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Development of application-based learning for autistic students

Cahyo Nugroho Sigit[1], Muarifin[2], Arief Darmawan[3], Lutfil Amin[4]
[1,2,3] Universitas Negeri Malang, Jl. Semarang No 5, Lowokwaru, Malang City, East Java Province, 65145, Indonesia
[4] Laboratory Special School of the Universitas Negeri Malang, Jl. Semarang No 5, Lowokwaru, Malang City, East Java Province, 65145, Indonesia
E-mail: cahyo.nugroho.2206148@students.um.ac.id

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Abstract: Poor levels of physical activity, cognitive ability, and social interaction are demonstrated in autistic children. These learning barriers in the school environment must be explicitly managed, including in terms of designing objectives, materials, methods, tools, and evaluations to achieve the actual learning objectives. Due to the complex learning barriers in autistic children, conventional learning must be collaborated with assistive technology. Based on these problems, this research aims to develop a drag-and-drop game application equipped with basic motion animation instructions. The research and development method uses the ADDIE model, which consists of five stages. The effectiveness test is carried out with a one-group pretest-posttest design, with treatment for three days and a duration of 105 minutes. With the results of the research based on the results of this overall trial, a score of 81.1% was obtained, which, when viewed from the classification table of product effectiveness scores, was included in the category of very valid for use in learning. The effectiveness test obtained a Sig value. (2-tailed) 0.000 <0.05 means H_a is accepted and has a significant effect on student learning outcomes. This development concludes that although the development results can be used well, teachers' ability to manage classrooms remains dominant in maintaining and regulating the learning focus of children with autism. Therefore, further research can develop and collaborate between assistive technology and learning models for physical education that can be applied and adapted to both group and individual physical activities for autistic children.

Keywords: Adaptive physical education; application; autism.

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INTRODUCTION

The need for learning media in autistic students is based on the needs of children with different learning characteristics. Autistic children tend to learn visually (Padmadewi et al., 2023). Therefore, the learning process for autistic students requires visual media to help students better understand the concept of motion. In this case, conventional methods such as lectures or verbal messages to children are less effective (Haes, 2019). This ineffectiveness is related to children's ability to remember. Prospective memory in autistic students has problems. This prospective memory should play an active role in learning as a memory function in a series of given movement tasks (Sheppard et al., 2018). The prospective memory function in life relates to the ability to remember to perform actions that have been planned and will be carried out in the future. However, in autistic students, this function does not work well because of their low focus on learning materials or objects, which requires an engaging visual approach (Macoun et al., 2021). Apart from the media, the learning approach also actively influences students.

The need for learning media that can be used easily and practically, attract children's focus by children's abilities, interactive command reinforcement, involve children's multi-sensory and focus on cartoon characters is a necessity in learning for children with autism (Fardani & Sayatman, 2020). Ideally, games collaborated with the role of video media have been proven to be an effective intervention in supporting the improvement of social skills for children with autism (Lee & Gutierrez, 2023). Based on previous research, the development of specialized applications for autistic children is still not well developed. This means that in addressing the diverse learning needs of autistic children, physical education teachers also need media that can provide an excellent stimulus to autistic students. This need is based on actual conditions, based on the results of the initial needs analysis, where the media used is limited to static visuals in the form of images and has yet to lead to structured motion animation.

Cognitive abilities strongly influence the learning conditions of autistic students. This cognitive ability is often interpreted with IQ (Siswantoyo & Oktavia, 2018). Intellectual impairment in autistic students is described through a classification of different IQ levels (Wolff et al., 2022). In motor aspects, autistic students with average IQ have impairments in static and dynamic balance abilities (Travers et al., 2013). Then, in autistic children, the agility of throwing, catching, and balance is moderately affected by IQ performance (Ramos-Sánchez et al., 2022). Based on the sources above, basic abilities in autistic children are influenced by diverse levels of intelligence. This diversity of abilities causes autistic students to need help understanding the concept of motion through visual media (Padmadewi et al., 2023). As these characteristics are present, learning media are arranged to be as enjoyable as possible to attract students' interest in learning (Asrul et al., 2014). The game approach through visual media with simple motion tasks can attract the focus and learning interest of autistic students (Almadani et al., 2022). This actual condition is based on observations and needs analysis interviews, which show that teachers still need efficient media in learning, based on video and animation.

