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“Optimizing Innovation in Knowledge, Education and Design”

EXTENDED ABSTRACT



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3.	MOBILIAID: Robotic Independence of Disabilities <i>Nur Husna Serip Mohamad & Nur Hana Serip Mohamad</i>	243-245
4.	Investigating the Acceptance of Course File Electronic Knowledge Acquisition PPPG (CEKAP)System Via UTAUT Model <i>Mastura Mohamad, Rozita Mengen, Nor Farhana Mohd Azmi, Noorsuraya Mohd Mokhtar & Nurul Zahidah binti Md Juperi</i>	246-250
5.	XL2S Pan Borneo Vs Rajang River Boardgame 2.0 (Empowering Fitness and Fun: A Board Game for Inclusive Physical Activity Among People with Disabilities) <i>Suhardi bin Kram, Abbylolita Sullah, Siti Nurr Atika binti Mohd Sanif, Luke anak Nikol, Asmalini binti Che Abu Shafie, Gordon Nicolaus Jemat Anchang, Ashley Irenaeus bin Jeck</i>	251-254
6.	MoTSEL: Model of Technology-Supported Learning for Special Educational Needs Learners in Institutions for Higher Learning <i>Roslinda Alias, Nor Aziah Alias & Azwadi Mokhtar</i>	255-261
7.	E-Care Sentinel: ECG- Based Emergency Alerts <i>Rosziana Hashim, Suziana Ahmad, Gloria Raymond Tanny, Dayanasari Abdul Hadi, Ahmad Alif Ahmad Aina, Ahmad Firdaus Mohd Rasdi & Muhammad Harries Ezary Ahmad Khairi</i>	262-269
8.	Enhancing Dyscalculia Identification Through an Innovative 3D Game Framework <i>Sazilah Salam, Bambang Pudjoatmodjo, Ahmad Naim Che Pee & Rikman Aherliwan Rudavan</i>	270-274

CATEGORY: AST ACADEMIC INVENTOR

1.	Program Outcomes Monitoring System for Civil Engineering Students (POSCES) <i>Md Rasul Mohamad Nor, Hazrina Ahmad, Nurjuhanah Juhari, Norlizan Wahid, Noor Syafeekha Mohamad Sakdun, Shafienaz Ismail & Ruqayyah Ismail</i>	275-279
2.	Web-Based System for Dyslexic: A Screening and Learning Style Recommendation <i>Nur Melissa binti Mohammad Faisal Wee, Mohd Zaki bin Sadik, Mohamad Hafiz bin Mohd Yusof, Nurul Hidayah binti Mohd Yusof & Ummi Qaisara Faqihah binti Reman</i>	280-282
3.	2DAMP: The Novel of (2D)-Aminoethyl MethacrylatePerovskite for Ammonia Gas Sensor <i>Hasyiya Karimah Adli, Muhamad Yuzaini Azrai Mat Yunin, Norfatihah Mohd Adenam & Hadhrami Ab Ghani</i>	283-288
4.	An Attractive Approaches in Studying Basic OC (Organic Chemistry) <i>Ropisah Binti Me, Nur Syakilla Asyiqin Binti Hasan & Nur Syaida Maisarah Binti Hasan</i>	289-292

Assalamualaikum warahmatullahi wabarakatuh,



First and foremost, I would like to express my gratitude to the organizing committee of i-Spike 2023 for their tremendous efforts in bringing this online competition a reality. I must extend my congratulations to the committee for successfully delivering on their promise to make i-Spike 2023 a meaningful event for academics worldwide.

The theme for this event, 'Optimizing Innovation in Knowledge, Education, and Design,' is both timely and highly relevant in today's world, especially at the tertiary level. Innovation plays a central role in our daily lives, offering new solutions for products, processes, and services. By adopting a strategic approach to 'Optimizing Innovation in Knowledge, Education, and Design,' we have the potential to enhance support for learners and educators, while also expanding opportunities for learner engagement, interactivity, and access to education.

I am awed by the magnitude and multitude of participants in this competition. I am also confident that all the innovations presented have provided valuable insights into the significance of innovative and advanced teaching materials in promoting sustainable development for the betterment of teaching and learning. Hopefully, this will mark the beginning of a long series of i-Spike events in the future.

It is also my hope that you find i-Spike 2023 to be an excellent platform for learning, sharing, and collaboration. Once again, I want to thank all the committee members of i-Spike 2023 for their hard work in making this event a reality. I would also like to extend my congratulations to all the winners, and I hope that each of you will successfully achieve your intended goals through your participation in this competition.

