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THE IMPACT OF AN INTEGRATED STEAM PROJECT DELIVERED VIA MOBILE TECHNOLOGY ON THE REASONING ABILITY OF ELEMENTARY SCHOOL STUDENTS

Yulia Elfrida Yanty Siregar[1], Yuli Rahmawati[2], Suyono[3]

[1]Doctoral Student of Basic Education, Universitas Negeri Jakarta (Indonesia)
[2,3]Faculty of Mathematics and Natural Sciences, Universitas Negeri Jakarta (Indonesia)

yulyasiregar@gmail.com, *yrahmawati@unj.ac.id*, *suyono@unj.ac.id*

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Abstract

The aim of this research is to describe the impact of implementing an integrated STEAM Project in mobile technology on the Mathematical Reasoning ability of elementary school students and to describe the process of designing an integrated STEAM Project and mobile application. A quantitative descriptive and quasi-experimental research design was employed, with data collection of test (pre-test and post-test), and Questionnaire A pre-test, and post-test was administered to determine the impact of the STEAM Project on students' reasoning abilities. A sample of 130 fifth grade students, 70 female students, and 60 male students from different elementary schools in Meuraxa District, Aceh Province, Indonesia participated in the research. Results show that an empirical analysis of mobile technology is valid and feasible for use with fifth grade elementary school students. Prior to implementing the STEAM Project, the average pre-test of reasoning ability was 40.44 with a standard deviation of 10.27. After implementation, the average score improved to 84.01 with a standard deviation of 7.31. The results of a Paired Sample Correlation obtained a mathematical reasoning ability score before and after implementation of the STEAM Project of 0.452. The calculations in the N-GAIN test table for the implementation of the STEAM Project on Reasoning Ability found 76 students, or 58.46 %, in the high category, and 54 students, or 41.54%, in the medium category. The results of this study provide information, and recommendations for the development of learning models that could improve reasoning abilities. The project could be used as a reference template to accelerate the recovery of quality education during challenging times such as a pandemic.

Keywords – STEAM project, Mobile technology, Reasoning ability, Elementary school.

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1. Introduction

The Covid-19 virus inhibited the face-to-face learning process necessitating educational institutions to resort to online or distance learning. Letter Number 4 of 2020 from the Minister of Education and

Culture in the Republic of Indonesia addressed the Implementation of Educational Policies in an Emergency Period for the Spread of Covid-19, and explained that learning process at home, through interactive and non-interactive online learning should provide meaningful learning experience for students. Online learning is a model of learning carried out using an internet network and electronic tools such as laptops and iPads (Brown, 2020; Miller, MacLaren & Xu, 2020; Song, Wu & Zhi, 2020). Teachers could use mobile technology to maintain teaching elementary school students during Covid-19 lockdowns (Christensen & Knezek, 2017). In addition to developing digital literacy, communication technology can be integrated into the learning process and provide access for the use of mobile and wireless technology in education that's mobile technology (Goktas, 2009; Groff, 2008; Sayre, 2008). Mobile learning begins with the expansion of e-learning with wireless and mobile technology (Cheon, Lee, Crooks, & Song, 2012; Sharples, 2000).

Four main policy strategies were carried out by the Indonesian Ministry of Education and Culture during Covid-19. The first strategy encouraged teachers to educate students in life skills and to contextualize education according to their respective conditions. Secondly, learning from home activities and tasks should vary between students according to their interests and the conditions regarding access to learning facilities at home. Third, through online learning, teachers should be creative and innovative in the use of learning strategies that successfully achieve learning objectives. In addition, teachers should design online learning by utilizing appropriate media to provide wider opportunities for students to explore the learning materials.

The policy strategies introduced during Covid-19 needed to improve students' life skills by integrating technology in a distance learning environment. An integrated STEAM project, based on the pedagogical imperatives of 21st century learning, is recommended as a vehicle for students to develop their life skills in a culture of innovation, creativity a collaboration. (Broggy, Reilly & Erduran, 2017; Chen & Lin, 2018; Erdogan, Navruz, Younes & Capraro, 2016; Hadinugrahaningsih, Rahmawati & Ridwan, 2017). By including a STEAM component to cooperative, project-based learning students will actively build their own knowledge and understanding within a constructivist pedagogical environment (Aktürk & Demircan, 2017; Kang & Kim, 2014). Projects developed within a STEAM framework require students to use developing technologies such as computing to help understand science and mathematical concepts through inquiry, and by paying attention to ethics, and aesthetics as art (Henriksen, 2017; Yakman, 2008).

Research question is any impact of implementation an integrated STEAM Project in mobile technology on the Mathematical Reasoning ability of elementary school students? How to describe the process of designing an integrated STEAM Project and mobile application? This research was conducted elementary schools Meuraxa District, Aceh Province, Indonesia.

1.1. Reasoning Ability and STEAM Project Integrated Mobile Technology

In a recent Indonesian national exam, the average score of 45.52% in mathematics continued to occupy the lowest position among the subjects tested. A result that indicates the mastery of concepts and the application of mathematics by Indonesian students is low compared to like countries (Puspendik, 2019). Results of the 2018 Program for International Student Assessment (PISA) test ranked Indonesia 74th out of 79 participating countries, and than the average math score of Indonesian students in the 2015 PISA assessment, it was 386 to 379 in 2018. The 2018 PISA Country Note stated that in mathematical competency only 28% of Indonesian students managed to reach level 2 or higher and only about 1% of Indonesian students reached level 5 or higher. A level 2 ability requires students to represent simple situations mathematically, while level 5 represents the ability to model complex situations. Test results indicate that many Indonesian students have difficulty solving simple mathematical problems (OECD, 2019).

