STEAM-Based Learning Media: Assisting in Developing Children's Skills

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Abstract

STEAM is a learning approach combining science, technology, engineering, arts/creativity, and mathematics. STEAM is not only a part of group studies, but also holistically integrates multiple approaches to solve problem. This research is a type of developmental research that aims to create a STEAM-based learning media for early childhood education through the ADDIE model. The data were collected from through one-group pretest-posttest design and analyzed according to the ADDIE developmental research technique. Participants of this research were young children aged 4-6 years who attended preschool and ECE teachers. The result shows that the developed media are proved to be valid in term of material and media feasibility. Moreover, it shows its practicality and effectiveness which comply with the standard use for early childhood education learning media; thus, it indicates that the developed media can be implemented as learning media for early childhood education.

Keywords: *learning media, STEAM, early childhood education.*

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Introduction

The main purpose of organizing early childhood education is to optimize all aspects of children's development and growth in order to prepare the skills required for the future. The 21st century is a century that is inseparable from digital technology development. In accordance with the Regulation of the Ministry of Education and Culture of the Republic of Indonesia Number 21 of 2016 on the Standard Competence for Graduates. In this regulation, the standard competence is stated in the 2013 learning curriculum which consists of soft skills, namely critical thinking, communication, collaboration, and creativity that are believed can be used to face the challenge offered in the 21st century upward. The education needs of the 21st century demand a different direction from previous targets, such as preparing students to face an increasingly stringent world in the struggle for thought and creativity, hence not only hard skills are important but mastering soft skills cannot be left behind (Maulidah, 2018). However, the reality is differently showed. Most learning targets especially in early childhood education focus on mastering hard skills rather than soft skills because it is presumably that children have not yet understood ways in mastering soft skills and it is more important to focus on hard skills as the foundation for future development (Budiyono, Husna, & Wildani, 2020; Afsari, Rusdiyani, & Khosiah, 2022). This situation can be seen from previous research conducted in Probolinggo, where showed only 20% early childhood education's teachers understood and willingly to use interactive technology in learning, while the remaining (80%) were reluctant to use digital-based interactive learning media in learning activity (Darimi, 2016; Cahyani & Sulastri, 2021).

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Teachers only focused on how to deliver the materials without considering its effectiveness in developing students understanding. Another study found that during previous online learning policy due to pandemic restriction, most early childhood education's teachers used WhatsApp as learning media as well communication media for parents and children related to learning activities. However, it was found that this media was not effective because it did not allow children to interactively communicate their difficulties in learning with teacher neither allowed teachers to explain and observe the development of student understanding in the material taught. These phenomena became the pivotal views that made researchers eager to find better and more appropriate approach and method which allow early childhood education's teachers to overcome the problems. Accordingly, STEAM-based approach was proposed to be able to serve as the approach and method used in bridging the situation between young children and teachers in early childhood education.

STEAM is a learning approach that combines Science (study of knowledge), Technology (study of products made for human needs), Engineering (study of design processes used to solve problems), Art (study related to creation and creativity), and Mathematics (study of the language of shapes, symbols, and numbers). STEAM is not just a group of fields of study, but it also blends various approaches holistically to solve problems (Yakman, 2010; Land, 2013; Salsabila & Muhid, 2021; Suryaningsih & Ainun Nisa, 2021). Zubaidah (2019) argues that STEAM is designed purposely to develop various 21st-century skills that are usable in daily life, such as reasoning, problem-solving, critical thinking, creativity, investigative skills, independent learning, technological literacy, collaboration, and other skills as well (Damayanti, et al. 2020; Cahyani & Sulastri, 2021; Suryaningsih & Ainun Nisa, 2021). In addition, this approach (STEAM) empowers teachers to plan and use project-based learning that involves five disciplines and allows teachers to produce a good learning environment that provides opportunities for children to engage and contribute directly (Damayanti, 2020; [a]Wahyuningsih, et al. 2020; [b]Wahyuningsih, et al. 2020). In contrast to traditional teaching models, through STEAM, teachers are able to unify disciplines as well as enhance dynamic synergies between the modeling process and mathematical and scientific contents (Paramita, Yahmin, & Dasna, 2021; Novitasari, 2022). Using STEAM-based learning, the acquired skills can be transmitted into practical skills that are necessary to have in the 21st century.

