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Improving Students' Understanding Through Aquaponicedify Interactive Module in Form 2 Design and Technology

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Abstract: Aquaponic system design encompasses the strategic planning and arrangement of components within sustainable and integrated farming systems that amalgamate aquaculture (fish farming) with hydroponics (soil-less plant cultivation). The efficiency of aquaponic systems hinges on a well-thought-out design, fostering a symbiotic relationship between fish and plants. The Standard Document of Curriculum and Design delves into the intricacies of Aquaponic Design, covering system advantages, components, schematics, and projects. This study introduces the AquaponicsEdify interactive module as an innovative approach to enhance students' comprehension of Aquaponic Design within the Form 2 Design and Technology curriculum. The AquaponicsEdify module employs gamification and captivating visuals to engage students actively in the learning process, transcending traditional note-centric instruction. The research objective is to assess the effectiveness of the AquaponicsEdify interactive module in augmenting students' understanding of Aquaponic Design. Utilizing an action study design, the study involved a Control Group undergoing conventional learning techniques and a Treatment Group exposed to the AquaponicsEdify module. The research instrument, comprising Pre- and Post-Tests, was administered to 48 respondents, and data analysis revealed a significant positive enhancement in students' comprehension of Aquaponic Design at Form 2. This study underscores the efficacy of incorporating the AquaponicsEdify interactive module to create an engaging and impactful learning experience in the field of aquaponic system design.

Keywords: Interactive Modules, Aquaponic Design, Level of Understanding

1. Introduction

In the pursuit of advancing education quality, the government initiated a transformative shift in educational paradigms, introducing 21st-century learning in 2014 to adapt to the dynamic and rapidly evolving world. Today's educational landscape integrates a diverse array of crucial elements aimed at cultivating highly skilled human capital. The 21st-century education revolves around student-centered learning, leveraging technology to instill collaborative skills, critical thinking, creativity, communication, and the application of moral values and ethics in daily life [1]. It emphasizes teacher practices that are student-centric and underscores the development of Higher OrderThinking Skills [1]. Given the profound impact of technology on outcomes, students must acquire technological knowledge to navigate the contemporary educational landscape [2].

The Malaysian Ministry of Education (KPM) advocates for the incorporation of technology in education to align with the ongoing trend of modernization [2]. As technology evolves, teachers must embrace innovative methods in education rather than adhering solely to traditional approaches. In this context, Design and Technology emerges as an elective

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subject in high schools, designed to cultivate creativity, innovation, and an understanding of ever-changing technology among mainstream students. The subject encompasses design appreciation, technology application, product manufacturing, and product design evaluation [3]. Through this curriculum, students gain theoretical knowledge, hands-on skills with tools and materials, and the opportunity to explore and express their interests and creativity by innovating products for enhanced user appeal and usability.

Within the realm of Design and Technology, the focus on Aquaponic system design is particularly relevant. Aquaponics represents a sustainable and integrated farming method amalgamating aquaculture and hydroponics. It necessitates meticulous planning, layout, and component arrangement for the harmonious coexistence of fish and plants. The Standard Document of Curriculum and Assessment (DSKP) delves into Aquaponic Design, encompassing system advantages, components, sketches, and projects.

In addition to its agricultural significance, aquaponics provides a unique educational opportunity. Problem-solving, systems thinking, and science process skills find seamless integration into aquaponics activities, serving as effective teaching tools [4]. This article explores the pivotal role of the AquaponicsEdify interactive module in enhancing students' understanding of Aquaponic Design within the Level 2 Design and Technology subject. Drawing insights from contemporary educational practices and technological integration, this study contributes to the ongoing discourse on innovative pedagogical approaches in the context of 21st-century education.

2. Reflection on Past Learning and Teaching

Upon the completion of the research, several challenges within the past Learning and Facilitation (PdPc) sessions came to the researcher's attention. Notably, student engagement and focus were hindered by a prevailing issue – a pronounced lack of attentiveness attributed to a combination of late scheduling and uninspiring teaching methodologies [5]. The placement of the Design and Technology subject in the concluding hours of the academic day (10th to 12th periods) resulted in student boredom and decreased concentration during class sessions.

Furthermore, students expressed difficulty in comprehending the intricate system designs of the Aquaponic system, leading to confusion and a sense of being overwhelmed. The struggle to memorize and understand the system components hindered their overall understanding, fostering a belief that they couldn't grasp the material effectively [6]. This lack of understanding manifested in an inability to distinguish between various aquaponic design systems, even when explained by the teacher.

