Research and Development in Education (RaDEn)

UMM

Research Article

How does an animated video on human sense improving students' with hearing impairment a concept understanding?

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Citation: Ramadani, S.D., Nadila, P., Utami, F.P (2024). How does an animated video on human sense improving students' with hearing impairment a concept understanding?. *Research and Development in Education (RaDEn)*, *4* (2), 1017-1029 https://doi.org/10.22219/raden.v4i2. 35262

Received: 22 July 2024
Revised: 13 September 2024
Accepted: 9 November 2024
Published: 10 November 2024

Abstract: The quality of education for children with special needs must be continuously improved to help them fully develop their potential. However, students with hearing impairments often face challenges in comprehending complex scientific concepts due to limitations in vocabulary and the abstract nature of traditional teaching materials. This study focuses on the development of animated learning videos covering human sensory systems to enhance conceptual understanding among students with hearing impairments. The research employed a Research and Development (R&D) approach using the ADDIE model (Analysis, Design, Development, Implementation, and Evaluation) and a pre-experimental one-group pretest-posttest design to assess the effectiveness of the videos. The product was tested on 10th-grade students at Special Senior High School of Magelang. Validation results showed that the animated video met the media criteria for validity, while the content criteria achieved high validity with scores of 79.6% and 80.4%, respectively. The effectiveness of the animated videos was further supported by an N-Gain score of 0.78, indicating a high level of improvement in student understanding. These findings suggest that the developed animated videos are highly feasible and effective tools for improving the conceptual understanding of students with hearing impairments.

Keywords: animated videos; hearing impairment; instructional media; human senses.

1. Introduction

Education is a pathway to acquiring deep knowledge, skills, values, and an understanding of the world and its environment (McFarlane, 2013; Roberts, 2022). The primary goal of education is the comprehensive development of human potential (Frisk & Larson, 2011). Every citizen has the right to education, including children with special needs, who deserve equal access to quality education (Artafanti & Pandia, 2018; Hermanto & Pamungkas, 2023). The quality of education for children with special needs must be enhanced to fully support their potential. Ideally, their education should be supported by adequate facilities and a curriculum designed based on students abilities and learning needs (Aprilia, 2021; Ashaver & Igyuve, 2013).

Biology is often considered a challenging subject due to its complex concepts and terminology, requiring students to develop an integrated understanding that spans from the microscopic level to the broader scale of the biosphere (Farahani et al., 2023). However, the characteristics of biological matter and the limitations of special-needs students, particularly students with hearing impairment, create complexity in the teaching process (Artafanti & Pandia, 2018). Students with hearing impairments face unique challenges in accessing auditory information that impacts their learning success (Rofiah et al., 2018; Villanueva & Hand, 2011). To achieve optimal students biological learning, it is essential to use appropriate materials, implement differentiation, integrate technology, collaborate with experts, and emphasize the development of life skills (Karanfiller et al., 2017; Nusir et al., 2013). Unfortunately, the lack of facilities to support the learning process increasingly hinders students from understanding biological concepts. As a result, the comprehension of biology lessons among special-needs students tends to be low (Sagala, 2024).

Observations and interviews with teachers at Specialized State Senior High School in Magelang, Central Java, indicate that the understanding of concepts among students with hearing impairment is still low, particularly regarding sensory material and function. One major obstacle is the students' limited scientific vocabulary, which is evident from their passive responses when asked about the concept. Additionally, the lack of sufficient learning media contributes to their difficulty in understanding. Although school has been equipped with LCD projector and students may carry smartphones, while this technology has not been utilized in the teaching process. This situation further inhibits students' understanding of sensory concepts and their functions (Nusir et al., 2013; Villanueva & Hand, 2011). Ignoring the difficulties of special-needs students can lead to negative effects, such as low academic achievement, reduced learning motivation, and limited experiences and perceptions of the world around them (Bachtsis et al., 2024).