Trends in Mathematic and Science Study (TIMSS) 2019 Assessment Framework on mathematical ability ranked Indonesian students 44th out of 49 participating countries with a score of 397. Indonesian students' poor performance on international assessment is the result of not being exposed to math problems that hone their mathematical reasoning skills (Hadi & Novaliyosi, 2019). An inability to reason mathematically indicates that the type of learning opportunities students are exposed to have not adapted to change. Teaching continues to focus on making students recognize and understand concepts, without first establishing a strong relationship to their previous knowledge.

Learning mathematics according to National Council of Teacher of Mathematics (NCTM), standards will produce students who are ready to compete in a global society and If the five standards are implemented. Five standards are thinking before acting by developing their; problem-solving, reasoning and proof, communication, connection, and representation skills (National Council of Teachers of Mathematics, 2013). They will work through a process of analyzing problems and creating solutions by making connections between disciplines and generating ideas to solve problems that they understand (Suren & Kandemir, 2020; Thanheiser & Sugimoto, 2020). By following a series of procedures, students will more easily achieve learning outcomes and build confidence in their ability to solve other problems.

Creativity, confidence, problem solving and collaboration important skills in the 21st century play important roles in different fields, including. Several teaching approaches have been developed to engage students in developing these skills. One of the approachers is STEAM-based Project to develop critical and creatice thinking skills (Rahmawati, Ridwan, Hadinugrahaningsih & Soeprijanto, 2019; Siregar, 2019). A STEAM Project invites students to solve problems related to everyday life by thinking comprehensively based on the five STEAM disciplines. Students develop mathematical reasoning skills, think critically and creatively, develop a positive attitude towards the subjects, and cultivate their character. In addition to collaboration, and communication are essential elements of the STEAM learning process as students solve problems by working in groups (Hadinugrahaningsih et al., 2017; Siregar, 2019; Taylor, 2018). The personal and interpersonal responsibilities embedded in the group process help students' build on their understanding of the learning material (Jamali, 2017; Negreiros, 2017; Rahmawati et al., 2019; Shaughnessy, 2013; Sokolowski, 2019). A STEAM Project invites students to understand contextual phenomena and encourages students to learn by exploring their individual and collective abilities (Harwell, Moreno, Phillips, Guzey, Moore & Roehrig, 2015). By using a STEAM Project approach, teachers can challenge students to solve problems in mathematical terms as well as well as in science, technology, engineering and art.

Reasoning is made up of five interrelated processes of mathematical thinking, categorized as sense-making, conjecturing, convincing, reflecting, and generalizing (Figure 1). (Bjuland, 2007).

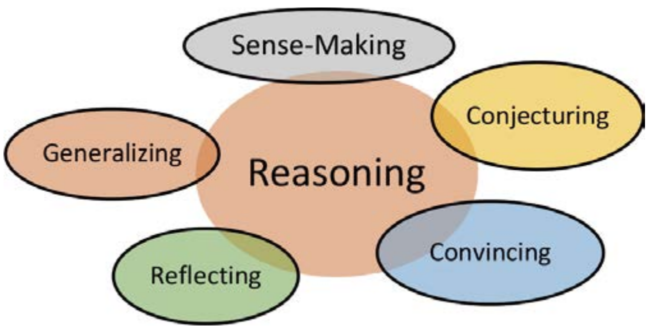


Figure 1. Reasoning Ability Indicator (Bjuland, 2007)

Sense-making is closely related to building problem schemas and communicating them by using symbols or mathematical language. Conjecturing is the activity of predicting a theory and a conclusion based on incomplete facts. Convincing is carrying out or implementing a settlement strategy based on the two previous processes. Reflecting is an activity to re-evaluate the three processes that have been carried out by looking back at their relationship to theories that are considered relevant. Generalizing takes in the whole process and identifies and conclude (Bjuland, 2007; Holyoak & Morrison, 2005; Lewis & Smith, 1993).

Reasoning is part of analytical thinking (Stein, Grover, & Henningsen, 1996). The learning activities have been designed according to STEAM for promoting analytical thinking skill in engineering and mathematics with the focus on learners ability to apply knowledge for creating work or innovation by problem solving appropriate for various situations (Kelley & Knowles, 2016; Ruangsiri, Nuangpirom & Akatimagool, 2020a). High order analytical skills, thinking competencies are divided essential components: (1) Component analysis, which includes the ability to identify, differentiate, and record information, (2) Relationship analysis, which includes the ability to find and relate them logically and appropriately, (3) Principles analysis, including the ability to mark goals or steps, and synthesize conceptual principles, and (4) Possibility or result analysis is the ability to develop knowledge applicable for work as we as to create innovation (Standar Nasional Pendidikan, 2005; Ruangsiri, Nuangpirom & Akatimagool, 2020b).

The application of STEAM Project related to everyday life is necessary to support analytical thinking elementary school students so that they are better prepared to face global competition. Reasoning also supports the improvement of mathematical ability, because it correlates information and processes as part of the problem-solving process. Five step STEAM project integrated mobile technology for student elementary school (see Figure 2).

