HIKAYAT DESA ISYARAT: LEARNING LANGUAGE OF THE IMPAIRED USING GAME-BASED APPROACH

AMIRAH IZZATI ABDULLAH
Universiti Teknologi MARA Kampus Jasin, Melaka
2022928403@student.uitm.edu.my

SITI FEIRUSZ AHMAD FESOL*
Universiti Teknologi MARA Kampus Jasin, Melaka
feirusz@uitm.edu.my

Article Info	Abstract
	Malaysian Sign Language (MSL), a topic unfamiliar to many, have been around since the 1960s. Some that are familiar chose to not delve into it as it seems difficult, time-consuming, and boring, while others, a small percent of eager learners, work-life constraints sadly further hinder their learning process. In order to remediate these ongoing issues, a fun yet engaging educational approach is needed—game-based learning (GBL). As one of the ever-evolving educational tools, GBL will surely pique the public's interest in MSL by making learning enjoyable. As games are basically an integral part of everyday life for the majority of people these days, a mobile 2D GBL approach promises accessibility and engagement. This project highlights on designing an interactive MSL learning game as well as evaluating its usability, enjoyment, and effectiveness. The Game Development Life Cycle (GDLC) is adopted for the smooth and organized progression of this project. Upon completion, 20 random respondents assessed the game in accordance to the E-Game Flow Model, resulting to quite a fruitful 80.5% enjoyment level, thus proving this effective educational approach. This project serves as an extensive guide for future educators or developers looking to promote MSL through GBL in a way that enhances one's engagement, understanding, and accessibility, while highlighting areas for future improvements and broader applications.

INTRODUCTION

Sign language—the language not verbally, but physically expressed by gestures or 'signs' done by the hands (Siong, T. J., Nasir, N., & Salleh, M., March 2021), created in order to give the verbally and hearing-impaired individual a 'voice' to communicate with not only with each other, but also with the hearing community. It consists of both manual gestures and

non-manual signals, where the manual gestures use hand and arm movements to convey meaning, while non-manual signals involve other features like head movement, facial expressions, and body shifting (Siong, T. J., Nasir, N., & Salleh, M., March 2021).

While half of the U.S. is capable of doing the American Sign Language (ASL) (State of Rhode Island, 2023), Malaysia has yet to reach such an achievement with the Malaysian Sign Language (MSL). Look around, and it's very noticeable how there's little to no chance for us to come across a person on the streets who has the knowledge to do sign language, nor is in any way associated with anyone deaf or mute. This proves just how very little Malaysians are exposed to sign language and the deaf-mute community.

Thus, this project aims to spark a sense of enjoyment in learning MSL which eventually will lead to the piquing of user's interest of the subject. As explained by De Jans et al. (2017), Game-based Learning (GBL) is a promising tool to raise awareness, which can motivate and enhance players' interest in a particular topic, and only requires little time investment. Kiryakova and colleagues (2014) also backs this claim such that it will not only be effective in extending the reach of sign language among communities and expose them to the knowledge, but it will also increase awareness towards the usage of it by providing enjoyment throughout the process of learning it.

Problem Statement

a) **The very lack of usage and awareness on MSL amongst Malaysians**

State of Rhode Island (2023) reported on their official website that ASL ranked as the U.S.'s third most common language, behind English and Spanish. However, in Malaysia, Faithour Co. (2022) recorded that only less than 100 certified sign language interpreters available for the 40,000 members of the Deaf community. A study conducted by Sardi (2022) also found that 79.1% respondents have heard of MSL, 11.8% never did, and 9.1% maybe have heard of it somewhere, thus proving that despite the majority knew of MSL, but the willingness to learn and use it on a daily basis still seems far-fetched.

b) **Lack of enjoyable factor in learning MSL amongst Malaysians.**

Study conducted by Sardi (2022) highlighted that 60% of people have time constraints in learning MSL, while 43.6% found it difficult to learn the language. And as sign language is best taught physically to better see and understand the hand gestures, it is however

deemed that such teaching method is 'boring', as proven in a study where among the factors preventing someone from learning MSL, "Learning session is boring" made it into the list with 4.5% of respondents chose so. Thus, Chen and Liang (2022) stated that gamification is positively related to student's enjoyment as well as improves a student's ability to learn new topics, proven by research done on biology college students, where lecture-oriented students were outperformed by those learning via gamification by 40%. As traditional learning gradually became boring for students, and since games are fun and engaging, learning via game makes the learning process the more exciting, and can positively influence student motivation and engagement. (Duterte, 2024)

Objectives

1) To design an interactive game for learning MSL using 2D Game-Based Learning (GBL) approach.
2) To develop a GBL for MSL using mobile GBL.
3) To evaluate usability, user enjoyment level, and effectiveness in learning MSL through GBL.

