Indonesian Journal of Educational Research and Technology

Journal homepage: http://ejournal.upi.edu/index.php/IJERT/

Fuzzy Delphi Method Application Towards Usability Evaluation of Problem Solving Framework: Application in Education

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ABSTRACT

Non-digital games are tools that can help children build and improve problem-solving skills. Children need to solve problems using analogies from one situation to another, following the correct steps. To improve these skills, teachers play a role in guiding children so that these skills can be enhanced along with their age and developmental stage. However, the application of problem-solving skills in learning activities has become a challenge for teachers to implement because there are no specific reference sources that can be used as a guide. This is also supported by the findings of a needs analysis where there is a need to develop a problem-solving framework that focuses on problem-solving steps using non-digital games. The problem-solving framework has been developed and needs to be evaluated for its usability in the usability evaluation phase using the Fuzzy Delphi Method. It aims to measure the usability and suitability of the non-digital game-based problem-solving framework that has been developed in the design and development phase. 25 preschool teachers were selected as experts to provide feedback through a questionnaire. The findings show that all experts in this phase agree that all main components, elements in the main components, and the priority flow for each element of the problem-solving framework have achieved an appropriate status and show a high consensus on the usability of the problem-solving framework that has been developed. Therefore, the problem-solving framework can be used by preschool teachers as a specific guide in implementing problem-solving activities using non-digital game.

ARTICLE INFO

Article History:
Submitted/Received 05 Mar 2023
First Revised 13 Apr 2023
Accepted 01 Jun 2023
First Available online 07 Jun 2023
Publication Date 01 Mar 2024

Keyword:
Problem-solving framework,
Non-digital games,
Problem-solving skills,
Fuzzy delphi method.

1. INTRODUCTION

Problem-solving skills are one of the important skills that children need to master (Clavio & Fajardo, 2008; Artut, 2015; Keen, 2011; Shiakalli, 2014; Nachiappan *et al*., 2019) and it is also one of the essential skills to be acquired before they step into the real schooling environment (Keen, 2011). This fact is also evidenced by the emphasis given to problem-solving skills in the National Standard Preschool Curriculum (2017), where four problem-solving skills need to be mastered by children, namely critical thinking, creative thinking, analytical thinking, and thinking strategies (National Standard Preschool Curriculum, 2017). These are the skills that children need to master to achieve maximum problem-solving skills (Clavio & Fajardo, 2008).

The importance of these skills has been demonstrated through previous research (Clavio & Fajardo, 2008; Shiakalli, 2014; Keen, 2011), where mastery of problem-solving skills can help children excel academically, make quick and effective decisions, improve attention, stimulate analytical and logical thinking, enhance memory, develop creativity, and encourage exploration (Clavio & Fajardo, 2008; Shiakalli, 2014). Based on the importance of mastering problem-solving skills, it is clear that these skills have a positive impact on children. Therefore, to develop and enhance these skills, the selection of appropriate learning approaches that suit the age and developmental stage of children is crucial (Clavio & Fajardo, 2008; Ashari & Baharuddin, 2017).

Learning through play is one of the approaches that are suitable for the age and developmental stage of children. This approach is emphasized in the National Preschool Standard Document (2017). It is a structured approach that provides children with opportunities to learn in a free, safe, enjoyable, and meaningful environment. The main focus of preschool education in Malaysia is to provide children with enjoyable and meaningful learning opportunities.

This is because play activities are the best form of learning and are a priority in early childhood education (Ashari & Baharuddin, 2017). Therefore, through an appropriate approach that suits the age and developmental stage of children, it can provide a fun and enjoyable teaching and learning process for them (Ashari & Baharuddin, 2017). In addition, it can also stimulate the development of children's brains, and through this stimulation, the developmental level in terms of psychomotor, cognitive, social, and emotional aspects can be developed in a balanced manner.

To enhance problem-solving skills through a play-based learning approach, the use of non-digital games is the most suitable teaching aid to be used in this approach. Learning through games needs to be specific to the scenario that needs to be highlighted to the students. Non-digital Games used for learning purposes should have learning content, clear learning outcomes, and follow the existing curriculum.

In addition, using non-digital games in learning activities can cultivate positive attitudes among students such as being more interested in learning, being competitive with peers, being cooperative, collaborative, active, increasing curiosity, striving for problem-solving and finding solutions. Games that can be used by teachers in a play-based learning approach are digital games and non-digital games (Clavio & Fajardo, 2008; Naik, 2017; Rasdi *et al*., 2021). However, appropriate game selection should take into account the age and developmental level of children aged four to six years old (Clavio & Fajardo, 2008).