Figure 2. Five step STEAM project integrated mobile technology for elementary school (Hadinugrahaningsih et al., 2017; Laboy-Rush, 2011)

First at reflection step, students are directed to brainstorm related knowledge that has been obtained from the mobile application or from other additional references. Second, at the planning stage to explore student knowledge towards abstract knowledge with collaboration. Third, in the developing stage, students formulate and interpret the context of problems in everyday life to get solutions to problems. Fourth at the application stage, the cognitive and psychomotor skills that have been obtained are transformed by designing a project that is carried out together with team work. Fifth, at the communication stage, character planting to appreciate the work of others becomes an important point at this stage. Students present their work, and express themselves through written or oral short stories related to their experiences in the mobile application.

Each stage of STEAM Project encourages students to be active learners and complete a project by starting with important questions, then developing project plans, preparing schedules, monitoring students and project progress, testing and evaluating results, and evaluating experiences. (Arnellis, Fauzan, Arnawa, & Yerizon, 2021; Rohaeti, 2016; Ruangsiri et al., 2020b).

2. Methodology

The aim of this research was to test the feasibility of teaching a STEAM Project, via mobile technology, to elementary school students. A second aim was to describe the impact of the STEAM Project on the elementary students' ability to reason mathematically. The research problem addressed by this project focused on whether a students' reasoning abilities increased by using mobile technology to deliver an Integrated STEAM Project. A quasi-experimental method with qualitative descriptions was used to gather data and report on the research.

2.1. Participants

Probability samples using a random sampling technique were used to select 130 fifth grade students for the research project. The group consisted of of 70 female students and 60 male students from different Elementary School in the Meuraxa District of Aceh Province in Indonesia.

2.2. Data Collection

Prior to conducting the research, an observation pre-test was used to diagnose whether students' reasoning abilities needed improving. Research data collection with tests (pretest and post test), and Questionnaire.

After analyzing the results of the pretest, next stage is the mobile application design. After the draft of the mobile application is complete, the stages of validation, evaluation and revision are carried out on the mobile application. The results of the evaluation of the experts validation, one try-out trial, Small group try-out, and Field Try-out. The finalization of the mobile application product has been valid and implemented (Figure 3).

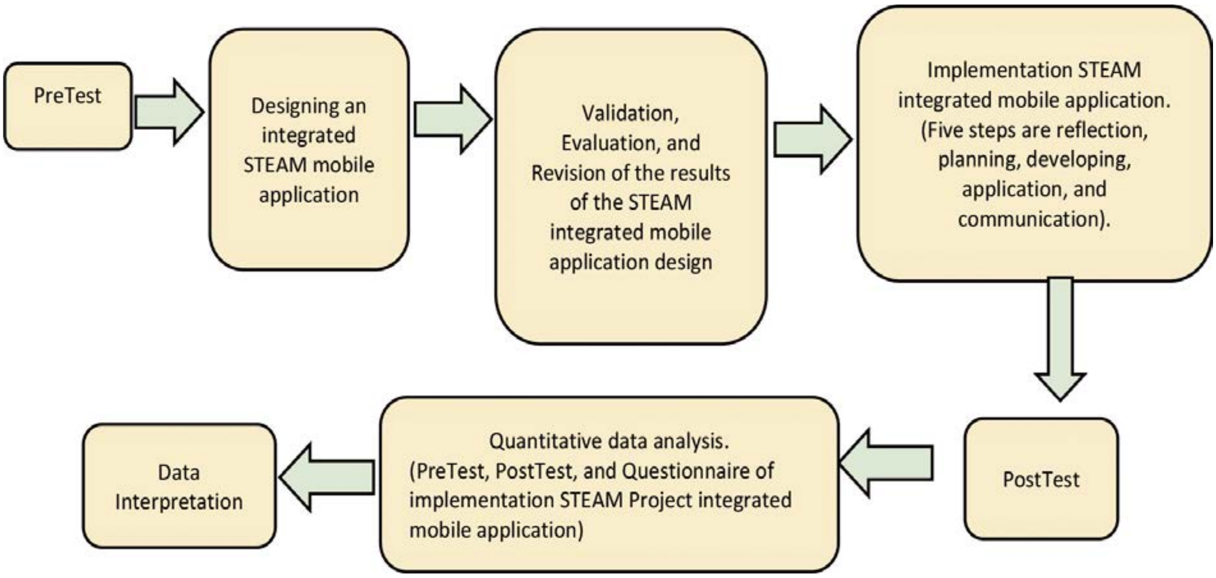


Figure 3. Research Flow and Data Collections Quantitative STEAM integrated mobile application

2.3. Research Design

Prior to the implementation of the STEAM Project a development design was carried out using the Dick and Carey Model of Instructional Design. Dick and Carey model focuses on the interrelationship between elements in the design process (Figure 4). This elements are context, content, learning and instruction. Then, on this model between Instructor, learners, materials, instructional activities, delivery system, and learning work together to produce the desired outcomes.