Project Scope

- **Target users:** Any eager learners in search of quick, easy, and fun way to learn MSL without risking much of their time and life commitment.
- **Game design:** 2D-based GBL in *Bahasa Melayu* (BM), using Unity 2D.
- **Game contents:** *Galeri Ilmu* (self-study; 2-sided animation), *Haluan Ujian* (self-challenge; image/word quiz, or both (Multi-Quiz)), 4 categories each (*Kata Ganti Nama, Keluarga, Perasaan, Warna*).

Project Significance

- Crucial in educating Malaysians to MSL as one of the most unknown and underrated languages in Malaysia.
- To cater work/study-committed people who are as eager to learn MSL at their own pace, time, and comfort.
- Indirectly help those with deaf/mute family members/friends, and educators of the impaired individuals.

LITERATURE REVIEW

Game-Based Learning (GBL)

Gachkova and Somova (2016) explained, GBL falls under the category of serious game designed with the objective to infuse entertainment and learner's gaming experience in achieving a certain learning goal. Connolly et. al. (2016) also stated, 'effective learning' is most efficient nowadays when it is active, hands-on, context-relevant, problem-oriented, and offers immediate feedback. Below are the E-Learning game elements that will be implemented in the development of an effective GBL.

Table 1: Game Elements of E-Learning

Game Elements	Descriptions
Challenges	Motivate players and affects their level of engagement depends on whether or not they achieve the goals. (Shi & Shih, 2015)
Rewards / Items	Points system that rewards and motivate the players. (Juhari & Abu Bakar, 2020)
Feedback	Usage of point, badges or other rewards to show that there is progress in development. (Gachkova & Somova, 2016)
Clear goals	Brings the element of curiosity and challenge to the game environment (Makhija et. al., 2023).
Time pressure	Player has to divide their attention between solving the task and battling the game's timer, (Juhari & Abu Bakar, 2020)

E-Game Flow Model

As per Mat Zain et. al. (2018), E-Game Flow Model is an evaluation tool used by experts in evaluating players' enjoyment level in playing games. A total of 8 elements involved in the E-Game Flow Model. However, this project only involves 7 of them, reason being that the Social Interaction (SI) element is not present, as the game is developed not for the sake of chasing leaderboard or to communicate with other non-impaired users, but to provide an easy, fun, and time-efficient method to learn MSL at their own pace, especially for those with study or work commitment. Table 2 below further elucidates each element and its criteria.

Table 2: Elements of E-Game Flow Model
(Source: Mat Zain et. al., 2018)

Elements	Item	Criteria
Concentration (CO): User able to maintain focus on the given task.	C1	Majority of the gaming activities are related to the learning objectives (MSL).
	C2	No distraction from the task is emphasized.
	C3	Generally, I am able to remain focused on the game.
	C4	My focus does not derail from the tasks on hand.
	C5	The game's tasks are not burdensome.
	C6	Workload in the game is adequate and relevant.
Goal Clarity (GC): Game able to provide appropriately-timed goals that are clear to the user.	G1	Game's overall goal was presented at the start of the game.
	G2	Game's overall goals were conveyed in a concise manner.
	G3	Intermediate, scene-specific goals was introduced at the start of each new scene / level.
	G4	Intermediate goals were conveyed in a clear way.
Feedback (FB): Given task able to produce speedy feedback	F1	I receive feedback from the game on my overall progress.
	F2	I receive immediate feedback on my in-game actions.
	F3	I receive instant feedback on my success or failure of intermediate goals.
Challenge (CH): The skills obtained are on par with the given challenges and both must exceed a specific goal.	H1	The game provides "hints" in text that helps me overcome the challenges.
	H2	The game provides video or audio auxiliaries that help me overcome the challenges.
	H3	The more my skills improved, the harder the challenges get.
	H4	The game provides appropriately paced new challenges.
	H5	The game provides various category of challenges that caters based on my learning objective.
Autonomy (AU): User's actions are not restricted, but are of free will while playing the game.	A1	I feel a sense of control and impact over the game.
	A2	I know clearly what to do to progress the game.
Immersion (IM): Deep but effortless involvement, reduced concern for self and sense of time.	I1	I can become involved in the game.
	I2	I lost track of time when playing the game.
	I3	I become unaware of my surroundings while in-game.
	I4	I temporarily forget about my everyday life concerns while playing the game.
	I5	I experienced an altered sense of time.
	I6	I feel emotionally involved in the game.

