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Developing and Validating a Game-Based Financial Literacy Assessment for Early Childhood

An Evidence-Centered Design Approach

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ABSTRACT

Financial literacy is an important skill that children need to have to face future economic challenges. However, the level of financial literacy among young children is still low, with many children lacking an understanding of basic financial concepts such as money management, saving, and distinguishing between needs and wants. Although various financial literacy education programs have been introduced, measuring the financial literacy of early childhood remains a challenge, as traditional evaluation methods are often ineffective and unsuitable for children's developmental characteristics. This article aims to develop and validate a game-based assessment instrument for measuring the financial literacy of early childhood, designed using the Evidence-Centered Design (ECD) framework. This study tested the effectiveness of game-based assessment in measuring financial literacy in early childhood through trials in two kindergartens in Malang, East Java, involving 100 students aged 5-6 years. The results of this study indicate that this game-based financial literacy instrument is enough valid and reliable for measuring children's financial literacy and the measurement results can be used as an evaluation tool for educators or institutions in developing more effective financial education policies that are appropriate to children's needs in schools.

Introduction

The important of socializing financial literacy from an early age is receiving growing attention. This is indicated by the large number of studies that have been conducted related to this topic [1]. This awareness arises from the evidence that the ability to manage finances makes a significant contribution to children's future well-being [2]. The commitment by various countries to make financial literacy part of their national development strategies demonstrates the importance of promoting financial literacy from an early age [3]. Several countries have successfully integrated financial education into their curricula, with different strategies but with the same goal of improving students' financial literacy from an early age. Consistent implementation based on national policies, as applied in Portugal [4], Canada, and Singapore, tends to have a positive impact on financial understanding among the younger generation [5].

In the context of education, especially early childhood education, various learning methods have been developed to introduce the concept of financial literacy to children from an early age, both non-digital and digital [3], [6]. However, the implementation tends to be limited to the local level and the realm of research, so it has not had a significant impact on children's understanding of financial literacy in general. This condition is partly due to the limited understanding of education practitioners regarding the financial knowledge needs of early childhood, which in turn has implications for education policies that do not fully accommodate the importance of financial literacy at the early childhood education level [7].

Even though financial literacy learning strategies for early childhood are increasingly developing, they need to be accompanied by efforts to assess the needs or scope of material related to students' financial knowledge [1]. This is important so that teachers can socialize financial education according to the needs of early childhood. Therefore, the evaluation aspect is no less important than the use of learning media in socializing financial literacy in early childhood[8]. Evaluation is not only to determine the extent of students' understanding of the material, but more importantly, evaluation can also help teachers meet the specific needs of early childhood learners [9]. So that teachers can effectively socialize financial education based on information from evaluation results.

However, there have been few studies examining the assessment aspect of financial literacy education. One of them is the development of a financial literacy questionnaire for early childhood with 4 indicators which include: children are involved in decision making, understand needs and desires, savings habits, and knowing financial institutions [10]. In fact, appropriate assessment is not only important as a tool to measure understanding, but also as a basis for consideration in improving the quality of learning and developing early childhood education policies that are appropriate to the needs of early childhood [11]. Although

numerous efforts have been made to socialize financial literacy education, accurately and effectively measuring the level of financial literacy in early childhood remains a challenge. Without accurate measurement, it is difficult for parents, teachers, or policymakers to determine the extent to which children understand basic concepts about money, saving, or distinguishing between needs and wants [12]. Accurate measurement will provide useful data for designing appropriate educational interventions, monitoring children's development, and evaluating the effectiveness of existing financial literacy programs [13].

Measuring children's financial literacy is not easy [14]. Traditional tests, such as paper-based multiple-choice tests, are often ineffective in measuring children's understanding [15]. Besides being uninteresting for children, traditional tests often do not function well when applied to early childhood. This is because traditional tests are considered unable to accommodate the developmental characteristics of early childhood and cannot provide an interactive and enjoyable learning atmosphere [16]. Furthermore, paper-based tests also have the potential to cause psychological stress in children. This is certainly contrary to the principles of early childhood learning which emphasize experience-based approaches and enjoyable learning [16].