Learning media innovation is one way to overcome perceived shortcomings in the learning process. Innovations can be achieved by leveraging advances in current information and communication technologies to effectively develop learning media (Gazali & Pransisca, 2020; Qadariah et al., 2020). One example of such innovation is the use of animation videos. Animation videos are dynamic educational tools that simulate life-like movement, allowing objects to change shape, size, and color, thereby enhancing the learning experience (Abdulrahaman et al., 2020; Suprianti, 2020). In this study, there was another innovation that included sign language translations in videos. It allows students with hearing impairment to learn on their own. Sign language plays a vital role in supporting concept acquisition for these students, helping them reach their academic potential (Rodrigues et al., 2022). By using sign language, they can access information that is often not designed to their needs in various media. Additionally, it enables to access previously inaccessible services (Mweri, 2014).

Animation-based learning videos are an effective choice for instructional media due to their interactive audiovisual nature, which can be designed based on students learning needs (Rabiasa et al., 2024). Using video (visual) media in learning can also boost memory retention from 14% to 38% and increase students' vocabulary by 200% (Fadillah & Bilda, 2019). Additionally, animation-based videos are particularly effective in enhancing the understanding of biological concepts for students with special needs. Animation offers strong visual representations, can be replayed, and captures students' attention, helping them better grasp the material and optimize their learning potential (Sae & Radia, 2023).

Biology learning media for students with hearing impairments has not been extensively developed, largely due to a lack of resources and research focused on their specific needs. Previous studies reported that media development for hearing-impaired students included videos on organic chemistry-based online software, which showed an increase in both concept comprehension and student interest (Souza et al., 2022). However, despite its efficiency, this media lacks subtitles, making it difficult for students to fully understand the content, particularly when sign language and demonstrations are unclear. Video-based learning media is a suitable solution for hearing impaired students, but research indicates that existing multimedia resources are not always effective in helping them grasp scientific concepts in primary and secondary education. Poorly designed multimedia presentations can increase cognitive load, thereby hindering rather than enhancing the learning process. With large amounts of information and various modalities, some presentation formats may confuse students and impede their understanding of key concepts (Rodrigues et al., 2022). Therefore, it is crucial to design multimedia materials that address the needs of students with hearing impairments. The inclusion of clear visual elements, the use of sign language, and appropriate training can help reduce cognitive load and improve comprehension. Additionally, teachers should receive specialized training to optimize the use of this technology in their instruction.

Based on the identified challenges and opportunities, the author conducted research on the development of innovative learning media, specifically animation-based videos

focused on the human senses concept. It is hoped that this animation-based learning video can provide a solution to existing problems, and enabling students to understand learning concepts more effectively. Therefore, this study aims to answer two key research questions i.e. (1) how is the feasibility and (2) how is the effectiveness of the the animation-based biology learning video on the concept of the human senses in enhancing the understanding of concepts among students?.

2. Materials and Methods

This research and development (RnD) employing the ADDIE model as its framework. The ADDIE model consists of five procedural stages i.e. analysis, design, development, implementation, and evaluation (Branch, 2010). The specific stages involved in this research are illustrated in Figure 1.

