

Research Article

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## AUGMENTED REALITY TEACHING MEDIA FOR ASTRONOMICAL SYSTEMS WITH SIGN LANGUAGE COMMUNICATION FOR THE HEARING IMPAIRED

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### Abstract

Astronomy education for hearing-impaired students presents significant challenges due to complex concepts and teaching materials not designed to accommodate their specific needs. This research developed an augmented reality (AR) application that integrated sign language interpretation with three-dimensional astronomical system visualizations to address these limitations. Results revealed statistically significant improvement in post-study scores ( $M = 14.93$ ) compared to pre-study scores ( $M = 12.09$ ),  $p < .05$ . Students demonstrated higher academic achievement after engaging with the AR-based astronomy teaching materials with sign language interpretation ( $M = 13.16$ ) compared to their pre-study performance ( $M = 11.29$ ),  $p < .05$ . Student satisfaction with the materials was high ( $M = 4.27$  on a 5-point scale). These findings suggest that astronomy teaching materials incorporating AR technology and sign language interpretation effectively support the learning of hearing-impaired students. This innovation aligns with experiential learning theory and universal design principles, promoting inclusive education and potentially serving as a model for developing teaching aids for students with special needs.

**Keywords:** Augmented Reality, Astronomical Systems with Sing Language, Students with Hearing Impairments

## **Introduction**

Learning about astronomy can often be challenging for the average learner. This is particularly relevant for hearing-impaired students, as the subject is often intricate and theoretical. Conventional instructional resources may not sufficiently elucidate concepts in astronomy. Augmented Reality (AR) technology is an innovation that has the potential to revolutionize teaching methods. It can create an interactive and engaging learning experience. Augmented reality (AR) technology has proven to enhance students' comprehension of intricate concepts.

Nevertheless, there is a pressing need for further research into developing AR-based educational materials for teaching astronomy to students with hearing impairments. This research focuses on education. The success of using AR and interpretive astronomy teaching materials for deaf people is important for many reasons. Promoting inclusive learning through the development of appropriate teaching media for learners with hearing impairments will help bridge the educational gap and promote equal learning opportunities. Improving the quality of science education Using AR technology to teach astronomy can potentially increase students' understanding and interest in science. Developing educational innovations, the results of this research will help develop guidelines for designing effective teaching materials for learners with special needs. Creation of new knowledge: This study will help increase our understanding of the application of AR technology in the context of special education. Preparing for the future, the knowledge gained from this research will play an important role in developing an education system that responds to the needs of diverse learners in the digital age. This capability is dependent mainly on communication skills. Inadequate communication abilities can lead to significant challenges, particularly when interacting with others, such as those with hearing impairments. Therefore, developing effective communication skills is essential to ensure the accurate and comprehensive transmission of information and knowledge (Hiranrat et al., 2023). Therefore, studying the success of AR and interpretive astronomy teaching media for deaf people is vital to developing integrated science education and promoting learning opportunities for all. Specially designed e-learning platforms for students with hearing impairments have the potential to significantly enhance learning outcomes. However, educators must carefully tailor these platforms to meet the specific needs of the learners. This involves creating content that aligns with their abilities and presenting it in an accessible format. By adapting e-learning to accommodate different learning styles and levels of comprehension, such platforms can support effective learning and improve educational achievements for students with hearing impairments (Hiranrat et al., 2023).

Particularly for individuals with hearing impairments who utilize sign language and visual cues to perceive information. Furthermore, the use of body language and facial expressions is essential for conveying emotions and meanings. Sign language enables individuals with hearing disabilities to access information similarly to those without such impairments (Amnura et al., 2021). The use of specialized media and techniques has yielded clear results in fostering student enthusiasm, particularly in promoting a reading culture among hearing-impaired students. These approaches enable students to enhance their communication skills, particularly in sign language. In summary, the tailored application of media and techniques has proven to be

effective, facilitating students' ability to read and write efficiently and successfully. This method not only enhances their literacy skills but also supports their broader educational development (Ahlin & Hiddinga, 2022)

## **Objectives**

1. To evaluate the effectiveness of astronomy teaching materials designed for students with hearing impairments.
2. To compare pre-class and post-class scores.
3. To assess students' satisfaction with the interpretation of these materials.