Previous research on the development of applications in autistic children for physical education in Indonesia is still not widely developed. However, some developments in learning in general regarding the introduction of thematic concepts have succeeded in creating application-based media in learning, including designing interactive media at Al Mashduqi School on material about weather and seasons, that the media developed can be used and useful in learning (Aini & Tresnawati, 2019). Then, the development of applications to improve fine motor skills in autistic children on the material of recognizing numbers, letters, and counting through the RAD (Rapid Application Development) method with the conclusion that the products developed are suitable for use but still need to be developed more innovatively and creatively so that the appearance in this application looks more attractive to users (Handayani et al., 2019). Another study with the theme of developing android-based learning media, in Special School (SLB) Harapan Bunda, with material on the introduction of the surrounding environment, fruit names, body members, family, and descriptions of body members, in general, in its application is feasible to use. However, some shortcomings

exist, and things that could be improved include the absence of a drag-and-drop gamification design to make the application more optimal (Fardani & Sayatman, 2020). Based on the conclusions of previous research, the implementation of application-based learning in learning can generally be applied to children with autism; it is estimated that the implementation of physical education learning through the development and use of assistive technology, such as applications, has promising potential to improve understanding of motion concepts and visualization of basic movements.

The results of the initial needs analysis were obtained from 6 respondents, including one sports teacher and five phase-a-class teachers. In physical education learning, the need for learning media is 91%, with a note that the types of media needed include visual, manipulative, assistive, and concrete media. Then, 83% of respondents revealed that the media was the main problem in learning for autistic children; this statement was accompanied by a note that the media presented must contain elements of technology, audio-visual, and moving animation. Interview notes from sports teachers show that the visual media in the form of existing static images are considered good but can still be optimized again. Hence, children are more motivated and interested in learning. This statement is supported by the results of the questionnaire, which show that the student response still needs to be improved. Then, in general, 86% of respondents stated the need for teaching media development in video modeling and supporting applications.

Based on these problems, this research aims to develop learning media through moving animated videos packaged in the form of a web-based application called Sobat Bugar. This goal is based on an initial needs analysis. In physical education learning, learning media based on animation or moving videos and integrated applications for physical education in autistic children are still rarely developed. In learning, the media applied is still limited. Then, based on previous research, the applications developed for autistic children are primarily suitable for use but have deficiencies in appearance that are less attractive and lack drag-and-drop gamification design. The contribution of this development, in addition to perfecting the shortcomings of previous research, also makes it easier for students to train conceptual thinking skills through drag-and-drop games and improve basic skills such as dynamic balance, single-leg jump, two-leg jump, underhand throw, and catch.

METHOD

Research Design

The method used is research and development with the ADDIE model (Branch, 2009). It consists of five stages 1) analysis, 2) design, 3) development, 4) implementation, and 5) evaluation. Data analysis used in the form of percentages on Likert scale instruments addressed to material, learning, media experts, teacher practitioners and students.

Participants

The population was 42 students while the selection of samples for this study was purposive sampling of phase-a students at Universitas Negeri Malang, Laboratory Special School (SLB LAB UM). Related subject characteristics as in Table 1.

Table 1. Description of Subject Characteristics

Description	Total	
	F	%
Gender		
Male	40	95,23
female	2	4,76
Age		
6-10	19	45,24
11-15	14	33,33
16-20	7	16,67
>20	2	4,76

Research Instruments

The instrument in this study is divided into three parts: instruments for expert validation tests, instruments for teacher practitioners, and student skill test instruments. Small group trials were used for product trials, with ten subjects, and then for large group trials, with 32 subjects. Then, at the trial stage, the modified tools include using flat markers with symbols, colored balls, and balance beams.

Research Procedure

This development procedure consists of five stages of development where the first stage is analyzing, design, development, implementation, and evaluation. The stages of development are as follows:

1. Analize

   Needs analysis is carried out by interviewing physical education teachers, then continued with observations of the learning process related to the media used and how students respond to the media used. as for the purpose of this stage to identify possible causes of performance gaps, through the stages 1). Validating the performance gap, 2). Determine instructional objectives, 3). Confirm the intended audience, and 4). Identify resources required.