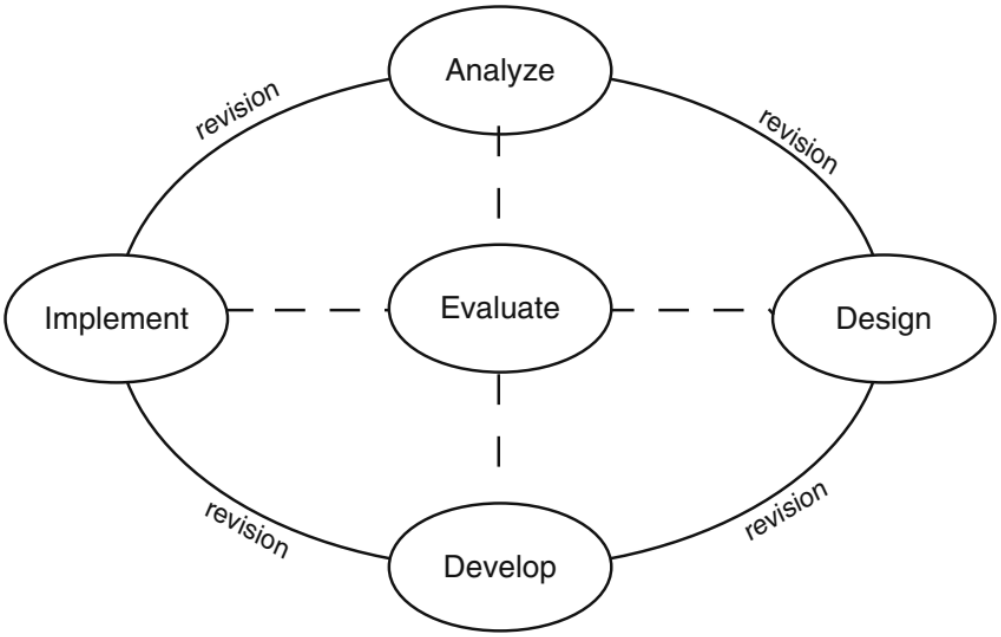

Figure 1. Steps of the ADDIE research model

Analysis involves identifying potential causes of performance disparities. The design phase includes verifying desired outcomes and selecting appropriate methods. Development focuses on creating and validating learning resources. The next step, implementation, entails preparing a learning environment that encourages student participation. Meanwhile, the evaluation phase assesses the quality of both the product and the instructional process before and after implementation (Branch, 2010). The subjects of this research included two biology learning media experts, two material experts specializing in Biology learning, and eight students from 10th-grade at Specialized Senior High School (SSHS) in Magelang, Central Java, Indonesia.

The steps for collecting research data begin with analyzing the results of observations of the learning process and interviews with class teachers This analysis includes evaluating the curriculum, material characteristics, and student characteristics. The findings from this analysis serve as the foundation for designing and creating learning video content using Canva and CapCut. The developed videos are then reviewed and assessed by experts in biology learning media and subject matter to determine appropriateness of the media. The assessment instrument employed is a questionnaire using a Likert scale. The video was then revised according to expert feedback, and subsequently tested with eight students from 10th-grade class. Data on students' conceptual understanding is gathered through pretest and posttest questions, which consist of ten multiple-choice items. The collected

data is then analyzed quantitatively to evaluate the effectiveness of the animation-based learning videos in improving conceptual understanding. Further details of the thinking framework in media development are explained in Figure 2.