## **Theoretical Background and Related Research**

Communication and information technology are the most important things in knowledge exchange. While each group has understanding, communication remains a challenge those with hearing disabilities can often be complicated. Augmented Reality (AR) technology offers a potential tool to create an engaging and immersive learning experience, especially in the teaching situation of astronomy and science at the lower secondary level. Basic and highest education as learning is creative. And provide opportunities for everyone to access. Developing AR teaching media that is appropriate for the hearing impaired, especially in the field of astronomy, is extremely important Because it will help learners with hearing needs to access complex content effectively. And it is important to deeply understand that astronomy is the scientific study of the universe and the celestial objects within it. The study of astronomy helps us understand the origin and evolution of the universe, including the relationships between the various objects within it. Astronomy is a field of study that is important to the development of our knowledge and understanding of the universe. The study of astronomy may not be conducive to deaf people. This is because most astronomy teaching media are auditory media, such as lectures and audio explanations. Or audio demonstrations, etc. Therefore, deaf people cannot fully access the content and learning process. The study found that Deaf people have the same potential to learn astronomy as normal people. There is a need to develop teaching materials on astronomy that are suitable for deaf people. The teaching media should emphasize the use of images and media that help in explanation. And create an understanding of other areas of astronomy. Awareness of the benefits. And private tutoring has positive effects. And the crucial link to social media use (Evanjeli et al., 2024) In terms of the concept, there are those who emphasize that teachers must change the traditional teaching methods. Technology should be used to assist teachers in delivering content through various media. Substitute teaching: Utilizing teaching media enables students to communicate effectively. (Srisakonsub & Nimnua, 2024) Starting with fundamental concepts about the dimensions of critical thinking and media literacy, as well as the effective use of media. (Wimano & Sanchana, 2023) The institutional level was found to be a model in a new educational context. In modern society, success results. Therefore, technology-based learning materials are expected to be of great use in the learning process (Mei & Sheng, 2011) Using YouTube from the perspective of educators and students at different levels. Education to facilitate learning.

This research focuses on exploring and analyzing the success of using AR technology in teaching astronomy and helping those with hearing impairments learn and understand. Emphasis is placed on the use of sign language as a form of conveying meaning, which is an important means of communication. It has been accepted by groups of people with hearing needs through data collection from experiments and surveys in real places. Presents evidence of AR's positive impact on astronomy learning and achievement. And complete understanding and promote equal educational opportunities for everyone in society. This research review will be important in proposing ways to develop effective communication and learning for people with hearing disabilities (Azi & Gündüz., 2020) The use of media has a positive effect on academic achievement, which is known to have a positive effect on the use of learning media. Media competence is an important part of "Social and Cultural Competence." Media competence arises in relation to various types of information and media messages. At each stage of teaching activities in the field of media, the use of teaching media in education is encouraged. And the use of media has content inserted to make students more involved (Phirom et al., 2024) The use of teaching media creates effectiveness depending on the group of learners using online learning media. Researchers have created a teaching media model by assigning teaching media into categories with lessons. This research aims to develop teaching materials on astronomy for deaf people. This teaching media, designed with specific pedagogical characteristics, prioritizes the incorporation of images and diverse multimedia elements That help explain and create understanding about astronomy. The user-friendly interface system allows students to display results and interact using images and sound media between computer devices. Lessons on astronomy (Smith & Geach., 2022) Making the use of teaching materials should be interesting. This made me interested in studying with the deaf group. And using letters is an important part of sign language. Communication can be between deaf and hearing people and even between deaf people from different communities (Morillas-Espejo & Martinezmartin, 2023) New media is widely used in English teaching and learning, especially in special education. In the new settings, hearing-impaired students' learning features are individualized learning style, visual-based learning mode, weakness in understanding, and laziness in learning. It is easy for hearing-impaired students to learn English via micro courses in American Sign Language, English reading, and writing. The student's learning process is divided into three stages: pre-class: micro-course learning; while-class: cooperative learning in groups; post-class: extensive reading for writing. Finally, English reading and writing learning and teaching mode is constructed on the basis of new media.