Observations by the researcher highlighted a pronounced student preference for visual learning tools, particularly graphics and multimedia, over traditional textbooks [7]. Recognizing the impact of visuals on human memory, the researcher sought to leverage this preference to enhance the learning experience. Graphics not only captured student attention more effectively but also facilitated better comprehension. Presenting explanations using visuals on teaching slides proved more impactful than traditional methods like the teacher drawing on paper. The use of visuals contributed to improved content retention and enhanced achievement of learning objectives.

In response to these challenges, the researcher envisioned an initiative to create a more engaging and effective learning environment. The proposed solution involves the development of an interactive module that is visually stimulating, with simple and easily understandable content. Embracing the gamification method in assessment adds an element of enjoyment to the learning process, diverting students from a monotonous focus on acquiring knowledge [7]. This innovative approach aims to make learning more enjoyable, preventing students from succumbing to fatigue or disinterest during class.

Drawing inspiration from the noted challenges and considering the evolving preferences of students, the researcher advocates for a pedagogical shift towards more visually engaging and interactive teaching methodologies. By embracing an initiative that aligns with student interests, the researcher aims to not only improve comprehension but also inject a sense of enthusiasm and joy into the learning process. The proposed interactive module, with its emphasis on simplicity, visual appeal, and gamified assessment, strives to create a vibrant and participative learning atmosphere, fostering a more profound understanding of the subject matter and ensuring that students remain actively engaged in the learning process.

3. Study Objectives

This study endeavors to assess the efficacy of the AquaponicEdify interactive module in enhancing students' understanding of the Aquaponic Design subject within the Design and Technology curriculum for Form 2 students. The specific objectives are as follows:

1. Design and develop an interactive AquaponicEdify module with the aim of improving students' understanding of the principles and concepts related to Aquaponic Design in the Design and Technology Form 2 curriculum.
2. Conduct a comprehensive evaluation to determine the effectiveness of the AquaponicEdify interactive module in enhancing students' comprehension of Aquaponic Design within the Design and Technology Form 2 curriculum.

By delineating these specific objectives, the study aims to contribute valuable insights into the potential benefits and impact of integrating the AquaponicEdify interactive module as an innovative tool for teaching and learning Aquaponic Design at the Form 2 level.

4. Literature Review

4.1 Learning Module

In the realm of education, a learning module serves as a comprehensive instructional unit designed to explore specific topics or skills within the broader context of a curriculum. These modules are meticulously crafted to operate independently, affording educators the flexibility to deploy them in various teaching and learning scenarios. Typically, learning modules encompass defined learning objectives, instructional content, interactive activities, assessments, and supplementary resources, functioning as self-contained educational packages tailored to specific subjects or concepts. The flexibility of these modules is highlighted in the findings that interactive modules, facilitated online, transcend temporal and spatial constraints. They often incorporate multimedia elements, such as videos, images, quizzes, and forums, enriching the learning experience and facilitating independent learning [8]. Their self-contained nature empowers educators to adapt and organize modules according to student needs or the educational context, fostering a focused and targeted approach to the subject matter. Focused on specific learning goals, this module fosters a focused and targeted approach to the topic being discussed. Noteworthy is the inherent interactivity woven into these modules, engaging students actively in the learning process through activities and assessments. Incorporation of multimedia elements, such as videos and simulations, further enhances the learning experience. The scalability of learning modules makes them adaptable to various educational systems, including traditional classrooms, online courses, or blended learning environments. In essence, the use of learning modules represents a modular and adaptable approach to education, catering to the diverse learning styles and preferences of contemporary students.

A study by Sudarman and Ardian [9] explored the development of an interactive module supporting Student-Centered Learning, demonstrating its feasibility and positive reception among students. Another study by Nurhikmah et al. [10] focused on the development of an interactive e-module in Multimedia Learning, assessing its practical effectiveness through expert validation. The results indicated high validity scores from material and media experts, suggesting the module's suitability for practical use in Multimedia Learning courses. Next research that related about Interactive E-Module Development in Multimedia Learning. This study which also develop an interactive e-module in the Multimedia Learning Course which to know the pratically of effectiveness the interactive module. The result showns the validity by material experts and media experts are obtained an average scored of 4.9 and 4.1. This can conclude that it can be tested to determine the pratically and effectiveness of interactive e-modules in learning process in Multimedia Learning Course at Education Technology Study Program in Makassar State University.