There was various research conducted related to STEAM-based learning media which showed how it was able to improve teacher competence in pedagogical aspects as well as its assistance to facilitate learning activities. However, most of them discussed on how STEAM used as learning media for students and rarely discussed or developed media which assisted teachers in teaching-learning activities. Consequently, this research development was conducted in order to develop learning media that could assist Early Childhood Education teacher, especially for teachers' preschool and nursery in designing learning activity. Although this research objectively aims to find out the practicality and effectiveness of the product developed from R&D research, this research was limited in term of the number of participants (groups to test the product effectiveness), duration of intervention given (period when the media used in learning activity), and other internal aspect of children as well as teachers who carried out the learning media. In addition, this research was a cycle of R&D where the revision and adjustment did not carry out after the first evaluation given. Furthermore, this research implicates to early childhood education stakeholders as well as policy makers as it can serve as reference for considering the STEAM-based learning media as one of options in providing the appropriate approach to develop skills necessary for future challenges.

Method

This research is a kind of research and development which aims to develop STEAM-based learning media. In this study, the R&D model selected was ADDIE developed from Sugiyono (2016). Hence, the referred ADDIE model used in this research was consisted of five stages, namely: analyzing, designing, developing, implementing, and evaluating (see Fig. 1).

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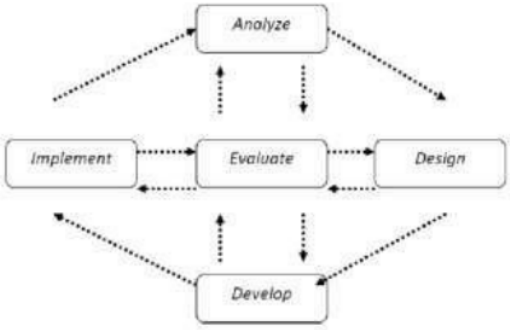

Figure 1. ADDIE Research Model

Stage 1: *Analyzing*; the main activity in this stage is to analyze the existed problem. In order to carry out this activity, several actions need to be done, such as surveying (to related parties/institution involved), drafting possible problems which are obtain from observing and documenting learning media and tools used by institution that have not fully implemented the STEAM-based learning approach (especially in early childhood education). Then, it is followed by consultation with and confirmation from related experts. In this stage the researchers conducted needs analyses which carried out through observation and interview to the targeted population.

Stage 2: *Designing;* in this stage, the researchers design and prepare the learning media which are based on STEAM approach, meaning that the designed learning media should be constructed on Science, Technology, Engineering, Art, and Mathematics.

Stage 3: *Developing;* this stage focuses on how to develop the design that is previously created into a prototype. In this research, the prototype developed is in form of the STEAM-based learning media for early childhood education especially for kindergarten.

Stage 4: *Implementing;* this stage shows how the product developed (prototype) used in real learning activities. This implementation is purposely done in order to find out the effect of the product to the learning quality (whether it can improve the learning outcomes or not). The intended qualities are including the effectiveness, attractiveness, as well as efficiency for learning activity. Moreover, prior to carry out this stage, the product (prototype) was examined by the related experts in order to determine its feasibility and advisability (for both material used and media technology). After examined by the experts, the product was given to the stakeholder in order to determine its readability.

Stage 5: *Evaluating;* the last stage in ADDIE is evaluation. The evaluation is performed for all stages (from stage 1 to 4). There are two types of evaluation performed, one is formative evaluation and second is summative evaluation. Formative evaluation is performed to collect data on each stage (from analysis to implementation) in order to perfect the product; while summative evaluation is performed at the end of the research in order to determine product's readability according to teachers or stakeholder's viewpoints. Evaluation is a form of analyses from the implementation results of the prototype. In this research, the evaluation was performed only up to the data obtained from the experts (serving as validators) and responses obtained from young children after the intervention given (prototype was implemented). Considering the responses, the data intended were related to find its advisability and practicality of the developed learning media for early childhood education.

Furthermore, to obtain the data related to product advisability and practicality, the product was given to participants as an intervention. The participants were thirty children

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aged 4-6 who attended three preschools and six ECE's teachers who taught in the preschools located in Surabaya and Sidoarjo, Indonesia. These participants were selected in order to test the media's practicality and effectiveness for learning. In addition, to test the media feasibility the experts conducted testing in terms of material and media advisability. The data were obtained through one group pretest-posttest design in the pre-experimental design method.