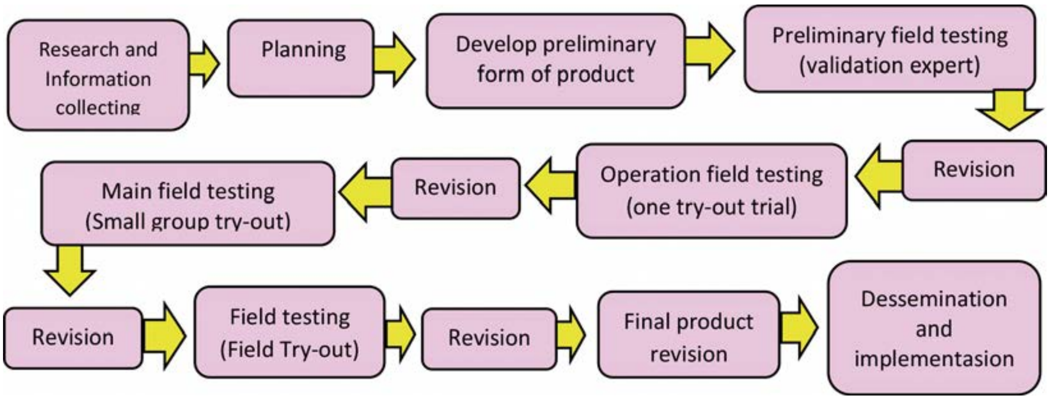


Figure 4. Flow chart Dick and Carey Model use to Design Instruction

The students' learning characteristics were then analyzed and the learning program arrange according to the STEAM Project integrated mobile aplication steps are reflection, planning, developing, application, and communication. In this study, students are given the opportunity to make products hidroponic for know consept volyme. During the lesson, students are given worksheets and reflective journals by mobile application, and than while the teacher, assisted by one observer, made observations to analyze the effectiveness of integrating implementation STEAM project and their impact on the development of students' reasioning.

2.4. Research Instruments

The draft mobile technology design was validated after consultation with five experts from the fields of Educational Technology, Elementary Mathematics and Science, Elementary School Curriculum, and Indonesian Language. The improvement and completion of the mobile technology materials were carried out as a result of feedback from the experts validation. Then, experts validation filled out the assessment sheet, questionnaires comprising of 20 questions were given to experts validation who were asked to choose answers by marking each item according to their opinion STEAM Project integrated mobile application (Table 1). Score using a 5-point Likert scale ranging from 1 (poor), 2 (fair), 3 (good), 4 (very good) and 5 (excellent).

After revision from the experts validation, next validation of one try-out trial, Small group try-out, Field Try-out. Students filled out the assessment sheet, questionnaires comprising of 20 questions. Students were asked to choose answers by marking each item according to their opinion STEAM Project integrated mobile application. Score using a 5-point Likert scale ranging from 1 (poor), 2 (fair), 3 (good), 4 (very good) and 5 (excellent) (Table 2).

Assessment Aspect	Questionnaire Items of Expert Validation
Design View /Layout	1,2,3,4,5, 6,7,8
Text/Typography	9,10,11,12,13
Language	14,15,16,17,18
Interactive link	19,20

Table 1. Questionnaire of Expert Validation

Assessment Aspect	Questionnaire Items of Student Validation
Easy to use (Navigation)	1,2,3
Design View (Display)	4,5,6,7,8,9,10
Content/Material Quality	11,12,13,14,15,16,17,18,19,20

Table 2. Questionnaire of one try-out trial, Small group try-out, Field Try-out

The draft reasoning ability instrument was designed in consultation with three expert validators from the elementary mathematics field. The reasoning instrument was improved after consultation (Table 3)

Questionnaires comprising of 20 questions for implementation STEAM Project integrated mobile application. Score using a 2-point ranging from 0 (No), and 1 (Yes) (see Table4).

This questionnaire is also a guide and reflection for teachers in implemention STEAM learning in the classroom. Questioner were given to teacher who were asked to choose answers by marking each item according to their situation and opinion during implementation STEAM Project integrated mobile application.

Reasoning Ability Indicator Activities	Basic competencies	Question Item Number	Questionnaire Items of Expert Validation
Sense-making, students construct problem schemas and represent knowledge. then try to communicate through symbols or mathematical language.	4.5 Resolve issues related to volume of Solid Figure	1	1,2,3,4,5
Conjecturing, students carry out predicting activities.	3.5 Analyze and determine the shape of Solid Figure.	2	6,7,8,9,10
Convincing, students implement solving strategies	4.4 Solve daily problems related to Solid Figure.	3	11,12,13,14,15
Reflecting, students carry out evaluation activities by looking back at their relationship with relevant theories.	4.6 Making nets of Solid Figure.	4	16,17,18,19,20
Generalizing, students make a conclusion obtained from collected facts.	3.4 Explaining the characteristics of Solid Figure.	5	21,22,23,24,25

Table 3. Questionnaire Items of reasoning ability instrument

Five stages of STEAM Project integrated mobile application	Focus activities students	Questionnaire Items
Reflection	Students brainstorm on the knowledge that has been obtained on the mobile application or from other references.	1,2,3,4
Planning	Students explore towards abstract knowledge from various references. Based on the information that students have obtained, students make a portfolio, and than submit portofolio from mobile application.	5,6,7,8
Developing	Students formulate and interpret the context of everyday life problems to find solutions to problems. Students are given problems to solve.	9.10,11,12
Aplication	Students and their groups collaborate to complete projects. Students are also directed to be able to write and take pictures or videos in completed project steps.	13,14,15,
Communication	Students are directed to present, and express themselves through written and oral short stories related to their experiences during project design. The results of the project are uploaded via the mobile application	16,17,18,19,20

Table 4. Questionnaire of Implementation STEAM Project integrate mobile application

3. Result and Discussion

3.1. Validation of Mobile Learning

Based on instructions from the Minister of Education and Culture in the Republic of Indonesia addressed the Implementation of Educational Policies in an Emergency Period for the Spread of Covid-19, and result of pre-test showed reasoning ability students was low. So, takes a learning that could improve students' reasoning and interactive online learning was created to provide meaningful learning experience for students via mobile application. This application is named "M-Learning Sekolah Dasar". Mobile device was choose, because based on the results of needs analysis, students answered gadgets one of the technologies often used.