In this digital era, digital game-based learning media have proven effective in teaching financial literacy, especially to children [17]. Children tend to learn better through this game-based approach. Therefore, the process of evaluating children's learning should also follow a similar approach. Amidst the limitations of traditional measurement methods, a more innovative approach has emerged, namely game-based assessment (GBA). This approach is a very promising alternative in measuring early childhood financial literacy. The use of games provides a more enjoyable and engaging learning experience for children, which can then also increase their engagement in the learning process [17]. Not only that, GBA allows for a more holistic measurement, because it can integrate various competency indicators in a format that is more contextual and relevant to children's real lives [18].

In the context of financial literacy, game-based assessments can assess children's understanding of basic financial concepts such as money and income, spending, saving, and sharing in a more authentic way. Game-based assessments provide a more participatory, fun, and adaptive assessment space compared to traditional assessments, which can seem rigid [18]. Despite the enormous potential of GBA, the use of this method in measuring early childhood financial literacy is still limited in its use. Therefore, this study aims to develop and validate a game-based assessment (GBA) instrument specifically designed for early childhood, by referring to the Evidence-Centered Design (ECD) model framework. This study aims to make an important contribution to measuring children's financial literacy in a more valid,

reliable, and fun way, which is expected to support the development of more effective financial education strategies in the future.

This study proposes the development of a game-based assessment instrument using the Evidence-Centered Design (ECD) approach. ECD was chosen because it is able to link financial literacy constructs with evidence of children's behavior observed in games, resulting in a more valid and authentic assessment. With valid and effective measurement instruments, educators, parents, and policymakers can obtain more accurate information about children's financial literacy levels. This information will serve as the basis for designing curricula that are appropriate for children's developmental stages, as well as planning appropriate interventions to shape healthy financial habits from an early age. Therefore, measuring children's financial literacy is not only important for monitoring individual progress but also for creating policies that can improve the overall quality of financial education.

Despite growing interest in financial literacy education for young children, few studies have developed and psychometrically validated game-based assessment instruments suitable for early childhood contexts. Therefore, this study aims to develop and validate a game-based financial literacy assessment using an Evidence-Centered Design framework. This study contributes to the limited literature on psychometrically validated game-based assessment in early childhood financial education.

Methods

This study uses a research and development approach in developing a game-based financial literacy assessment for children. The approach used in developing the game refers to the Evidence-Centered Design (ECD) model, which allows for valid and reliable assessment based on evidence of student performance during interactions in the game. Assessment-based games were developed through the ECD model, which consists of three main components: a) Student Model, b) Evidence Model, and c) Task Model [18].

The instruments were tested on 100 students aged 5-6 years at 2 kindergartens in Malang, East Java. During this session, students were asked to interact with the game-based financial literacy assessment and complete all of the tasks. Data was collected through direct observation of student interactions with the game. The collected data will be analyzed using descriptive statistical methods to calculate the average score and distribution of students' financial literacy understanding. Validity and reliability tests were also conducted to ensure that this game can accurately measure competence. The analysis conducted includes Corrected Item-Total Correlation and Cronbach's alpha. Item analysis covering difficulty and discrimination levels was also added.

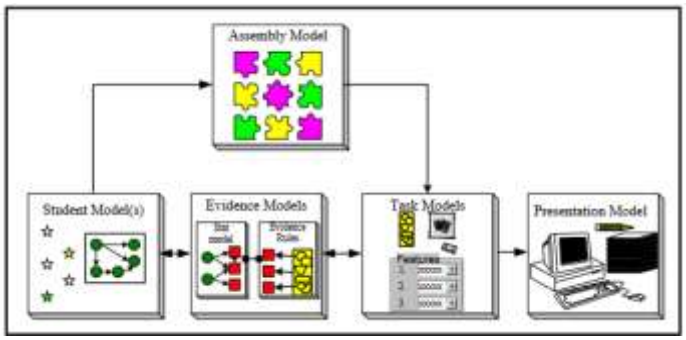

Fig. 1. The Core Model of the ECD Framework

Results and Discussion

This financial literacy assessment-based game was developed using the ECD model, which consists of three main components [19]–[20]:

1. Student Model: identification of competencies to be measured,
2. Evidence Model: determination of evidence needed to measure these competencies, and
3. Task Model: design of a series of tasks in the form of games. The integration of game-based assessment as a presentation model was added at a later stage, including assessment goals and game mechanisms.