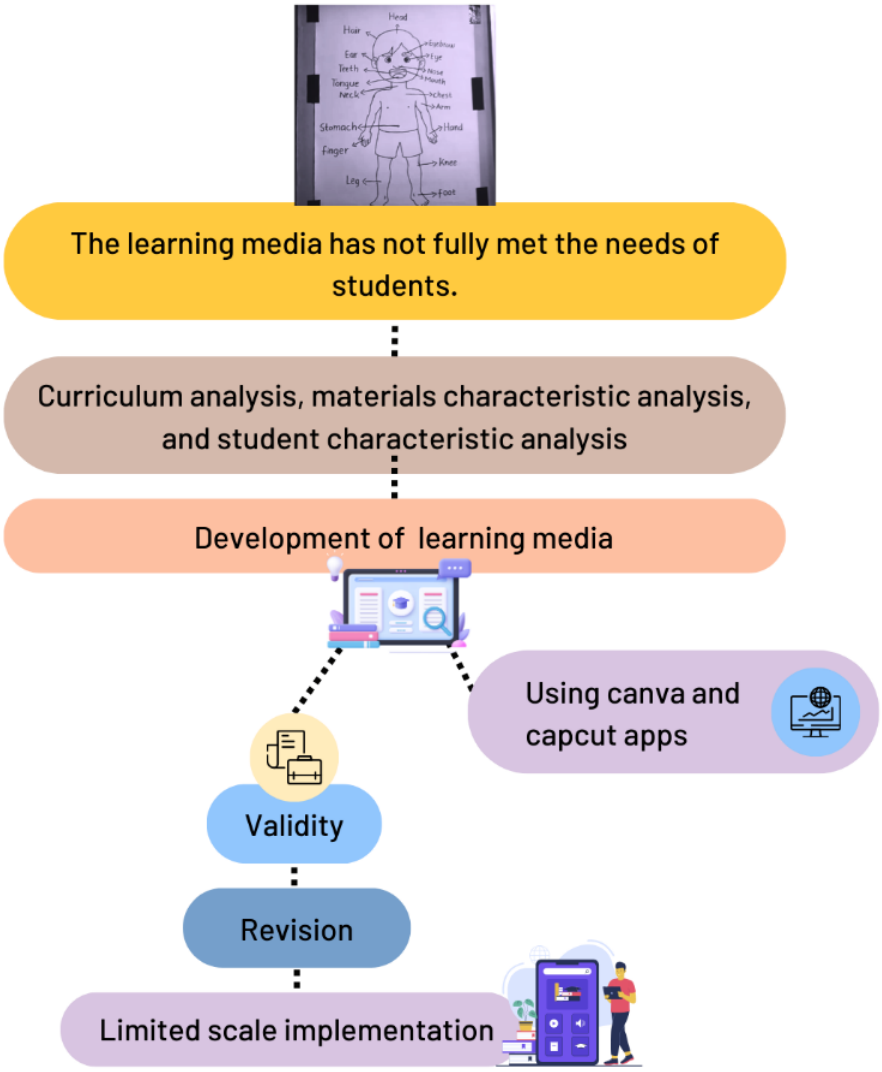

Figure 2. Framework for developing learning media

The validation process utilized a Likert scale with five response options, namely strongly agree (5), agree (4), quite agree (3), disagree (2), and strongly disagree (1). The feasibility of the animation-based learning videos, as evaluated by the validators. The total score was subsequently converted into a percentage using the Formula 1.

$$Feasibility = \frac{Scores\ obtained}{maximum\ score}\ x\ 100\,\% \quad \text{.....(1)}$$

The results of the data ansalysis were then presented and concluded in accordance with the media suitability criteria. The assessment criteria can be seen in Table 1.

Table 1. Media eligibility categories

No	Percentage (%)	Mark	Category
1	80 < x ≤ 100	A	Highly Valid
2	60 < x ≤ 80	B	Valid
3	40 < x ≤ 60	C	Enough
4	20 < x ≤ 40	D	Less Valid
5	0 < x ≤ 20	E	Invalid

Analysis of Video Effectiveness on Students' Concept Understanding

The average student scores before and after learning using animation-based learning videos (pretest and posttest) were analyzed using the N-Gain test with the equation according to Hake (1999) in Formula 2 . Then the N-Gain results are interpreted according to Table 2.

$$N - Gain = \frac{posttest\ score - pretest\ score}{maximum\ score - pretest\ score} \quad \text{..... (2)}$$

Table 2. Interpretation of N-Gain scores

N-Gain Score	N-Gain Criterion
0,70 ≤ N-Gain ≤ 100	High
0,30 ≤ N-Gain < 0,70	Currently
0,00 ≤ N-Gain < 0,30	Low

3. Results

The results of the curriculum analysis and material characteristics indicate that the topic of human senses and their functions is included in Phase E of the independent curriculum (Hasanah et al., 2022). Learning outcomes (CP) for Phase E at SSHS require students to understand the concepts of sound and light and their relationship to the care of the human senses. However, the learning outcomes and learning objectives flow (ATP) are more flexible, adapting to the needs and abilities of students, which leads to a simplification of both the learning material and objectives. The learning objectives for SSHS students in the topic of human senses and their functions are simpler compared to regular schools, focusing on identifying the five human sense organs and their functions (Utama & Marlina, 2023; Wardany et al., 2023). This simplification is necessary to ensure the alignment of CP and ATP, which is crucial when developing learning resources, as they serve as guidelines for creating educational media.

An analysis of student characteristics revealed that students with hearing impairments have a low conceptual understanding of biological concept, particularly regarding the human sense organs and their functions. It is attributed to their limited hearing, which affects vocabulary acquisition, as well as the lack of effective media for delivering the material (Marschark et al., 2015; Rodrigues et al., 2022). Most hearing impaired students rely on sign language and lip-reading for communication. Therefore, animated videos equipped with sign language interpreter would be highly beneficial in enhancing their understanding of the human sense organs and their functions (Debevc et al., 2014; Galindo-Neto et al., 2019; Hanum et al., 2018).