2. Design

   Verifies desired performance and appropriate test methods. through 1). Conducting task inventory, 2). Developing performance objectives, 3). Generating a testing strategy

3. Development

   Product testing through expert justification, as for expert respondents such as material, learning, and media experts. The three experts stated that the media developed was suitable for implementation. Analysis of product feasibility is calculated using the percentage formula (Akbar, 2022), as follows:

$$\text{Validitas audience} = \frac{TSe}{TSh} x\ 100$$

Description:

TSe : Total empirical score

TSh : Total maximum score

To get the overall calculation of the effectiveness of the product developed using combined validity formula (Akbar, 2022), as follows:

$$V = \frac{V^1 + V^2 + V^3}{\text{Number of validators}}$$

Description:

V : Combined validity

$V_1+V_2+V_3$: Score from each validator

After obtaining the total results, they are then classified based on effectiveness criteria (Akbar, 2022), as in Table 2.

Table 2. Classification of product effectiveness scores

No	Score range	Category	Description
1	75,01 - 100 %	Very valid	Used without revision
2	50,01 – 75,00 %	Fairly valid	Used with minor revisions
3	25,01– 50,00 %	Invalid	Unusable
4	00,00 – 25,00 %	Strongly invalid	Prohibited use

4. Implementation

   Implementation was conducted on a total of 10 subjects for small group testing, then large group testing on 32 different subjects. As well as overall learning evaluation assessed by teachers involved in learning through media feasibility instruments.

5. Evaluate

   The evaluation stage aims to provide a reduction in the analysis, design, development, implementation, and assessment activities related to the feasibility or quality of a product that has been developed.

Data analysis

Descriptive statistics like percentages, means, and standard deviation were used to analyze the data related to the study topics.

RESULTS AND DISCUSSION

This section includes an explanation of the results obtained from the research and draws similarities and differences between the research and previous research. The explanation of the research results is described separately according to the ADDIE research stages, related to the results of the data acquisition as follows:

1. Analize

   This activity was carried out on February 2, 2023 through interview activities and observation data, the development needs as in Table 3.

Table 3. Initial Needs Analysis Results

No	Aspect	Component	Description
1	Validating the performance gap	Learning barriers	1. The need for effective communication 2. The need to increase learning motivation 3. The need for learning media 4. Student response has not been maximized
2	Determine instructional objectives	Learning objectives	1. Recognising living things and basic movement characteristics
3	Confirm the intended audience	Supporting media needs	1. Visual media 2. Manipulative media 3. Assistive technology 4. Concrete media
		Student learning needs	1. Concrete learning objectives 2. Interesting media 3. Good learning climate
4	Identify resources required	Student learning interest	1. Contains technology elements 2. Moving picture/video 3. Concrete/rill
		Availability of supporting media	1. Computer 2. LCD projector 3. Projection screen

2. Desain

   The goal of the develop stage is to verify the desired performance and appropriate test methods. The drag & drop game design is based on the introduction of specific animals such as storks, deer and elephants. In particular, the determination of these animals is adjusted to the characteristics of basic locomotor, non-locomotor, and manipulative movements. The game is shown in Figure 1.