In the context of early childhood financial literacy, financial competence is an indirect observable trait (latent trait), requiring evidence-based modeling. The OECD [21] states that children's financial literacy encompasses: financial knowledge, financial behavior, and financial attitudes. ECD is well-suited for developing children's financial literacy instruments because children's responses are not always explicit and need to be interpreted through visual and situational stimuli [8].

A. Student Model

At this stage, the competencies to be measured are determined. Determining the competencies targeted by the test, which encompasses the knowledge, skills, and abilities (KSAs). The determination of these competencies is based on a review of literature and theories related to financial literacy for early childhood. Thus, two main references were established as the basis for determining early childhood financial literacy competencies. Financial literacy material for preschoolers includes concepts of numbers, thinking about the future (time), money and income, markets and exchanges, financial institutions, decision-making skills (choices), social values, exchange and value (exchange and value) [22]. These financial literacy concepts were then simplified by the Financial Services Authority into:

1. Knowledge of the concept of money and skills to recognize various types of money,
2. Knowledge about the use of money in daily life and skills to distinguish between needs and wants,

3. Knowledge and skills to set aside money for savings and future, 4) Awareness to share with others [23].

In early childhood financial literacy, target abilities are not immediately apparent. They are only visible in the way children respond or choose actions [24]. Based on references, this can be summarized into three latent variables that describe the financial literacy abilities of early childhood, namely: 1) Financial Knowledge, 2) Financial Decision-Making, and 3) Social Values.

Table 1. Summary of Student Model

Code (θ)	Variable	Defintion	Indicator	Component Material	Sources
θ_1	Financial Knowledge	Children's knowledge of financial concepts	the ability to recognize money, income, and banking features	Money, Income Banking feature	[22]–[23]
θ_2	Financial Decision-Making	Ability to make simple financial decisions	The ability to make decisions	Needs vs. Wants, Saving money	
θ_3	Social Value	Social attitudes and values	The ability to recognize social attitudes	Sharing	

B. Evidence Model

The evidence model describes how to determine the ability variables to be measured, along with the information provided based on student performance. The evidence model describes how to determine the ability variables to be measured, and the information provided based on student performance. This includes evidence rules and measurement models [25]. Evidence Rules are the rules established in the instrument being developed. In other words, they are called assessment criteria. In this case, the evidence rules stipulate that a correct answer is awarded a score of 1; an incorrect answer is awarded a score of 0. In the measurement model at this stage, the results of the previously collected domain analysis (concepts of money, income, needs and wants, saving, banking features, and sharing) are presented in the form of assessment arguments. These arguments explain the relationship between the assessed knowledge/skills (KSA) and the child's work products, as well as observations made. The evidence model is shown in Table 2.

Table 2. Summary of Evidence Model

Item Code	Material	Task Description	Observables	Evidence Rules	Measurement Model
Q1	Money	Children recognize money	Image selection	True = 1; False = 0	Variable: recognize money (θ_1).
Q2	Money	Children recognize money	Image selection	True = 1; False = 0	Variable: recognize money (θ_1).
Q3	Money	Children recognize money	Image selection	True = 1; False = 0	Variable: recognize money (θ_1).
Q4	Saving money	Children identify saving behaviors	Image selection	True = 1; False = 0	Variable: Saving money (θ_2).

Item Code	Material	Task Description	Observables	Evidence Rules	Measurement Model
Q5	Needs vs Wants	Children can distinguish between needs and wants	Image selection	True = 1; False = 0	Variable: needs vs wants (θ_2).
Q6	Sharing	Children identify sharing behaviors	Image selection	True = 1; False = 0	Variable: Sharing (θ_3).
Q7	Saving money	Children identify saving behaviors	Image selection	True = 1; False = 0	Variable: Saving money (θ_2).
Q8	Banking feature	Children recognize bank/ATM features	Image selection	True = 1; False = 0	Variable Bank Feature (θ_1).
Q9	Banking feature	Children recognize the bank office	Image selection	True = 1; False = 0	Variable: Bank Feature (θ_1).
Q10	Income	Children understand that income comes from work	Image selection	True = 1; False = 0	Variable: income (θ_1).