Nevertheless, the implementation of problem-solving skills using non-digital games in problem-solving activities is one of the challenges that need to be implemented by teachers (Nachiappan *et al*., 2019). This is because teachers need to apply knowledge, skills, and values

DOI: https://doi.org/10.17509/ijert.v4i1.58699
p- ISSN 2775-8419 e- ISSN 2775-8427

to carry out problem-solving skills in learning activities. To implement problem-solving skills in learning activities, teachers need to have a clear understanding of problem-solving skills, steps, and strategies suitable for children's developmental stages. However, there is no specific reference source that can guide teachers in carrying out such learning activities.

Since 2014, research on problem-solving learning activities for preschool children is very limited (Nachiappan *et al*., 2019). These studies focus more on the implementation of problem-solving learning activities for primary schools, secondary schools (Suhaimi *et al*., 2014) and higher education institutions.

Furthermore, based on past findings, the game framework developed is specifically for digital game frameworks for middle school and higher education students only (Ibrahim *et al*., 2009). In addition, past studies have yet to prove, particularly focusing on the main components and elements that are needed to implement problem-solving activities using non-digital games.

Based on the findings of the design and development phase, the main components and elements for each main component have been designed and developed, where there are five main components: activity objectives, teacher preparation, teacher roles, child roles, and activity assessment. Therefore, the usability evaluation phase refers to the ability to measure the usability and suitability of the non-digital game-based problem-solving framework that has been designed and developed in the design and development phase. The purpose of this phase is to assess the suitability of the problem-solving framework as a guide for preschool teachers in implementing problem-solving activities using non-digital games.

Thus, the Fuzzy Delphi Method (FDM) was used in this phase to answer the research question. The following are the main research questions and follow research questions by subform the usability evaluation phase:

What is the usability of the non-digital game-based problem-solving framework?

i) What is the expert consensus on the suitability of the main components in the skill-based problem-solving framework?
ii) What is the expert consensus on the suitability of the elements for each main component in the non-digital game-based problem-solving framework?
iii) What is the expert consensus on the priority flow of elements for each main component in the non-digital game-based problem-solving framework?
iv) What is the expert consensus on the overall usability of the non-digital game-based problem-solving framework?.

2. METHODS

2.1 Design and Development Research

In this study, the approach that will be used is the Design and Development Research (DDR) approach. This approach is assertion that development research is a highly systematic process that encompasses the design, development, and evaluation of a product. This study focuses on the second type of design and development research, which is related to the development of models or frameworks.

This type of research aims to develop new models/frameworks or improve existing models/frameworks for use in teaching and learning processes. This type of research emphasizes the validity or effectiveness of existing models or the development of new models, processes, or techniques.

Based on this study, the results need to undergo an evaluation of the developed model. Therefore, this study has three main phases: needs analysis, design and development, and usability evaluation. Thus, this study focuses on the third phase, which is the usability

DOI: https://doi.org/10.17509/ijert.v4i1.58699
p- ISSN 2775-8419 e- ISSN 2775-8427

evaluation phase, aiming to assess the suitability of the problem-solving framework as a guide for preschool teachers in implementing non-digital game-based activities. Usability evaluation refers to the usability and suitability of a developed model or framework. The usability evaluation is a measurement of the ability of a product to function based on the objectives and goals of its development.

In this study, the researcher has used the Fuzzy Delphi Method for the usability evaluation phase, where the researcher uses the Fuzzy Delphi Method to assess the perceptions and satisfaction of the users, consisting of preschool teachers, towards the framework. This is supported by Jeng and Tzeng's (2012) assertion that the evaluation of a developed product can be measured based on the opinions and satisfaction of an expert in the field.

Fuzzy Delphi Method is a method and measurement instrument that was rebranded from the Delphi technique (Jamil *et al*., 2015). This method was introduced by Murray, Pipino, and Gigch in 1985. FDM is a more effective measurement tool as it is seen as capable of solving problems with uncertainty and ambiguity in a study (Jamil *et al*., 2015). Fuzzy Delphi Method is a decision-making method based on analysis that combines Fuzzy theory with the Delphi method.

2.2 Research Samples

The method was chosen based on the researcher's desire to obtain expert views and consensus on a particular matter. This study used purposive sampling based on Ahmad's 2018 approach; purposive sampling is suitable for studies using the FDM. A total of 25 experts with more than five years of teaching experience were selected for this process.