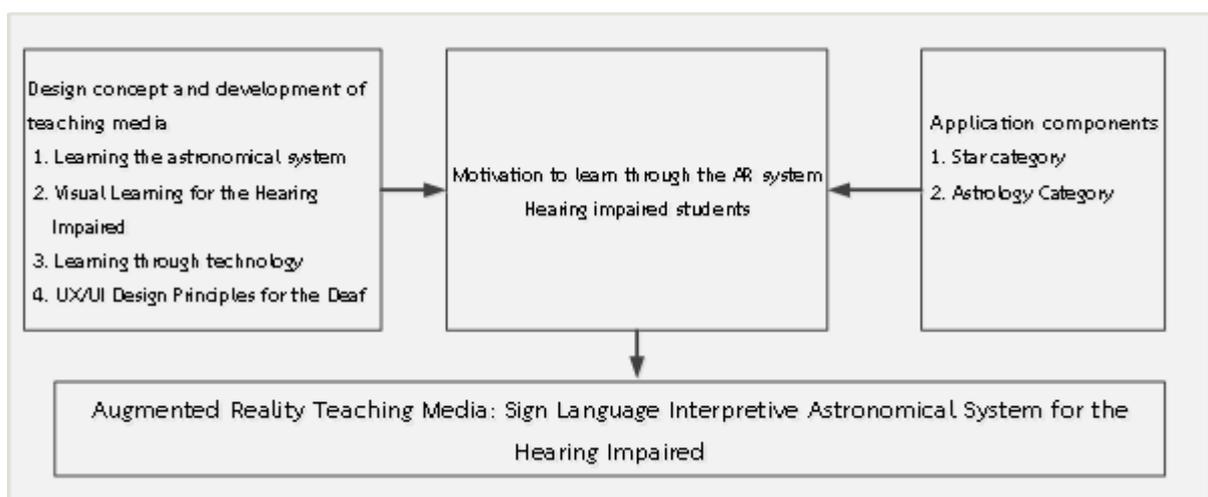
Augmented reality teaching media is used to teach astronomy, and sign language interpretation is provided for hearing-impaired students, ensuring the delivery of the teacher's intended content. To develop student learning through information technology devices, Windows, iOS, and Android systems, using AR, VR media

**Table1** Synthesis of variables for the success of teaching materials

Process	Description
Understanding student disability and success, accessibility requires working together. We encourage you to reach out and work with us (Betts et al., 2013)	Participation
Students with disabilities use their mobile devices for the same reasons as non-disabled students. Students with disabilities also use universal mobile device features and applications to assist them (Catherin et al., 2019)	Applications
augmented reality, educational technologies, mathematics education, meta-synthesis (Elif & Hasibe, 2022)	technologies, education
language documentation, technology, recent advances, resource creation, resource mobilization (Andrea et al., 2022)	technology, advances
It should be integrated into teaching lessons for students with different academic disabilities (Alghazo & Al-Otaibi, 2016)	integration
distanced learning, deaf students, learning media (Khasawneh, 2023)	learning media
Learning Strategies, Deaf Students, Make-up Skills (Mohamad & Sudana, 2024)	Learning Strategies
Interactive Multimedia, Teaching Aids, Teaching and Learning, Deaf students (Arianto et al., 2021)	Teaching learning

Summary and research concept regarding success factors of teaching media for the hearing impaired are as follows.