C. Task Model

Task models outline how to organize the kinds of situations required to gather the types of evidence required for the evidence models. They outline the presentation materials that are given to the examinee as well as the work products that are produced in response. Additionally, they include task model variables that explain the features of the task and their connections to the work products and presentation materials [20]. At this stage, the item design (interactive game format):

Table 3. The Summary of the Task Model

No.	Component	Task model	Target (θ)	Score	Item
1	Money	Recognize money by selecting one of the money displays according to the requested amount	θ_1	1/0	1
		Compare the amount of money by selecting the money display as requested	θ_1	1/0	2
		Select the amount of money displayed according to the price of the item displayed	θ_1	1/0	3
2	Income	Choose one of the 3 image views of how people make money	θ_2	1/0	10
3	Needs vs Wants	Choose one of the 3 image views that show the need	θ_2	1/0	5
4	Saving Money	Choose one of the 3 food image displays that help children save money.	θ_2	1/0	4
		Choose one of the 3 image displays of activities that children do when they have pocket money left over.	θ_2	1/0	7
5	Banking Feature	Choose one of the 3 images of the safest place to save	θ_1	1/0	8
		Select one of the 3 images of the bank feature	θ_1	1/0	9
6	Sharing	Choose one of the 3 images of activities that children will do if a friend doesn't bring a lunch box.	θ_3	1/0	6

D. Presentation Model

At this stage, the instrument can be delivered in any desired manner. The choice of instrument display is tailored to the needs.

1. Assessment Goal

This instrument is designed to test children's basic financial knowledge in the form of a test with questions covering: 1) Money, 2) Income, 3) Needs and wants, 4) Saving, 5) Bank features, 6) Sharing. The questions are compiled based on a question grid. The number of questions presented is 10 multiple-choice questions with 3 answer options.

2. Game Mechanism

Media Selection. Tests can take various forms. The most common form is the paper test. However, in this context, the use of paper tests may be difficult because students need assistance in completing them, which is prone to cheating. Therefore, the researcher chose another medium. Another form of media that is suitable for assessment is game-based assessment. This assessment is directed at the play process carried out by early childhood. Thus, the researcher chose the media used as a test design packaged in the form of a game (Game-Based Assessment). The advantage of game-based assessment is its ability to reduce anxiety that often arises in traditional tests [26], as well as providing more direct and contextual feedback [19], [27]. The use of games in assessment allows for more holistic data collection on children's skills [15], [21]. This is important because young children learn differently from older children, and accurate measurement will ensure that their learning is well facilitated [24], [27]. Format Selection. Game-based Assessment as a test instrument in this study is formatted in the form of an application that runs on Android. Games have always been a preferred learning medium for children [28]. By choosing a game approach, this test, which measures children's financial knowledge, becomes more enjoyable.

The use of a game-based approach in this study was not intended to increase excessive exposure to digital games in early childhood. The games in this study were positioned as structured assessment tools used for short durations, focused on learning objectives, and implemented under adult guidance. Unlike commercial digital games that have the potential to encourage long-term use, the game-based assessment developed consisted of a limited number of tasks completed within a short period of time to measure children's financial literacy skills.

Recent research has shown that the impact of screen use on early childhood is determined not only by the duration of use, but also by the context of use, content quality, and adult involvement. Interactive, educational, and adult-supervised digital experiences have different characteristics than passive and excessive screen use [29]. Furthermore, the implementation of this game-based assessment still requires teacher or parent guidance, as with conventional early childhood assessments. The guidance counselor's role is to help children understand instructions, support technical navigation when necessary, and

ensure that the assessment process remains focused on measuring financial literacy skills. The use of appropriately designed educational games can increase early childhood engagement, motivation, and participation in learning [30].

Therefore, game-based assessment in this study is positioned as a structured, limited, and supervised assessment instrument, rather than as a form of free-form gaming that risks increasing screen addiction.

3. Development

The test instrument was developed based on the test design developed in the previous stage. The questions were structured according to a question grid. There were 10 multiple-choice questions with three answer options, consisting of text, audio, and images. It is because the test participants were young children (5-6 years) who were still in the early stages of reading skills development, but already understood instructions [31]. The game-based assessment components developed included titles and characters, questions, and scores. The game interface was designed to be as engaging as possible so that this game-based assessment could increase children's engagement in learning and provide a more authentic experience in measuring their understanding. The following are the identities of the game-based instruments developed:

Table 4. Specification of Media

Media Title	FinQuizKid
Material	Financial Literacy
User	Preschool learner
Platform	Aplikasi Android format apk

The following is a display of the FinQuizKid as a game-based assessment to measure the financial knowledge of children aged 5-6 years.

