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ASTRONOMY EDUCATION FOR THE PERSONS WITH DISABILITY: A SYSTEMATIC LITERATURE REVIEW

'Iffah Mohamad Nawawi [1]
Mohd Hafiz Safiai [2]
Ezad Azraai Jamsari [3]
Mohamad Zulfazdlee Abul Hassan Ashari [4]
Md. Yazid Ahmad [5]

ABSTRACT

Objective: This research is carried out to deliberate the involvement of disabled people in the field of astronomy as well as the role, contribution and importance of astronomy to them. In addition, this study also examines the initiatives which have been taken to reduce the gap between communities in guaranteeing equal rights in the aspect of education for those groups.

Method: This study is a qualitative study which employs an approach of document analysis, through a comprehensive search of academic databases, government reports, and grey literature, relevant studies were analyzed using thematic analysis.

Results and Discussion: The results of this study found a lack in the number of programs and activities carried out for disabled people in Malaysia in the aspect of astronomical science education, in addition to a lack of suitable instruments and facilities to enable these groups to gain exposure to astronomy.

Research Implications: This study is anticipated to widen government awareness and venues to people with disabilities in ensuring that they have equal access and opportunities for full participation in the implemented astronomical science programmes.

Originality/Value: This study contributes to the literature by conducting a systematic review of the literature on astronomy education for the disabled person. The finding might have enlightened the needs of disabled people in astronomy education.

Keywords: Education, Science, Astronomy, Initiative, Disable Person.

EDUCAÇÃO ASTRONOMIA PARA PESSOAS COM DEFICIÊNCIA: UMA REVISÃO SISTEMÁTICA DA LITERATURA

RESUMO

Objectivo: Esta investigação é realizada para deliberar sobre o envolvimento das pessoas com deficiência no campo da astronomia, bem como o papel, a contribuição e a importância da astronomia para elas. Além disso, este estudo também examina as iniciativas que foram tomadas para reduzir o fosso entre as comunidades na garantia de direitos iguais no aspecto da educação para esses grupos.

[1] Sekolah Raja Perempuan Taayah, Perak, Malaysia. E-mail: iffahnawi96@gmail.com
Orcid: https://orcid.org/0009-0000-7649-4519
[2] Research Centre for Syariah, Faculty of Islamic Studies & Institute of Islam Hadhari, National University of Malaysia. E-mail: hafizsafiai@ukm.edu.my Orcid: https://orcid.org/0000-0001-6330-7315
[3] Research Centre for Arabic Language and Islamic Civilization, National University of Malaysia, Malaysia.
E-mail: ezad@ukm.edu.my Orcid: http://orcid.org/0000-0001-9901-8240
[4] Research Centre for Arabic Language and Islamic Civilization, National University of Malaysia, Malaysia.
E-mail: mozaha@ukm.edu.my Orcid: https://orcid.org/0000-0003-1878-8556
[5] Research Centre for Syariah, Faculty of Islamic Studies, National University of Malaysia, Malaysia.
E-mail: yazid@ukm.edu.my Orcid: https://orcid.org/0000-0003-3569-1705

Método: Este estudo é um estudo qualitativo que emprega uma abordagem de análise documental, por meio de uma busca abrangente em bases de dados acadêmicas, relatórios governamentais e literatura cinzenta, estudos relevantes foram analisados por meio de análise temática.

Resultados e Discussão: Os resultados deste estudo revelaram uma falta no número de programas e atividades realizadas para pessoas com deficiência na Malásia no aspecto da educação em ciências astronômicas, além de uma falta de instrumentos e instalações adequadas para permitir que esses grupos ganhem exposição à astronomia.

Implicações de pesquisa: Prevê-se que este estudo amplie a conscientização do governo e os locais para pessoas com deficiência, garantindo que tenham acesso e oportunidades iguais para participação plena nos programas de ciências astronômicas implementados.

Originalidade/Valor: Este estudo contribui para a literatura ao realizar uma revisão sistemática da literatura sobre educação em astronomia para pessoas com deficiência. A descoberta pode ter esclarecido as necessidades das pessoas com deficiência no ensino de astronomia.

Palavras-chave: Educação, Ciência, Astronomia, Iniciativa, Pessoa com Deficiência.

EDUCACIÓN ASTRONÓMICA PARA PERSONAS CON DISCAPACIDAD: UNA REVISIÓN SISTEMÁTICA DE LA LITERATURA

RESUMEN

Objetivo: Esta investigación se lleva a cabo para deliberar sobre la participación de las personas con discapacidad en el campo de la astronomía, así como el papel, contribución e importancia de la astronomía para ellas. Además, este estudio también examina las iniciativas que se han tomado para reducir la brecha entre comunidades a la hora de garantizar la igualdad de derechos en el aspecto educativo de esos grupos.

Método: Este estudio es un estudio cualitativo que emplea un enfoque de análisis de documentos, a través de una búsqueda exhaustiva de bases de datos académicas, informes gubernamentales y literatura gris, se analizaron estudios relevantes mediante análisis temático.

Resultados y Discusión: Los resultados de este estudio encontraron una falta en el número de programas y actividades llevados a cabo para personas discapacitadas en Malasia en el aspecto de la educación en ciencias astronómicas, además de una falta de instrumentos e instalaciones adecuados para permitir a estos grupos obtener exposición a la astronomía.

Implicaciones de la investigación: Se prevé que este estudio amplíe la conciencia gubernamental y los espacios para que las personas con discapacidades garanticen que tengan igualdad de acceso y oportunidades de participación plena en los programas de ciencia astronómica implementados.

Originalidad/Valor: Este estudio contribuye a la literatura al realizar una revisión sistemática de la literatura sobre educación astronómica para personas discapacitadas. El hallazgo podría haber iluminado las necesidades de las personas discapacitadas en la educación astronómica.

Palabras clave: Educación, Ciencia, Astronomía, Iniciativa, Persona con Discapacidad.

1 INTRODUCTION

In line with current technological development, astronomical science education is seen to gain more attention. There are various programs and activities undertaken to attract

community interest in the field. Taking the country of Brunei Darussalam as an example, Astronomical Society of Brunei Darussalam (PABD) was established with the aim of ensuring that the people of Brunei get exposure to the field of astronomy and among the organised programmes are national-level astronomical observations (Ahmad, 2019). In Malaysia, meanwhile, according to a report on the Malaysia Ministry of Science, Technology and Innovation website titled Malaysian Space Odyssey: 20 Years Together with the National Planetarium (2022), the establishment of The National Planetarium as a space science education centre has also succeeded in injecting interest and increasing awareness to the public in the field of space science.

Astronomy is one of the most important disciplines in human life. In addition to being able to study movements of stars and planets, this science can also describe the state of the universe more closely. However, a certain group of the global population have no opportunity to experience the greatness of this knowledge. Persons with disabilities are a group of people who are said to have been excluded and fallen behind in astronomical science education. This minority group is also said to receive less exposure to astronomy due to the lack of facilities and assistance which can enable them to access this discipline more closely. This group is often left behind and given less attention even though they also have the same rights as other groups of society. Therefore, this study was conducted to examine the involvement of people with disability in the field of astronomy and to analyse the role and contribution of astronomy to them.