Professor Dr. Roshima Haji Said
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WELCOME MESSAGE (i-SPIKE 2023 CHAIR)



We are looking forward to welcoming you to the 3rd International Exhibition & Symposium on Productivity, Innovation, Knowledge, and Education 2023 (i-SPIKE 2023). Your presence here is a clear, crystal-clear testimony to the importance you place on the research and innovation arena. The theme of this year's Innovation is “*Optimizing Innovation in Knowledge, Education, & Design*”. We believe that the presentations by the distinguished innovators will contribute immensely to a deeper understanding of the current issues in relation to the theme.

i-SPIKE 2023 offers a platform for nurturing the next generation of innovators and fostering cutting-edge innovations at the crossroads of collaboration, creativity, and enthusiasm. We enthusiastically welcome junior and young inventors from schools and universities, as well as local and foreign academicians and industry professionals, to showcase their innovative products and engage in knowledge sharing. All submissions have been rigorously evaluated by expert juries comprising professionals from both industry and academia.

On behalf of the conference organisers, I would like to extend our sincere thanks for your participation, and we hope you enjoy the event. A special note of appreciation goes out to all the committee members of i-SPIKE 2023; your dedication and hard work are greatly appreciated.

Dr. Junaida Ismail

Chair

3rd International Exhibition & Symposium Productivity, Innovation, Knowledge, and Education 2023 (i-SPIKE 2023)

Enhancing Dyscalculia Identification Through an Innovative 3D Game Framework

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ABSTRACT

This study focuses on academic learning difficulties, particularly dyscalculia—a learning disorder affecting individuals with average to high intelligence. The subtle nature of dyscalculia complicates its identification, often resulting in students being inaccurately perceived as disinterested or lacking motivation, which in turn erodes their self-confidence. To tackle this challenge, our research introduces an inventive strategy that utilizes a game framework for dyscalculia identification, built upon the foundational Petri-Net storytelling structure. This approach seamlessly integrates within 3D gaming environments, discreetly assessing mathematical prowess without inducing assessment-related stress. Referred to as the "3D-DIG (3D Dyscalculia Identification Game) Framework," this serious gaming architecture incorporates a dedicated monitoring layer. This layer captures and assesses students' mathematical problem-solving methods as they engage with in-game challenges. Our study yields three key outcomes: i) Development of a proactive 3D Game framework designed to identify potential dyscalculia in students. ii) Creation of an all-encompassing student answer database, documenting misconceptions, and specific learning obstacles. iii) Compilation of video-based assessment records, offering educators insights into students' interactions during in-game challenges. Together, these extensive datasets empower educators with essential tools for accurately pinpointing dyscalculia and providing tailored assistance to affected students. Our innovative approach not only refines the identification process but also contributes to nurturing a more inclusive and supportive learning environment.

Keywords: Dyscalculia identification, learning difficulties, 3D-DIG framework, 3D game, Mathematical proficiency assessment

INTRODUCTION

Dyscalculia, a specific learning difficulty in mathematics, profoundly affects students' mathematical aptitude. This concealed disability can impact individuals across the spectrum of normal to high intelligence, as evidenced by studies by Zygouris et al. (2017), Hussain et al. (2022), and Astuti et al. (2022). Detecting dyscalculia poses a significant challenge, often leading educators to misinterpret students' struggles with in-class mathematical problems as indicators of laziness or lack of competence in the subject. Consequently, untreated dyscalculia can lead to students falling behind in their mathematical skills, further eroding their self-confidence and engendering concerns about participation in activities, societal perceptions of their mathematical abilities, and forming social connections, as underscored by Morin et al. (2019) and Marlina (2019).

Addressing dyscalculia entails two distinct approaches: identification (to ascertain whether an individual faces challenges in learning mathematics) and intervention (to support students already diagnosed with dyscalculia). This study focuses on the identification phase, specifically targeting students at risk of dyscalculia using a unique framework developed by the researcher—the 3D Dyscalculia Identification Game (3D-DIG Framework). This innovative framework is employed to identify potential dyscalculia in students, forming the cornerstone of our investigation.

The 3D Dyscalculia Identification Game (3D-DIG) Framework

The Framework

The 3D-DIG framework consists of six layers, namely Assessment, Storytelling, Gameplay, Monitoring, User experience and Technology. Figure 1 shows the 3D dyscalculia identification game framework.