This phase includes preparing the video script, as presented in Table 3, creating the visual design, and selecting a sign language interpreter. While preparing the video scripts, it is essential to align them with the teaching modules developed based on the CP and ATP. A key challenge is simplifying sentences to ensure that the information conveyed in the video is accessible to hearing impaired students, who have specific needs regarding sentence structure due to their hearing limitations. Therefore, using clear and effective language will enhance understanding for hearing impaired students (Hansen et al., 2018). The visual design of learning videos for hearing impaired students must also consider the selection of appropriate colors, layouts, and animations. Involving a skilled sign language interpreter is crucial to ensuring equitable access to the information presented.

Table 3. Summary of video script

No	Videos	Duration (minutes)	Material	Information
1.	Intro and Opening	1′		Explain topic material to be presented in the learning video
2.	Apperception	3′	Explanation of the five organs senses in humans	
3.	Core	6′	Function from each of the five organs senses in humans along with working receptors	
4,	Closing	18″		Provide a conclusion at the end of the video
	Total duration	**10′ 18″**		

The software used to develop learning videos is *Canva* and *CapCut*. These tools were selected for their ease of use and comprehensive features. Additionally, both *Canva* and *CapCut* offer intuitive interfaces, allowing users (whether beginners or experienced) to quickly adapt and create high-quality videos (Mahardika et al., 2021; Priandini et al., 2023). The video creation process begins with designing visual elements in *Canva*, where users can choose from a variety of templates, graphic elements, and animations to enhance the video content. Once the visual design is complete, audio is added for relevant narration or sound effects. The next step involves importing the results from *Canva* into *CapCut* for further editing, which includes adjusting the video length, adding text, applying transition effects, and importantly, inserting sign language videos. These integration ensures that the learning videos are accessible to all, including those with hearing impairments (Galindo-Neto et al., 2019). By combining *Canva* and *CapCut*, interactive, informative, and inclusive learning videos can be produced easily. The final result is a video that is not only visually appealing but also effective in conveying educational messages to students.

The assessment or validation of the animation based learning video based on material aspect, conducted by two Biology experts. and their assigned functions are distributed on a scale of presentation. The validation results indicate that this animation-based learning video achieved the percentage of 80,4%, categorizing it as highly valid category. The results of more detailed assessments can be seen at Table 4.

Table 4. Material expert assessment results

No	Rated aspect	Result (%)	Criteria
1	Content Eligibility	82.5	Highly Valid
2	Clarity	78.3	Valid
	Average rating	**80.4**	**Highly Valid**

Similar to the validation results from the material experts, the video validation conducted by two biological learning media experts was standardized and presented on a percentage scale. The validation indicates that the learning videos achieved an average score of 79.6%, categorizing them as valid. The results of more detailed assessments can be seen at Table 5.

Table 5. Media expert assessment results

No	Rated aspect	Result (%)	Criteria
1	Accessibility	85	Highly Valid
2	Clarity	80	Highly Valid
3	Sign language clarity	70	Valid
4	Legibility	83.3	Highly Valid
	Overall Assessment	**79.6**	**Valid**

Based on expert assessment, it can be concluded that the animation-based learning media that has been developed is very feasible to use. Therefore, the video that has been validated and refined based on expert feedback is then tested on students. This animation-based learning video can be accessed by students on the *YouTube* by clicking the available link. After that, *YouTube* will display the beginning of the animation-based learning video on the material and sensory functions as in Figure 3.

Figure 3. Initial appearance of the animation-based learning video

In terms of presentation, the material in the video is organized according to the video script (Table 3). The content includes an explanation of the five sense organs, the functions of each organ along with the corresponding receptors, and concludes with a summary at the end of the video. An example of the media content is illustrated in Figure 4.

Figure 4. Display of the five senses material and their functions in the video

The visual design of the learning videos is customized to the characteristics of hearing-impaired students, ensuring an appropriate appearance, color scheme, and layout that make the videos engaging and easy to understand. The use of bright colors and clear text enhances students' comprehension of the material. Additionally, incorporating relevant images and animations can strengthen their visual understanding. Animated movements are designed to have a rhythm that is neither too fast nor too slow, helping to maintain students' attention without overwhelming them. This consideration is crucial, as deaf students can be sensitive to rapid movements, making it difficult for them to capture conveyed information (Anugerah et al., 2020). The assessment of students' conceptual understanding, both before and after using the animation-based learning videos on the five senses and their functions, involved analyzing their answers individually. These results were then converted into percentages. As shown in Figure 5, there was a noticeable increase in students' understanding of concepts before and after using the media.