According to Kamus Dewan Edisi Keempat, the word "*ilmu falak*", also known as the science of astronomy, is the scientific discipline on the stars which involves the study of their position, movement and calculation as well as interpretation in relation to the stars. In general, early humans were able to understand the universe by observing events or natural phenomena that occured around them (Budiwati, 2020). One of the early discoveries of astronomy was around 2000 BC by the Assyrians in Sumeria which is now known as southern Iraq. This discovery recorded eclipse events that happened in their locations through ancient artifacts and paintings (Mat Zin, Ismail & Nirizain, 2015).

Along with current technological progress, the science of astronomy is also getting more and more attention to the point that it has become a necessity among world citizens from the angle of determination of the time, the beginning of the month, the study of weather changes and etc. There are various efforts or programmes that are carried out not only at the international level but also the existence of astronomy clubs or societies in schools become one of the factors that attract interest of youngsters to understand astronomical science education. However, there

is a small number of people in the community who lack or may not get any exposure about this field of knowledge, and they are people with disabilities. Such group should not be left out because they also have the right to learn and to know, just like others. Their disabilities should not be made a barrier for them to get actively involved in the field of astronomy. History had proven that the astronomer John Goodricke was also a deaf person who was awarded the Copley Medal by the Royal Society for his achievements in variable star research (Chaple, 2013).

According to Merced & Gastrow (2018) in World Report on Disability (2011) by The World Health Organization and the World Bank, it was estimated that more than one billion people worldwide, or approximately 15 percent of the world population, live with some form of disability. However, this group is considered a population whose involvement is less in science. The reason for this is possibly due to the lack or absence of appropriate access to technology, other than societal unawareness of their rights in the aspect of education. The National Science Foundation (NSF) is a government agency that plays an important role in Science, Technology, Engineering and Mathematics (STEM) Education. According to Burrelli and Falkenheim (2011) in the study of Martin et al. (2011), NSF stated that disabled persons, women and ethnic and minority race groups are groups with less involvement in the field of science and engineering either at the educational or occupational level.

Merced & Gastrow (2018) stated that the lack of resources and support is one of the reasons why people with disabilities are not able to get involved in the area of science and reveal their potential. In addition, unavailability of appropriate access technology and the attitude of certain quarters of the community who ignore their importance in participating in this arena are also among the reasons why they continue to be marginalized. According to Alston and Hampton (2000) in the article Dunn et al. (2012), it was stated that the perceptions of parents and teachers who assume disabled students are not able to succeed in STEM education is an example of the lack of encouragement or support from parties closest to them.

According to Suleyman (2022) since the past few years countries in Africa have seen that the field of astronomy has the potential in helping the society from the aspect of education and it also bring change country toward a better direction. However, people with disabilities are a group of people whose involvement is less in the field and programme of astronomy. Disabled people in Africa can be estimated to be at 10 percent of the population and the number can reach up to 20 percent in poorer areas. Therefore, the area of astronomy should be accessible by each group of the society regardless of their background, learning style and individual ability. Suleyman also mentioned that there are some common problems faced by people with disability to access the science of astronomy. Among them is the lack of

learning aids in astronomy education laboratories for students who have visual impairment, while for groups of people with hearing disability the limitations of sign language in various languages and interpreters who do not have an astronomical background are among the reasons why they cannot understand what is being conveyed. Next, the lack of apparatus such as smart power wheelchairs and the lack of support or assistance for those with physical disabilities to participate in field events are one of the reasons they cannot get involved in this area.

2 METHODOLOGY

This study is a systematic review of literature reviews which claims to be the 'standard method' for literature review, such as replicable, transparent, objective, impartial, and rigorous, and thus superior to other approaches to conducting literature reviews (Boell & Kecmanovic, 2015). Systematic literature reviews provide a systematic and transparent means for collecting, synthesizing, and assessing study findings on a particular topic or question (Jesson et al., 2011). The literature collected comes from various sources that focus on the astronomy education for the person with disability. The primary purpose of this research is to explore the evidence in publications that report on the equal access and opportunities for the disabled person in astronomy education and obtain the correct formulation so that they can be used as a basis for overcoming them.

2.1 STUDY DESIGN

Study design is planned by the researcher and is developed by filling in all aspects in the selected design procedure (Ismail & Ali 2020). To conduct a study, the researcher needs to clearly identify the study design to understand the whole study well (Rosmawati 2014). The method used in this study is a qualitative method. According to Hamzah (2004), qualitative research is a study that emphasises efforts to find and provide explanation and non-numerical observations even though there is information that refers to statistics and most studies in this field provide information, interpretation, or meaning in any communication process. Qualitative studies can also obtain quality information by focusing on a small sample. This study employed content analysis methods for data collection. Next, the raw data accumulated using this method were analysed using an appropriate approach, i.e. descriptively and thematically.

2.2 DATA COLLECTION METHOD

Data analysis used in this research is the thematic analysis and data extraction (Khaizaar & Hidayat, 2022; Kusmaryono et al., 2022). Studies were selected if they met some criteria which were written in English and Arabic discussed astronomy education for the persons with disability. In the initial search, by considering the existing criteria obtained, the total number of publications related to astronomy education for the persons with disability were found. The collected publications come from publications in journals, conference proceedings, books, and book series. The publication is limited only to the last 25 years, namely from 1998 to 2023; using the search keywords is the astronomy education for the disabilities.

2.3 DATA ANALYSIS METHOD

According to Adibah (2019), the data analysis method is a stage in the research process where the collected data will be processed to answer the formulation of the problem. The data analysis methods used by the researcher in this study were descriptive and thematic content analysis and these methods are suitable with qualitative study design. Descriptive data analysis is a way to examine the status of a group of people, objects, conditions, systems of thought or events that occur (Adibah, 2019). In this study, the collected data will be processed so that they appear more organized and tidier before being analysed by the researcher through the content analysis method. After that, the products from the data will be concluded. Next, outcome of the analysis will be recorded and used as research results.

3 RESULTS

Astronomy is one of the disciplines that are no stranger to society today. Apart from observing natural phenomena and events, the science of astronomy is also linked to method of determining the direction of the *qibla*, prayer times, and looking at the new moon to determine the Islamic calendar months. The establishment of the National Planetarium complex is also no stranger to school students and the general public to get to know and learn the field of space science. However, based on the research findings obtained by the researcher through observation of previous studies, it was found that people with disabilities are less involved in the field of astronomy. Nebiyu Suleyman (2022) stated that groups with disabilities are those with less involvement in the field and programmes of astronomy.

Merced & Gastrow (2018) also stated that among the factors behind groups with disabilities not being able to engage in the field of science are due to the lack of resources and supports from the surrounding people. Apart from that, the absence of access to technologies which are suitable and the attitude of some people who ignore their interests to join this field are also reasons why disabled people continue to be marginalized. This is reinforced by Dunn et al. (2012) who stated that perceptions held by parents and teachers who think that disabled students cannot succeed in the field of Science, Technology, Engineering and Mathematics (STEM) education is an instance of the lack of encouragement or support from parties closest to them. The above statement is supported by Raja Zainal Badri & Amen (2018) who explained that among the most difficult challenges for Persons with Disabilities (PwD) are not only from peers, lecturers and fellow students who study at the same Institutions of Higher Education (IHE) but also from the state of preparedness of IHE itself to accept such students. Furthermore, according to observations made by Shanahan (2016), a master's degree student in the field of astronomy at Wesleyan University Middletown, Connecticut, the United States of America, students with disability have difficulty going to lecture rooms and laboratories to conduct research. This is because the infrastructure and facilities are not user-friendly toward PwD who have physical deficiencies.