Knowledge Improvement (KI): How much knowledge has improved after playing the game.	K1	The game increases my knowledge on the presented subject.
	K2	I am able to grasp the fundamental ideas of the subject.
	K3	I try to apply the acquired knowledge within the game.
	K4	The game motivates me to make use of the subject taught.
	K5	I am eager to explore more about the subject.

Project Development Technology (Platform and Genre)

➢ **Platform: Mobile 2D**

Since our phone is always with us, hence the best option. As the users, especially the eager learners, can study MSL anytime and anywhere.

➢ **Genre: Visual Novel**

Users can enjoy a little bit of visual and storyline as part of the learning process.

METHODOLOGY

According to Ramadan and Widyani (2013), Software development Life Cycle (SDLC) was the go-to methodology for any project development. However, in the cases of game development, simply implementing SDLC proven inadequate as developers are confronted with several issues during its life cycle. So, to address this, the Game Development Life Cycle (GDLC) is presented, with several quality criteria that can help efficate the game development process. Presented in Figure 1 shows the architecture of the GDLC model.
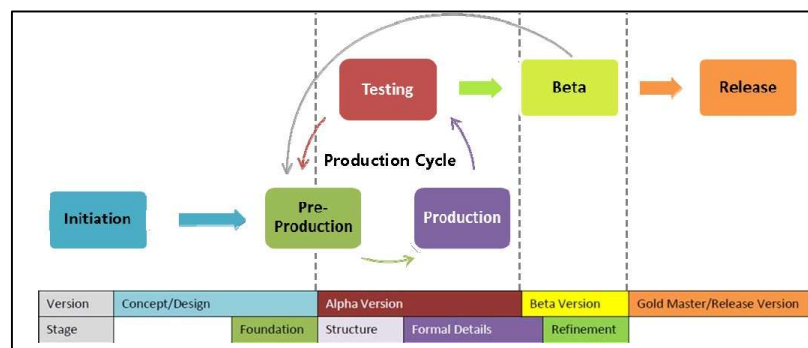
Figure 1: Game Development Life Cycle (GDLC) phases
(Source: Ramadan and Widyani, 2013)

Phase 1 : Initiation

Starting point of the GDLC model, where requirements on game development that can cater the general public who wants to learn MSL are gathered and analysed.

Phase 2 : Pre-Production

a) **Use Case Diagram (UCD)**

An essential tool used for documenting and visualizing all of the game's functional requirements that helps the game's designers and developers in planning, communicating, and finalizing the game's core functionality before development begins, ensuring that the final game meets the user's needs and expectations.

Figure 2: Use Case Diagram of *Hikayat Desa Isyarat*

b) **Flowchart**

Flowchart serves as a 'map' for developers to organize the flow of the game as well as identify potential problems before production. Figure 3 shows the flowchart of the game.

Figure 3: Flowchart of *Hikayat Desa Isyarat*

PCMJ

Progress in Computer and Mathematics Journal (PCMJ)
volume 3 [November, 2025]
e-ISSN: 3030-6728
Website: fskmjebat.uitm.edu.my/pcmj

c) **Low-Fidelity Storyboard**

A typical storyboard is a series of frames with simple sketches consisting of basic shapes and elements representing the game's components, showcasing each of the interface's layout and describes how user can interact with each of the game's elements on-screen, which serves as the game developer's design visualization to the development team.

d) **Hardware Requirements**

Referring to the physical specification of computer parts required to effectively deploy any related game development software and tools, as well as running the finalized game. Table 3 and 4 shows the required hardware specification in the development of the project.