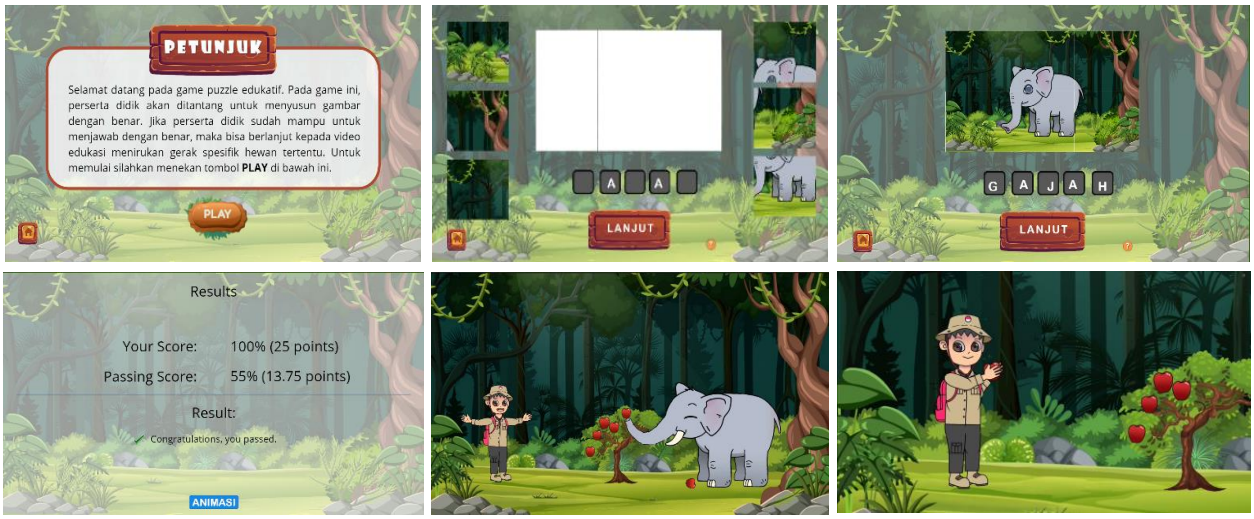

Figure 1. Drag & Drop Games and Interactive Animations

The testing strategy based on its purpose is to provide feedback to the teacher regarding the learning process of students. In this case, assessment of learning outcomes can be taken from tests and students performance in the learning process. The instruments used in measuring the ability of dynamic balance, single leg jump, two leg jump, underhand throw, and catch in this study, related instrument criteria as in Table 4.

Table 4. Student Ability Assessment Indicators

No	Aspects	Criteria
1	Dynamic balance	1. Both hands stretched out 2. Stand on a 3-meter balance beam and alternately step forward 3. Can maintain balance without falling
2	Singel leg jump	1. Arms are bent and raised at waist level while hovering 2. The lead foot takes one step forward and is followed by the other foot bending backwards. 3. There is a short period where both feet are in the air
3	Two leg jump	1. Preparatory movements include flexion of both knees and arms extended behind the body. 2. The arms are extended forwards and upwards, reaching full extension above the head. 3. There is a short period where both feet are in the air
4	Underhand throw	1. The selected hand swings down and back, reaching behind the body while the chest is facing the cone 2. Step forward with the opposite foot with the favored hand towards the cone. 3. Bend the knee to the lower body 4. Release the ball near the floor so that the ball does not bounce more than 4 inches.
5	Catch	1. The preparation stage where the hands are in front of the body and the elbows are bent. 2. The arm is extended while grabbing the ball as it comes. 3. The ball is caught with both hands

3. Development

Product development consists of several stages, namely the product design stage, the expert validation test stage, and the product revision stage. The results, in relation to each validator are contained in table 5 as follows:

Table 5. Expert Test Description

No	Aspects	Score	Description
1	Material expert	85,7	1. Application implementation needs to be optimized 2. The assessment rubric is made simple in accordance with the principles of PE.
2	Learning expert	91,2	1. The need for audio that matches the characteristics of motion tasks in children
3	Media expert	89,7	1. There is a need for guidance in operating the media 2. The clarity of the buttons on the application needs to be clarified with special symbols.
Combined validity		88,9	Very valid and used with minor revisions

4. Implementation

The implementation stage refers to the ADDIE model, on the feasibility of the product on respondents in the form of teacher practitioners as many as 6 subjects. With a small trial group of 8-20 subjects, the first trial was on 10 Laboratory Special School students at Universitas Negeri Malang, related to the overall results on the pre-test assessment of small group tests, students were able to perform the motion tasks given with guidance predominantly by the teacher, then continued with repeated trials on 32 different subjects. The results of the large group trial are contained in Table 6.

Table 6. Description Of Student Ability Assessment on The Large Group Test

No	Aspects	Description	
		Pre-test	Post-test
1	Dynamic balance	60,42	81,25
2	Singel leg jump	64,06	81,25
3	Two leg jump	60,42	82,81
4	Underhand throw	65,63	71,88
5	Catch	63,02	73,44

Based on the calculation of the average student ability through the pre-test and post-test tests (Table 6), a prerequisite test is carried out in the form of a normality test. This data calculation uses the *Kolmogorov-Smirnov* test which is calculated through SPSS software. This normality test is intended to determine the distribution of a normally distributed data. With the provisions of normally distributed data if it meets the criteria for the calculated sig value > 0.05. As for the related normality test calculation results as in Table 7.