Also, the teaching and learning process for people with disabilities is very different compared to typical non-disabled groups. Kamaruzaman (2017) mentioned in his article that level of astronomical science education at the school level is still low because of the exposure given in the teaching and learning process is not carried out comprehensively. If astronomical science education in mainstream schools is of a low level, questions remain as to how comprehensive exposures, if any, are given to groups of students with disabilities. According to Bunyamin (2015), a major challenge in implementing Integrated STEM is the lack of skilled teachers and that of professional teacher training in Integrated STEM. Similarly, as with the problems faced by disabled people, the researcher also observes similar challenges which is the lack of teachers with specific skills to teach disabled student groups. This is confirmed by Saiful (2017) who stated that teachers are less willing to accept and do not cooperate in the teaching and learning process of these special students as well as lack the knowledge to teach these special groups. Looking at the factors that become obstacles to people with disabilities from getting involved in astronomy, this study also contributes to efforts or activities which are carried out to make sure that disabled groups can also get themselves involved in the field of astronomical science.

Efforts made to incorporate disabled people into education can be categorised into the types of disability or impairment such as learning disability, hearing disability, visual disability and physical disability. For those with learning difficulties, an activity during the International Year of Astronomy 2009 used the method of storytelling or narration of a talk entitled "The Life of Stars". The storyline relates the formation and evolution of stars. In it, each stage of star evolution was linked to some human experience, such as being born, growing up, etc. to attract the interest of people with learning disabilities and for easier understanding (Ortiz et al., 2010). For people with hearing disability or impairment, an initiative taken was by using the technique of vocabulary video tutorials via the sign language used by American Sign Language (ASL) applied in a context of web-based astronomy education. This study was conducted for first-year students of the National Technical Institute for the Deaf at the Rochester Institute of Technology, New York because the field of astronomical science involves vocabulary which is complex and difficult to understand. It was reported that, by using this technique, the hearing-impaired students could easily understand astronomy (Dodd & Ting 2007).

In Bulgaria, a multimedia compact disc CD was produced to help people with hearing impairment and accompanied with basic terms of physics and astronomy along with explanatory texts in various illustrations as reported by Zamfirov et al. (2007). Meanwhile in California, astronomists at UC Riverside and teachers at the California School for the Deaf Riverside (CSDR) set up an astronomy workshop. Using electromagnetic emissions, sound and sonification (a cosmic phenomenon process) which were then sent to students via a sound laboratory accompanied by video and image narration to shed light on the sounds of the universe. This workshop received positive feedback from more than 80 hearing impaired students. Learning method such as that has a very large and positive impact because according to Moores (2001) auditory method is one of the communication and teaching methods which are suitable for those with hearing impairment because it covers listening to exercises, teaching them how to listen to sounds and to differentiate between the different sounds.

More studies have been done on visually impaired groups because in astronomy eyes to see and witness natural events and phenomena. Ortiz et al. (2010) reported the use of as many as 50 braille books titled 'Volver a ver welding estrella' and a planetarium show entitled “The Sky in Your Hand” which was also held for visually impaired people. The audience were given a hemisphere-shaped replica engraved with constellations so that anyone who is holding it can touch the shape of the star constellation and follow the script through certain sound associated with each of the object covered by the script.

The tactile material method is one of the effective activities for the visually impaired. This method was used in the Dedoscopio Project in Chile as described by Sabando & Munoz (2021) and in Peru by Quiroz et al. (2021). Arcand et al. (2019) stated in a study that creation of three dimensional (3D) tactile material allowed the group of blind and visually impaired (BVI) participants to learn directly various techniques and approaches facilitating them to access astronomy well. The creation of software for people with physically disability was also one of the efforts to involve this group in the field of astronomy. A software produced was for them to communicate using a computer that had been connected to the wheelchair. The software was called 'Astroadapt' intended as a tool to communicate which also contains information like pictures and brief explanations about the field of astronomy and this activity was also done during the International Year of Astronomy 2009 (Ortiz et al., 2010).

In Malaysia, there are also efforts to give opportunities to disabled people to get involved in astronomy such as the Matahati Angkasa Program and the launch of a book written in Braille on the country's first astronaut entitled 'Malaysia First Step In Space' organised by the National Planetarium (Shahril 2013). Also, the Agensi Angkasa Negara (ANGKASA) introduced the first astronomy teaching aid, ‘Space Insight Education Kit’ (SIEK), specifically for students with visual impairment (Utusan Borneo Online 2014) and a programme was also carried out for children including children with disability by the Apadilangit group for children with visual disabilities (Arishah 2019). In addition, in May 2022, the 'Space Insight Planetarium Golden Heart' programme was launched by the RH Dato' Sri Dr. Adham Baba, Minister of Science, Technology and Innovation specifically for people with disabilities such as visually impaired, of short stature and wheelchair users (Ministry of Science, Technology and Innovation (MOSTI 2022). Although efforts to involve people with disabilities in the field of astronomy have been satisfactory, Mhd Fairos Asillam who was the Chief Assistant Director (Education) of the National Planetarium admitted in the World Asteroid Day webinar that there are still many areas of improvement on the efforts that done to give better exposure to disabled people more efficiently (National Planetarium, 2022).

Therefore, disabled people also need to get involved in the field of astronomy because of its importance to people with disabilities. This group does not often get the same educational rights as others due to the disability factors they have. There is a need for them to know where the planet earth is located relative to the sun, how the moon and stars move as the field of astronomy is very closely related to a person’s daily life. This point is supported by Percy (1998) as some students may be fortunate to get the best education but other students such as those

with disabilities and students in rural areas away from the city may be marginalized. This study has divided the analysis of this literature review and summarized in Table 1 below:

Table 1

Survival and Sustainability Education Astronomy Against Group People Disorder Effort (Disabled)