Data Analysis

After data were collected through interviews, observations, questionnaires, and documentation they were analyzed qualitatively and quantitatively. Instruments were validated using questions and scored, then scale according to the Linkert scale in order to determine the category. The questions used for the validation were developed from previous research conducted on STEAM-based learning (Gustiani, 2019; Zhang, Yang, & Wang, 2019; Dewi, Astawan, & Suarjana, 2021; Efiawati, et al. 2021; Sari, Jumadi, & Ekayanti, 2021; Fatmawati & Aziz, 2022). In addition, the verification was carried out by the experts of the respective disciplines. To measure data validity and practicality, the percentage from score obtained is calculated then scale according to criteria set previously. The scale criteria were developed and modified from Ridwan (2012) and was calculated using the formula as below:

$$P\ (100\%) = \frac{total\ score\ obtained}{maximum\ score} \text{ x } 100\ \%$$

The percentage is then scale using the criteria set for its validity (see Table 1), practicality (see Table 2), and effectiveness (see Table 3). For validity, the test was done by the respective experts (for material was carried out by material expert and for media was carried out by media expert). Each expert examined the media respectively according to each expertise. For practicality, data were obtained through questionnaires given to children who participated in this research. The responses were then calculated to obtain the percentage using the formula and scale using the criteria set. Meanwhile, in order to see the effectiveness of the learning media, the N-gain formula was used to calculate the data before scaling into the criteria set according to 5-scale Linkert scale. The N-gain formula to calculate the effectiveness of the research is as below:

$$\text{N–gain} = \frac{(S\ post - S\ pre)}{(S\max - S\ pre)}$$

Notes:

N-Gain	: skill improvement
S post	: posttest score
S pre	: pretest score

Table 1. Criteria of Validity

Interval	Category
81% - 100%	Strongly valid
61% - 80%	Valid
41% - 60%	Fairly valid
21% - 40%	Invalid
0% - 20%	Very invalid

Table 2. Criteria of Practicality

Interval	Category
81% - 100%	Very practical
61% - 80%	Practical
41% - 60%	Fairly practical
21% - 40%	Impractical
0% - 20%	Very impractical

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The effectiveness analysis was obtained based on how effective the product developed improving young children's skills. The improvement is seen in the score difference between the pretest and posttest. The pretest was conducted before children were given the media as an intervention (using non-STEAM-based learning media), and the posttest was conducted after the interventions were given (using STEAM-based learning media). As this research was developmental research, the ADDIE model was implemented as the model to conduct the research. In ADDIE, there are five stages carried out in developing the product, namely: Analysis, Design, Development, Implementation, and Evaluation. These stages were carried out inferentially through normalized N-gain analysis.

Table 3. Normalized *N-Gain* Criteria

Interval	Category
$0.00 < gain < 0.30$	Low
$0.30 \leq gain < 0.70$	Average
$0.70 \leq gain \leq 1.00$	High

(*modified from Hake in Pratiwi et al. 2021*)

Result and Discussion

As mentioned earlier, this research is developmental research using the ADDIE research model consisting of 5 stages, namely 1) analytical stage, 2) designing stage, 3) developmental stage, 4) implemental stage, and lastly 5) evaluating stage. These stages can be explained as follows:

Analytical stage

Lee & Owens (2004) define needs analysis as the difference between real conditions and desired conditions which can determine the priority of actions taken. In this research, the needs analysis is carried out to see and analyze the gap between the real situation and the ideal situation. Here, researchers performed a preliminary observation in order to see the real situation. Accordingly, from the preliminary observation, it was found that only 20% of ECE's teachers carry out interactive online learning that provides feedback, while the remaining 80% were using online media which only allowed them to upload materials and notified parents such as WhatsApp. This method proved to be less interesting and easily caused children to lose their attentiveness to the materials taught. In addition to lack of attractiveness, the method used only gave parents opportunities to submit the task given to children without showing children's activeness in learning. It indicated that the learning process did not perform effectively and efficiently. Thus, it created a gap and problem which allows researchers to find the best solutions for effective and optimal learning activities in early childhood education. Accordingly, this research was targeted to develop the appropriate learning media for early childhood education that implements science, technology, engineering, art, and mathematics, so there are preliminary analyses conducted in order to provide the best data prior to designing the product. These analyses can ease the researchers because they provided the information related to problems or conditions that need to be addressed in the designed product.

a) Needs analysis

As previously explained, needs analysis is an important step prior to conduct R&D research. In the ADDIE model, the needs analysis stage focuses more on the gap occurring between the real and ideal conditions (Akkas & Suryawati, 2021; Dewi, Astawan, & Suarjana, 2021). In this research, the needs analysis was carried out first by targeting the early childhood education teachers who taught preschool. In addition to the condition of learning activities, the analysis included the initial understanding of teachers related to

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interactive learning as well as digital-based learning. From the needs analysis, this research found that most targeted populations had less understanding and mastery of the STEAM-based learning approach, especially in developing learning media and tools (see Table 4).