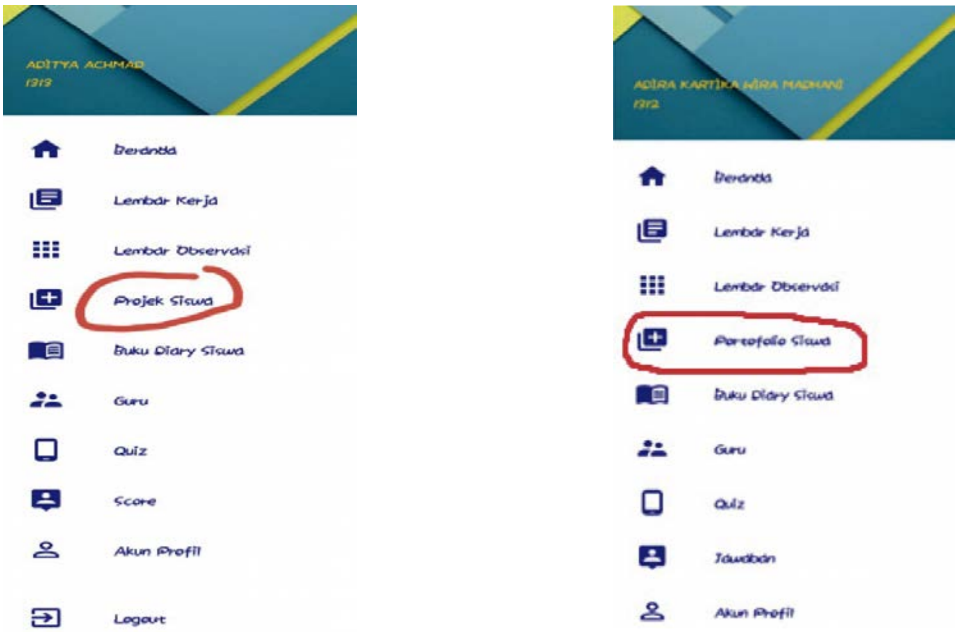
According to research (Jensen, Neeley, Hatch & Piorczynski, 2017; Sokolowski, 2019), STEAM Project design and development can improve students' reasoning. So, developed a learning that integrated the STEAM Project and the Mobile application.

Expert validation suggested improving the background colour by using a lighter colour more attractive to elementary school age students. Improvements to the accuracy of the colour proportions with a more appropriate layout was also suggested with the accuracy of the font size making it easier to read. A third, improvement focused on the menu and image layout.

The Figure 5 shows the main menu display before and after suggestions made by the psychological validator, and the educational technology validator that the display was unattractive and not in accordance with the characteristics of elementary school students.

(a) Before Revision (b) After Revision

Figure 5. Layout Before & After Revision



(a) Before Revision (b) After Revision

Figure 6. Layout Before & After Revision

Figure 6 shows the main menu display before and after suggestions from the Indonesian Elementary School and curriculum validator that the display had incorrect spelling and that the student project display should be replaced by a student portfolio.

Figure 7 shows the student project menu before and after the educational technology and mathematics validator pointed out that the display could not be accessed, and the mathematics material could be downloaded by students in pdf form.

(a) Before Revision (b) After Revision

Figure 7. Layout Before & After Revision

Assessment Aspect	Questionnaire Items of Expert Validation	Average Questionnaire Items of Expert Validation
Design View /Layout	1,2,3,4,5, 6,7,8	4,6
Text/Typography	9,10,11,12,13	4,7
Language	14,15,16,17,18	4,8
Interactive link	19,20	4,8

Table 5. Results of expert validation Integrated STEAM Project for Mobile Technology

In Table 5, the results of expert validation on aspect layout an average of 4.6, aspect text/typography an average 4,7, aspect language an average 4,8, and aspect interactive link an average 4,8. Result shows that all items are valid and can be tested for fifth grade elementary school students. The evaluation form of suggestions was used to improve and complete as a follow-up by the researchers before tested for student.

After making improvements to suggestions from experts. Next, it was tested to students. Stages of one to one try-out trial was carried out with a total of 5 students, selecting students with the same characteristics and abilities of students. Then, students filled out the assessment sheet, questionnaires comprising of 20 questions. Students were asked to choose answers by marking each item according to their opinion STEAM Project integrated mobile application. Score using a 5-point Likert scale ranging from 1 (poor), 2 (fair), 3 (good), 4 (very good) and 5 (excellent).