Table 7. Kolmogorov-Smirnov Normality Test

	N	Test statsistic	Sd	Sig. (2-tailed)
Kolmogorov-Smirnov	32	0,113	3,00	0,200

Based on the Table 7, the researcher can conclude that the calculation of the normality test using *Kolmogorov-Smirnov* shows a significance value of 0.200 > 0.05, so the conclusion of this distribution data is that this research data is declared normally distributed. Then testing the homogeneity test through the *Levene-test*, with the criteria of sig value > 0.05 then the data is declared homogeneous. The results of the homogeneity test calculation are listed in table 8 below:

Table 8. Levene's Homogeneity Test

	Levene Statistic	df1	df2	Sig.
Based on Mean	2,051	1	62	0,157

Based on the Table 8, the researcher can conclude that the calculation of the homogeneity test using the *Levene test* shows a significance value of 0,157 > 0,05 so the conclusion of this distribution data is that the research data is declared homogeneous. Then it can be continued by using the parametric statistical *Paired Sample t-Test* according to Table 9.

Table 9. Independent Samples Test

			95% Confidence		
	t	Mean difference	Lower	Upper	Sig. (2-tailed)
t-test for Equality of Means	-3,765	-4.625	-7.080	.000	0,000

The data in the Table 9 of results from calculations using the *Paired Sample T-Test* approach method obtained Sig. (2-tailed) = 0,000. These results are smaller than 0.05, therefore it can be concluded that the hypothesis H_a is accepted and H_o is rejected, which means that H_a is accepted and there is a significant effect on student learning outcomes using drag & drop game media and interactive animation.

5. Evaluate

The development of the application that was carried out based on the assessment of the three expert validators stated that the media developed was suitable for use, then on the results of the trial on the aspect of suitability with a score of 85.5%, then on the aspect of attractiveness with a score of 80%, the aspect of clarity with a score of 80%, the aspect of convenience with a score of 80%, and the aspect of effectiveness with a score of 80%, with this overall validity obtained a score of 81.1% which when viewed from the classification table of product effectiveness scores is in a very valid category for use in learning. Even so, notes from the results of the trial outline that although the application of the application developed is considered effective, it is still the dominant role of the teacher to manage and direct all students in learning. The results of the evaluation of the application of the media are shown in Table 10.

Table 10. Description of Teacher Assessment on The Large Group Test

No	Aspects	Score
1	Suitability	85,5
2	Attractiveness	80
3	Clarity	80
4	Ease	80
5	Effectiveness	80
Combined validity		81,1

Based on the results of research into the development of applications for children with autism, that in basic movements in the form of dynamic balance, single leg jump, two leg jump, underhand throw, and catch the concept of selected movements is focused on training postural stability in children with autism. Based on the pre-test results show the average test result of 62,71 and dominantly on the underhand throw item of 65,63. While in the post-test, the average test result was 78,13 and the dominant high in the two legs jump test item was 82,81. Calculations using the *Paired Sample T-Test* approach method from the pre-test and post-test results obtained a Sig value. (2-tailed) = 0.000 <0.05 therefore, it can be concluded that the hypothesis H_a is accepted and H_o is rejected, which means H_a is accepted and there is a significant effect on student learning outcomes by using drag & drop game media and interactive animation. The increase in basic movement skills in autistic children is assumed to be due to the supporting media used in addition to the drag and drop game and basic motion animations in the form of dynamic balance, single leg jump, two leg jump, underhand throw, and catch to strengthen children's understanding of the concept of movement. Then due to various cognitive function disorders and limited motor abilities, the implementation of this application is also accompanied by patterned supporting media such as flat markers that are symbolized by two soles of the foot for two leg jump movements and patterned one foot for single leg jump movements to make it easier for children.

Autistic children experience developmental delays in movement caused by social interaction, behavioral and emotional disorders (Atmaja, 2019). Therefore, the fulfillment of movement in autistic children through physical education learning experiences many obstacles. In the motor aspect, many experience delays in movement development (Kroncke et al., 2016). On the psychological aspect, they experience anxiety, fatigue, muscle tension, and poor sleep quality (Siswantoyo & Oktavia, 2018). In the behavioral aspect, they experience repetitive habits, dislike of new things, hyperactive behavior, and hypoactive behavior (Atmaja, 2019). In the social aspect, autistic children have difficulty understanding the will of other individuals and have no interest in interacting with other individuals (Siswantoyo & Oktavia, 2018). So that children with autistic disorders need optimization of positive behavior. Optimization of positive behavior, in this case, is a major need in autistic children (Atmaja, 2019). Positive behavior is behavior that refers to a positive response by children to the environment, so that movement independence can be improved. Primarily through efforts to learn through play by involving children in the concept of providing games in physical education learning (Bunker & Thorpe, 1986). However, it is important to understand that learning for autistic

children is at the simplest level of implementation. All activities are focused on how the games implemented can enrich children's movements.