These experts consisted of preschool teachers under the Ministry of Education Malaysia who were directly involved in the teaching and learning process with children. The appropriate number of experts for the Delphi method is between 10 and 15 if there is a high level of consistency among experts. The Delphi method, the number of experts involved should be between 10 and 50. **Table 1** shows the demographic findings of the respondents for all experts involved in this phase three study.

Table 1. Demographics of experts in the usability evaluation of problem-solving framework.

Item	Details	Frequency	Percentage
Gender	Male	6	24%
	Female	19	76%
Teaching experience	0 – 5 years	0	0%
	6 – 10 years	1	4%
	11 – 15 years	11	44%
	16 – 20 years	5	20%
	20 years and above	8	32%
Academic qualification	Certificate	-	-
	Diploma	-	-
	Degree	24	96%
	Others	1	4%

According to **Table 1**, the majority of the experts are female with a percentage of over 70% compared to male experts who only make up 24%. In terms of teaching experience, the data shows that most experts have more than 10 years of teaching experience, with a percentage of over 95%. Meanwhile, the majority of experts hold a bachelor's degree, with a percentage of over 95%.

DOI: https://doi.org/10.17509/ijert.v4i1.58699
p- ISSN 2775-8419 e- ISSN 2775-8427

2.3 Research Instrument

The research instrument used in this phase is a questionnaire for usability evaluation purposes. According to questionnaire development can be achieved through literature review, expert interviews, and focus groups. In this study, the researcher adapted the items from the FDM questionnaire by Jamil 2016.

The questionnaire was validated by two experts, namely content and language experts. The questionnaire consists of five sections: i. Section A - Respondent demographics, ii. Section B - Suitability of the main components, iii. Section C - Suitability of elements in the main components, iv. Section D - Usability based on the suitability of the flow/priority of elements for each main component of the non-digital game-based problem-solving framework, and v. Section E - Overall usability of the non-digital game-based problem-solving framework.

Due to the Covid-19 pandemic, the questionnaire was translated into a Google Form to facilitate preschool teachers' feedback. A brief explanation of the development of the non-digital game-based problem-solving framework was provided to ensure that the experts clearly understood the framework. The questionnaire was distributed individually through Telegram and WhatsApp applications. The participating experts then provided feedback on the usability evaluation of the problem-solving framework in the questionnaire provided.

3. RESULTS AND DISCUSSION

The findings of this usability evaluation phase are based on the suitability of the main components, the suitability of the elements for each main component, the suitability of the flow of elements for each main component, and the overall usability of the non-digital game-based problem-solving framework. The criteria for the problem-solving framework are based on the established thresholds for the threshold value (d) ≤ 0.2 (Cheng & Lin, 2002), a percentage agreement of expert groups ≥ 75% (Murry & Hammons, 1995), and a fuzzy score (A) α-cut of 0.5 (Tang & Wu, 2010; Bodjanova, 2006).

3.1 Suitability of the Main Components in the Problem-Solving Framework

Based on **Table 2**, all main components of the problem-solving framework are in suitable status for use based on the agreement and views of the involved experts. The research findings indicate that all the main components in the problem-solving framework, namely activity objectives, teacher preparation, teacher and student roles, and activity assessment, are suitable for use. A framework or model used by educators for the learning process should consist of activity objectives, teacher preparation, teacher and student roles, and activity assessment.

Based on the above statement, it is clear that the experts' agreement on the suitability of the main components in this framework is consistent with previous studies such as the above statement. In addition, this framework is based on the Magic Circle Game-Based Learning Model (2010), the TASC Model (1993), and the Krulick & Rudnick Problem Solving Model (1995), which approach the similarity of these models.

The sequence of the main components in this framework is produced based on the implementation of problem-solving activities using non-digital games. Therefore, the suitability of these main components refers to the appropriate models' foundation and has been approved through the usability evaluation of this framework.

DOI: https://doi.org/10.17509/ijert.v4i1.58699
p- ISSN 2775-8419 e- ISSN 2775-8427

Table 2. Suitability of main components in the problem-solving framework.

No.	Main Component	Triangular Fuzzy Number Criteria		Defuzzification Criteria				Evaluation Status
		Threshold Value (d)	Expert Agreement Percentage (%)	m1	m2	m3	Fuzzy Score (A)	
1.	Activity Objective	0.154	100.00%	0.676	0.848	0.960	0.828	Suitable
2.	Teacher Preparation	0.175	96.00%	0.700	0.860	0.956	0.839	Suitable
3.	Teacher's Role	0.089	100.00%	0.740	0.908	0.988	0.879	Suitable
4.	Children's Role	0.138	100.00%	0.692	0.864	0.968	0.841	Suitable
5.	Activity Assessment	0.130	100.00%	0.676	0.856	0.968	0.833	Suitable

3.2 Suitability of Elements for each Main Component

Based on **Table 3**, the study findings indicate that all elements within the objective activity component of the problem-solving framework are deemed suitable for use based on the agreement and perspectives of the involved experts.