No.	Research	Background	Objective	Method	Results
1	Dunn et al. (2012) *Assisting Students with High Incidence Disabilities to Pursue Careers in Science, Technology, Engineering and Mathematics.*	Factors and causes of lack of involvement of disabled people in Science, Technology, Engineering and Mathematics (STEM) fields.	To analyse issues faced by people with disabilities in STEM fields and measures taken to enable them to have full access to the fields.	Data analysis and case studies	Two factors prevent disabled people to get involved in STEM fields. 1. Teachers have low expectations for students with disability. 2. Inability to easily access STEM fields.
2.	Shanahan (2016) *Disability is not a Disqualification*	Issues faced by People with Disabilities in astronomy education.	To identify problems experienced by people with physical disability.	Descriptive survey	The main factors for the physically disabled to access the field of astronomy are from the perspectives of provided facilities and infrastructure.
3.	Kamaruzam (2017) *Pengajaran dan Pembelajaran Astronomi Islam Di Malaysia: Suatu Pengenalan.*	The teaching and learning process of astronomy education in the Malaysian education system.	To present an introduction to the development of the field of Islamic astronomy and its teaching and learning process in the Malaysian education system.	Data analysis	Level of exposure to or understanding of school-level astronomy education is still low because of the exposure given in the teaching and learning process is not holistic.
4.	Raja Zainal Badri & Amen (2018) *Isu Dan Cabaran Pelajar Kurang Upaya Penglihatan di Institusi Pengajian Tinggi.*	Issues faced by people with disabilities in the field of education.	To study the issues and challenges of people with visual impairment in Higher Education Institutions.	Qualitative via methods of interview and questionnaire.	The main issues experienced by this group is loss of self-confidence, financial constraint and the skewed view of society towards them.
5.	Cassandra G. Hall et al. (2021) *Teaching college students with intellectual disabilities: Faculty experiences with inclusive higher education.*	The teaching and learning process of inclusive higher education programmes for groups with disability.	To identify the appropriate teaching and learning methods for disabled people and the experience from a university that has inclusive higher education programmes.	Qualitative via methods of interview and questionnaire.	A study was carried out to see the views of 23 professors from a university regarding their experience in teaching groups with intellectual disabilities and to identify the role and strategy of the faculty in helping them to access the field of education as well as to examine several issues which become challenges for them in handling education for the group with the disability.
6.	Bunyamin (2015) *Pendidikan STEM Bersepadu: Perspektif*	Teaching and learning of STEM education and the main	To review the development of Integrated STEM in the United States of America	Data analysis.	The main challenges in implementing Integrated STEM are the constraint of skilled teachers and the lack of professional training colleges for Integrated STEM. In addition, studies are

	Global, Perkembangan Semasa di Malaysia, dan Langkah Ke Hadapan.	challenges in implementing Integrated STEM.	and the initiatives taken in Malaysia to use this approach.		still few on school-level Integrated STEM approaches and they are more focused on higher education.
7.	Noreen Grice (2007) *Resources for Making Astronomy More Accessible for the Blind and Visually Impaired Students.*	Concentration to efforts and measures taken for disabled people to enable them gain full access to the field of astronomy.	To analyse printed and online resources in the field of astronomy as a suitable learning method for visually impaired group.	Data analysis.	A number of projects have been undertaken to help the group. Activities such as creating a solar system model using sport equipment such as small marble, basketball, etc. were more effective than teaching and learning through reading texts and it helped students with visual disability to recognize the planets well.
8.	Ortiz et al. (2010) *A Fascinating Adventure: Astronomical Activities for People with Disabilities during IYA 2009.*	Efforts and measures taken for disabled people to enable them get full access to the field of astronomy.	To list astronomical activities developed during the International Year of Astronomy 2009 aimed at people with disabilities.	Data analysis and descriptive survey.	Among the activities carried out were in the form of storytelling or talks, donation of as many as 50 braille books which are titled for the visually impaired and various other efforts carried out to give opportunities to disabled people to get involved in the field of astronomy.
9.	Sabando & Munoz (2021) *Dedoscopio Project: Making Astronomy Accessible to the Blind and Visually Impaired (BVI) Communities Across Chile.*	Effort and steps taken for disabled people to enable them to gain full access to the field of astronomy.	To set up a project (Dedoscopio) for visually impaired groups.	Data analysis and descriptive survey.	Among the activities in the project was establishment of a medium to explain astronomical concepts and phenomena using tactile materials.
10.	Alexis Rodríguez Quiroz et al. (2021). *Inclusive Astronomy in Peru: Contribution of Astronomy Teaching for Visually Impaired People.*	Effort and steps taken for disabled people to enable them to gain full access to the field of astronomy.	To establish a learning process in various forms by exploiting new technologies to bring the field of astronomy closer to minorities in Peru such as visually impaired people.	Data analysis and descriptive survey.	The inclusive astronomy education project is known as AstroBVI (Astronomy Blind and Visually impaired) and is designed for the blind and visually impaired community in Latin America and through this project they can gain basic knowledge basic of and have exposure to astronomy while at the same time raising awareness to the local community.
11.	Kimberly Kowal Arcand et al. (2019) *Touching the stars: improving NASA 3D printed data sets with blind and visually impaired audiences.*	Efforts and measures taken for disabled people to enable them to get full access to the field of astronomy.	An effort carried out to address those who are blind or visually impaired was the creation of three dimensional(3D) tactile material.	Qualitative and data analysis	Progress was achieved through technology and development program of 3D models of tactile materials using the Chandra X-ray Observatory for data improvement.
12.	Judy Egelston Dodd and Simon Ting (2007) *Video-Tutorials for Tech Sign Vocabulary in*	Efforts and steps taken towards disabled people to enable them to gain full access to the	Techniques of vocabulary video tutorials via sign language used by American Sign Language (ASL) in the context of	Data analysis.	The technique used by ASL showed that many students understood astronomy by using videos tutorials.

	Astronomy. Journal of Science Education for Students with Disabilities.	field of astronomy.	web-based astronomy for first-year students at the National Technical Institute for the Deaf at the Rochester Institute of Technology, New York.		
13.	Milen Zamfirov et al. (2007) *Innovation in teaching deaf students' physics and astronomy in Bulgaria.*	Efforts and steps taken for disabled people to enable them to gain full access to the field of astronomy.	A strategy was carried out to 13- and 14-year-old students with hearing disability who attended mainstream and special schools in Bulgaria.	Qualitative and data analysis	One multimedia CD was produced, accompanied by basic terms in the field of physics and astronomy along with explanatory texts in various illustrations. The use of terms is explained in Bulgarian, Bulgarian Sign Language and English. This method was also introduced to explain the basic concepts of physics and astronomy, where the terms used are very difficult and complicated to understand.
14.	D. Leo-Winkler (2019) *The Vibrating Universe: Astronomy for The Deaf. Journal of Science Education and Technology.*	Efforts and measures carried out for groups with disabilities to enable them to gain full access to the field of astronomy.	California School for the Deaf Riverside (CSDR) had organised an astronomy workshop which was intended specifically for hearing impaired people using sound laboratory on the school site.	Qualitative and data analysis	The workshop received positive feedback from more than 80 hearing impaired students, enabling them to enjoy image and vibrations produced in the workshop.
15.	Donald F. Moores (2001) *Educating The Deaf: Psychology, Principles, and Practices.*	Teaching and learning process for people with disability.	Suitable methods for teaching and learning process for hearing impaired group.	Data analysis	The auditory method is one of the suitable methods of communication and teaching for people with hearing impairment as it covers listening to exercises, teaching to listen to sounds and to distinguish between different sounds.
16.	Kumiko Usada Sato et al. (2019) *Astronomy networks and best practices for inclusion in Japan.*	Efforts and steps taken for disabled people to enable them to have access to the field of astronomy.	To build an inclusive astronomy community as an effort to bring groups such as people with disability to international level.	Data analysis	Building domestic and international networks is an important matter to spread inclusive activities. Besides, such matter makes it easier for educators who experience difficulties when dealing with diverse communities such as groups of disabled people.
17.	Monica de la Guardia Duran (2019)	Effort and steps taken towards	To promote the observatory of the University of Havana	Data analysis and survey.	The observatory at the University of Havana Cuba houses instruments such as the Main Telescope: Equatorial Refractor,