Assessment Aspects	Questionnaire Items of Student Validation	Average Items of Student Validation
Easy to use (Navigation)	1,2,3	4,7
Design View (Display)	4,5,6,7,8,9,10	4,7
Content/Material Quality	11,12,13,14,15,16,17,18,19,20	4,8

Assessment aspect	Problem Finding	Solutions
Easy to use (Navigation)	The application is very good, but it often takes a long time to upload images and videos because the size is large and internet quota is not optimal.	Added admin storage capacity.
Design View (Display)	-	-
Content/Material Quality	-	-

Table 6. Results of one to one try-out trial

Assessment Aspect	Questionnaire Items of Student Validation	Average Items of Student Validation
Easy to use (Navigation)	1,2,3	4,6
Design View (Display)	4,5,6,7,8,9,10	4,7
Content/Material Quality	11,12,13,14,15,16,17,18,19,20	4,7

Assessment aspect	Problem Finding	Solutions
Easy to use (Navigation)	Internet network is not optimal.	Request to student change provider internet and give extend time for submit assignments.
Design View (Display)	-	-
Content/Material Quality	-	-

Table 7. Results of small group try-out

In Table 6, the results of students trial on aspect navigation an average of 4.7, aspect display an average 4,7, and aspect material quality an average 4,8. The results showed that all items were valid and feasible to be continued. The evaluation form of suggestions was used for improvement and refinement as a follow-up for researcher.

After making improvements to suggestions from 5 students. Next, it was tested to 25 students. Stages of Small group try-out was carried out with a total of 25 students, selecting students with the same characteristics and abilities of students. Then, students filled out the assessment sheet, questionnaires comprising of 20 questions. Students were asked to choose answers by marking each item according to their opinion STEAM Project integrated mobile application. Score using a 5-point Likert scale ranging from 1 (poor), 2 (fair), 3 (good), 4 (very good) and 5 (excellent).

In Table 7, the results of students trial on aspect navigation an average of 4.6, aspect display an average 4,7, and aspect material quality an average 4,7. The results showed that all items were valid and feasible to be continued. The evaluation form of suggestions was used for improvement and refinement as a follow-up for researcher.

After making improvements to suggestions from 25 students. Next, it was tested to 100 students. Stages of Field Try-out was carried out with a total of 100 students, selecting students with the same characteristics and abilities of students. Then, students filled out the assessment sheet, questionnaires comprising of 20 questions. Students were asked to choose answers by marking each item according to their opinion STEAM Project integrated mobile application. Score using a 5-point Likert scale ranging from 1 (poor), 2 (fair), 3 (good), 4 (very good) and 5 (excellent).

Assessment Aspect	Questionnaire Items of Student Validation	Average Items of Student Validation
Easy to use (Navigation)	1,2,3	4,7
Design View (Display)	4,5,6,7,8,9,10	4,8
Content/Material Quality	11,12,13,14,15,16,17,18,19,20	4,8

Assessment aspect	Problem Finding	Solutions
Easy to use (Navigation)	All day application error	Repaired the management system.
Design View (Display)	-	-
Content/Material Quality	-	-

Table 8. Results of Field Try-out

In Table 8, the results of students trial on aspect navigation an average of 4.6, aspect display an average 4,7, and aspect material quality an average 4,7. The results showed that all items were valid and feasible to be continued. The evaluation form of suggestions was used for improvement and refinement as a follow-up for researcher.

3.2. Validation of the Reasoning Ability Instrument

The draft reasoning ability instrument was designed in consultation with three expert validators from the elementary mathematics field. The reasoning instrument was improved after consultation.

Results Table 9 show that all items are valid and can be tested for fifth grade elementary school students. After expert validation, the instrument was tested on 100 students. Instrument tested was carried out when tested the Field Try-out mobile application. Analysis of the reasoning instrument trial is as follows.

Reasoning Ability Indicator Activities	Basic competencies	Question Item Number	Questionnaire Items of Expert Validation	Average Questionnaire Items of Expert Validation
Sense-making, students construct problem schemas and represent knowledge. then try to communicate through symbols or mathematical language.	4.5 Resolve issues related to volume of Solid Figure	1	1,2,3,4,5	Material: 4,6 Design: 4,7 Language: 4,7
Conjecturing, students carry out predicting activities.	3.5 Analyze and determine the shape of Solid Figure.	2	6,7,8,9,10	
Convincing, students implement solving strategies	4.4 Solve daily problems related to Solid Figure.	3	11,12,13,14,15	
Reflecting, students carry out evaluation activities by looking back at their relationship with relevant theories.	4.6 Making nets of Solid Figure.	4	16,17,18,19,20	
Generalizing, students make a conclusion obtained from collected facts.	3.4 Explaining the characteristics of Solid Figure.	5	21,22,23,24,25	

Table 9. Questionnaire Items of Expert Validation

	Correlations	ITEM 1	ITEM 2	ITEM 3	ITEM 4	ITEM 5	TOTAL
Item 1	Pearson Correlation	1	.902**	.869**	.759**	.811**	.914**
	Sig. (2-tailed)		.000	.000	.000	.000	.000
	N	100	100	100	100	100	100
Item 2	Pearson Correlation	.902**	1	.922**	.856**	.904**	.981**
	Sig. (2-tailed)	.000		.000	.000	.000	.000
	N	100	100	100	100	100	100
Item 3	Pearson Correlation	.869**	.922**	1	.785**	.787**	.930**
	Sig. (2-tailed)	.000	.000		.000	.000	.000
	N	100	100	100	100	100	100
Item 4	Pearson Correlation	.759**	.856**	.785**	1	.825**	.914**
	Sig. (2-tailed)	.000	.000	.000		.000	.000
	N	100	100	100	100	100	100
Item 5	Pearson Correlation	.811**	.904**	.787**	.825**	1	.930**
	Sig. (2-tailed)	.000	.000	.000	.000		.000
	N	100	100	100	100	100	100
Total	Pearson Correlation	.914**	.981**	.930**	.914**	.930**	1
	Sig. (2-tailed)	.000	.000	.000	.000	.000	
	N	100	100	100	100	100	100