Table 3. Suitability of elements for the objective activity component in the problem-solving framework.

No.	Activity Objective	Triangular Fuzzy Number Criteria		Defuzzification Criteria				Evaluation Status
		Threshold Value (d)	Expert Agreement Percentage (%)	m1	m2	m3	Fuzzy Score (A)	
1.	O1	0.145	100.00%	0.660	0.840	0.960	0.820	Suitable
2.	O2	0.126	96.00%	0.684	0.864	0.968	0.839	Suitable
3.	O3	0.118	96.00%	0.700	0.876	0.972	0.849	Suitable
4.	O4	0.130	96.00%	0.692	0.868	0.968	0.843	Suitable
5.	O5	0.093	100.00%	0.724	0.896	0.984	0.868	Suitable

The research findings indicate that all elements for each main component in the problem-solving framework are appropriate. Referring to the findings on the elements of the objective activity component, based on the agreement of experts, all of the elements are appropriate to be used as objective activity elements where all of these elements are based on the learning outcomes of problem-solving activities using non-digital games. This is because the objective of this framework is based on three main dimensions of effective learning outcomes, namely knowledge, skills, and application. Wherein formulating the objectives of teaching and learning activities, must be based on three main dimensions, namely knowledge, skills, and application.

Based on **Table 4**, the research findings indicate that all elements within the teacher preparation component of the problem-solving framework are deemed suitable for use based on the agreement and perspectives of the involved experts.

DOI: https://doi.org/10.17509/ijert.v4i1.58699
p- ISSN 2775-8419 e- ISSN 2775-8427

Table 4. Suitability of elements for the teacher preparation component in the problem-solving framework.

No.	Teacher Preparation	Triangular Fuzzy Number Criteria		Defuzzification Criteria				Evaluation Status
		Threshold Value (d)	Expert Agreement Percentage (%)	m1	m2	m3	Fuzzy Score (A)	
1.	PG1	0.114	96.00%	0.724	0.892	0.976	0.864	Suitable
2.	PG2	0.122	96.00%	0.740	0.900	0.976	0.872	Suitable
3.	PG3	0.137	96.00%	0.708	0.876	0.968	0.851	Suitable
4.	PG4	0.116	100.00%	0.708	0.880	0.976	0.855	Suitable
5.	PG5	0.168	96.00%	0.668	0.840	0.952	0.820	Suitable
6.	PG6	0.105	100.00%	0.716	0.888	0.980	0.861	Suitable
7.	PG7	0.114	100.00%	0.732	0.896	0.980	0.869	Suitable
8.	PG8	0.061	100.00%	0.724	0.904	0.992	0.873	Suitable
9.	PG9	0.096	100.00%	0.700	0.880	0.980	0.853	Suitable
10.	PG10	0.093	100.00%	0.724	0.896	0.984	0.868	Suitable

For the teacher preparation component elements, based on the agreement of experts, all ten elements are appropriate to be used as teacher preparation elements. Based on this research finding, the teacher preparation elements meet the requirements that need to be carried out by teachers as preparation before conducting problem-solving activities using non-digital games.

This research finding is reinforced by the statement contained in the National Preschool Standard Curriculum (2017) which states that teacher teaching preparation must encompass several important aspects such as planning the learning content to be delivered to students, determining Content Standards, Learning Standards, and Performance Standards, planning to use appropriate learning approaches for children aged four to six years, and designing assessment methods appropriate for the activities conducted.

Based on **Table 5**, the study findings indicate that all elements in the teacher's role component for the problem-solving framework are suitable for use based on the agreement and views of the involved experts.

Table 5. Suitability of elements for the teacher's role component in the problem-solving framework.

No.	Teacher's Role	Triangular Fuzzy Number Criteria		Defuzzification Criteria				Evaluation Status
		Threshold Value (d)	Expert Agreement Percentage (%)	m1	m2	m3	Fuzzy Score (A)	
1.	PG1	0.081	100.00%	0.748	0.916	0.992	0.885	Suitable
2.	PG2	0.082	100.00%	0.772	0.932	0.996	0.900	Suitable
3.	PG3	0.078	100.00%	0.764	0.928	0.996	0.896	Suitable
4.	PG4	0.068	100.00%	0.748	0.920	0.996	0.888	Suitable
5.	PG5	0.083	100.00%	0.732	0.904	0.988	0.875	Suitable
6.	PG6	0.075	100.00%	0.740	0.912	0.992	0.881	Suitable

DOI: https://doi.org/10.17509/ijert.v4i1.58699
p- ISSN 2775-8419 e- ISSN 2775-8427

For the teacher’s role component elements, based on the agreement of experts, six elements are appropriate to be used as teacher role elements. This research finding is in line with the role of teachers found in Standard 4 of SKPMg2, which is as a monitor, mentor, and motivator.