	The Astronomical Observatory of the University of Havana. A Projectfor its Rehabilitation as a Center for Science Popularisation.	disabled people to enable them to gain full access to the field of astronomy.	in Cuba to attract youths and children to the field of astronomy.		Meridian Circle, Secretan Telescope and several other didactic materials which are uniquely valuable. This will also attract the interest of teenagers and children to get involved in the field of astronomy.
18.	Noorkhairan Nordin et al. (2020) *Kajian Keberkesanan Penubuhan Kelab Falak dan Astronomi di Sekolah Angkat Jabatan Mufti Negeri Melaka.*	Efforts and steps taken towards disabled people to enable them to get full access to the field of astronomy.	To evaluate the level of effectiveness of the club establishment from various aspects such as student perception of astronomy, the impact of club establishment and the impact of implementation of *falak* club activities to students.	Quantitative	The establishment of *Kelab Falak dan Astronomi* [Falak and Astronomy Club] successfully achieved its main goal of raising awareness and understanding of the science of *falak* and astronomy among students. In addition, some suggestions for improvement related to the club structuring and future studies were also discussed.
19.	John R. Percy (1998) *Astronomy Education: An International Perspective.*	Importance of astronomy science education for disabled people.	To identify the steps and actions that need to be taken so that minorities like people with disabilities receive education in the field.	Data analysis	Among the suggested actions that need to be taken: - Make education part of the professional astronomy organisation. - Always be aware of development in astronomical science education. - Give contribution and support in astronomy education.
20.	Azmi & Mat Basir (2020) *Ratifikasi Konvensyen Pertubuhan Bangsa-Bangsa Bersatu terhadap Hak Orang Kurang Upaya: Implikasi dan Realiti dari Dimensi Perundangan dan Kesamarataan.*	The importance of astronomy education for disabled people.	To analyse legal provisions in Malaysia related to disabled people and the right to life through the Federal Constitution and relevant legal provisions.	Qualitative and data analysis.	Malaysia as one of the members of the United Nations is obligated to apply international laws and treaties regarding human rights if they are not contradictory to local norms and values. Some ideas were shared as a solution for the government to improve the issues of this group.
21.	Abdullah (2017) *Program Pendidikan Inklusif bagi Murid-Murid Berkeperluan Khas di Malaysia*.	Teaching and learning for groups with disabilities in STEM education.	To clarify in detail the concept of inclusive education, type of inclusive programme,the importance of inclusive programme, issues and challenges in inclusive programmes as	Qualitative and data analysis.	Giving opportunities to students with special needs to gain various knowledge and able to train them interpersonal communication skills with other typical students.

			well as suggestions in dealing with those issues.		
22.	Wanda Diaz Merced and Michael Gastrow (2018) *Astronomy and Inclusive Development: Access to Astronomy for People with Disabilities.*	Efforts made for disabled people to enable them to have full access to the field of astronomy.	To test the effectiveness of specially designed software tool to translate astronomical data into audio signals that can be interpreted by visually impaired group.	Qualitative and Quantitative	People with disability have the potential to regularly access and broadly get involved in the field of astronomy up to global level.

4 DISCUSSIONS

Astronomy education or *falak* education can actually be said as one of the scientific disciplines that is often heard. For example, it is often linked to methods of determining *qibla* direction, prayer time, and sighting of *hilal* or new moon to determine the Islamic calendar month. Besides, the National Planetarium complex is already a household name among school students and the general public who wish to know and learn the field of space science. However, based on the research findings obtained by the researcher through observation of previous studies, there are not many research which involve groups of disabled persons in the area of astronomy and matters related to it in this country based on the following discussion:

4.1 DEFINITION OF PEOPLE WITH DISABILITY (PWD)

According to Azmi & Mat Basir et al. (2020), person with disability in general is defined as someone who has an impairment from the mental, physical and other point of view. In the United Nations Convention (UN) on the Rights of Persons with Disabilities, it is stated that persons with disabilities include those who have long-term physical, mental, intellectual or sensory impairments which in interaction with various barriers may hinder their full and effective participation in society on an equal basis with others. Referring to Pelan Tindakan Orang Kelainan Upaya 2016-2022, people with disability is also referred to as a person with a long-term disability in physical, mental, intellectual or sensory terms that when faced with various obstacles may not be able to participate fully and effectively participation in society (Tahir et al. 2020). The World Health Organization (WHO) estimated that as many as 7 percent of the population in countries in the world have a disability and about 2 percent will need some form of rehabilitation services (Rosli et al., 2017).

Based on the above statement, it is clear that the shortcomings of this group will be an obstacle for them to fully participate in society or in certain other fields. Even so, this should not deny their rights as citizens of a country. Unlike other vulnerable groups such as children and women, people with disabilities are the most vulnerable to discrimination due to the impairments they have. This is stated in the Ratification of the United Nations Convention on the Rights of Persons with Disabilities: Implications and Reality from the Legal and Equality Dimensions, people with disabilities are included in the category of "vulnerable" groups that are exposed to discrimination and mistreated by various parties. Various discussions from a legal point of view against the negative perception and discrimination experienced by women

and children have been held, but relatively less have been held for disabled people. This statement is further reinforced by the UN's recognition of the United Nations Convention on the Rights of Persons with Disabilities (CRPD) for the first time first in the 21st century.

4.2 CATEGORIES OF PERSONS WITH DISABILITIES

According to statistics from the Malaysia Department of Social Welfare [Jabatan Kebajikan Masyarakat JKM], the number of registered disabled persons until January 2021 by the state was 592,856. Of that, 203,765 people are those with learning disability, followed by 216,011 who are physically disabled, 40,569 hearing disabled, 52,584 visually disabled and 49,205 mentally disabled as well as 27,688 who are registered with disability under various other categories. According to Ismail et al. (2015) disabled people are also classified into four categories, namely visually impaired, hearing impaired, limb impaired and intellectually impaired. Next, according to the Akta Orang Kurang Upaya (OKU) 2008, the Malaysia Ministry of Women, Family and Community Development through the Social Welfare Department has categorised disabled people into seven groups, namely (Din et al., 2019):

a. Hearing impaired person is an individual who cannot hear clearly using both ears without using a hearing aid or cannot hear at all even with the use of a hearing aid. There are four levels that can be categorised as hearing impaired, namely:

i. Mild - (20 - < 30 dB) (for adults);

ii. Moderate - (30 - < 60 dB);

iii. Severe - (60 - < 90 dB);

iv. Profound - (> 90 dB).

b. Visually impaired persons are individuals who cannot see or have limited vision either on one eye or both eyes even though by using corrective aids such as glasses or contact lens. Vision impairment is divided into two, namely:

i. Blind is that with a vision less than 3/60 in the better eye even with the use of corrective aids or a field of vision less than 10 degrees from fixation;

ii. Limited vision (low vision/ partially sighted) which is vision worse than 6/18 but equal to or better than 3/60 even with the use of corrective aids or a field of vision less than 20 degrees from fixation;

c. Physically disabled person is someone who has a disability in any part of the body either losing its function or lacking any part or limb of the body including the condition of an imperfect limb which affect one’s ability. This category includes dwarfism, stump (hand

or foot or both), clubfoot, paralysis, spina bifida, muscular dystrophy and cerebral palsy. For impairment that does not affect function like stump in one finger, having six or more fingers and missing or incomplete earlobes are not categorized as physically disabled;

d. A person with learning disability is someone who has intellectual problem that is not in line with their biological age. Those who belong to this category are slow, down syndrome, intellectual disability, autism, Attention Deficit Hyperactive Disorder (ADHD), specific learning problems (dyslexia, dyscalculia, dysgraphia) and global development delay;

e. Persons with speech disability are individuals who have speech problem but can hear;

f. Mentally disabled is a person who faces a severe mental illness who has undergone treatment or has been diagnosed for at least 2 years by a psychiatrist. As a result of the illness experienced, they are still unable to function either partially or completely in matters related to themselves or relationships in society even after undergoing psychiatric treatment. Among the types of mental illness are schizophrenia, mood disorder and serious and chronic organic mental disorder;

g. Multiple disabilities are individuals who have more than one type of disability and are generally not suitable classified under anywhere of five other existing categories. For example, an individual with 2 types of disabilities in terms of vision and hearing will be registered in the category of multiple disabilities.