Table 4. Observation sheet for Need Analysis

Observation item	Description
Materials	- Do they meet the 4C standards for ECE learning? - Do they meet the development (4.0 era)? - Do they integrate other disciplines and science in learning? - Are they compatible for the future need?
Teachers' difficulty	- Do they find it difficult to meet the standard set by the government? - Do they understand how to design appropriate teaching-learning strategy? - What kind of problems do they have related to design learning media/strategy that meets the standard required? - What kind of needs do they state to meet the required standard?
Students' acceptance	- Do they enjoy the learning? - Do they understand the materials given? - Do they have any resistant with the teaching-learning activity? - Do they improve their knowledge?

b) Situation Analysis

Apart from the needs analysis, in order to gain a thorough understanding of product development, it is also necessary to carry out an analysis of situations that probably affect the expected outcome (Branch, 2009). The situation analysis was carried out to find out whether there were other conditions/situations in the targeted environment possibly affecting the results while implementing the product developed (Baharuddin, 2018). By then, the result from the situation analysis could serve as a reference for product development. In this research, it was found that the situation in the targeted environment was considered feasible to implement the STEAM-based learning media meaning that the intended media can be developed.

c) Task Analysis

In task analysis, the researchers had to collect data regarding the type of tasks previously given and what kind of tasks were needed by the children in developing their skills (Branch, 2009; Sugiyono, 2017; Baharuddin, 2018). Accordingly, it was found several tasks that related to STEAM-based learning, yet they did not fully indicate the STEAM-based learning approach. Task analysis is conducted to determine aspects that can be used in STEAM-based learning media which intend to develop. Moreover, task analysis will provide a certain view for the researchers prior to design the product, so they can avoid any confusion and ambiguity in designing the product. In this research, the results of task analysis were sent to related experts to be assessed and examined before concluded and given to researchers for the follow up.

d) Problem and Event Analyses

Problem and event analyses that were done in this research include problems and events that occur in the existing environment. These problems were limited to time allocation, lack of student activity in the classroom, and lack of independence in learning (the students' dependence on teachers' instructions on learning materials). Meanwhile, event analysis was related to all activities (events) that happened during learning activities. This analysis was related to the possibility of the product's effectiveness or ineffectiveness. By analyzing important events, researchers can determine the types of materials used and what is not in the developed product.

e) Goal Analysis

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At the goal analysis, researchers analyzed the learning objectives and how it impacts the developed learning materials. In this research, the goal of the R&D research on STEAM-based learning media was to provide better learning media for early childhood education, especially in developing their soft skills to prepare the foundation for future challenges. The specific learning objectives contain statements about the competencies that must be mastered by students after the learning is carried out. From the analysis, it is found the need of STEAM-based learning approach for early childhood education, because it allows young children to develop awareness and habit on the co-existence of science, technology, engineering, art, and mathematics as part of knowledge development.

f) Media and Data Analyses

Media and data analyses are analyses that were done by researchers to get an understanding of what assisting media can be used in the developed learning media as well as how the data obtained were possibly used as data that support the research in designing the product. In media analysis, researchers selected certain media that could be used as learning aids for the developed product. Accordingly, from the selection, the STEAM-based learning proposedly used interactive media that can develop 4 C skills (critical thinking, communication, collaboration, and creativity). In addition to media analysis, researchers conducted analyses on the data obtained from examining the documents related to learning media previously used by teachers, such as lesson plans or learning plans. By then, it was expected that during the following stage, the process of developing STEAM-based learning media for early childhood education can be done smoothly as well as offer the best possible result as desired by the researchers.