In addition, this research finding also supports all elements found in this component, namely the teacher's role as a facilitator, demonstrator, facilitator, mentor, and also as motivator for children throughout problem-solving activities carried out (Keung & Cheung, 2019; Kizi & Ugli, 2020; Rindu & Ariyanti, 2017).

This teacher's role is important throughout the activity because it is a determinant of whether the activity conducted achieves the learning objectives or not. The teacher acts in all roles throughout the problem-solving activity with the children. The teacher's role throughout game-based learning activities is one of the important factors in producing effective learning.

Based on **Table 6**, the research findings show that all elements in the children's role component for the problem-solving framework are deemed suitable for use based on the agreement and views of the involved experts.

Table 6. Suitability of elements for the children's role component in the problem-solving framework.

No.	Children's Role	Triangular Fuzzy Number Criteria		Defuzzification Criteria				Evaluation Status
		Threshold Value (d)	Expert Agreement Percentage (%)	m1	m2	m3	Fuzzy Score (A)	
1.	PK1	0.088	100.0%	0.716	0.892	0.984	0.864	Suitable
2.	PK2	0.105	100.0%	0.684	0.868	0.976	0.843	Suitable
3.	PK3	0.083	100.0%	0.708	0.888	0.984	0.860	Suitable
4.	PK4	0.150	96.00%	0.676	0.852	0.960	0.829	Suitable
5.	PK5	0.146	96.00%	0.668	0.848	0.960	0.825	Suitable
6.	PK6	0.148	100.00%	0.636	0.820	0.952	0.803	Suitable
7.	PK7	0.154	96.00%	0.644	0.828	0.952	0.808	Suitable
8.	PK8	0.148	100.00%	0.636	0.820	0.952	0.803	Suitable
9.	PK9	0.148	84.00%	0.572	0.764	0.920	0.752	Suitable
10.	PK10	0.137	96.00%	0.676	0.856	0.964	0.832	Suitable
11.	PK11	0.125	92.00%	0.580	0.772	0.932	0.761	Suitable

For the children’s role component elements, based on the agreement of experts, the elements are appropriate to be used as child role elements for the problem-solving framework. Based on research findings, these elements are suitable as they are reinforced by aspect 4.6 in SKPMg2 (2018), Standard 4, which is the student as an active learner.

This finding is also reinforced by the statements who state that children need to be active throughout problem-solving activities, i.e., they need to explore and delve into the problems given in the activity, communicate with peers in the group, be free to express ideas, be brave in making decisions, act quickly to make decisions, solve problems together with other peers, check the work of others, and show their work to other peers.

Based on **Table 7**, the research findings show that all elements in the activity assessment component for the problem-solving framework are in the appropriate status for use based on the agreement and views of the involved experts.

DOI: https://doi.org/10.17509/ijert.v4i1.58699
p- ISSN 2775-8419 e- ISSN 2775-8427

Table 7. Suitability findings for the elements of the activity assessment component in the problem-solving framework

No.	Activity Assessment	Triangular Fuzzy Number Criteria		Defuzzification Criteria				Evaluation Status
		Threshold Value (d)	Expert Agreement Percentage (%)	m1	m2	m3	Fuzzy Score (A)	
1.	PA1	0.159	100.00%	0.684	0.852	0.960	0.832	Suitable
2.	PA2	0.153	100.00%	0.644	0.824	0.952	0.807	Suitable
3.	PA3	0.156	100.00%	0.700	0.864	0.964	0.843	Suitable
4.	PA4	0.126	96.00%	0.716	0.884	0.972	0.857	Suitable
5.	PA5	0.154	96.00%	0.644	0.828	0.952	0.808	Suitable
6.	PA6	0.145	100.00%	0.660	0.840	0.960	0.820	Suitable
7.	PA7	0.161	100.00%	0.628	0.804	0.940	0.791	Suitable
8.	PA8	0.180	88.00%	0.612	0.800	0.932	0.781	Suitable
9.	PA9	0.149	100.00%	0.668	0.844	0.960	0.824	Suitable

The suitability of assessment activity components based on expert agreement reveals that nine elements are suitable for use as assessment activity components. Referring to the elements of assessment activities refer to assessments that are not only conducted by teachers but also involve children in the assessment activities.