Table 3: Laptop Hardware Requirements

Hardware	Windows and Device Specifications	
Personal Computer	Edition	Windows 10
	Device name	LAPTOP-BS642TX
	Processor	Intel(R) Core(TM) i5-7200U CPU @ 2.50GHz-2.70 GHz
	Installed RAM	16.00 GB
	Device ID	A5189E35-CC2F-47B1-9105- CD2D484B0CCE
	Product ID	00327-30536-20147-AAOEM
	System Type	64-bit operating system, x64-based processor

Table 4: Android Mobile Device Requirements

Hardware	Android and Device Specifications	
Personal Android Mobile Device	Operating System	Android 8.0 (Oreo) or later
	CPU	Qualcomm Snapdragon 600 series or equivalent (ARM64 recommended)
	GPU	OpenGL ES 3.0
	Installed RAM	4 GB or more
	Storage	At least 2 GB+ of free space
	Screen Resolution	1080p (1920 x 1080)

e) **Software Requirements**

Refers to the device's needed internal components to ensure the game's smooth design, build and testing. Such components are the game engines, development tools, and other

Progress in Computer and Mathematics Journal (PCMJ)
volume 3 [November, 2025]
e-ISSN: 3030-6728
Website: fskmjebat.uitm.edu.my/pcmj

applications necessary to the game development. Table 5 below displays the necessary software that will be utilized for this project.

Table 5: Software Requirements

Software	Description	Functionality
Unity	The chosen game engine that will be used in creating the 2D game according to the finalized plan.	• Used as game engine to develop the 2D game. • To design the game environment to make them look more interesting and appealing.
PhotoScape X	A photo editing app used to create and modify various elements or images for the game.	• To create buttons, icons, and any UI elements needed in the game.
Blender	A graphic software used for the creation of 3D almost-realistic models of any real-world object.	• To create the hand sign models for the MSL category in Study Mode.

Phase 3 : Production

After creating and gathering the game's 2D graphic assets, animations, environment design, sound, and background music, all will be compiled and merged to create a functional and playable game as per the requirements. Figure below showcases some of the interfaces.
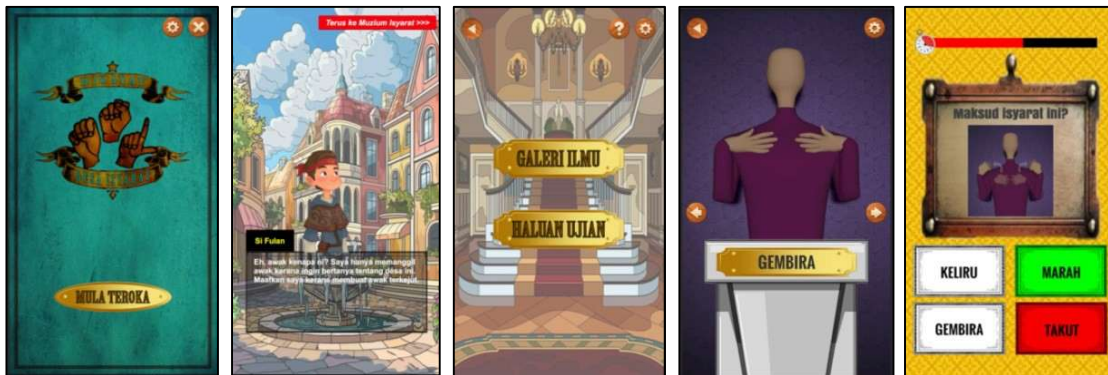

Figure 4: Game interfaces of the game *Hikayat Desa Isyarat*

Phase 4 : Functionality Testing

The most crucial phase of the GDLC. where the game will be play-tested to identify and fix bugs, assess functionality, and gather feedback. Another crucial aspect is the System Usability Scale (SUS) Questionnaire, widely used to evaluate the usability of a system, rated

on a 5-point Likert scale. This will help game designers and developers identify usability issues and improve game functionality based on user feedback. Table 6 shows the list of questions for a SUS questionnaire.

Table 6: SUS Questionnaire

No.	Questions
1	I think that I would like to use this system frequently.
2	I found the system unnecessarily complex.
3	I thought the system was easy to use.
4	I think I would need the support of a technical person to be able to use this system
5	I found the various functions in this system were well integrated.
6	I thought there was too much inconsistency in this system.
7	I would imagine that most people would learn to use this system very quickly.
8	I found the system very cumbersome to use.
9	I felt very confident using the system.
10	I needed to learn a lot of things before I could get going with this system.

