An Exploratory Factor Analysis: Instrument for Assessment of Episodic Memory Impairment in Early Childhood

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Abstract. Early childhood memory has an important role in child development, enabling them to recall significant events and demonstrate developmental milestones. This study aims to investigate the factor validity of an instrumen assessment of episodic memory impairment in early childhood. Employing a quantitative research method, we recruited a sample of 109 randomly selected early childhood aged 4 to 6 years participants. The instrument utilized was a researcher-developed 33-item assessment sheet. Data analysis was conducted using exploratory factor analysis (EFA) with SPSS. The results revealed nine underlying factors within the episodic memory impairment detection instrument for early childhood: (a) Birthday event memory, (b) Vacation event memory, (c) Spatial information memory, (d) Storybook memory, (e) Time-based temporal information memory, (f) Family-based temporal information memory, (g) School event memory, and (h) Memory of Sequence of Events, (i) Recurrent event temporal information memory. The study concludes that the instrument assessment of episodic memory impairment in early childhood consists of nine factors.

Keywords: Episodic memory, Early childhood, Exploratory factor analysis.

1 Introduction

Assessment is a term frequently encountered, particularly in the educational realm. It serves to identify the specific aspects to be measured within this context. In early childhood education, assessment acts as a benchmark for gauging the success of developmental milestones in children [1]. Measurement assessment can be defined as a systematic process of gathering and analyzing data to address inquiries about the characteristics of individuals, groups, or programs [2]. This process encompasses several stages: Objective formulation, involving the determination of what to measure and the purpose of the assessment; Instrument selection, entailing the choice of a measuring tool aligned with the assessment objectives, such as tests, questionnaires, or observations; Data collection, consisting of conducting measurements using

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the selected instruments; Data analysis, encompassing the processing of obtained data to generate relevant information; and Result interpretation, involving the interpretation of data analysis outcomes within the context of assessment objectives.

Measurement assessments can be categorized based on their objectives: Diagnostic assessment, which identifies student learning difficulties; Placement assessment, which determines student groupings according to ability; Formative assessment, which monitors student learning progress; and Summative assessment, which evaluates student final achievement. Measurement assessments can be categorized based on their objectives: Diagnostic assessment, which identifies student learning difficulties; Placement assessment, which determines student groupings according to ability; Formative assessment, which monitors student learning progress; and Summative assessment, which evaluates student final achievement.

Measurement assessments play a crucial role in diverse fields, including education, where they assess student achievement, the effectiveness of learning programs, and the quality of teaching; psychology, where they measure personality, intelligence, and individual interests; program evaluation, where they assess the success of programs or interventions; and research, where they test hypotheses and collect empirical data. Measurement in early childhood also needs to be done

Early childhood, a golden period in human development, necessitates careful measurement. During this stage, the child's brain undergoes rapid growth and is highly susceptible to environmental stimulation. Appropriate stimulation can optimize children's potential in various developmental aspects, such as cognitive, language, motor, social, and emotional. Early childhood education (ECE) aims to provide optimal stimulation during this golden period. Through engaging and interactive learning activities, children are encouraged to explore their surroundings, develop skills, and cultivate positive character. ECE serves as a robust foundation for human resource development [3].

The importance of early childhood education has been recognized globally. Various studies have shown that children who receive good stimulation from an early age tend to have improved development compared to children who do not [4] [5]. his aligns with the views of experts such as Bruner (1966), who stated that children learn through active interaction with their environment. Additionally, Vygotsky (1978) emphasized the crucial role of social interaction in children's cognitive development. Cognitive development is closely linked to children's memory abilities.

Memory is the brain's capacity to store, organize, and retrieve information. This complex cognitive process enables us to learn from experiences, develop identities, and engage with the world around us. Memory is the ability to store, retain, and recall information from past experiences within the human brain. It serves as a collection of remembered experiences, empowering individuals to learn, adapt, and control the influence of past experiences on current behavior and future thought processes. Memory constitutes a vital component of cognitive function, playing a crucial role in the learning process. Individuals with effective memory function generally exhibit superior learning abilities. Cognition refers to the actions and processes of "knowing," encompassing awareness and judgment. Cognitive function includes rational thinking abilities such as learning, remembering, judging, orientation, perception, and attention. It encompasses how a person acquires information, how that

information is represented and transformed into knowledge, how knowledge is stored in memory and subsequently recalled, and how knowledge is utilized by a person to guide their attitudes and behaviors.