This finding is consistent with the statements of Clavio and Fajardo (2008) which state that assessments conducted by teachers are throughout problem-solving activities where teachers act as observers of children as they engage in these activities. This finding is also supported by aspect 4.5 SKPMg2 in Standard 4 which states teachers as assessors. Elements involving teachers in the assessment of problem-solving activities are appropriate.

Based on **Table 8**, the research findings show that the flow of priority for all elements in each main component of the problem-solving framework is suitable for use based on the agreement and views of the involved experts.

Overall, the sequence of elements in the component of activity objectives that focus on enhancing knowledge and skills in problem-solving and the ability to apply them in daily life demonstrates a suitable sequence for conducting problem-solving activities using non-digital games. This is in line with the statements of Ali & Mahamod (2015); Hanifah *et al*. (2019); Nachiappan *et al.* (2019) that in conducting activities using non-digital games, activity objectives need to be clearly defined in line with the knowledge and skills to be measured to produce effective learning outcomes, and children can apply this knowledge and skills.

The findings of the study for the teacher preparation component have met the criteria for teacher preparation stated by Ali & Mahamod (2015); Hanifah *et al*. (2019) in which teacher preparation for conducting activities using non-digital games is by stating learning objectives, providing enjoyable and motivating activities for students, suggesting flexible implementation periods, specifying implementation steps, determining appropriate teaching methods and techniques, determining suitable game materials, combining several types of games, determining the number of students in groups according to their level, determining activity/worksheets for students, using language that is easy and suitable for students' abilities, providing variety, and arranging activities from easy to difficult. Therefore, the agreement on the priority sequence of elements by teachers for all teacher preparation elements is suitable for conducting problem-solving activities using non-digital games.

DOI: https://doi.org/10.17509/ijert.v4i1.58699
p- ISSN 2775-8419 e- ISSN 2775-8427

Table 8. Details of the usability evaluation for the suitability of the flow of priority for elements in each main component.

No.	Main Component	Triangular Fuzzy Number Criteria		Defuzzification Criteria				Evaluation Status
		Threshold Value (d)	Expert Agreement Percentage (%)	m1	m2	m3	Fuzzy Score (A)	
1.	Flow/priority of elements for the objective activity component.	0.150	100.00%	0.652	0.832	0.956	0.813	Suitable
2.	Flow/priority of elements for the teacher preparation component.	0.155	100.00%	0.636	0.816	0.948	0.800	Suitable
3.	Flow/priority of elements for the teacher's role component.	0.150	100.00%	0.652	0.832	0.956	0.813	Suitable
4.	Flow/priority of elements for the child's role component.	0.066	92.00%	0.860	0.972	0.992	0.941	Suitable
5.	Flow/priority of elements for the activity assessment component.	0.155	100.00%	0.660	0.836	0.956	0.817	Suitable

Based on the suitability of the priority sequence of these elements, overall, all of these elements encompass the role of teachers as stated by Ali & Mahamod (2015); Hanifah *et al.* (2019); Nachiappan *et al.* (2019) in which the teacher's role in conducting problem-solving activities using games is to plan and prepare before conducting learning activities, guide children throughout the learning activity, effectively convey information to children, make assessments of children's work throughout the activity, communicate with children during the activity, constantly encourage and guide children throughout the activity.

Based on the suitability of the sequence of elements in the overall role of children's components, all of these elements encompass the role of children in problem-solving activities using non-digital games. This finding is consistent who stated that children need to be involved in using and connecting new information with existing knowledge and experiences, to think analytically and creatively, to generate ideas involving the highest level of creative thinking, to justify their chosen decisions, to be involved in decision-making processes and to think analytically and evaluate, to use existing knowledge and skills to solve problems and to act, and to be encouraged to communicate and share ideas and work results with others. Overall, it is clear that children need to actively participate in problem-solving activities using non-digital games.

Based on the suitability of the sequence of elements in the overall assessment component, all of these elements encompass the role of children in problem-solving activities in the assessment of problem-solving activities using non-digital games, where teachers and children need to participate throughout the assessment process. This statement is consistent where children need to assess their work and that of their peers, teachers need to encourage the assessment process, teachers also need to help children assess quality work, children need to communicate, share ideas, and work results with their peers, teachers need to encourage children to share their work results with their peers, and children need to link new knowledge they have acquired with real life.

