by the Ministry of Education and Culture for the 2013 curriculum. The researchers then chose to analyze the content of STEAM-based TPACK integration on animal and human motion organs in teacher books and student books, which all elementary schools in Indonesia use.

3.3. Data Analysis

Data analysis was obtained by searching for data arranged systematically through interviews, notes, and other evidence, which were then concluded so that they were easy to understand, and the information conveyed was well received by the readers. Data analysis was conducted in several stages, including elaborating the data into their respective parts, synthesizing, compiling based on patterns, and sorting the data to be studied. The data were analyzed using the Miles and Huberman technique with the following steps: Data reduction or removing unnecessary data; presenting data by adjusting categories; drawing conclusions on the problem formulation that has been given.

3.4. Validity and Reliability

The instrument used in this study was the integration activity analysis sheet and was validated using the expert test or Gregory test. Here, valid instruments produce valid data as well. The instrument was validated on each indicator using content validity, assessed by two experts in the related material field. Then, it was calculated using the Gregory formula. The following is the tabulation of Gregory's formula.

Table 1. Tabulation of Gregory's formula

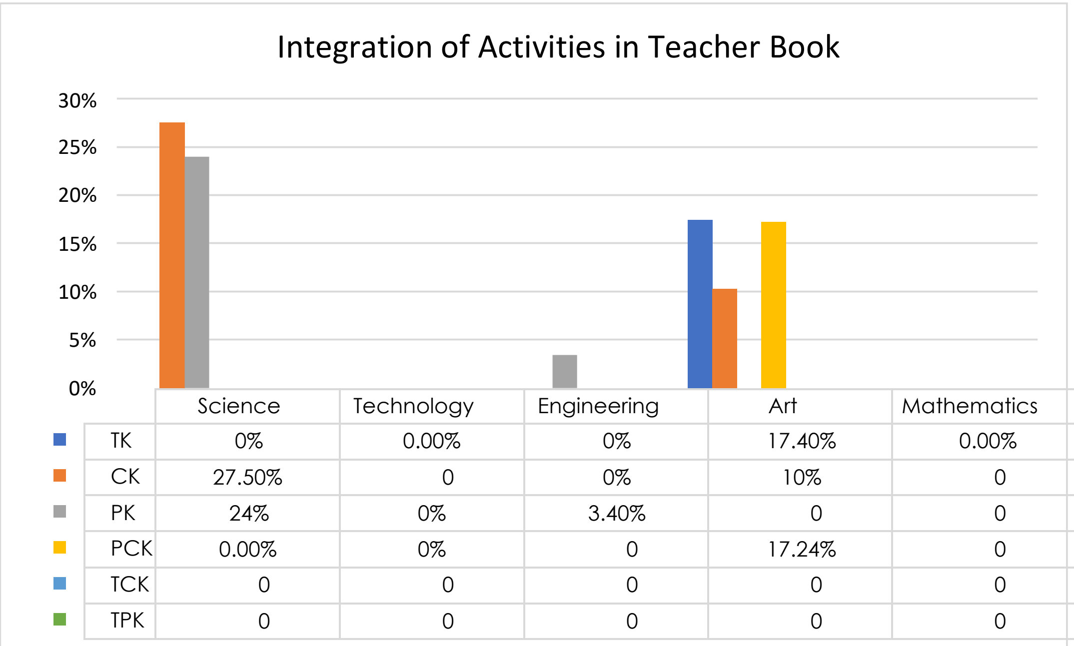
<table>
<tr><td></td><td colspan="3">Expert 1</td></tr>
<tr><td>Tabulation 2 x 2</td><td colspan="2">Less Relevant
(Scores 1-2)</td><td>Relevant
(Scores 3-4)</td></tr>
<tr><td>Expert 2</td><td>Less Relevant
(Scores 1-2)</td><td>A</td><td>B</td></tr>
</table>