Designing Stage

The designing stage is the stage where researchers plan the product manufacture/creation (Branch, 2009; Baharuddin, 2018). Planning is an important stage in making a product (Afriana, Permanasari, & Fitriani, 2016) because it decides how the product will be made as well as what elements are needed to successfully create the product (Arifatun & Sudarmin 2015; Zhang, Yang, & Wang, 2019; Budiyono, Husna, & Wildani, 2020; Cahyani & Sulastri, 2021; Suryaningsih & Ainun Nisa, 2021). In many cases, there are situations where products developed are failed to meet the expected results due to immature planning or incomplete design (Baharuddin, 2018). In the designing stage, researchers need to create/produce an initial product (prototype) or product design. In the R&D research on education especially in learning media development, the intended media developed are mostly consisting of lesson plans, teaching strategies, and media/devices used to aid the learning activity. In this research, the learning media developed consisted of lesson plans and a type of device used in learning. The intended media developed were supposedly created using a STEAM-based approach. Accordingly, all necessary frameworks, materials, and devices, including assessment tools should be in line with the proposed goal which is to develop soft skills that are important for future development. Before creating a prototype, the researchers re-examine the plan and consider all the data found in the previous stage (analytical stage) as the consideration before creating the prototype. After the design was set, the final design had to be validated and verified by experts in the related field. In this research, the validation and verification were done by two senior lecturers and a professor who were experts in early childhood education management and teaching. From the validation and verification, the researchers made revisions and adjustments according to the recommendation and suggestions before the final design was verified and validated. In this designing stage, the final design included all aspects and competences that necessary to have by young children and how the product would become.

Design of STEAM-Based Lesson Plans and Learning Media

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In the design of STEAM-based learning, it is necessary to emphasize the characteristics of learning for early childhood education, namely playing while learning and learning while playing (Yakman, 2010; Setiawan & Saputri, 2019; Zhang, Yang, & Wang, 2019; Zubaidah, 2019). Therefore, the design of the lesson plan must meet these criteria. In contrast to lesson plans in primary and secondary education, in early childhood education, lesson plans are made in the form of daily and weekly (Sujiono, 2016; [a]Wahyuningsih, et al. 2020; [b]Wahyuningsih, 2020; Sumarno, et al. 2021; Novitasari, 2022). This is because the forms of targets, strategies, and learning approaches used in early childhood education are different from other levels of education. In this R&D research, the form of STEAM-based learning design that is made is for daily learning plans based on the developed media. In this daily lesson plan, there are basic competency criteria that are required, namely:

1. HOTs elements for early childhood education
2. 6 aspects of child development (religious moral values, social emotional, physical motor, cognitive, and language and artistic abilities
3. STEAM-based learning approach
4. an assessment of child development.

From the daily lesson plans made, teacher was asked to make a weekly lesson plan. The results of the lesson plans will then be assessed by a team of experts and researchers whether they meet the STEAM standards and meet the basic criteria for competence for early childhood education. After the lesson plan was made, the lesson plan as well as all learning aids prepared were used as a form of intervention for early childhood learning.

Developmental Stage

The developmental stage is crucial stage because it determines how the product (prototype) will be. Once there is a mistake occurs in this stage, the product (prototype) cannot be produced; hence, it requires careful action in conducting this stage. In this research, the developmental stage was a stage where the researchers attempted to produce the prototype in form of the learning media consisting of lesson plans which include teaching materials, teaching strategy, and media used for teaching. All aspects related to learning media should be referred to the STEAM-based approach which combines science, technology, engineering, art, and mathematics. after the initial prototype was made according to the final design, the initial prototype was given to the experts in order to be validated and verified its advisability and readability. Accordingly, the final result for this stage was in form of media that can be used in teaching, including lesson plans, workbooks, handbooks, teacher's guidelines, and complimentary media for teaching.

Implementing Stage

In implementing stage, researchers did experimental actions by using the prototype in the real situation. In this experiment, there are two actions performed. Each action purposely to determine whether the product developed was valid, reliable, feasible, and advisable to be used as learning media in early childhood education. The first stage was by given the prototype to groups of experts in order to assess the validity and reliability of the product developed in term of materials and media used technically. In this action, the results from experts stated that the product developed met the requirement in term of materials and media for early childhood education. These were proved by the 85% indicators formulating the learning goals, 81.25% of materials and media provably meeting media requirement for the stage of child development, and 75% of reliability in learning assessment. These results indicated that the first action in implementing stage was fulfilled meaning that the product developed (prototype) was valid and reliable to be used as learning media in early childhood education.