Several studies have explored the implementation and impact of learning modules. Article [11] conducted a study on the "Implementation of an Interactive E-Module to Improve Concept Understanding of Students," focusing on 10th-grade students experiencing difficulties in understanding redox materials. The study employed an interactive e-module using Kvisoft Flipbook, revealing a significant improvement in students' understanding, supported by a Z-score from the Wilcoxon test. On the other hand, [12] investigated "Improving Students' Critical Thinking Skills: Is Interactive Video and Interactive Web Module Beneficial?" where the study compared interactive media's impact on students' critical thinking, involving chemistry education students from the University of Riau and State Islamic University of Sultan Syarif Kasim Riau. Findings indicated that interactive web modules based on phenomena learning were more effective in enhancing students' critical thinking skills than interactive videos.

Study by [13] introduces an innovative device, the Automatic Thread Insertion Kit Sewing (ATIKs), designed for practical sewing applications in vocational fashion design education. The study emphasizes the practical application of technology in vocational education, aiming to enhance the skill development of students. The paper contributes to the intersection of technology and vocational education, showcasing a tangible application of engineering and innovation in the context of practical skill acquisition. On the other hand, [14] explores students' perceptions regarding the use of modern technology as teaching aids. The study sheds light on the students' attitudes, preferences, and opinions towards the incorporation of technological tools in education. By understanding these perceptions, educators and policymakers can make informed decisions about the integration of technology in teaching. Exploring technology's role, [15] delved into the "Potential Implementation of Android-Based Interactive Multimedia for Student Learning Activities." This study gauged students' perceptions of Android-based interactive multimedia in mathematics learning during the Covid-19 period, revealing that while the majority had not used interactive multimedia, students preferred learning through this medium. Additionally, [16] focused on the "Development of Learning Media Electronic Module (E-Module)" using the ADDIE development model. The study highlighted that electronic modules could significantly aid students in the learning process, providing valuable insights from reviewed journals.

In [17], the development of interactive multimedia modules for teaching Home Economics at the daily secondary school level in Malaysia contributes to the field of educational technology. The authors employ a multimedia approach, suggesting a shift from traditional teaching methods to more dynamic and engaging instructional materials. By incorporating multimedia elements into the modules, the paper aims to enhance the learning experience of students in the subject. The significance of this work lies in its potential to improve the effectiveness of teaching and learning in the specific domain of home economics, aligning with the broader trend of integrating technology into education. Another study by [18] aimed to "Improve Social Interaction and Learning Achievement in Computer and Networking Materials in Grade X-9 at Vocational High School 1 Padang." The results, obtained through qualitative and quantitative methods, indicated increases in both social interaction and cognitive aspects of learning achievement. Lastly, [19] explored "Interactive E-Module Oriented VAK Content Subject Communication Data" at SMK Negeri 3 Singaraja. The study designed an e-module oriented towards Visual, Auditory, and Kinesthetic (VAK) content for class XI students of the TKJ program. Results showed the successfully designed and valid VAK modality-oriented e-module significantly improved student learning achievement.

In conclusion, the collective findings from these studies affirm the positive impact of interactive modules on students' understanding and learning outcomes. The growing attention and adoption of modules in educational research worldwide underscore their significance in enhancing learning experiences for students, both at the school and university levels. These studies collectively underscore the pivotal role of interactive modules in modern education, with a focus on adaptability, interactivity, and enhanced learning experiences.

5. Methodology

5.1 Research design

This study employs an action research design focused on a daily high school setting. The research design serves as a comprehensive plan to facilitate the achievement of the study's objectives [20]. It encompasses essential components such as strategy, literature review, data collection methods, tools, procedures, and the engagement of participating respondents, constituting a crucial framework for the research.

5.2 Research Population and Sample

The study sample, in accordance with [21], is derived from a student population of 54 individuals, with 48 students randomly selected for the research. The respondents are students sharing similar backgrounds in terms of curriculum achievements, ethnicity (Malay), and religion (Muslim). The researcher has categorized them into two groups: the Control Group and the Treatment Group, each comprising 24 individuals.

5.3 Research Instrument

1) Pre and Post Test

The pre-test/post-test comparison group design, a widely utilized method in clinical research, is employed for evaluating the students' understanding of the Aquaponic Design topic in the subject Design and Technology Form 2 [22]. The Pre-Test is administered before the teaching and learning session to gauge the respondents' existing knowledge on the study's subject. Following the completion of the PdP session, the Post-Test is administered. Both tests align with the guidelines of the DSKP for Design and Technology Form 2. The questions for both tests are equivalent, ensuring fairness, but the implementation period for the two tests is separated by two weeks.