	Relevant (Scores 3-4)	C	D

The validity test with Gregory was carried out with an instrument mechanism by researchers and submitted to experts. Then, the experts put a score on each instrument item with a description of a score of 1 or 2, meaning that it is invalid and a score of 3 or 4, meaning that it is valid. After scoring, the assessments given by the expert validators were tabulated into a 2x2 cross-matrix table, as shown in Figure 1.2. The scores were then calculated on average to obtain the instrument validity results. Furthermore, it is necessary to test the validity of the data obtained by increasing persistence. The researchers re-checked the data found by reading related references. Increasing persistence was done by reading various sources related to the research object supported by triangulation theory. Theory triangulation utilizes two or more theories to be combined. It is also necessary to design a complete data collection; thus, a more comprehensive or acceptable data validity will be generated. In addition, the theories used were the TPACK theory, according to Koehler & Mishra (2009) and Oster & Peled (2014), integrated with the STEAM theory by Starzinski (2017) and STEM Task Force Report (2014).

4. Findings

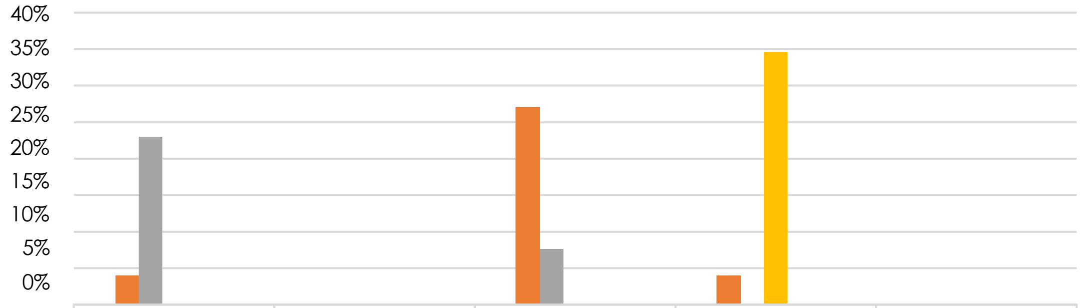
Activities in the thematic books were analyzed based on the integration between the TPACK components and each aspect of STEAM. The teacher book was coded BG, and the students book was coded BS. The analysis showed that every activity in the thematic book did not necessarily include integration between TPACK and STEAM. It was assessed based on operational verbs in each theory of TPACK and STEAM, which were then used as a reference in determining indicators. The occurrence of activities integrated with TPACK and STEAM in the thematic book was then calculated, and the results are presented in Figure 1.



	Science	Technology	Engineering	Art	Mathematics
TK	0%	0.00%	0%	17.40%	0.00%
CK	27.50%	0	0%	10%	0
PK	24%	0%	3.40%	0	0
PCK	0.00%	0%	0	17.24%	0
TCK	0	0	0	0	0
TPK	0	0	0	0	0

Figure 1. Graph of findings regarding integrated activity in teacher book

Figure 1 is a calculation of the total of each finding. The findings of the integrated activities of TPACK and STEAM in the teacher book amounted to 26 items, with the highest finding of integration between content knowledge and science as much as 27.50%. The second highest finding was on the integration between pedagogical knowledge, as much as 24%. It was followed by the third most common finding, namely the integration between technological knowledge with art and pedagogical content knowledge with art, as much as 17.40%. The next finding was that 10% of activities integrated content knowledge with art. Meanwhile, the least findings were found in the integration between pedagogical knowledge and science, which was 3.4%. In addition, it is seen that the indicator that did not appear was mathematics.



	Science	Technology	Engineering	Art	Mathematics
TK	0%	0,00%	0%	0	0,00%
CK	4,00%	0	27%	4%	0
PK	23%	0%	7,60%	0	0
PCK	0,00%	0%	0	34,60%	0
TCK	0	0	0	0	0
TPK	0	0	0	0	0
TPACK	0	0	0	0	0

Figure 2. Graph of findings regarding integrated activity in the student book

In Figure 2, the activities in the students book were 26 items, with the most findings on integration between art and pedagogical content knowledge as much as 34.60%, almost half of the findings. The next highest finding, 27%, was on activities that integrated content knowledge with engineering. However, it is possible to integrate more than one occurrence within a single activity. The analysis results are presented in the form of a table below:

1) Integration of Science with TPACK

a) Integration of Science with Content Knowledge

Table 2. Integration of Science with Content Knowledge

Code	TPACK and STEAM Integration	Indicator	Item	Page	
				Teacher Book	Students Book
S1/P6	Integration of Science with Content Knowledge	Containing the ability to prepare learning in a unique way owned by integrating one subject with science subjects, which are	Preparing learning by motivating students	66	
S2/P4				115	
S2/P6				141	
S3/P6				214	
S1/P1			Integrating other subjects with natural science subjects	3	
S1/P1				16	
S1/P5				44	
S1/P6				53	
S2/P1				58	
					199

Code	TPACK and STEAM Integration	Indicator	Item	Page	
				Teacher Book	Students Book
		modified in one content			
Total				**9**	

Table 2 shows that this indicator appeared in teacher and student books as much as 4% and 27.50%, respectively. The indicators appearing in the teacher book uniquely explained the educators' ability to prepare for learning. Typical learning started by motivating students. The next indicator appeared in the student book: integrating science subjects with other subjects.

b) Integration of Science with Pedagogical Knowledge

The combination of science and pedagogical knowledge can be in the form of group formation and activities to initiate learning. The following are the content analysis results on thematic books:

Table 3. Table of Contents Integration of Science with Pedagogical Knowledge

Code	TPACK and STEAM Integration	Indicator	Item	Page	
				Teacher Book	Students Book
S3/P5	Integration of Science with Pedagogical Knowledge	Containing the ability to design, organize, and apply effective learning strategies to attract the creativity of students until the natural science learning objectives are achieved	Containing learning strategies in the form of presentations		178
S3/P6					182
S3/P6					191
S2/P1			Containing learning strategies in the form of demonstration	81	
S1/P5			Containing learning strategies in the form of discussions	55	
S2/P2				91	
S2/P4				116	
S3/P5				203	
S2/P2					68
S3/P5					178
S3/P6					182
S2/P6			Containing learning strategies in the form of games	142	
S3/P6				215	
Total					13

Table 3 shows that TPACK and STEAM integration indicators appeared in 24% of teachers' books and 23% of students' books. It is shown that TPACK implementation, namely pedagogical knowledge in natural science subjects, was in the form of organizing classes and applying effective learning strategies. Effective learning can be through discussion activities, groups, learning while playing, and others.

2) Integration of Engineering with TPACK

a) Integration of Engineering with Content Knowledge

Table 4. Content Integration of Engineering with Content Knowledge

Code	TPACK and	Indicator	Item	Page

	STEAM Integration			Teacher Book	Student' Book
S1/P2	Integration of Engineering with Content Knowledge	Containing the ability to design, organize, and apply effective learning strategies to attract the creativity of students until the natural science learning objectives are achieved	Containing learning strategies in the form of presentations		15
S2/P2					66
S3/P2					136
S3					192
S3					194
S3					195
					200
Total				7	

Table 4 shows that the emergence of indicators of integration of TPACK with STEAM was only in student books, as much as 27%. It is clear that there were orders for students to follow the procedures for carrying out activities. Following the activity, the procedure is included in the engineering indicators, namely the existence of relevant activities regarding the steps or procedures for making something.

3) Integration of Engineering with Pedagogical Knowledge

Table 5. Table of Contents Integration of Engineering with Pedagogical Knowledge

Code	**TPACK and STEAM Integration**	**Indicator**	**Item**	**Page**	
				Teacher Book	**Students Book**
S2/P1	Integration between Engineering and Pedagogical Knowledge	Containing class organizing techniques that aim to guide students to learn independently	Containing group formation activities	54	
Total				1	

Table 5 shows that the emergence of indicators of STEAM integration with TPACK, which was only found in the teacher book as much as 3.4%. The indicator indicates an order to organize the class by forming small groups. Students discussed with their groups while educators continued to supervise and guide the discussion.