Overall, it is clear that the priority sequence of all elements for each component is appropriate for use in the problem-solving framework based on the agreement of all experts consisting of teachers. Therefore, based on these research findings, it has achieved the main goal of developing this framework.

According to **Table 9**, the findings show that the priority flow of all elements for each main component in the problem-solving framework is suitable for use by preschool teachers based on the agreement and views of the experts involved.

Table 9. Assessment of overall usability for the problem-solving framework.

No.	Item	Triangular Fuzzy Number Criteria		Defuzzification Criteria				Evaluation Status
		Threshold Value (d)	Expert Agreement Percentage (%)	m1	m2	m3	Fuzzy Score (A)	
1.	Item 1	0.147	100.0%	0.684	0.856	0.964	0.835	Suitable
2.	Item 2	0.166	92.0%	0.668	0.844	0.952	0.821	Suitable
3.	Item 3	0.149	100.0%	0.668	0.844	0.960	0.824	Suitable
4.	Item 4	0.155	100.00%	0.660	0.836	0.956	0.817	Suitable
5.	Item 5	0.161	100.00%	0.644	0.820	0.948	0.804	Suitable
6.	Item 6	0.155	100.00%	0.660	0.836	0.956	0.817	Suitable
7.	Item 7	0.116	100.00%	0.708	0.880	0.976	0.855	Suitable
8.	Item 8	0.144	96.00%	0.692	0.864	0.964	0.840	Suitable
9.	Item 9	0.118	96.00%	0.700	0.876	0.972	0.849	Suitable
10.	Item 10	0.130	96.00%	0.692	0.868	0.968	0.843	Suitable

Overall, the findings of this study indicate that all elements in this section are agreed upon by experts and the problem-solving framework is suitable for use. Ten items have been answered by all experts to assess the overall usability of the problem-solving framework. The study's findings indicate that it is approved by experts and that the problem-solving framework is suitable for use.

This clearly shows that the problem-solving framework is suitable for use by all preschool teachers as a complete reference and guide for conducting problem-solving activities using non-digital games. This study's findings are supported by Nachiappan *et al*. (2019) statement that teachers need a specific guide to implementing problem-solving activities that focus on steps and strategies appropriate to the developmental stage of preschool children.

Based on all the main components and elements in this problem-solving framework, it is suitable to be used as a guide. the study's findings, where a good framework or model has main components and elements that can clearly and effectively guide and assist its users. A good framework needs to have main components of clear activity objectives, teacher and student roles, and activity assessment. Therefore, it is clear that this problem-solving framework is suitable for use by all preschool teachers as the main guide for conducting problem-solving activities using non-digital games for children.

DOI: https://doi.org/10.17509/ijert.v4i1.58699
p- ISSN 2775-8419 e- ISSN 2775-8427

4. CONCLUSION

In the usability evaluation phase of the study, all research experts agreed that all main components, elements within the main components, and priority flows for each element in the problem-solving framework based on non-digital games had achieved the appropriate status and could be used by preschool teachers as a specific guide in carrying out problem-solving activities using non-digital games for children. Therefore, this framework can be simulated by preschool teachers to enhance problem-solving skills among preschool children. The framework has been named the Non-Digital Game-Based ProSkiND Problem-Solving Framework for Preschool Children.

5. ACKNOWLEDGEMENTS

A heartfelt appreciation and millions of thanks are extended to Assoc. Prof. Dr. Alias bin Masek, the main supervisor from the Faculty of Technical and Vocational Education, Universiti Tun Hussein Onn Malaysia (UTHM), for his guidance and mentoring in conducting this study on the Fuzzy Delphi Method Application Towards Usability Evaluation of Problem Solving Framework. This appreciation is also extended to the 25 preschool teachers who participated as field experts in this study. Thank you for all your cooperation and support.

6. AUTHORS' NOTE

The authors declare that there is no conflict of interest regarding the publication of this article. The authors confirmed that the paper was free of plagiarism.

7. REFERENCES

Ali, A., and Mahamod, Z. (2015). Pembangunan dan kebolehgunaan modul berasaskan bermain bagi pembelajaran kemahiran bahasa melayu kanak-kanak prasekolah. *Jurnal Pendidikan Bahasa Melayu*, *6*(1), 16-29.

Artut, P. D. (2015). Preschool children's skills in solving mathematical word problems. *Educational Research and Reviews, 10*(18), 2539-2549.

Ashari, Z. M., and Baharuddin, M. K. (2017) Play based pedagogy in pre-school: A meta analysis research. *Man in India*, *97*(12), 237-243.