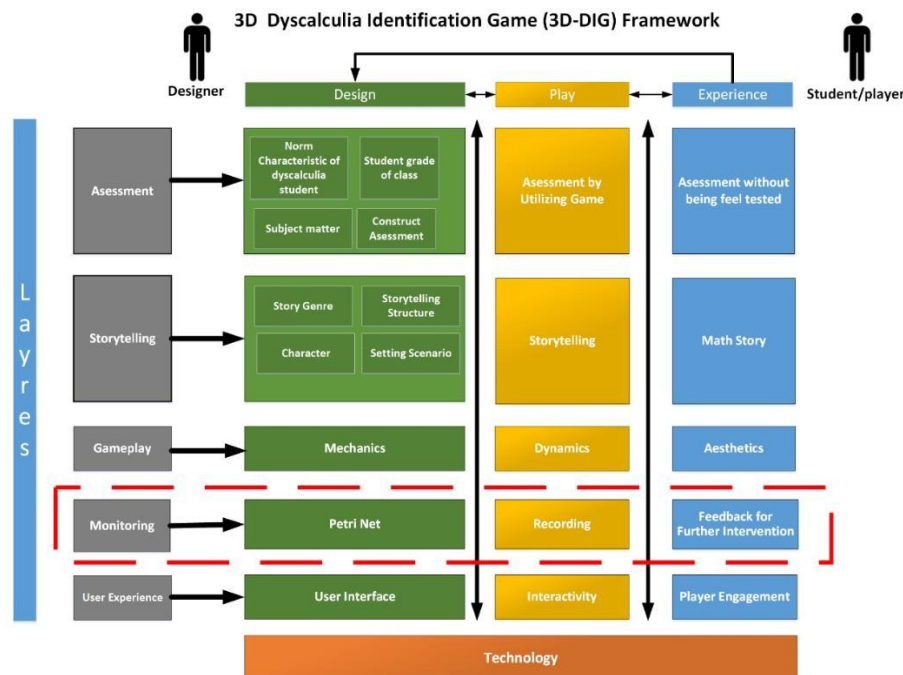


Figure 1. The 3D-DIG framework

The 3D-DIG framework aims to:

1. Identify potential students with dyscalculia.
2. Provide a 3D game for dyscalculia assessment.
3. Provide monitoring feature that record screen activities and student's answer.

The 3D Game

The 3D game prototype provides 8 gameplay levels to identify common dyscalculia norm characteristics as shown in Table 1.

Table 1. Eight gameplay levels

No	Level	Norm Characteristics	Topics
1	1,2	Distinguish Number	Distinguishing numbers such as 6 and 9, 17 and 71, and 3 and 8
2	3	Addition	Determining the + symbol, determining numbers, solving the $a + \dots = b$ operation, adding numbers with storing technique, and word problems for addition operations
3	4	Subtraction	Determining the - symbol, determining numbers for solving $a - \dots = b$ operation, subtraction numbers with borrowing methods, and word problems for subtraction operations.
4	5	Addition	Additions that involves hundreds numbers
5		Subtraction	Subtractions that involves hundreds numbers
6	6	Greater than	Determine > (greater than) symbols
7		Less than	Determine < (less than) symbol
8		Equal	Determine = (equal) symbol
9		Addition	Additions involving two variables in $a + b = \dots$ patterns
10	7	Subtraction	Subtractions involving two variables in $a - b = \dots$ patterns.
11	8	Addition	Additions involving three variables in $a + b + c = \dots$ patterns
12		Subtraction	Subtractions involving three variables in $a - b - c = \dots$ patterns

Figure 2 and Figure 3 depicts the 3D game that utilized to identify student whether have potential dyscalculia or not.



Figure 2. The Main Menu



Figure 3. The 3D game Environment

Figure 4 depicts the sample screen of a student solving the game challenge. The 3D game has a feature to record the student's answer and student's video. The student's video recording consists of student face video and student's screen activities.



Figure 4. The student Screen Activities

RESULT AND DISCUSSION

By using the 3D game, the student's answer is saved into the database web server and the student's video is saved into the local hard drive (considering the internet bandwidth). Using the 3D game, the dyscalculia assessment can be done without the presence of the teacher and without the students feel that they are being tested.

Table 2 shows some results of a student after playing the 3D game prototype. It indicates that the student does not have problems counting other numbers but has deficiency in distinguishing numbers 6 and 9.

Table 2. Student Results in Distinguish Number 6 and 9

Indicator	Answer	Description	Diagnosis
Counting 9 object.	9	The solution is 6	The player chooses 9 for the solution. The player does not have a problem counting object among collection of objects. The student may have difficulty distinguishing numbers 6 and 9.
Counting 4 objects (Balloon).	4	The solution is 4	Player does not have a problem in counting objects that involves number 4.
Counting 8 objects (Cabbage).	8	The solution is 8	Player does not have a problem in counting objects that involves number 8.
Counting 17 objects (broccoli).	17	The solution is 17	Player does not have a problem in counting objects that involves number 17.

The 3D game generates a comprehensive database of student responses, encompassing misconceptions and specific learning hurdles. The game also compiles records of video-based assessments that provide educators with insights into student interactions during in-game challenges. Collectively, these expansive datasets equip educators with crucial resources to precisely identify dyscalculia and offer customized support to impacted students.

CONCLUSION

In conclusion, 3D-DIG framework provides the following usefulness:

1. The use of a 3D game format makes the assessment process more engaging and enjoyable for students. It can increase student motivation and participation.
2. Early detection result allows teacher for timely intervention and support to dyscalculia students.
3. The game's assessment results can be used to tailor personalized learning pathways for students with dyscalculia.

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