5.4 Data Analysis

The data obtained from both pre and post-tests, featuring questions aligned with the Aquaponic Design topic, undergo a thorough review, filtration, organization, and presentation in a comprehensible format. To delve deeper into the insights derived from students' marks, the analysis will be conducted utilizing the SPSS version 27 application.

5.5 Study Procedures

The research adheres to the Action Research Model [23], an inquiry approach emphasizing collaboration and active participant involvement in shaping and executing change. The process commences with the planning stage, wherein the researcher identifies the problem or issue requiring resolution and formulates the necessary actions. Subsequently, planned actions or interventions are executed, potentially involving changes in teaching methods, learning approaches, or the school environment. According to [24], Kemmis and McTaggart's (1988) Action Research Model aligns with the researcher's steps in navigating the action research cycle. This cycle initiates with an initial reflective stage (initial survey), followed by activity planning and implementation to address student challenges, observation, and reflection after each undertaken activity.

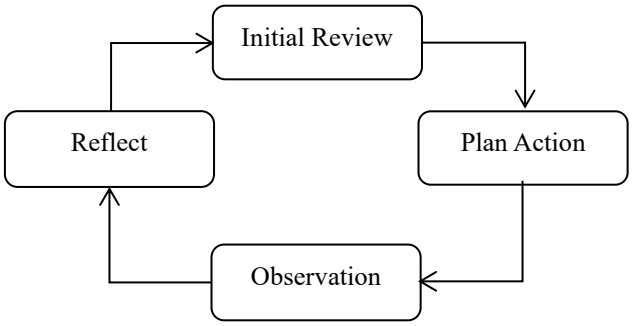

Figure 1 : Action Research Model, Kemmis and McTaggart (1988)

1) Initial Review

The reflective process initiates by revisiting the prior teaching and learningsession, focusing on Aquaponic Design for Form 2. Through this introspection, the researcher identifies strengths, weaknesses, and challenges encountered during the PdP. This marks the commencement of the action research, aimed at comprehending the issues faced by students and strategizing solutions. Observations are conducted to analyze challenges within the teaching and learningprocess, ensuring that the ensuing teaching design effectively addresses students' real needs [25]. The initial phase highlights a deficiency in Teaching Aids and a reliance on conventional teaching methods, primarily utilizing textbooks.

2) Plan Action

The initiation involves conducting a Pre Test on Aquaponic Design, administered after an observation-based teaching and learning session. This one-hour assessment gauges students' existing knowledge of the subject. Observation reveals difficulties faced by students in addressing questions related to system names and component functions within Aquaponic Design. The Pre Test comprises 25 questions categorized into Part A, Part B, and Part C, each carrying two marks. The total score of 50 marks is then converted into a percentage. The researcher segregates students into Control and Treatment Groups based on their Pre-Test scores. The Control Group adopts conventional teaching methods, while the Treatment Group benefits from an interactive module to enhance Aquaponic Design understanding.

The researcher plans what needs to be done for the students to improve their understanding. The use of interactive modules is widely used in teaching and learning sessions. Interactive modules in the context of learning is a strategy that aims to increase interaction between students and learning materials. Interactive modules often include multimedia elements, technology-based tasks and instant feedback. E-module developed can be used anytime and anywhere by using a smart phone which is already owned by students in this era of technology [26]. By using technology, this module can create a more engaging and participatory learning environment. Students can engage in activities such as simulations, interactive quizzes and online discussions.

3) Observation

Step 2 comprises the implementation of actions, starting with an intervention for the Treatment Group during the teaching and learning activities. The AquaponicEdify interactive module is introduced to the respondents, containing concise notes and assessments with a gamification element. Other teachers, specializing in the same subject,conduct the teaching session to ensure impartiality. The PdP session lasts for one hour, with a 30-minute assessment activity. Observations reveal active and focused student participation, resulting in the successful achievement of daily learning objectives.