The above explanation regarding the types of disability categories is expected to open the public eyes to the fact that this group experiences difficulties in undergoing daily life. Furthermore, there are some within the society who often view negatively at the 'privileges' that they have. Because of that, some people with disabilities rarely come forward or get involved in social activity because they feel ashamed of the deficit that they have. This will cause them to be less confident of themselves and if this continues, this group will be left behind in the current of modernization.

4.3 INVOLVEMENT OF PWDS IN THE FIELD ASTRONOMY

Dunn et al. (2012) stated that disabled people are among the groups that are less involved in the field of Science, Technology, Engineering and Mathematics (STEM). Their disability causes them to be seen as less capable in these fields, in addition to the lack of exposure to, having no role models in and absence of individual support for them to venture into STEM. This study aims to identify issues related to the involvement of people with learning

disability, emotional and behavioural disorders in STEM programmes in colleges and provide transition planning strategies to encourage students to participate in STEM and thereby succeed in this field. This article is also generalised towards all fields of science and is not focused on astronomy alone.

Shanahan's (2016) involvement in Middletown Wesleyan University, Connecticut, United States of America as a master's degree student in the field of astronomy faced several problems not only from the acceptance of those around him but also from the point of amenities to go to lecture rooms. As a physically disabled person, Shanahan had difficulty going to lecture rooms and laboratories to conduct research because of the numerous flights of stairs he had to take which slowed down his daily commute. Many other astronomers had to hide their difficulty in fear of it interfering with their work and life. Representing people with disability. Shanahan voiced the issue of the involvement of this group in several conferences and helped to create the American Astronomical Society (AAS) which ran a working group for the accessibility of disabled people in this field. However, some obstacles remain in the thinking of some section of the society that is one's ability is an indicator of the level of involvement in some areas. This article shows the existence of a lack of 'user friendly' facilities in some universities.

Kamaruzaman (2017) presented in writing on the development of the field of Islamic astronomy and its teaching and learning process in the Malaysian education system. It was also summarised that astronomical science education in Malaysia is placed as a sub-field under the subject of science at primary school level and under a sub-area lesson in physics, science and geodesic science for secondary schools. In general, the exposure or understanding of astronomy education at school is still at a low level because the teaching and learning process is not carried out comprehensively and also because of the lack of equipment such as telescopes as well as the lack of teachers who are expert in the subject matter. Various initiatives have been carried out by the government and certain other organisations to encourage the teaching and learning such as those through the establishment of a National Planetarium, creation of Space Science Education Portal and so on. At the higher education level, courses such as falak syari'e and others have been offered to students to produce graduates skilled in the field of falak syari'e or Islamic astronomy.

Raja Zainal Badri & Amen (2018) studied the issues and challenges of visually impaired people in higher education institutions. The results of the study found that among the main issues experienced by this group are loss of self-confidence, financial constraints and society's view of them. Among the challenges faced are challenges in accessibility, acceptance of friends and difficulties in learning at university. However, the first part of the article only touched on

the teaching and learning process of astronomy education that does not involve people with disabilities, while the later part of the article did not touch on astronomy education but focused on the issues and challenges of students with visual disability and their involvement at the IHE level only.

Many of those with intellectual disability continue their education to a higher level in colleges and universities. A study was carried out by Hall et al. (2021) to look at the views of 23 professors from a university regarding their experience teaching people with intellectual disabilities. Interviews were carried out to ascertain the role and strategy of the faculty in helping this group to access the field of education as well as to examine issues which proved to be collective challenge for them in managing education for intellectually disabled students. Various suggestions for improvement were made to further encourage intellectually disabled people to access higher education and those can be used as a guide for other educational institutions height another which intend to incorporate programmes of inclusive higher education for people with disabilities. In general, this article presented the involvement of groups with intellectual disabilities in higher education institution and did not specify the involvement of disabled students in specific courses such as astronomy.

4.4 ROLE AND CONTRIBUTION OF ASTRONOMY TOWARDS PEOPLE WITH DISABILITIES

Bunyamin (2015) discussed the development of Integrated STEM in the United States of America and the efforts which have been initiated in Malaysia to use this approach. This article also suggested matters to be given attention and consideration in implementing Integrated STEM education which include construction of new curricula of Science and Mathematics which are based on principles of the discipline and holding of discussions with all stakeholders towards a comprehensive and inclusive Integrated STEM education. The researcher argued in the discussion section that the main challenges in implementing Integrated STEM are the lack of skilled teachers and the lack of professional teacher training specific for Integrated STEM. In addition, studies in Integrated STEM approaches for school levels are still lacking and studies have been more focused on higher education level. Looking at the challenges presented in this article, these are the same challenges experienced by astronomical science education for disabled people, one of which is the lack of teachers with special skills to teach students with disabilities.

Grice (2007) compiled resources on making astronomy more accessible for visually impaired students. According to an estimate by the American Foundation for the Blind, there were 10 million visually disabled people in the United States of America. It was found that projects had already been undertaken this group of people. Activities such as creating a solar system model using sports and games apparatus such as small marbles, basketball and so on were found to be more effective than teaching and learning via text reading as they helped visually impaired students to recognize the planets well. Ortiz et al. (2010) listed some astronomical activities that had been developed during the International Year of Astronomy 2009 which was aimed for disabled groups; be they physical, intellectual or others. Among the activities carried out was in the form of storytelling or talk entitled "The Life of Stars". This activity was specifically dedicated for disabled people who have learning difficulties. A total of 50 braille books titled 'Volver a ver las estrella' were donated to visually impaired prople. The braille book was translated into the Spanish language from an internet website which was built by Astronomical Observatory of Padova in 2000. Also, a planetarium show was held for visually impaired people entitled 'The Sky in Your Hand'.

This activity took inspirations from Sebastian Musso of Argentina. Participants in the activity were given a hemispherical replica of constellations which were engraved on its surface so that the person holding it could touch the constellation shape while following a script with certain sounds associated to the objects being covered. Finally, a software was created for the physically disabled group for communication using a computer connected to the wheelchair. The software is called 'Astroadapt' and is intended as a tool to communicate information such as pictures and brief explanations about the field of astronomy.