**. Correlation is significant at the 0.01 level (2-tailed).

Reliability Statistics	
Cronbach's Alpha	N of Items
.954	5

Table 10. Results of Analysis of the Validity and Reliability of Reasoning Instruments

The analysis of the reasoning instrument in the Table 10 to 100 samples, shows the results of the Pearson correlation 0.914 on item 1, 0.981 on item 2, 0.930 on item 3, 0,914 on item 4, 0.930 on item 5, and the results of the reliability test showed a value of 0.954. The SPSS test above, shows the Pearson correlation value between item scores and total scores obtained a significance value < 0.001. For each item the value is smaller than alpha (α = 0.05), indicating that each item of the reasoning instrument is declared valid.

The implementation of the STEAM Project was carried out with 130 respondents from three elementary schools in Banda Aceh City, Indonesia. During the first step, students were given a pre-test then learning activities following the STEAM Project process were carried out using mobile technology. After the learning activity was completed, students were given a post-test questionnaire.

The results of the pre-test carried out by the 130 research respondents obtained an average value of 40.45 on the reasoning ability test (Table 11). Based on the results of pre-test showed reasoning ability students was low. So, it takes a learning that could improve students' reasoning and skills. The STEAM Project design and development can improve students' mathematical reasoning as well as teach them how to learn to know, learn to do, and learn to be through the process of engaging in the learning activities (Jensen et al., 2017; Sokolowski, 2019). Teaching using mobile technology has the potential to provide effective learning opportunities for students.

Mean	N	Std. Deviation	Std. Error Mean
40.45	130	10.27	.90101

Table 11. Results of Average Pre-test Mathematical Reasoning

The post-test activity was carried out to see what impact the STEAM project had on the development of students' knowledge and how they use written and oral forms to describe and evaluate their experiences while designing projects.

In the post-test evaluation results were limited to only the 10 students per day who were allowed to attend school due to the implementation of social distancing rules during Covid-19. Students worked on five essay test questions to assess the effectiveness STEAM Project integrated mobile application.

An average score of 84.01 was achieved on the reasoning ability test achieving the high category (Table 12). Based on the average results of the pre-test and post-test, it was identified that using mobile technology to deliver STEAM Projects has the potential to have a positive effect on mathematics learning. (Mayes & Gallant, 2018) support this finding by explaining that learning media that combines text and visual learning is better than text, and than STEAM Project learning can development, skills, knowledge, and understanding in designing STEAM interdisciplinary projects (Bakermans, 2018; Wilson & Javed, 1996; Peters, 2018).

The effectiveness of a STEAM Project delivered on mobile technology can be determined using the difference test of two averages (t-test). Before to test of difference between two averages (t-test), test data analysis requirements by testing normality of pre-test and post-test. After knowing the normality of data, data tested for homogeneity can be tested for effectiveness using the t-test.

The results of the data analysis of normality test, homogeneity test, and the difference between two averages (t-test) are as follows in Table 13.

The Kolmogorov-Smirnov statistical results show a reasoning pretest of 0.117, and Sig or p-value = 0.000 ≤ 0.05, H_0 rejected or the results of the reasoning pretest are normally distributed on population. The statistical results of Kolmogorov-Smirnov on the results of post-test reasoning 0.239, and Sig or p-value = 0.000 ≤ 0.05, H_0 rejected or the results of the post-test reasoning were normally distributed in the population. It can, therefore, be concluded that the pre-test and post-test data are normally distributed. The results of the homogeneity test are as follows (Table 14).

The results of statistical analysis in the Levene Statistics table are obtained F = 16.527; and p-value = 0.000 ≤ 0.05 or H_0 rejected. Thus, the reasoning ability data from the pre-test and post-test results are homogeneous. Furthermore, the results of the average difference test (t-test) of the Pre-test and post-test of reasoning ability can be seen as follows (Table 15).

Mean	N	Std. Deviation	Std. Error Mean
84.01	130	7.31674	.64172

Table 12. Results of the Average Post-test Reasoning

Tests of Normality	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	Df	Sig.
Reasoning Pre-test	.117	130	.000	.981	130	.073
Reasoning Post-test	.239	130	.000	.874	130	.000

[a]Lilliefors Significance Correction

Table 13. Normality Test with Kolmogorov-Smirnov

Test of Homogeneity of Variances			
Results reasoning Pre-test & Post-test			
Levene Statistic	df1	df2	Sig.
16.527	1	258	.000

Table 14. Homogeneity Test Results

Paired Samples Statistics					
		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	PRETEST	40.4462	130	10.27306	.90101
	POSTEST	84.0154	130	7.31674	.64172

Paired Samples Correlations				
		N	Correlation	Sig.
Pair 1	PRETEST & POSTEST	130	.452	.000