Phase 5 : Beta Testing

Beta phase involves further testing and refinement of the game. This phase is often referred to as the "polishing" phase, where the game is fine-tuned to ensure it meets the desired quality standards. The game may be released to a limited audience, such as a group of testers or influencers, to gather feedback and identify any remaining issues, which will be explained further in the Results and Discussion section later.

Phase 6 : Release

The grand finale, marking the game's completion and market-ready. Creation of marketing medium such as game trailers and promotional pictures, then finally distributing the game through various platforms as per planning in the earlier phases. As the game was developed as a 2D mobile game for enjoyment and accessibility, it will be made available as a downloadable APK file.

PCMJ

RESULT AND DISCUSSION

Pre-Test and Post-Test Evaluation

A total of 20 respondents assisted in the play-test. In the Pre-Test Evaluation, one question asked on the respondent's MSL knowledge. A "No" will send respondents directly to the play-test. Otherwise, they will first be presented a set of 8 MSL questions of 2 basic hand signs each from the 4 MSL categories. Then, in the Post-Test Evaluation, the same 8 questions will be asked again to measure their improvement after play-test. Figures below displays the results, and from the majority of similar post-answers, it is evident that the respondents improved remarkably in terms of understanding the MSL knowledge taught.

Respondent(s)	Do you know any basic Mala Adakah anda tahu apa-apa a	What is this MSL Apakah isyarat ta	What is this MSL Apakah isyarat ta	What is this MSL Apakah isyarat ta	What is this MSL Apakah isyarat ta	What is this MSL Apakah isyarat ta	What is this MSL Apakah isyarat ta	What is this MSL Apakah isyarat ta	What is this MSL Apakah isyarat ta
1 (F)	No								
2 (F)	Yes	IBU	BIRU	SEDIH	SAYA	GEMBIRA	KAMU	ABANG	HITAM
3 (F)	No								
4 (F)	Yes	DATUK	BIRU	SEDIH	SAYA	GEMBIRA	MEREKA	KAKAK	HITAM
5 (F)	No								
6 (M)	No								
7 (M)	No								
8 (M)	No								
9 (F)	Yes	DATUK	BIRU	SEDIH	SAYA	GEMBIRA	KAMU	ABANG	HITAM
10 (F)	No								
11 (M)	No								
12 (F)	No								
13 (F)	Yes	DATUK	KUNING	SEDIH	SAYA	BEBAS	KAMU	ABANG	KELABU
14 (F)	No								
15 (F)	No								
16 (F)	Maybe	BAPA	BIRU	SEDIH	SAYA	GEMBIRA	MEREKA	ADIK LELAKI	HITAM
17 (F)	No								
18 (F)	Yes	IBU	MERAH	SEDIH	SAYA	SUKA	KAMU	ABANG	PUTIH
19 (F)	No								
20 (F)	Yes	NENEK	KUNING	BENCI	KITA	SUKA	KALIAN	ADIK PEREMPUAN	PUTIH