Bodjanova, S. (2006). Median alpha-levels of a fuzzy number. *Fuzzy Sets and Systems*,*157*(7), 879-891

Cheng, C., and Lin, Y. (2002). Evaluating the best main battle tank using fuzzy decision theory with linguistic criteria evaluation. *European Journal of Operational Research*, *142*, 174-186.

Clavio, J. C. V and Fajardo A. C. (2008). Toys as instructional tools in developing problem-solving skills in children. *Education Quarterly*, *66*(1), 87-100.

DOI: https://doi.org/10.17509/ijert.v4i1.58699
p- ISSN 2775-8419 e- ISSN 2775-8427

Hanifah, S., Vincent, P. and Muhammad, I. B. (2019). Modul membaca awal prasekolah menggunakan nyanyian berasaskan teori psikolinguistik kognitif dan aplikasi kaedah belajar melalui bermain. *Jurnal Pendidikan Malaysia*, *44*(1), 45-58.

Ibrahim, R., Yusoff, R. C. M., Mohamed, H. and Jaafar, A. (2009). Students perceptions of using educational games to learn introductory programming. *Computer and Information Science*, *4*(1), 205.

Jamil, M. R. M., Siraj, S., Hussin, Z., Noh, N. M., and Sapar, A. A. (2015). Aplikasi teknik Fuzzy Delphi terhadap keperluan elemen keusahawanan bagi pensyarah kejuruteraan Politeknik Malaysia. *International Journal of Entrepreneurship and Technopreneur*, *5*(1), 135-50.

Jeng, D. J. F., and Tzeng, G. H. (2012). Social influence on the use of clinical decision support systems: revisiting the unified theory of acceptance and use of technology by the fuzzy DEMATEL technique. *Computers and Industrial Engineering*, *62*(3), 819-828.

Keen, R. (2011). The development of problem solving in young children: A critical cognitive skill. *Annual Review of Psychology, 62*, 1-21.

Keung, C. P. C., and Cheung, A. C. K. (2019). Towards holistic supporting of play-based learning implementation in kindergartens: A mixed method study. *Early Childhood Education Journal*, *47*(5), 627-640.

Kizi, J. K. G., and Ugli, M. K. S. (2020). Teaching culture as a tool to english teaching methodology. *Science and Education*, *1*(3), 591-594.

Masnan, A. H., and Radzi, N. M. M. (2015). Pengetahuan persediaan pengajaran guru prasekolah baru. *Jurnal Pendidikan Awal Kanak-kanak Kebangsaan*, *4*, 90-108.

Murry, J., and Hammons, J. (1995). Delphi: A versatile methodology for conducting qualitative research. *Review of Higher Education*, *18*(4), 23-36.

Nachiappan, S., Osman, R., Masnan, A. H., Mustafa, M. C., Hussein, H., and Suffian, S. (2019). The development of preschools' higher order thinking skills (HOTs) teaching model towards improving the quality of teaching. *International Journal of Academic Research in Progressive Education and Development*, *8*(2), 39-53.

Naik, N. (2017). The use of GBL to teach mathematics in higher education. *Innovations in Education and Teaching International*, *54*(3), 238-246.

Rasdi, S. S., Masnan, A. H., Hamzah, M., and Ghazali, M.(2021). Pembangunan dan kebolehgunaan modul pengajaran berasaskan game board dalam pembelajaran operasi nombor kanak-kanak prasekolah. *Jurnal Pendidikan Awal Kanak-Kanak Kebangsaan*, *10*(2), 7184.

Rindu, I., and Ariyanti, A. (2017). Teacher's role in managing the class during teaching and learning process. *Script Journal: Journal of Linguistic and English Teaching*, *2*(1), 83-100.

Shiakalli, M. A. (2014). Constructing squares as a mathematical problem solving process in pre-school. *Review of Science, Mathematics and ICT Education*, *8*(1),43-61.

DOI: https://doi.org/10.17509/ijert.v4i1.58699
p- ISSN 2775-8419 e- ISSN 2775-8427

Tang, C.W. and Wu, C.T. (2010). Obtaining a picture of undergraduate education quality: A voice from inside the university. *Springer Higher Education*, *60*, 269-286.

Zakaria, S., Othman, B. A., Mohammed, H., Zaid, N. M., and Abdullah, Z. (2014). Penerapan kemahiran berfikir aras tinggi melalui model stesen rotasi pelbagai mod. *Konvensyen Antarabangsa Jiwa Pendidik*, *2014*, 11-13.

DOI: https://doi.org/10.17509/ijert.v4i1.58699
p- ISSN 2775-8419 e- ISSN 2775-8427