### Conceptual Framework



**Figure 1** the research framework for the study

## **Methodology**

The 112 junior high school students were formally interviewed at a hearing in Nakhon Pathom Province. The sample group used was 31 students who knew the purposive sampling method. Learning communication of deaf students begins with experiences or thoughts that are most familiar to them. Teachers play a crucial role in adjusting the instructional content to suit the individual abilities of each student. Therefore, the provision of teaching materials based on knowledge must stem from the interactions between teachers and students. (Ikhsan et al., 2024) The approach used in this study is qualitative with a phenomenology method. The data in this study were obtained through observation, in-depth interviews, and a literature study. The results of this study indicate that learning communication in deaf students begins with the things closest to the children. These things can be experiences or what the child is thinking. The teacher will lead the opinion on the material to be taught at that time. Then, the teaching given is adjusted to the abilities of each child. The conclusion of this research is the provision of teaching materials to deaf students guided by individual learning. How to find out the best learning techniques for deaf students are obtained through the experience of interaction between classroom teachers and students (Linangkung et al., 2023) The principles of the ADDIE Model are used in the following steps: 1) Set the content to study the solar system. From books and manuals related to stars, Analyze and determine the storyline to be consistent with the content. 2) Design learning media. Writing flowcharts for learning media (Flowchart) Writing storyboards for applications on the solar system. As a guideline for creating learning media 3) Practicing creating applications About the solar system using the Unity program. Check the accuracy and format of learning materials. Creating symbolic objects (Markers) by selecting images to be consistent with the three-dimensional model. Select images to have a variety of colors. Select images to have intersections of lines and colors with the Unity program used to create and develop applications. The researcher created a user satisfaction assessment form using a 5 - level rating scale. The satisfaction assessment form consists of 2 aspects: the format and characteristics of the teaching media. It consists of clear, easy-to-read letters in a beautiful, interesting format. Learning activities provide opportunities to interact with media. Suitability of the lesson for use Learning activities are fun, enjoyable, and interesting, and the content consists of Clear content descriptions, appropriate content sequencing, and appropriate content difficulty. The amount of content is appropriate. The content can be used in everyday life. Quantitative data were analyzed using descriptive statistics, including mean and standard deviation.



Figure 2 shows the system's operation page

## Results

Table 2 Tests of Normality Student

	Kolmogorov-Smirnov <sup>a</sup>			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
<b>1. Format of teaching media</b>						
1.1 The letters are easy to read and clear	.119	31	.200	.801	31	.990
1.2 Beautiful format	.126	31	.300	.817	31	.101
1.3 Easy to use	.131	31	.300	.884	31	.127
1.4 Suitability for use	.127	31	.300	.856	31	.226
1.5 Learning activities are fun, enjoyable, and interesting	.135	31	.300	.627	31	.106

	Kolmogorov-Smirnov <sup>a</sup>			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
<b>2. Content</b>						
2.1 Clarity	.121	31	.200	.858	31	.114
2.2 Sorting	.124	31	.200	.943	31	.847
2.3 Difficulty	.124	31	.200	.946	31	.838
2.4 Quantity	.117	31	.200	.963	31	.827
2.5 Can be used in everyday life	.132	31	.300	.881	31	.117

From the table of normality test results using Kolmogorov-Smirnov and Shapiro-Wilk, it was found that the significance values (Sig.) of all variables in Kolmogorov-Smirnov were in the range of .200 to .300, indicating that there was no significant difference between the data and the normal distribution, which was higher than the significance level of .05 for several variables such as "Sorting" and "Quantity" reflecting that the data in these variables tended to be normal. However, some variables such as "Learning activities are fun, enjoyable, and interesting" may still need further examination because the Sig. Values were quite close to the significance level of .05.

**Table 3** compares the mean knowledge scores before class and after class of the experimental group that studied the Augmented Reality teaching media lesson for the hearing-impaired

List	N	$\bar{X}$	S.D.	df	t	p
Before studying	31	12.09	1.14	30	12.624*	0.00
Principles of study	31	14.93	1.82			

\*Statistically significant at the .05 level.

Shows that the mean score after studying had a mean of 14.93 and a standard deviation of 1.82, higher than the mean before studying, with a mean of 12.09 and a standard deviation of 1.14, significantly higher than before studying Level .05.