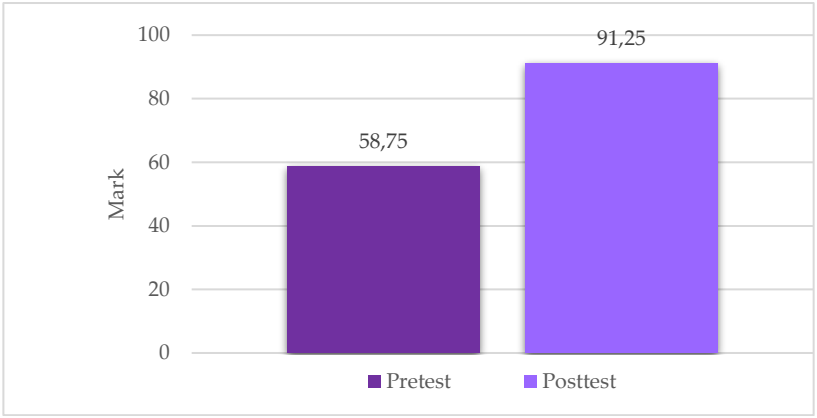

Figure 5. Average concept understanding both before and after using the animation-based learning videos

Furthermore, the results of the N-gain tests show a value of 0.78 which means students' conceptual understanding after learning using the animation-based learning videos is increasing in high categories, as shown in Table 6.

Table 6. N-Gain test calculation results

Information	Pretest	Posttest
Number of Students (n)	8	8
Lowest Value	40	80
The highest score	70	100
Average	58.75	91.25
***N-Gain* Score**	**0.78**	
Category	**High**	

4. Discussion

A learning media can only be tested on students if it has been validated as effective by learning experts and practitioners through a thorough validation process. According to Aka et al (2018) and Kristanti et al (2018), development products must at least obtain good category assessment results for implementation. As a tool for teachers to achieve learning goals, it is important to pay attention to the quality of the media so that it suits the learning goals and can be used optimally. The most important criterion in selecting media is that the media must be adapted to the learning objectives to be achieved (Baur & Emden, 2020). Therefore, to ensure that animation-based learning videos are in minimally suitable condition before being tested, validation by experts is very important so that there are no fatal errors in aspects of video preparation.

The results of the material expert assessment (Table 4) indicate that this animation-based learning video is highly valid for testing with students regarding its content. The material in a learning media must be conceptually appropriate to prevent future misconceptions. Sae and Radia (2023) said that the accuracy of concepts is a crucial factor in assessing the quality of learning media. The human senses material and its functions received the percentage of 82.5%, indicating that the content in the developed video is very suitable for use in learning, as it aligns with the CP and ATP. The preparation of this material involved collaboration with class teachers who teach biology, ensuring that it meets students' needs and abilities.

Meanwhile, in terms of clarity, the percentage of 78.3% was obtained, categorizing it as valid. This score is lower than those of other aspects, highlighting the need to improve the clarity of the sentences used to simplify them in order to accommodate the limited vocabulary of hearing-impaired students. Based on these recommendations, language simplification in the video content has been implemented to ensure that students can easily

grasp the material. This approach is particularly relevant for students with hearing impairment (Putri & Poedjiastoeti, 2022).

The results of the media expert assessment (Table 5) show that this animation-based learning video is highly valid, both in terms of accessibility, clarity of design, clarity of sign language and visual readability with an average percentage of 79.6%. Visual designs for hearing impaired students need to be presented simply and avoid overly busy design ornaments. The visual elements used must be easy to understand and clear and it is best not to use animation with fast movements because this can confuse the focus of hearing impaired students (Baglama et al., 2018; Syamsuddin et al., 2023). Based on the overall results of expert validation, it can be stated that this animation-based learning video is in the very suitable category for use.