Consequently, after the first action was done, it was followed by the group testing. This test was carried out in order to determine the feasibility and advisability of the prototype for

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the real users (young children and ECE teachers). In this action, there were two tests were done, one was small group test and next was big group test (consisting more participants than the previous group). For the targeted participants, this research was targeted young children aged 4-6 years who attended preschool located in Surabaya and Sidoarjo. Population of these participants was taken from three preschools, two were located in Surabaya and another was located in Sidoarjo, East Java, Indonesia. In this research, researchers were carried out the steps of field testing developed by Rusijono & Mustaji (2008), namely individual testing, small group testing, and group (larger group) testing. In individual testing, the experiment was carried out to three young children (randomly selected from participants) and an ECE teacher to determine the feasibility and advisability of the prototype. For the children, in each selected preschool, a child was randomly selected as a subject. While a teacher was randomly selected of three preschools. The result of this test showed that the product was both feasible and advisable to be used as learning media, proved by the improvement of participants tested (young children) and the easiness of ECE teacher in implementing the media. Next, it was a small group testing. In order to further proving both feasibility and advisability of the product developed, the product had to be implemented in bigger scale; hence, the small group testing was carried out. In this test, the participants were 9 children (3 were randomly selected from both preschool) and two ECE teachers who were randomly selected of the three preschools. In this test, the product was given to the young children as well as teachers. Later, the researchers asked the teachers to use the product to develop lesson plan as well as strategies to develop soft skill as stated in learning goal.

The results of the small group testing showed that the product developed was both feasible and advisable in term of improving young children's skills and teaching easiness; thus, these indicate that the product met the requirement for the following test, a group testing. Group testing is the final testing for the implementing stage. This test is mandatory because it can prove that the product developed from R&D research is applicable because it meets all the requirements and standard needed. In this research, the last testing was conducted on all participants (three classes). Each class consisted of 10 young children and two teachers (one lead teacher and an assistant). In this group testing, the results obtained proved that the product developed was able to meet all the standards and requirement that can be used as learning media for early childhood education (see Table 3).

Evaluating Stage

The last stage in the ADDIE research model is the evaluation stage. In this stage, there are two evaluations conducted, namely formative evaluation and summative evaluation. However, in this research, it was only a formative evaluation conducted. This decision was made due to the scope and the round of this research, meaning that this research was the first round of R&D research which requires follow-up research by providing bigger populations and duration of the experiment in order to find out possible variables that have not yet been seen in this research. Researchers conducted a formative evaluation to determine the quality of the system developed. This evaluation was performed on the handbook with a STEAM-based learning approach and other media used in teaching. These media were supposedly able to increase young children's creativity. The evaluation was targeted to determine the media's validity, practicality, and effectiveness. Product validity was assessed by validators of media experts and material experts (see Table 5). The practicality of the product was assessed from teachers' responses which were obtained through questionnaires given to teachers and young children (see Table 6). Product effectiveness was measured through the pre-test and post-test which were given before and after the product was implemented to determine the initial and final abilities of young children. The analysis of the effectiveness of the product in increasing children's abilities is calculated using N-Gain (see Table 7).

From the analyses, it was determined that the product considered as valid according to the result obtained from the expert validators. It was seen that in term of content validity

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(considering content, language, presentation, and design), all indicators proved that the product was strongly valid (91%); while in term of media validity (pedagogy, construction, and technique) the product was strongly valid as well (90%). Both results indicated that the product was valid and feasible to be used as learning media for early childhood education, especially in preschool.

Table 5. Product Validation

No	Validator	Indicator	Score	Result (percent)	Category
1	Content Expert	Content feasibility	24	$P\,(\%) = \frac{91}{100}\ x\ 100\% =$	Strongly valid
		Language feasibility	22		
		Presentation feasibility	23	0.91 x 100% = 91%	
		Learning design	22		
2	Media Expert	Pedagogy	22	$P\,(\%) = \frac{81}{90}\ x\ 100\% =$	Strongly valid
		Construction	26		
		Technique	33	0.9 x 100% = 90%	

For the practicality, the data were obtained from the field testing (small group and larger group). Whilst the product was implemented, participants were given questionnaires to find their responses referring to product practicality (easiness in using). From the data obtained, the analysis shows that the product developed was practical and easy to use, meaning that it met the requirement for practicality evaluation (see Table 6).