Figure 5: Pre-Test Evaluation's Basic MSL Quiz Result

Respondent(s)	What is this MSL Apakah isyarat ta	What is this MSL Apakah isyarat ta	What is this MSL Apakah isyarat ta	What is this MSL Apakah isyarat ta	What is this MSL Apakah isyarat ta	What is this MSL Apakah isyarat ta	What is this MSL Apakah isyarat ta	What is this MSL Apakah isyarat ta
5 (F)	DATUK	BIRU	SEDIH	SAYA	GEMBIRA	KALIAN	KAKAK	HITAM
6 (M)	BAPA	BIRU	SEDIH	SAYA	GEMBIRA	MEREKA	KAKAK	HITAM
8 (M)	BAPA	UNGU	SEDIH	SAYA	BANGGA	KALIAN	KAKAK	HITAM
9 (F)	DATUK	BIRU	SEDIH	SAYA	GEMBIRA	MEREKA	KAKAK	HITAM
10 (F)	DATUK	BIRU	SEDIH	SAYA	GEMBIRA	MEREKA	KAKAK	HITAM
11 (M)	DATUK	BIRU	SEDIH	SAYA	SUKA	MEREKA	ADIK LELAKI	HITAM
12 (F)	DATUK	BIRU	SEDIH	SAYA	GEMBIRA	MEREKA	KAKAK	HITAM
13 (F)	DATUK	BIRU	SEDIH	SAYA	GEMBIRA	MEREKA	KAKAK	HITAM
14 (F)	DATUK	BIRU	SEDIH	SAYA	GEMBIRA	MEREKA	ABANG	HITAM
15 (F)	NENEK	MERAH	SEDIH	SAYA	BANGGA	MEREKA	ABANG	HITAM
16 (F)	DATUK	BIRU	SEDIH	SAYA	GEMBIRA	MEREKA	KAKAK	HITAM
18 (F)	DATUK	BIRU	SEDIH	SAYA	GEMBIRA	MEREKA	KAKAK	HITAM
4 (F)	DATUK	BIRU	SEDIH	SAYA	GEMBIRA	MEREKA	KAKAK	HITAM
7 (M)	DATUK	BIRU	SEDIH	SAYA	GEMBIRA	MEREKA	ABANG	HITAM
17 (F)	DATUK	MERAH	SEDIH	SAYA	BANGGA	MEREKA	KAKAK	HITAM
19 (F)	DATUK	BIRU	SEDIH	SAYA	GEMBIRA	MEREKA	KAKAK	HITAM
3 (F)	DATUK	BIRU	SEDIH	SAYA	GEMBIRA	MEREKA	KAKAK	HITAM
2 (F)	DATUK	BIRU	SEDIH	SAYA	GEMBIRA	MEREKA	KAKAK	HITAM
20 (F)	DATUK	BIRU	SEDIH	SAYA	GEMBIRA	MEREKA	KAKAK	HITAM
1 (F)	DATUK	BIRU	KECEWA	SAYA	GEMBIRA	MEREKA	KAKAK	HITAM

Figure 6: Post-Test Evaluation's Basic MSL Quiz Final Result

Progress in Computer and Mathematics Journal (PCMJ)
volume 3 [November, 2025]
e-ISSN: 3030-6728
Website: fskmjebat.uitm.edu.my/pcmj

System Usability Scale (SUS) Findings

Respondents will then assess the game's System Usability Scale (SUS) of 10 questions on a scale of 'strongly disagree' to 'strongly agree'. Below is the calculation formula for the SUS according to Bellio (2024), as well as the SUS response score and its calculations.

Table 7: SUS score calculation formula

Description	SUS score calculation	Final SUS score
Odd-numbered questions = Positive questions	Response score – 1 = Adjusted response score	Adjusted response score * 2.5
Even-numbered questions = Negative questions	5 – Response score = Adjusted response score	

Table 8: Total SUS score of each respondent and the average SUS score

Respondent	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Total
1	4	2	5	2	4	1	5	1	4	2	85
2	5	1	4	5	4	2	4	1	5	1	80
3	4	4	4	4	4	4	3	4	5	5	47.5
4	5	2	5	2	4	2	5	1	5	1	90
5	5	2	5	2	5	2	4	2	4	3	80
6	3	2	5	2	4	1	5	1	5	1	87.5
7	5	2	5	1	4	2	4	2	4	1	85
8	5	2	5	2	5	2	5	2	5	2	87.5
9	5	1	5	1	5	1	5	1	5	3	95
10	4	3	5	5	5	2	4	2	4	4	65
11	5	4	5	5	4	4	3	3	4	4	52.5
12	3	3	3	4	3	3	4	2	3	5	47.5
13	4	2	4	1	4	2	4	1	5	1	85
14	4	1	4	3	4	2	5	1	4	2	80
15	5	1	5	1	5	1	5	1	5	1	100
16	5	3	5	2	5	1	5	1	5	1	92.5
17	4	1	5	1	4	1	5	1	5	1	95
18	5	2	5	2	5	2	5	2	5	2	87.5
19	4	4	5	1	5	1	5	1	5	1	90
20	4	2	4	2	4	1	5	2	4	3	77.5
AVERAGE SUS SCORE											80.5

Overall Findings

Majority of respondents have remarkably improved their knowledge on MSL from the evident comparison of their quiz results from Pre-Test and Post-Test Evaluation. Average SUS Score is considerably high as well at 80.5%, indicating the game's usability is positively received by the majority. All in all, the findings have solidified the need for this project so as to imprint a positive impact on the general public on MSL.