According to Sabando & Munoz (2021), people with visual impairments are among those marginalized from the field of astronomy in Chile. To ensure that this group can access the field of astronomy, a project (dedoscopio) has been established. Various activities were held including using a tactile material medium to explain astronomical concepts and phenomena. The study done by Quiroz et al. (2021) successfully developed and demonstrated a form of teaching to give an exposure of astronomy to visually impaired minorities in Peru. This inclusive astronomy education project known as AstroBVI (Astronomy Blind and Visually Impaired) was designed for the blind and visually impaired community in Latin America through which the targeted minorities acquired basic knowledge of and exposure to astronomy and at the same time awareness of the local community was increased. This project has had a positive impact on inclusive education for the visually impaired in Argentina, Bolivia, Brazil, Chile, Colombia, Costa Rica, Ecuador, Honduras, Mexico, Paraguay, Peru, Venezuela, Spain

and Nepal. Based on the articles of Ortiz et al. (2010), Sabando & Munoz (2021) and Quiroz et al. (2021), activities which were organised were limited to certain languages, namely Spanish and English only and they also focused on the visually impaired communities in mostly Latin American countries.

Arcand et al. (2019) stated that astronomy is a field of science that mostly involves visuals and this causes those with deficiency in terms of vision or the inability to see to be unable to fully participate in this field. Various efforts have been made to deal with this problem, including through the creation of three-dimensional (3D) tactile materials. The study describes the advancement attained through technology and development program of 3D model of tactile material using the Chandra X-ray Observatory for data improvement. Emergence of cheaper 3D printing technology has opened up new opportunities for people to visualise astronomy via touching aside from books which cost highly to print and are also limited in their distribution to external networks.

Overall, the feedback from the participants regarding the model and the programme was encouragingly positive. Various discussions were held regarding the size, texture, quality and quantity of 3D printing. 3D printing technology also allows blind or visually impaired (BVI) participants to directly learn the various techniques and approaches which make it easier for them to access astronomy well. The study discussed methods and facilities provided for those with visual disabilities and the study also further added that although the field of astronomy involves a lot of visuals, there are also other types of disabled people who cannot get involved in the field of astronomy, citing those with hearing impairment as an example. Those with hearing disability are able to see but do not have a deep understanding of what they see and touch.

Referring to Dodd & Ting (2007), the article elaborates on a video tutorial technique of vocabulary through sign language used by American Sign Language (ASL) in the context of web-based astronomy for first-year students of the National Technical Institute for the Deaf at the Rochester Institute of Technology, New York. The technique used by ASL showed that many students were able to grasp astronomy using the video tutorials. Use of sign language in science courses are a big challenge for deaf students of all ages because they involve scientific vocabulary that is complex and difficult for students to understand. The video tutorials were also able to help teachers as one of the preparations for teaching students with hearing disability there.

Zamfirov et al. (2007) explained a new strategy implemented in Bulgarian schools in physics and astronomy education to 13- and 14-year-old students with hearing problems. The

strategy had positive impact on hearing impaired students in the mainstream as well as those attending special schools. A multimedia CD was produced, accompanied by basic terms in the field of physics and astronomy along with explanatory texts in various illustrations. The usage of terms was in Bulgarian language, Bulgarian Sign Language and English. This method was introduced to explain basic concepts of physics and astronomy where the terms used are difficult and complex to understand. The method can also be used in other curriculum subjects such as biology, chemistry and geography. In general, the works of Dodd & Ting (2007) and Zamfirov et al. (2007) are related to contribution in helping students with disabilities to engage in astronomy education but were limited to those with hearing impairment only and the studies were also conducted in a few areas only.

Winkler (2019) stated that involvement of people with hearing disability in STEM fields are often neglected and they also often lag behind educationally and in general activities related to STEM. An initiative taken by astronomers at UC Riverside and teachers at the California School for the Deaf Riverside (CSDR) was to set up an astronomy workshop specifically for students with hearing impairment using the sound laboratory on the school site. Astronomy was chosen as the main medium because it is a knowledge discipline which creates a sense of awe and increases scientific knowledge of nature and space. The workshop used electromagnetic emissions, sound and sonification (a process of cosmic phenomena) which were then delivered to students through a sound laboratory designed specifically for those with hearing impairment. These were accompanied by a narration using videos and images to shed light on the sounds of the universe. The workshop received positive feedback from more than 80 hearing impaired students.

The learning method involving sound and vibration which was used in the previous article above is one of the methods suitable for students with hearing disabilities. This was proven by Moores (2001) who stated that auditory method is one of the methods of communication and teaching that is suitable for hearing impaired students because it includes listening exercises, teaches how to listen to sounds and how to distinguish between different sounds. This shows that the workshop which was specially designed by astronomers at UC Riverside and the teachers at the California School for the Deaf Riverside (CSDR) was suitable for hearing impaired people. Winkler (2019) also stated that such programme is also suitable to be carried out in other areas to give opportunities for hearing impaired people to participate in this field.

Sato, Mineshige & Canas (2019) stated that an inclusive programme in the field of astronomy is one of the mediums to draw closer those lacking opportunity or those whose involvement is lacking in the field of astronomy such as disabled people. It was thought that

building domestic and international networks is important to spread inclusive activities. Many educators experience difficulties when dealing with a diverse community such as people with disabilities because of the lack of resources or communities to cooperate with each other and to exchange ideas. This article elaborated methods taken in Japan to deal with related problems, by building an inclusive astronomical community as an effort to bring people with disabilities to an international group level thus facilitating them to access the field of astronomy.

In Cuba, one of the steps taken to attract the interest of people especially among children and youth to astronomy is to re-promote the observatory of the University of Havana. Since the middle of 2008, the Department of Scientific Culture "Felix Varela" University of Havana under the leadership of Dr. Edwin Pedrero has been considering to promoting the observatory with a view of making it a centre for the dissemination of knowledge regarding astronomy and other related sciences. Among the instruments housed in the observatory of the University of Havana are the Main Telescope: Equatorial Refractor, Meridian Circle, Secretan Telescope and some other didactic materials of special value (Duran 2019). This article discusses one of the methods to attract the interest of children and youths in particular by reactivating the observatory of the University of Havana in Cuba. However, this article does not concern disabled people specifically and the project prioritized children and youth.

The study of Nordin et al. (2020) found that the establishment of an astronomy club named *Kelab Falak dan Astronomi* successfully achieved its main goal of raising awareness and understanding of falak (Islamic astronomy) and astronomy among students. Among the effects and impacts of the establishment of the club on students from selected schools were an increase in knowledge of astronomy, majority of respondents had a good level of interest in astronomy and respondents were exceedingly satisfied with the establishment of the club in their respective schools. The researchers also gave proposals for club improvement to ensure the level of its effectiveness can be improved. This study shows that the establishment of an astronomy in school plays an important role in attracting student interest to delve into the area of astronomy. However, this article only focused on a few schools and the respondents did not include students from any disabled group.

In the context of Malaysia, measures taken by the government and private organizations or NGOs to ensure that disabled people can get involved in astronomical science include the organising of Program Angkasa Matahati, 'Touch The Sky' Exhibition and several competitions. These were organised 2013 by The National Planetarium involving people with visual disabilities and trainee teachers from Institut Perguruan Ilmu Khas Cheras, Kuala Lumpur. One of the purposes of the programme was to help people with disabilities understand

the concepts of astronomy and space science, thus giving them the opportunity to explore and learn new experience. In addition, the competition which involved the trainee teachers was to measure the level of creativity of those teachers in creating teaching aids to cultivate science and technology for visually impaired students.