Based on the results of a survey of the characteristics of learning styles of autistic children, 80% of children have a tendency to learn visually learner, then 77% of children learn gestalt learner and 75% of students learn rote learner (Yolanda & Mukhlis, 2021). In the visual learner learning style, optimally the use of media used is predominantly visual or image-based, while in the gestalt learning style autistic children tend to memorize sentences as a whole without understanding the meaning of each word, then in the rote learner style autistic children have a tendency to memorize information as it is, without understanding the meaning of the symbols they memorize. Even so, children with autistic disorders have a delay in absorbing information, and have characteristics that are easily bored, then they are mostly visual learners (Puspita et al., 2019). These limitations in autistic children certainly cause a phenomenon called learning difficulties. Learning difficulties in autistic children are manifested in several specific characteristics including difficulty recognising and understanding material, difficulty organising reading, everything is numerical, and difficulty receiving auditory information. The characteristics of learning barriers in autistic children require appropriate media.

The use of pictorial media in the aspect of communication development of autistic children has an impact on understanding and mastering vocabulary on objects with two syllables and four letters (Ulumudin, 2019). However, in gross motor aspects, especially in the movements of throwing the ball with hands, walking backwards, doing squat jumps, washing mirrors, cutting bananas, and brushing teeth. Children's understanding with video media intervention in autistic children results in faster understanding than static image media (Kellems et al., 2018). Video based learning is a potential way to help autistic students achieve learning goals (Delisio & Isenhower, 2020). Ideally, the language in the media should be simple, visualize specific concepts, be varied, provide meaningful learning, be able to assess student progress, and be multifunctional (Padmadewi et al., 2023). In addition to video based approaches, learning through game approaches can help autistic students to recognize work instructions, interact with peers, discipline, hone their fun, and reduce their stress (Purbasari et al., 2020). Furthermore, a game approach collaborated with video modeling (VM) has been shown to be an effective intervention in supporting the improvement of social skills for children with autism (Alhuzimi, 2022). This approach can certainly provide assistance to children's interest and focus on learning. However, video prompting also needs to be collaborated with gestural prompting, verbal prompting and physical prompting considering other problems faced by autistic students such as diverse IQ characteristics (Hu & Karna, 2019).

Based on these learning characteristics, a video-based approach is a promising approach to learning, especially for concept recognition in children with autism (Delisio & Isenhower, 2020). However, video media also needs to be collaborated with text, audio, and simple movement concepts to meet the diverse learning needs of autistic children. These learning needs cause module based learning media to be less well

understood by students, for example, such as the development of teaching modules for static balance (Kurniawan, Heynoek, et al., 2022). Development of teaching modules for dynamic balance in elementary school children (Kurniawan et al., 2021). Then the development of teaching modules for autistic children on manipulative material (Kurniawan, Noviardah, et al., 2022). The development carried out still requires visualization of images or media that must be adapted to the learning characteristics of autistic students. The limitations in the development of the module make the novelty of the development carried out by researchers in providing understanding functions through visualization of moving media concepts packaged in applications. The results of research related to the development of game applications for children with autism, including improvements to emotional aspects in children with autism can be done through games (Kalantarian et al., 2019). Then the findings that game development and intervention have an influence on involvement in social aspects (Penev et al., 2021). Based on these findings, having similar results with the development of interactive games and tested through experiments, the results show that the use of interactive games has an influence on language communication, behavioral movements, daily living skills, and sensory integration (Ma & Yang, 2021). Then the visual function and information input to children must be done briefly and clearly.

CONCLUSION

The application development carried out based on the assessment of the three expert validators stated that the media developed was suitable for use. Then the implementation of drag and drop applications and interactive media in the form of animation for three meetings significantly affects the ability of balance, singel leg jump, two leg jump, underhand trow and catch. From the results of the trial, although the application developed is considered effective, its application still requires a dominant teacher role to organize and direct the focus of all autistic students in physical education learning. Therefore, further research can develop and collaborate between assistive technology and learning models in physical education that can be applied and adapted to physical activities both in groups and individually for autistic children.

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