Fig. 2. The display of the title

Fig. 3. The character's choice

Fig. 4. The example of a question

Fig. 5. The Scoring

4. Validity of Instrument

Item quality analysis was conducted to ensure the suitability of the test instrument as a tool for measuring learning outcomes. Item validity was evaluated using Corrected Item–Total correlation. The results of the analysis show that of the 10 items assessed, 5 items were categorized as sufficiently valid, 4 items were categorized as valid, and 1 item was invalid because it produced a negative correlation coefficient. A negative correlation coefficient indicates that the item is inversely correlated with the total score, so it does not contribute to measuring the same construct as the other items. Therefore, the item was declared invalid and recommended for revision. Even if there are negatively correlated items, it does not necessarily indicate item malfunction. However, this can occur when the number of items is too small [37].

The reliability of the instrument was tested using the KR-20 coefficient, which is relevant for multiple-choice tests. The reliability value obtained was 0.528, indicating that the instrument has sufficient internal consistency. According to Nunnally and Bernstein (1994), reliability ≥ 0.50 is acceptable for the initial stage of educational instrument development [38], although reliability improvement is still recommended through revision of low-performing items. Furthermore, the difficulty level analysis shows that all items are in the moderate and easy categories, reflecting that participants were able to answer most items without significant difficulty. This level of difficulty composition is adequate for obtaining a general picture of participants' abilities, but the ideal item distribution includes a variety of easy, medium, and difficult questions so that the diagnostic information obtained is more comprehensive [39]–[40].

The difference of all items was in the good category, indicating that the items were able to effectively distinguish between high and low ability of testees. These results are consistent with the criteria of Ebel and Frisbie (1991), which emphasize that adequate

discrimination power is a crucial indicator to ensure that items have good discriminatory ability [41].

Table 5. Summary of trial results

Item	Corrected Item-Total Correlation		Cronbach's Alpha		Difficulty		Difference	
	Value	Decision	Value	Decision	Value	Decision	Value	Decision
Q1	0.233	Enough	0.528	Enough	0.83	Easy	0.79	Excelent
Q2	0.204	Enough			0.84	Easy	0.79	Excelent
Q3	0.214	Enough			0.55	Moderate	0.64	Excelent
Q4	0.129	Enough			0.54	Moderate	0.61	Excelent
Q5	0.332	Valid			0.78	Easy	0.74	Excelent
Q6	0.306	Valid			0.81	Easy	0.79	Excelent
Q7	0.301	Valid			0.71	Easy	0.81	Excelent
Q8	0.250	Enough			0.58	Moderate	0.63	Excelent
Q9	0.355	Valid			0.65	Moderate	0.76	Excelent
Q10	-0.076	Not valid			0.59	Moderate	0.52	Excelent

Conclusion

This study demonstrates that a game-based assessment developed using the Evidence-Centered Design Model can be an effective and enjoyable tool for measuring financial literacy in early childhood. This instrument not only provides a fun experience but can also be used to generate data on children's understanding of financial literacy for follow-up learning. However, there are several limitations that need to be considered, including challenges in measuring more abstract concepts and limited technological accessibility. Further research is needed to test the effectiveness of this instrument on a larger and more diverse sample, as well as to refine items with lower reliability. With further development, game-based assessment can be a very useful tool in shaping healthy financial habits in children from an early age, as well as in designing more effective financial socialization for early childhood education.

Limitations and Suggestions

This study has several limitations that should be acknowledged. First, the sample size was limited to 100 children from two kindergartens in Malang, East Java. This limitation may limit the generalizability of the findings to a broader and more diverse population. Cultural, socioeconomic, and institutional differences may influence children's financial experiences and proficiency in using digital devices, potentially affecting performance outcomes. Second, the reliability coefficient (KR-20 = 0.528) indicates that the items are quite consistent with each other, suggesting a need for improvement. Third, although the game-based format increased engagement and reduced test anxiety, variations in children's digital literacy and access to technology may influence interaction patterns during the assessment.

Future research should involve larger, more heterogeneous samples across different regions and educational contexts to enhance external validity and test the instrument's cross-cultural applicability. Further psychometric validation using more sophisticated measurement

models, such as Item Response Theory (IRT) or Rasch modeling, is warranted. Future studies could also utilize data on children's feedback during play.

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Conflict of Interest

To ensure fair and objective decision-making, authors state no conflict of interest.

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