4) Integration of Art with TPACK

a) Integration of Art with Content Knowledge

Table 6. Integration of Art with Content Knowledge

Code	**TPACK and STEAM Integration**	**Indicator**	**Item**	**Page**	
				Teacher Book	**Students Book**
S2/P5	Integration between Art and Content Knowledge	Containing content that integrates the arts with other sciences through activities that increase the creativity of students in solving problems	Containing content that integrates art and other subjects	133	
S3/P5				205	
S1/P1					10
S1/P5			Containing content that invites students to increase their creativity in	56	

Code	TPACK and STEAM Integration	Indicator	Item	Page	
				Teacher Book	Students Book
			solving problems through works of art		
Total				4	

Table 6 shows that there was an integration between art and the teacher's ability to collaborate on other subjects, packaged in the form of activities. 17.40% of integrated activities were found in the teacher book and 4% in the students book. This activity aims at training students in solving problems through activities to increase creativity. The subjects combined with art in the research results are science. Students are asked to draw a book cover design in accordance with a predetermined theme.

b) Integration of Art with Pedagogical Content Knowledge

Table 7. Integration of Art with Pedagogical Content Knowledge

Code	TPACK and STEAM Integration	Indicator	Item	Page	
				Teacher Book	Students Book
S1/P6	Integration between Art and Technological Knowledge	Increasing students' creativity through artistic activities, such as fine art, sound art, or craft art, which are packaged according to technological developments	Containing measurements of student creativity through artwork activities	69	
S2/P5				131	
S2/P6				142	
S1/P1					15
S1/P4					43
S1/P6					55
S2/P2					66
S2/P6					115
S3/P2					136
S3/P5					172
S3/P4			Containing measurements of students' creativity through sound art activities		157
S2/P5			Containing measurements of student creativity through drawing art activities	133	
S3/P5				205	
S3/P5					176
TOTAL				14	

Table 7 shows that an integration between art and pedagogical content knowledge in teacher and student books as much as 17.24% and 34.60%, respectively. The indicator mentioned the existence of learning activities through works of art. Works of art that can be applied by learning are in the form of visual arts, sound arts, and drawing arts.

5. Discussion

The STEAM application in learning activities is considered effective since STEM has an effective way to engage students in higher-order thinking and improve problem-solving skills by placing science and mathematics in the context of technology and engineering (Firdaus & Rahayu, 2019). STEAM can also collaborate with the ability of teachers, i.e., TPACK. In particular, the activity focuses on professional development to improve teacher skills related to teaching knowledge in various situations (Zufriady & Kurniaman, 2019). In this study, the activities in the fifth-grade thematic book on animal and human motion organs indicated that they had not utilized the technology in the teacher book, both simple and modern. In terms of simple technology design, it must be careful, considering the affordability of available technological tools and choosing the most appropriate tool for students to complete learning activities (Wang, 2019). In addition, the mathematical aspect of the thematic book in theme 1 about animal and human motion organs also did not appear because, in this theme 1, it only contained subjects of natural science, arts and culture, social sciences, civic education, and Indonesian language, while mathematics was on another theme. The following is a further discussion of the findings:

1. *Integration of Science with Content Knowledge*

   The indicator in the content was the ability to integrate natural science subjects with other subjects, modified in a content. Activities found in the teacher book were as much as 27.50% and 4% in the students book. The indicators that emerged were the ability to prepare subjects in a typical way, followed by motivating students. Giving motivation can be used as a driving force, both from within and outside oneself [9]. Motivational activities are also included in TPACK's ability, i.e., delivering and preparing content well. In addition, more items that appeared in the indicators of the integration of science with content knowledge were collaborating with the content of science lessons with other subjects (Koehler & Mishra, 2009).

   Indicators appeared in the form of the ability to prepare subjects in a typical way, followed by motivating students. Giving motivation can be used as a driving force, both from within and outside oneself (Rumbewas et al., 2018). The content of science subjects was accompanied by motivational activities from educators. After the motivational activity, the students' curiosity about the picture above grew. More items appeared in indicators of the integration of science with content knowledge, namely, collaborating the content of science lessons with other subjects. Madden et al. (2013) stated that science is a visible science that attracts students' attention and is experienced in everyday life. The scientific content in this content and activity was material for animal movement organs, integrated with Indonesian subjects in the form of determining the main ideas in writing. Thus, students can understand the information conveyed through the content presented (Triwati, 2021).

2. *Integration of Science with Pedagogical Knowledge*

   In this integration, the indicator that appeared the most was containing learning strategies for managing the classroom in the form of discussions. Discussion is a conversational process involving a group of people to share and receive information to unite minds so that problems can be solved. In this case, students were active when doing project-based learning and enthusiastic about conducting experimental group activities and discussing (Naila, 2020). Observing indicators are also included in the early stages of a scientific approach to natural science subjects (Melita Rahardjo, 2019).