In addition to the Touch The Sky Exhibition and Program Angkasa Matahati, the National Planetarium also launched a Braille book written about the nation's first astronaut titled "Malaysia's First Step In Space". Besides being able to increase knowledge about space, attendees of the programme also shared feelings of joy and pride on the exploration of Malaysia's first astronaut, Datuk Dr. Sheikh Muszaphar Shukor Sheikh Mustapha while on the International Space Station (ISS) (Shahril 2013). Later in 2014 the National Space Agency (ANGKASA) introduced the first teaching aids for teaching astronomy called 'Space Insight Education Kits' (SIEK), specifically for visually impaired students (Utusan Borneo Online 2014).

In 2019, a programme was carried out for children including children with disabilities by the Apadilangit group. This programme helped them to learn the science of astronomy. For children with visual disability, Apadilangit employed some techniques to introduce the science of astronomy through tactile senses such as creating earth and moon models using 3D models. The founder of Apadilangit, Muhammad Hafez, was inspired to develop the programme for the visually disabled children after attending a convention on astronomy meant for the general public in Japan in 2018 (Arishah 2019). In addition, a special activity for visually disabled people has been proposed in conjunction with the launching ceremony of the Pelancaran Inisiatif Program Pembudayaan Astronomi Dan Sains Angkasa 'Big Bang Astronomy 2021' called 'Space Insight; Planetarium Golden Heart', with the aim of recognizing and learning the solar system and its function in everyday life (MOSTI 2021). In May 2022, the 'Space Insight Planetarium Golden Heart' programme was launched by Rt. Hon. Dato' Sri Dr. Adham Baba, Minister of Science, Technology and Innovation specifically for people with disabilities such as those with visually impairment, of little stature and wheelchair users (MOSTI 2022).

4.5 REQUIREMENT FOR PEOPLE WITH DISABILITIES IN ASTRONOMY EDUCATION

People with disabilities have the right to education not only in astronomy education but also in all scientific fields. This is clearly mentioned in the Akta Orang Kurang Upaya 2008 which was enacted as a result of Malaysia ratifying the United Nations Convention on the

Rights of People with Disabilities and as a fulfilment of her international obligation. This Act was drafted in accordance with local norms, containing 46 provisions that outline the registration, protection, rehabilitation, development and well-being of people with disabilities, the establishment of a National Council for Disabled People and other related matters (Azmi & Mat Basir, 2020).

Referring to the preamble of the Akta Orang Kurang Upaya 2008, this act was enacted as an accessibility provision for people with disabilities to the physical, social, economic and cultural environment, health and education as well as to information and communication and to enable their full and effective participation in society. Indirectly, this can provide the same rights and opportunities to disabled people, just like to others in the community. The right to education for people with disabilities is mentioned in the Akta Orang Kurang Upaya 2008 under Seksyen 28 Akses Kepada Pendidikan (Akta Orang Kurang Upaya 2008):

a. People with disabilities shall not be excluded from the general education system because of their disability. Children with disabilities shall also be not excluded from preschool, primary, secondary and higher education on the basis of equality with disabled people or children, including vocational training and lifelong learning;
b. The government and private education providers shall provide reasonable adaptations suitable for people with disability in terms of infrastructure, equipment and teaching materials, teaching method, curriculum and other forms of support that meet various requirements and to enable the disabled people to further their studies;
c. The government and private education providers shall take appropriate measures to enable people with disabilities to learn life and social development skills to facilitate their full and equal participation in education including the following:

i. to facilitate the learning of Braille, alternative script, augmentative and alternative methods, means and format of communication and orientation and mobility skills, and facilitate peer support and mentoring;
ii. to facilitate the learning of Malaysian Sign Language and the promotion of linguistic identity of the deaf community;
iii. to ensure that the education of people and especially children, who are blind, deaf or deaf blind is delivered in a language, method and means of communication most suitable for individual, and in an environment which maximizes academic and social development. Each party has its respective role in ensuring people with disabilities get the same rights as the rest of the community in terms of education, employment, health, etc.

According to Percy (1998), astronomy education is very important because it can attract interest of various strata of the society especially the young generation to delve into the field of science and technology. In addition, not only can astronomy contribute to the development of physics and other fields of science, but it also has its own specialty. Astronomy can open up the mind of the society to natural event phenomena that occur in everyday life such as seasonal changes, navigation and the climate and can teach about the existence of the universe and its amazing contents. Percy also stated that there are several problems in astronomy education, one of which is that fortunate students may get the best education but others such as disabled and rural students may be marginalized. This study shows that there is a need for astronomy education for society in general including those who are disabled. Cooperation from all parties such as educators, astronomers, planetarium operators and other related parties are crucial for accessibility to astronomy for all classes of the society.

Abdullah (2017) stated in his study that the Inclusive Education Programme (IEP) was introduced as one of the efforts to provide equal educational opportunities to all students with special needs regardless of their disability and impairment. IEP is a programme that involves not only typical students but also students with special needs in a school community. It also opens up space for students who belong to the categories of physical disability, emotional and behavioural disorder (autism and ADHD), specific learning difficulty (dyslexia) as well as difficulty in reading, writing and arithmetic to learn together with typical students thus more optimally improving their ability. However, there were some issues in implementing IEP. Among them were that the teachers were less willing to accept and did not cooperate in the teaching and learning process with these special students and that many lack the expertise to teach these special groups. The study however stated that IEP is necessary to give opportunity to these students with special needs for them to gain various knowledge as well as to train them communication skills with other typical students.

The International Astronomical Union (IAU) is an astronomy institution committed to inclusive development in their vision and strategy. In order to realize their agenda, groups that are often marginalized from the world of science such as persons with disabilities should have access to the field of astronomy. A small-scale study had given emphasis towards groups with visual disabilities on their knowledge of astronomy. The study tested the effectiveness of a software tool designed especially for translating astronomical data into audio signals that can be interpreted by those with visual impairment. In addition, people with disabilities have the potential to get involved in the field of astronomy broadly and beyond to a level that is global

(Merced & Gastrow 2018). Among examples of astronomers from the disabled group are John Goodricke (hearing disabled) and Wanda Diaz Merced (visually disabled).

The United Nations Office for Outer Space Affairs (UNOOSA) believes that the field of astronomy can contribute to inclusive education and is able to have an impact on disabled people from the aspects of education, employment and in daily life. UNOOSA stresses that each party has a responsibility in building an inclusive society to ensure that every group can experience the greatness of astronomy.

5 CONCLUSIONS

People with disabilities are entitled to the same rights as others. Their disability should not be an obstacle to gaining access to education, employment and so on. In the context of astronomical science education, various initiatives have been carried out to encourage the involvement of this group, but not comprehensively. Based on research and literatures, the researcher views projects and programmes implemented abroad are more advanced than those undertaken in Malaysia. This study is anticipated to create new initiatives to help people with disabilities get involved in astronomy. Not only can the efforts made give exposure of the field of astronomy to disabled people but also attract many of the younger generations to get to know and explore the field of space science.

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