In addition to testing the feasibility of the video, this research also aims to analyze the effectiveness of animation-based learning videos in enhancing students' conceptual understanding. As seen in Figure 3, the pretest and posttest scores improved after the use of animation-based learning videos, indicating that the video successfully facilitated student learning about the five senses and their functions while boosting concept comprehension. This finding is further supported by the N-Gain analysis, which yielded a score of 0.8, placing it in the high category. This suggests a significant improvement in students' understanding of concepts after using the videos. Anugerah et al (2020) found that visual media, such as videos, help students quickly recognize object shapes by directly observing images, while also enhancing their ability to analyze and draw conclusions from visually presented material. Similarly, Liu and Elms (2019); Tiantong and Teemuangsai (2013) reported that students were highly engaged and focused when learning involved animation elements, which made the material more captivating. Jundu et al (2020) also emphasized that the use of simple, easy-to-understand language in learning videos positively influences students, aiding concept comprehension and increasing their interest in paying close attention to the material.

The advantages of this animation-based learning video include its flexibility, accessibility anytime and anywhere, and the ability for students to study independently without teacher assistance (Liu & Elms, 2019; Rabiasa et al., 2024). It also enhances hearing impaired students' understanding of the material on the five senses and their functions (Syifa & Haka, 2021). Hafizah (2020) supports this by stating that videos can facilitate student learning both inside and outside the classroom. However, the shortcomings of this animation-based learning video are that the location of the sign language is not up to standard and the selection of the main character animation is the same size and location as the sign language translation video, so it has the potential to disturb the concentration of students when watching the video in the learning process. To overcome existing shortcomings, adjustments are needed in video design to make it more inclusive for students with hearing impairment (Galindo-Neto et al., 2019). One solution is to reduce the size of the animated characters and place them in a section that does not distract students' focus on the sign language translation (Hansen et al., 2018; Souza et al., 2022).

On the other hand, there are advantages to the sign language aspect, namely the sign language used in developing learning videos is *Indonesian Sign Language System* (SIBI) because SIBI is officially used by the deaf community in Indonesia (Anggraeni et al., 2023; Rofiah et al., 2018). This language was developed and standardized by the Indonesian government through the Ministry of Education, Culture, Research and Technology to facilitate communication and learning for people with hearing disabilities and is used in specialized schools (Nugraheni et al., 2023). Based on the research results, the use of sign language in biology learning in class is good, students with hearing impairment can use the communication system well when learning based on body movements, verbal (mouth movements) and writing (Hanum et al., 2018; Syifa & Haka, 2021). It shows that animation-based learning videos that contain sign language are very appropriate to student characteristics. According to Nugraheni et al (2023) and Rofiah et al (2018) The use of

everyday signs for deaf people is guided by SIBI, but several facts in the field say that *Bahasa Isyarat Indonesia* (BISINDO) has become the everyday language for deaf people. BISINDO is a natural sign language used by the deaf community in Indonesia. This language developed naturally from daily interactions and communication needs among the deaf community.

Based on the previous explanation, animation-based learning video media that contains sign language is very suitable for use and effective in increasing understanding of the concept of deaf students at SSHS Magelang regarding the five senses and their functions phase E which contains sub-chapters for the five sense organs and their functions and the receptors that work on the five senses. The development of animation-based instructional videos for students with hearing impairment presents a tremendous opportunity to increase the accessibility and effectiveness of education for those with hearing impairments.

5. Conclusion

Based on the research results, it can be concluded that animation-based learning videos are very suitable for use based on assessments from material experts and media experts, and are effective in increasing students' conceptual understanding with N-Gain score of 0.78, which means that students' conceptual understanding after learning using animation-based learning videos has increased in high category. The development of the animation based learning video on biology study has significant implications in increasing understanding of the concept of the student with hearing impairment especially in the sensory material and function. In addition, this animation-based learning video has been proven to facilitate biology learning based on the five senses and their functions, so that it can become the basis for developing innovative learning media, creative learning models, and more inclusive education policiesFor future research, it is recommended to analyze the impact of learning videos on other aspects of learning, such as motivation, interest, and student creativity, to further explore the potential effects of animated videos on enhancing students' abilities.

Author Contributions: S.D. Ramadani: conceptualization, methodology, and designing research, writing original draft, review and editing. P. Nadila: develop media, collecting data, writing original draft, and editing. F.P. Utami: methodology, formal analysis, and data curation.

Acknowledgement: The authors would like to express their gratitude to Universitas Tidar for supporting this research, and to Specialized High School of Magelang for their collaboration and the resources provided.

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