**Table 4** Tests of Normality Teacher

	Kolmogorov-Smirnov <sup>a</sup>			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
<b>1. Format of teaching media</b>						
1.1 The letters are easy to read and clear	.125	31	.201	.807	31	.105
1.2 Beautiful format	.132	31	.301	.823	31	.107
1.3 Easy to use	.137	31	.301	.890	31	.000
1.4 Suitability for use	.133	31	.301	.862	31	.112

	Kolmogorov-Smirnov <sup>a</sup>			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
1.5 Learning activities are fun, enjoyable, and interesting	.141	31	.301	.633	31	.110
<b>2. Content</b>						
2.1 Clarity	.127	31	.201	.864	31	.120
2.2 Sorting	.130	31	.201	.949	31	.853
2.3 Difficulty	.130	31	.201	.952	31	.844
2.4 Quantity	.123	31	.201	.969	31	.833
2.5 Can be used in everyday life	.138	31	.300	.887	31	.123

The table shows the results of the normality test of data using the Kolmogorov-Smirnov and Shapiro-Wilk methods. For Kolmogorov-Smirnov, all Sig. Values are greater than 0.05, indicating that the data in each item can be considered normally distributed at a significant level. For Shapiro-Wilk, most Sig. Values are still in the range greater than 0.05, except for item 1.3, which shows a Sig. A value of .000 indicates that the data in that item does not follow a normal distribution. The obtained values help to analyze the normality of the data clearly for deciding on further statistical analysis.

**Table 5** Comparison results of students' academic achievement before and after regular teaching

List	N	$\bar{X}$	SD	df	t	p
Before studying	31	11.29	2.21	30	7.184*	0.00
Principles of study	31	13.16	1.84			

\*Statistically significant at the .05 level.

It was found that the achievement of hearing-impaired students learning with regular teaching on the topic of the success of the Augmented Reality teaching media, astronomy system. Interpreting sign language for the hearing impaired Have academic achievement after studying. The mean was 13.16, and the standard deviation was 1.84, higher than before studying. The mean was 11.29, and the standard deviation was 2.21, with statistical significance at the .05 level.

**Table 6** Analysis of satisfaction scores from questionnaires of hearing-impaired students

List	$\bar{X}$	SD	Interpret results
<b>1. Format of teaching media</b>			
1.1 The letters are easy to read and clear	4.26	0.44	very
1.2 Beautiful format	4.24	0.42	very
1.3 Easy to use	4.27	0.39	very

List	$\bar{X}$	SD	Interpret results
1.4 Suitability for use	4.23	0.41	very
1.5 Learning activities are fun, enjoyable, and interesting	4.25	0.43	very
<b>2. Content</b>			
2.1 Clarity	4.17	0.23	very
2.2 Sorting	4.20	0.40	very
2.3 Difficulty	4.19	0.39	very
2.4 Quantity	4.11	0.27	very
2.5 Can be used in everyday life	4.15	0.26	very
<b>Joint Average</b>	<b>4.20</b>	<b>0.36</b>	<b>very</b>

Shows the Satisfaction of 31 hearing-impaired students. They were satisfied with aspect.

The format and characteristics of the learning media. The five questions asked were: 1) clear, easy-to-read letters; 2) beautiful format 3) easy to use 4) Suitable for use 5) Learning activities make you feel fun, enjoyable, and interesting. It was found that students were highly satisfied with the beautiful and engaging format.

The results of the research found that the Satisfaction of students with hearing disabilities was at a high level. The mean was 4.27, and the standard deviation was 0.39, according to the developer's assumptions. Has been set above Satisfaction in the second aspect, content, which consists of 5 questions: 1) clarity, 2) sequencing, 3) difficulty, 4) quantity, 5) can be used in daily life. It was found that students with hearing disabilities were satisfied with the overall user satisfaction questionnaire. Has the highest level of Satisfaction and has an average of 4.20.