CONCLUSION

"Learning Language of the Impaired using Game-Based Approach" project has been proven successful in promoting enjoyment in learning the MSL via *Hikayat Desa Isyarat*, a simple, educational visual novel game meant to make learning MSL, an unfamiliar topic to most Malaysians, a fun and enjoyable subject to learn regardless of place and time. Through the Pre-Test and Post-Test evaluations performed, as well as the System Usability Scale (SUS), this project is able to deduce that game-based learning is a necessity as knowledge is better retained when enjoyment and fun is involved. That being said, thanks to the conclusive evidence, this project has successfully proven to have fulfilled all its proposed objectives.

REFERENCES

Bellio, J. (2024, December 19). System Usability Scale (SUS) Practical Guide for 2025. UXtweak. https://blog.uxtweak.com/system-usability-scale/

Connolly, T. M., Boyle, E. A., MacArthur, E., Hainey, T., & Boyle, J. M. (2012). A systematic literature review of empirical evidence on computer games and serious games. Computers and Education/Computers & Education, 59(2), 661–686. https://doi.org/10.1016/j.compedu.2012.03.004

De Jans, S., Van Geit, K., Cauberghe, V., Hudders, L., & De Veirman, M. (2017). Using games to raise awareness: How to co-design serious mini-games? Computers & Education, 110, 77–87. https://doi.org/10.1016/j.compedu.2017.03.009

Faithour Co. (2022, September 22). Malaysia is a country with many spoken languages, but there is still a long way to go for Malaysian Sign Language (BIM). faithour. https://www.faithour.com/bim-deaf/

Gachkova, M., & Somova, E. (2016). BulDML at Institute of Mathematics and Informatics: Game-based Approach in e-Learning. Math.bas.bg. https://doi.org/1314-0752

Juhari, A. N., & Abu Bakar, M. H. (2020). Popular game elements used in designing game-based learning STEM application for school students – A review - UKM Journal Article Repository. *Journalarticle.ukm.my*. http://journalarticle.ukm.my/17191/1/01.pdf

Kiryakova, G., Angelova, N., & Yordanova, L. (2014). *Gamification In Education*. https://www.sun.ac.za/english/learning-teaching/ctl/Documents/Gamification%20in%20education.pdf

Makhija, A., Jha, M., Richards, D., & Bilgin, A. (2023). *Work-in-Progress - Using Feedback To Support Learning Statistics in Higher Education Within a Game-based Learning*. https://doi.org/10.56198/zh3jozf14

Mat Zain, N. H., Bin Johar, R. H., Abdul Aziz, A., Baharum, A., Jaafar, A., & Mohd Yasin, A. (2017, October). An Evaluation of Player Enjoyment in Game-Based Learning Arithmetic Drills via Racing Game. http://dx.doi.org/10.1007/978-3-319-70010-6_59

Mat Zain, N. H., Hashim, M. H., Baharum, A., Ismail, I., Abdul Aziz, R., & Mohd Yasin, A. (2018, February). Evaluating Player Enjoyment in Mobile Games. http://dx.doi.org/10.1166/asl.2018.10751

Ramadan, R., & Widyani, Y. (2013, September). *Game development life cycle guidelines*. ResearchGate; unknown. https://www.researchgate.net/publication/271548605_Game_development_life_cycle_guidelines

Sardi, R. (2022). E-Sign Language: An Approach For Communities To Learn Malaysian Sign Language. *European Proceedings of Multidisciplinary Sciences*. https://doi.org/10.15405/epms.2022.10.60

Shi, Y.R., & Shih, J.L. (2015). Game Factors and Game-Based Learning Design Model. *International Journal of Computer Games Technology*, *2015*, 1–11. https://doi.org/10.1155/2015/549684

Siong, T. J., Nasir, N., & Salleh, M. (2021, March). *A mobile learning application for Malaysian sign language education*. ResearchGate; IOP Publishing. https://www.researchgate.net/publication/350711934_A_mobile_learning_application_for_Malaysian_sign_language_education/link/609c1b95a6fdcc220a2e2278/download?_tp=eyJjb250ZXh0Ijp7ImZpcnN0UGFnZSI6InB1YmxpY2F0aW9uIiwicGFnZSI6InB1YmxpY2F0aW9uIn19

State of Rhode Island. (2023, September 8). *American Sign Language | Commission on the Deaf and Hard of Hearing (CDHH)*. ricdhh. Retrieved April 4, 2024, from https://cdhh.ri.gov/information-referral/american-sign-language.php