   The following findings appeared on game-based learning indicators. Learning by using games is included in the provision of content, which is included in the indicators of pedagogical knowledge. Learning science through games is interesting and interactive, prioritizing cooperation and communication to increase curiosity (Irwan et al., 2019).

3. *Integration of Engineering with Content Knowledge*

   Activities integrated with engineering and content knowledge were found in 27% of students' books. Engineering found in this activity is that students were asked to follow a procedure for implementing the activity. Here, children practice an activity according to procedures (Selly, 2017). Thus, engineering with content knowledge is the right integration to be combined with being presented through activities in thematic books. One of the success factors is the mastery of the material the teacher owns (Azhar & Muchtar, 2022). Learning can be said to be successful if the teacher can convey a procedure for implementing learning well, followed by students who accept and follow a procedure. One of the success factors is the mastery of the material the teacher owns (Azhar & Muchtar, 2022).

4. *Integration of Engineering with Pedagogical Knowledge*

   These findings appeared on indicators that included group-building activities led by educators. It is in accordance with the pedagogical knowledge application. The results of other studies also mentioned positive results in the achievement of learning outcomes; it could be seen from the evidence of knowledge and skills transfer revealed after one year of teaching done with peers (Watulingas et al., 2022). Moreover, cooperative learning can be applied according to predetermined procedures. With the formation of groups or cooperative learning, students will try to master the material and solve the problem together (Slavin, 1990). Pedagogical science plays a crucial role in teaching and is supported by teachers' ability in pedagogical knowledge. Teachers must study the knowledge that will be learned to students (Ayık & Coştu, 2021).

5. *Art Integration with Content Knowledge*

   In accordance with the indicators that appeared, the integration between art and content knowledge was 5%. The indicator that most often emerged was in the first item, i.e., being able to integrate one subject with art in the teacher book. Thus, the purpose of learning art is to improve cognitive abilities and self-creativity and explore further the experiences obtained (Swaminathan & Schellenberg, 2015).

6. *Art Integration with Pedagogical Content Knowledge*

   In the students book, the indicators that appeared in the activity were in the form of increased activity through art activities. In this regard, the element of art in learning is an important aspect. Art will be more meaningful when combined or integrated with the teacher's abilities (Mu'minah & Suryaningsih, 2020). Art itself has many types, but in this thematic book, art types were found in the form of fine art, sound art, and drawing art. The application of art in thematic books can be presented as activities that students can carry out.

6. Conclusion

Based on the analysis results of the thematic books of teachers and students of fifth-grade elementary schools on the theme of animal and human motion organs, it can be concluded that the activities in the student and teacher books contained STEAM-based TPACK integration. Meanwhile, the integration that was not found was the integration between all aspects of TPACK and mathematics. This consideration was carried out based on the absence of content in mathematics subjects on the theme of animal and human motion organs. On the other hand, the most integrated activities were in the arts, with pedagogical content knowledge as much as 34.60%, found in student books, and the integration between science and content knowledge. Similar to the content in student books, activities in both student books and teacher books were not found to be integrated with mathematics. This study implies that it is hoped that the thematic evidence, integrated with TPACK and STEAM, helps smooth teaching and learning activities in elementary schools. This study is expected to be a reference for the book publishing team to improve the book quality so that the STEAM and TPACK aspects are presented well.

Limitation

The limitation of this research is that it analyzes thematic books only on certain themes. Coverage is still limited to the theme of animal and human movement organs. In addition, this study also only focuses on books in grade 5 elementary school, has not analyzed thoroughly in high grade for the theme of science learning.

Recommendation

Recommendations based on the results of this study, namely the results of the analysis indicate that the integration of STEAM based on TPACK in thematic books still needs to be improved. Teachers need to develop STEAM-based learning, not only based on pedagogic, personality, social, and professional skills. Rather the ability to integrate TPACK in learning to adapt learning in the 21st century

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Conflict of Interest

Researchers in researching and publishing articles there are no elements that indicate conflict of interest.

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