## Discussions

1. The results of the research found that the average score after studying was lower than the average score before studying with statistical significance at the .05 level ( $p < .05$ ), consistent with the research of (King et al., 2023). The study found that multimedia-based learning materials using animated videos with sign language, visual explanations, and case examples were effective in improving learning outcomes, increasing participation, and creating accessibility for deaf students in online learning. This highlights the importance of considering visual learning principles for deaf students in educational settings. Consistent with the research of (Ployjiw & Michel, 2023), The effectiveness of Augmented Reality (AR) books as a learning tool for primary school students with hearing impairments in grade 1 was studied with a target group of 10 students at all levels from Tungmahamek School for the Deaf, selected using stratified random sampling. The results of the study found that the development of AR-Books was effective at 85.33/87, with E1 and E2 values exceeding the specified standards. In addition, the learning outcomes after using AR-Books were significantly higher than before the intervention at a statistical significance level of 0.05. In addition, students' satisfaction with the use of AR-Books was also high. Consistent with the research of (Wannapiroon et al., 2021), an interactive AR learning

model for SMART classrooms using the Imagineering process is divided into four steps: modeling, AR media, ICT teacher development, and scaling up. The target group is teachers and students from both higher education and vocational education levels. Experts certify that the model is of the highest quality and the learning media is of very good quality.

2. Results from research found that the efficiency of hearing-impaired students who studied learning with AR teaching media achievement after studying was significantly higher than before studying at the .05 level ( $p < .05$ ), consistent with the research of (Astuti et al., 2022) which found that the group with anxiety in exams had lower academic achievement. Test anxiety, on the other hand, is related to achievement. Academic learning in science reading decreased because of exam anxiety, which is why income equality affects exam performance. Consistent with the research (Alqarni, T. 2021), four weeks of AR technology and two scales used in this study were reliable and validated. The results showed significant results for AR technology in improving students' learning outcomes. In addition, the results supported the idea that AR technology has the potential to improve the positive attitudes of students with learning disabilities. The results showed that AR technology helped students promote positive attitudes towards students and promoted students' learning outcomes. Consistent with the research of (Deng et al., 2024), The perceived quality of use, perceived interaction speed, and perceived usability significantly affect the effectiveness of communication. In addition, the effectiveness of communication has a positive effect on social trust and perception, and social perception has a positive effect on information. Both factors positively affect expression intention. Based on these findings, this study offers recommendations for the design of AR hearing aids to meet the specific needs of PHI, aiming to improve their quality of life. In addition, this study provides important insights for the future growth of this emerging industry.

3. Results from the research found interpretive satisfaction with astronomy teaching media for the hearing impaired in terms of the format of teaching media. What users are most satisfied with is the usability aspect. The mean value was 4.27, and the standard deviation was 0.39, consistent with the research. The study found that teaching music to deaf children can be successful if they are allowed to learn to play and perform music. The author's experience teaching at a deaf school in Melbourne highlights the positive impact a music program can have on deaf students. The researcher found that social media influences students' knowledge perception, indirectly affecting student satisfaction. Directly reach the public by emphasizing the image of digital platforms to increase public understanding and participation. Significant impact requires awareness of the importance of communicating with content, digital engagement, information, and satisfaction (Katherine & Lisalee, 2024). This should study the factors affecting the success of the Augmented Reality teaching media and astronomy system. Meaningful meaning of sign language for the hearing impaired, such as content factors, technical factors, and teacher factors, should study the effects of Augmented Reality teaching media on astronomy systems. The meaning of sign language for the hearing impaired, such as the impact on knowledge, Attitude impact, and behavioral effects, Is an important issue for furthering research on the success of Augmented Reality teaching media and astronomy systems. Interpreting sign language for the hearing impaired will help them better understand the said teaching media. The research results can be used to develop teaching

materials that are effective and appropriate for the hearing impaired. Consistent with the research (Sebastian & Kuswanto, 2024), It was found that the use of augmented reality in physics learning can improve students' intellectual abilities, including self-awareness, conceptual understanding, analytical thinking, higher-order thinking, visualization, abstract thinking, scientific knowledge, creativity, computational thinking, reasoning, and problem-solving. In addition, using augmented reality media can help students achieve the best learning outcomes and positively affect emotional abilities. Future research is expected to be able to present the influence of augmented reality media in physics learning to develop students' emotional abilities and attitudes in depth. Consistent with the research of (Nebytova et al., 2021), The effectiveness of using AR technology shows positive dynamics when considering all criteria of the tests used in this study. The technology is quite easy to use. In addition to the athletes with hearing impairments mentioned above, the results of this study can also be applied to children with other special needs who play sports.