Paired Samples Test									
		Paired Differences					T	Df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	PRETEST - POSTEST	-43.56923	9.54219	.83691	-45.22507	-41.91339	-52.060	129	.000

Table 15. Test the difference of two means (t-test) Pre-test and Post-test Reasoning

Category	Total students	Student Percentage
High	76	58.46
Medium	54	41.54
Low	0	0
Total	130 Student	100%

Table 16. Data on the calculation results of the N-GAIN test

The Paired Samples Statistics table shows the average pre-test of reasoning ability obtained a score of 40,44 and standard deviation 10.27. After implementing the STEAM Project on mobile technology, the results of reasoning rose to obtained a score of 84.01 with a standard deviation of 7.31. This shows a difference in the average reasoning ability of students before and after using the mobile technology to complete the STEAM Project. Furthermore, in the Paired Sample Correlations table, the correlation coefficient of mathematical reasoning ability scores before and after implementing the STEAM Project is 0.452 with sig number, or p-value = 0.000 ≤ 0.05 or not significant.

The table of N-GAIN test implementation of the STEAM Project on reasoning ability shows results scored by 76 students or 58,46 % in the high category and 54 student or 41.54 % in the medium category (Table 16).

The effectiveness test of the STEAM Project obtained t-test and N-Gain test calculations that show differences in the mathematical reasoning abilities of fifth grade students before and after implementation STEAM Project Delivered Via Mobile Technology.

Based on the data above, in the reflection, planning, developing, and application stages, students have carried out all STEAM Project integrated mobile application activities according to the procedure. However at the communication stage, one activity is not carried out by students that is reflection of collaborate with friends. Overall, the percentage of implementation STEAM Project integrated mobile application with Hydroponics theme got a score 19 out of 20 items focused on student activities. This shows that 95% of students have participated in the learning of the STEAM Project integrated mobile application.

It can therefore be concluded that the reasoning ability of students who use mobile technology improved and can be recommended as a learning model to improve reasoning abilities and create solutions to mathematical problems.

The results of this study are supported by research that claims STEAM learning methodology has a positive impact on reasoning abilities (Mayes & Gallant, 2018; Tekerek, 2016; Thuneberg, Salmi & Bogner, 2018).

Figure 8. Students doing a hydroponic project

In this hydroponic project, the meeting of student learning materials on the concept of volume, making unit cubes, identifying the shape of solid figure consisting of rockwoll in the form of blocks, mineral bottles in the form of tubes. Next, students cut rockwool in the form of a unit cube with a size of 2 cm as a medium for seeding mustard greens. In this hydroponic project, students also make a mixture of various types of fertilizers to become homogeneous as hydroponic plant nutrients (Figure 8). The implementation of the volume concept in this project is carried out when students pour nutritional water into mineral bottles as plant pots. The concept of volume is also meaningful to students, because when you pour too much nutrient water, it will cause the plants to rot.

Mathematics acts as a tool for students to represent their ideas in easy-to-understand mathematical language. Mathematics concepts that rely on the NCTM standard equips students to reason, and find solutions to problems by applying and connecting mathematical concepts with STEAM disciplines. Students reported feeling happy about learning mathematics through the STEAM Project. They developed an attitude of thoroughness, self-reflection, and critical and creative thinking that had an impact on their motivation to use mathematics in everyday life. Applying STEAM methodology in the classroom is fun, and develops curiosity and motivation to take part in learning activities (Choi & Hwang, 2018; Kelley & Knowles, 2016; Suciari, Lbrohim & Suwono, 2021).

Based on the opinions expressed by the students, it can be concluded that students are interested in using mobile technology in learning because smartphones are ubiquitous for their age group. Mobile technology can facilitate the teaching of STEAM projects and can provide opportunities for all students to access learning when location and distance to learning institutions are problematic. STEAM delivered by mobile technology can help students achieve learning goals effectively and efficiently. STEAM projects delivered by mobile technology provide real-world experience for students to develop different thinking and creativity skills. STEAM projects also provide another way for teachers to educate students about character building, which has become an important part of education (Chen & Huang, 2020).

4. Conclusion

The study resulted in five important outcomes. First, STEAM integrated mobile application can improve students' reasoning ability. Second, the empirical analysis of Mobile Application considered valid and feasible for use STEAM Project with fifth grade elementary school students. Third, STEAM project integrated mobile application improved the average pre-test results before implementation, the average pre-test of reasoning ability was 40.44, with a standard deviation of 10.27. After implementation, the average result was 84.01 with a standard deviation of 7.31. Fourth, results of Paired Sample Correlations obtained a mathematical reasoning ability score before and after implementation of the STEAM Project of 0.452. Fifth, the results of the calculations in the N-GAIN test table for the implementation of the STEAM Project learning on Reasoning Ability obtained 76 students or 58.46 % in the high category, and 54 students or 41.54% in the medium category. The results of the analysis show the STEAM Project integrated mobile application improves students' reasoning abilities. Improving students' life skills during the COVID-19 pandemic in providing meaningful learning according to the direction of Minister Education and Culture of the Republic of Indonesia. The limitations of this study only to identify reasoning abilities, but there are other findings with STEAM Project Delivered in Mobile Technology also teaches an attitude of thoroughness, abilities of communication mathematics in complete projects. It is suggested for future researchers to identify these findings scientifically.

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