Table 6. Response Recapitulation

No	Testing	Score		Percentage		Category
		Yes	No	Yes	No	
1	Small-group testing	57	3	95%	5%	Very practical
2	Group testing	184	16	92%	8%	Very practical
	Total =	**241**	**19**	**93%**	**7%**	**Very practical**

Meanwhile, for the effectiveness, the data were obtained from the results of pre and post tests and calculated using N-Gain formula. The data were taken from both small group testing and larger group testing. Both groups were tested because the researchers desired to see the effectiveness seen when the product was tested in both group testing. From the analysis, the result shows that in both testing the N-Gain score considered high (0.71) meaning that the product considered effective as learning media for early childhood education.

Table 7. *Pre-test* and *Post-test* Recapitulation using *N-Gain*

No	Testing	Mean *N-Gain* Score	Category
1	Small-group test	0.71	High
2	Group test	0.71	High

Discussion

Early childhood education is supposedly aimed at optimizing all aspects of children's development and growth in order to prepare them for facing all challenges offered in the future (Sujiono, 2016; Avisati & Schwabe, 2019; Damayanti, et al. 2020; aWahyuningsih, et al. 2020; bWahyuningsih, et al. 2020; Efiawati, Syafrida, & Parapat, 2021; Fatmawati & Aziz, 2022). In the 21st century, people need to acquire various skills, not only hard skills but also soft skills because the challenges faced will come in many different forms, conditions, and situations (Badriyah, Anekawati, & Azizah, 2020; Damayanti, et al. 2020; Budiyono, Jusna, & Wildani, 2020; Cahyani & Sulastri, 2021; Lestari, 2021). In accordance with the Regulation of the Ministry of Education and Culture of the Republic of Indonesia Number 21 of 2016, students need to be competent in soft skills because they will compete with more people who come

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from around the world and own various abilities. Some of the soft skills that should be acquired are critical thinking, communication, collaboration, and creativity (Cahyani & Sulastri, 2021; Lestari, 2021). Accordingly, the need to develop a learning media that possibly allows the students to obtain and train their soft skills is highly required. Regarding the conditions, one of the learning approaches that can be used to develop learning media is STEAM-based learning. Considering the objective, R&D research is necessary because it can ensure the media selected meets all necessary requirements and standards for learning (Yakman, 2010; Land, 2013; Gustiani, 2019; Lestari, 2021; Zhang, Yang, Wang, 2019; Zubaidah, 2019; Setiawan & Saputri, 2019; Cahyani & Sulastri, 2021; Dewi, Astawan, & Suarjana, 2021). Prior to conduct the research, preliminary actions were carried out by spreading questionnaires, doing observations, and documenting the issues, problems, as well as needs in early childhood education especially preschool. The data obtained indicated the need for media that can facilitate learning especially targeting on improving students' soft skills. In addition, the data from documentation showed that most learning media and tools such as lesson plans did not implement techniques or approaches that combine various aspects of learning such as technology, art, science, and mathematics. Mostly, techniques and approaches applied were separately targeted to the aspects. Therefore, introducing a STEAM-based learning approach in early childhood education was presumably the best decision in order to embed various skills on young children.

In order to develop STEAM-based learning media, this R&D research employed the ADDIE research model developed by Branch (2009) and Baharuddin (2018). In ADDIE research model, there are five stages included, namely: Analysis, Designing, Development, Implementation, and Evaluation. In analysis stage, there are three types of analyses were carried out, namely: need analysis, curriculum analysis, and environment analysis. Need analysis was carried out in order to find out the real situation occurred including issues and problems faced as well as the ideal expected from teaching-learning activities (Baharuddin, 2018). The need analysis was carried out by doing observation and interviews with the related parties (teachers and students). The result from this need analysis, the researchers found out the absence of learning media that can facilitate the teaching-learning which is targeted in improving young children's soft skills as well as combining the various aspects of knowledge. The second analysis was curriculum analysis. In this analysis, researchers conducted research through documentation which was by collecting the necessary documents regarding learning curriculum for early childhood education. The result showed that from the documents obtained, it was not found any curriculum description regarding the combination of various aspects in learning which can assist in improving young children's soft skills. The last analysis was environment analysis. This analysis is important because inappropriate learning environment may cause serious effects in the learning outcomes (Darimi, 2016; Efiawati, Fauziyah, Syafrida, & Parapat, 2021; Salsabila & Muhid, 2021; Afsari & Khosiah, 2022; Fatmawati & Aziz, 2022). From the environment analysis, the researchers concluded that the learning environment in the targeted population were suitable and appropriate to implement the new approach including STEAM-based learning.