## **Recommendations**

This research has developed Augmented Reality teaching media to convey knowledge about astronomy using sign language, helping the hearing-impaired access this knowledge more easily. The content covers planets, the sun, the earth, the moon, and various important astronomical phenomena using AR technology, presenting 3D objects with explanations using sign language and customizable subtitles.

Results of an experiment using this media with deaf students in Thailand. It was found that they were able to significantly improve their understanding of astronomy. After using this new form of learning media, the students have a high level of satisfaction. It shows that sign language-based AR media is an interesting new way to convey knowledge to the hearing impaired.

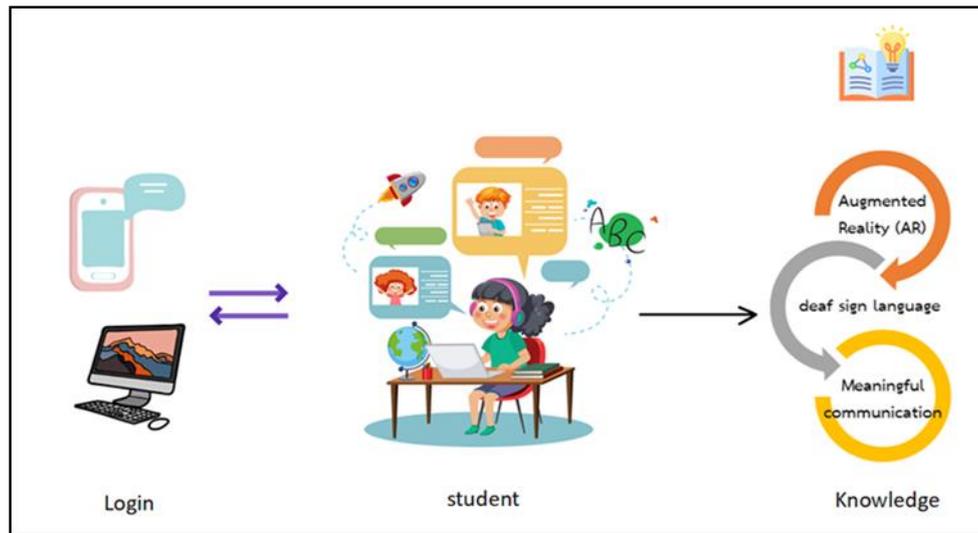
## **New Knowledge**

1. Increase the learning experience. Using AR helps increase the experience and interest in learning Augmented Reality teaching media. Astronomy system. Using Augmented Reality (AR) learning experience in astronomy teaching media is one of the methods. It is challenging and interesting and can be used to enhance learning in this subject very well by bringing in AR technology to help create a more realistic experience. Students will be able to see astronomical objects. Such as planets, comets, stars, or images related to research in space. That is part of student learning.

2. Better understanding for the hearing-impaired. Importing sign language helps deaf users understand content better. Using sign language to help deaf users understand content is an effective way to increase understanding for deaf people. Sign language is a versatile communication system. and has details using symbols and the movements of the hands and body to communicate meaning by using sign language to teach or explain content. Hearing-impaired people can understand and learn content more effectively.

3. Develop an astronomy teaching media system using augmented reality (AR), importing sign language meanings into part of the AR system, and developing a system that can actually be used. It uses modern

technology to create a highly effective learning experience. The system combines sign language with so-called "markers," or pointers, that are used to help the AR system recognize and understand objects to be displayed in the AR virtual world. This means that users can use language. Hands to control and interact with objects appearing in the virtual environment. This creates a more realistic and effective learning experience for hard-of-hearing users.



**Figure 3** New knowledge gained from research

Introducing AR technology into teaching the astronomy system with emphasis on providing meaning in sign language for the hearing impaired. The results show that such a system can enhance the learning experience and help students understand the content well. This makes it an interesting option for developing teaching methods in astronomy.

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