Figure 2: Contents of the AquaponicEdify Interactive Module

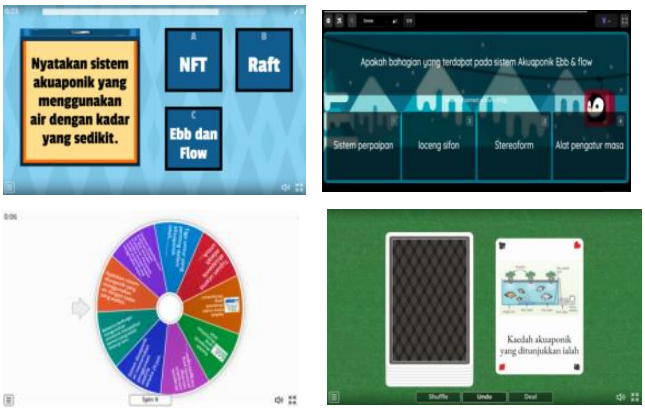

Figure 3: Examples of Assessment Exercises Using Gamification

Respondents were taught by other teachers who teach the same subject to avoid issues of bias. The PdP process runs for 1 hour and the assessment activity for 30 minutes. Based on observation, it can be seen that the students are active and focused in class. The learning objectives of the day were well

achieved.

4) Reflect

Step 3 entails the execution of the Post Test. Following a two-week teaching and learning process, both Control and Treatment Groups undergo a post test to evaluate their understanding based on the preceding activities. Respondents are given one hour to answer questions related to Design and Aquaponics. Post completion, the researcher assesses answers and compares results with the Pre-Test scores, conducting observations to ascertain improvements or areas requiring further attention.

6. Findings

The initial data collected for this study encompassed pre and post-tests, focusing on the topic of Aquaponic Design. An interactive module was employed within the study sample. Before the commencement of the teaching and learning sessions, a pre-test was administered to both the Control Group and the Treatment Group. The data obtained underwent analysis using Statistical Program for the Social Science (SPSS) software version 27, employing descriptive analysis and paired t-test methodologies. Table 1 presents a comparative analysis of scores between the Control Group and Treatment Group respondents for both the Pre-Test and Post-Test. The study involved a total of 24 respondents, evenly distributed between the Control and Treatment Groups.

Table 1 : Comparison of Grade Marks for the Control an Treatment Groups

GROUP	TEST	GRADE				
		A	B	C	D	E
CONTROL	Pre	0	0	15	9	0
	Post	0	0	15	9	0
TREATMENT	Pre	0	0	7	15	2
	Post	15	8	1	0	0

Analysis of the Pre-Test results of Control Group revealed that none of the respondents achieved Grade A, Grade B, or Grade E scores. Specifically, 15 respondents obtained Grade C, and 9 respondents obtained Grade D. Subsequently, the Control Group underwent traditional teaching methods, demonstrating a slight improvement in student achievement for the Aquaponic Design title during the Post-Test. Notably, 15 respondents achieved Grade C and Grade D by 9 individuals. Furthermore, the Treatment Group, which experienced teaching sessions utilizing the AquaponicEdify interactive module, demonstrated notable differences in Pre-Test results. None of the students attained Grade A or B, with 7 students receiving Grade C and 15 students obtaining Grade D. Two students scored Grade E. Post-Test results, however, indicated significant improvement in student achievement, with a total of 15 students achieving Grade A, 7 students obtaining Grade B, and 2 student securing Grade C. Importantly, no students received Grades D or E. This suggests a more positive change in grade achievement for the Treatment Group compared to the Control Group.

Table 2 : Independent results T-test Pre Test for Control and

Groups	Mean	N	SD	Std Error Mean
Control	44.58	24	9.987	2.039
Treatment	32.96	24	10.703	2.1848

Treatment Group

		Levene test		T-test for equality		
		F	Sig.	t	df	Sig. (2 tailed)
Pre1	Equal varieces	0.34	.854	3.890	46	.001
	Not equal variances			3.890	45.781	.001

Table 2 represents a non-significant difference, as indicated by a p-value of 0.854 (P<0.005) during their Pre Test intervention. In practical terms, a high p-value (e.g., 0.854) in the Levene test suggests that there is no strong evidence to indicate a significant difference in variance between the groups. This is positive news for the validity of subsequent parametric tests, allowing them to proceed with the assumption of equal variances.

Table 3 : Independent results T-test Post Test for Control and Treatment Group

Groups	Mean	N	SD	Std Error Mean
Control	43.29	24	8.770	1.790
Treatment	78.58	24	10.607	2.165

		Levene test		T-test for equality		
		F	Sig.	t	df	Sig. (2 tailed)
Post1	Equal varieces	1.67	.202	12.562	46	.001
	Not equal variances			12.562	44.43	.001

Table 3 showcases independent results from the T-test for the Post Test conducted on the Control and Treatment Groups. Following the Levene's test with a p-value of 0.202, a t-test was executed to compare the means of the two groups. A significance level of 0.202 suggests insufficient evidence to reject the null hypothesis of equal variances. Consequently, one might assume that the variances of the two groups are not significantly different. In other words, there is no significant difference in the results for the post-test between the Control and Treatment Groups