The second stage was designing stage. In this stage, the researchers designed the product that was planned to develop (Branch, 2009; Jampel, 2014; Baharuddin, 2018; Adib & Saputri, 2019; Dewi, Astawan, & Suarjana, 2021). In this research, the researchers decided to use STEAM-based learning approach in developing learning media for early childhood education. In designing stage, there were two steps done, first was drafting the product design and second was consulting the draft design. After both steps were done and finalized, the final design was complete and ready to develop into real product (prototype). In the second step of designing stage of this research, researchers consulted to experts who are early childhood practitioners (lecturers and professors) regarding early childhood education. After consulting, the researchers made necessary adjustment to the design as suggested by the experts.

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Following the designing stage, the developmental stage was done. In this stage, researchers developed the final design into prototype. Similar to previous stage, the researchers consulted to the respective experts regarding various aspect of the prototype, such as the possibility of practicality, effectiveness, feasibility, reliability, as well as advisability. After the consultation made and the recommendation obtained, the initial prototype was made into the final prototype consisting of lesson plans, students' handbook, teacher's guidebook, and media used for teaching-learning activity. Before made into final prototype, the similar assessments from respective experts were done. The prototype developed was a learning media that employed STEAM-based learning approach. Further, the final prototype was brought into the next stage, which is implementing stage. In implementing stage, the prototype was given to targeted participants in order to determine its feasibility, reliability, advisability, practicality, and effectiveness. There were two actions carried out in this stage, one was expert validation and two was experimental action. In expert validation, the prototype was given to be validated and verified by experts regarding the content and media. The results for both indicated that the prototype was valid so it could be used and appropriate as learning media (see Table 4). Secondly was the experimental action. In this action, the researchers used the prototype in real teaching-learning condition in order to test its practicality, feasibility, advisability, and effectiveness. There were three tests in this experimental action, one individual testing by using the prototype to three students (individually) and an ECE teacher. These participants were randomly selected from population regardless any condition. The result of this experiment served as reference for the small group testing. In small group testing, the experiment was done to 6 young children and two ECE teachers who were selected from each preschool (one preschool from Surabaya and one preschool from Sidoarjo). Before conducting the experiment, the respective participants were tested (pre-test) in order to find out the student's initial condition. After pre-test was done, the small group (each group consisted of three young children and an ECE teacher) was asked to use the prototype as learning media in teaching-learning activity. After given the intervention, the small group was tested (post-test) in order to see the outcomes. Similarly, in larger group testing, all three actions were done. The larger group consisted of all participants selected from the population. In both group testing, the results showed the improvement of learning outcomes (increase score), meaning that the intervention (prototype) was successfully increase young children's soft skills (see Table 5 and 6). This result indicate that the product (prototype) was reliable, feasible, advisable, practical, and effective to be used as learning media in early childhood education.

Last stage is the evaluation stage. In this stage, all data gathered from all stages were analyzed and calculated in order to determine the reliability, feasibility, advisability, practicality, and effectiveness of the product. In this research, the researchers only employed formative evaluation instead of employing both standard evaluations (formative and summative). This decision was made due to the scope and scale of the R&D research which presumably limited only few numbers of participants and population. The result from the evaluation stage proved that the prototype was possibly used as learning media which embedded the STEAM-based learning approach because it met all the requirements and standards for early childhood education in term of feasibility, practicality, and effectiveness.

Conclusion

In conclusion, this R&D research in developing STEAM-based learning media for early childhood education shows that the media developed was provably feasible, reliable, advisable, practical, and effective as learning media to improve young children's soft skills. These can be seen from the data analyses which indicate that the media were strongly valid and feasible in terms of content and media used (91% and 90%), strongly practical regarding practicality and reliability (95% and 92% for both group testing), and effective and advisable regarding its usefulness (0.71 of N-Gain score).

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Accordingly, researchers suggest follow-up research by increasing the scope of population, the numbers of participants, and the duration of experiments (intervention). This is because the researchers expect the occurrence of other variables which possibly affect the final result; thus, further adjustment for the prototype can be done. In addition, this research implies to serve as reference for other research in early childhood education especially regarding the curriculum design and learning media as well as to all related stakeholders and policy makers who have responsibility and involve in early childhood education prior to make any decision and necessary action to develop early childhood education.

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