Table 4 : Paired t-test results for Control Group

Paired Differences (Control Group)								
			Std.	95% Confidence		t	df	Sig. (2-
Pre	Mean	SD	Error	Interval of the				tailed)
test-			Mean	Difference				
Post								
test	-7.083	2.629	.537	-1.818	-0.402	-1.32	23	.200

Table 4 presents the outcomes of the paired t-test analysis conducted on the Control Group. The results reveal a lack of statistical significance, indicated by a p-value of 0.200 ($p>0.05$). The paired t-test value, standing at 1.32, further supports this non-significant finding. The mean difference of 7.083 highlights that the effectiveness of conventional methods, as employed in this study, is notably diminished. This outcome suggests that alternative approaches or interventions may need exploration for greater efficacy within the Control Group context.

Table 5 : Paired t-test results for Treatment Group

Paired Differences (Treatment Group)								
			Std.	95% Confidence		t	df	Sig. (2-
Pre	Mean	SD	Error	Interval of the				tailed)
test-			Mean	Difference				
Post								
test	-45.625	11.021	2.24	-50.28	-40.97	-20.28	23	.001

Table 5 outlines the outcomes derived from the paired t-test analysis conducted on the Treatment Group. The results show a pronounced level of statistical significance, with a remarkably low p-value of 0.001 ($p<0.05$). The paired t-test value, registering at an impressive 20.28, further corroborates the noteworthy nature of this significant finding. The substantial mean difference of 45.625 underscores a considerable improvement in intervention test scores. This notable enhancement serves as a compelling indicator of the effectiveness of incorporating the AquaPonicEdify interactive module. It signifies positive and tangible advancements in students' comprehension levels within the Aquaponic Design learning context. Taken together, these results emphasize not only the pedagogical value but also the resounding success of the applied intervention method. The efficacy of the AquaponicEdify module is evident, suggesting its potential as a robust tool for enhancing educational outcomes in the realm of Aquaponic Design.

7. Discussions

Based on the comprehensive analysis of the data, it is evident that the research objective of this action research has been successfully achieved. The AquaponicEdify interactive module emerges as an effective tool in enhancing students' understanding of Aquaponic Design within the realm of Form 2 Design and Technology. The choices made by teachers regarding strategies, methods, and media profoundly impact the attainment of competencies crucial in the 21st century [27]. Emphasizing 21st-century learning, which centers around students' abilities and learning skills [28], educators can diversify their teaching approaches to bolster student understanding and foster heightened engagement. Such varied methodologies stimulate students' minds, promoting focused and attentive participation in class. Leveraging technology is anticipated to elevate the quality of teaching, contributing to an overall improvement in the learning process [29]. Furthermore, the integration of learning multimedia is acknowledged for creating an active and informed learning environment, serving as a valuable reference beyond traditional teaching methods [30].

The utilization of the AquaponicEdify interactive module proves instrumental in cultivating a more profound understanding and active participation among students. The module's efficacy extends beyond mere note-taking, incorporating assessments through gamification methods. This approach aids students in responding to related questions post the teaching and learning process. Well-designed gamified systems offer continuous opportunities for learners to enhance their knowledge, providing spontaneous feedback throughout the interactive experience [31]. The learning and teaching process becomes a dynamic fusion of education and play, offering dual benefits to students through the AquaponicEdify interactive module. Electronic learning modules have been substantiated as effective tools, enriching students' learning experiences [32]. The dynamic and interactive nature of the delivery medium simplifies the learning of complex material [33]. The researcher's objective goes beyond the research study itself; it is to indirectly assist students in comprehending the intricacies of Aquaponic Design. This title is acknowledged as challenging due to the multitude of systems involved, often leaving students without a clear understanding of the studied aquaponic system.

8. Conclusion

In conclusion, the integration of AquaponicEdify interactive module has demonstrably yielded positive outcomes by significantly enhancing students' comprehension levels and fostering a heightened degree of active engagement in the classroom. The teaching and learning sessions for the Design and Technology curriculum have become notably more captivating. The effectiveness of AquaponicEdify interactive module extends beyond traditional note-taking, incorporating engaging PAK21 activity suggestions and assessments that utilize gamification methods. This multifaceted approach not only facilitates learning but also integrates play, thereby fortifying students' understanding in a more holistic manner. The teaching and learning experience become not only

educational but also enjoyable, creating an environment that effectively evaluates and reinforces students' comprehension.

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