Episodic memory is our window into the past, allowing us to relive personal experiences in vivid detail. If we remember our fifth birthday, for example, episodic memory allows us to vividly reconstruct the party scene. We can see the colorful birthday cake, hear the laughter of our friends, and feel the joy of opening presents. Not only that, episodic memory also stores the emotions associated with the event. We may still feel the nervous sensation of waiting for guests or the joy of opening the most desired gift. Through episodic memory, we can connect ourselves to the past and build a unique personal identity.

The concept of episodic memory was introduced by a psychologist named Endel Tulving. He distinguished episodic memory from other forms of declarative memory such as semantic memory. He stated that semantic memory is the storage of general knowledge about facts that exist in the world, but episodic memory is the ability to store one's personal experiences that one has. Episodic memory is not only about "what" happened, but also about "when" and "where" the event occurred. In addition, episodic memory also involves spatial and temporal dimensions. We remember not only the event itself, but also its relationship to other events in our lives. In other words, episodic memory is a personal narrative that develops over time.

Episodic memory involves the memory of personal experiences, whereas semantic memory involves the memory of facts and concepts [6]. Episodic memory is the foundation of our memory. Our ability to recall past events in detail, such as our fifth birthday or our first vacation, relies on this memory system. Episodic memory does more than store information; it also allows us to process and connect experiences. In other words, episodic memory acts as a personal time machine that takes us back in time. This ability to remember past events in detail is an evolutionary legacy that helped our ancestors adapt to changing environments.

One of the main functions of episodic memory is as a mental simulation tool. By remembering past experiences, we can imagine different scenarios in the future. For example, when planning a vacation, we might imagine different destinations based on previous vacation experiences. This ability to record future events helps us make better decisions. In addition, episodic memory also allows us to learn from past mistakes by visualizing what could have happened if we had taken different actions. In other words, episodic memory does more than just record the past; it also shapes our future..

A very influential model of memory processes. Although they did not provide a single comprehensive definition of memory, their model described memory as a system consisting of several components, including: Sensory register: Temporary storage of sensory information. Short-term store: Temporary storage of information being processed. Long-term store: Long-term storage of learned information. [7].

Memory can be categorized into several types based on the duration of storage, the type of information stored, and how the information is accessed. Here are some of the main types of memory:

1. Sensory Memory: This is the shortest type of memory, lasting only a few seconds. Information captured by the five senses (sight, hearing, touch, smell, and taste) is stored in its raw form in sensory memory.

2. Short-Term Memory: Short-term memory has a limited capacity and a short duration, usually only a few seconds to a few minutes. The information we are currently focusing on is stored in short-term memory.
3. Working Memory: Similar to short-term memory, but working memory is more active and involves the manipulation of information. Working memory allows us to perform cognitive tasks such as problem solving and decision making.
4. Long-Term Memory: Long-term memory has an unlimited capacity and a very long duration, even a lifetime. Information that is important and meaningful to us will be transferred from short-term memory to long-term memory.
5. Explicit Memory: Explicit memory is memory that we can consciously access. It is divided into two types:
    a. Episodic Memory: Memories of personal experiences, such as birthdays or holidays.
    b. Semantic Memory: Memories of facts and general knowledge, such as names of capital cities or mathematical formulas.
6. Implicit Memory: Implicit memory is memory that we cannot consciously access, but influences our behavior. Examples include motor skills (cycling) and classical conditioning (response to certain stimuli).

Research shows that newborns already show early signs of memory ability [8]. For example, babies can recognize their mother's voice or the faces of people they often interact with. As they get older, children's episodic memory abilities develop. At toddler age, children begin to be able to tell their experiences simply, such as remembering family vacations or their birthdays.

However, it should be noted that the development of episodic memory in early childhood is influenced by various factors, such as: Quality of interaction with parents: Warm, responsive interactions, and often involving storytelling or reading activities can stimulate the development of children's episodic memory. Individual characteristics: Each child has a different development rate. Genetic factors can also affect the ability to remember. Environment: A stimulating environment, such as playing with various toys, exploring new places, and interacting with peers, can enrich children's experiences and strengthen episodic memory.

Episodic memory plays a very important role in children's development, including: Identity formation: By remembering past experiences, children begin to build self-awareness and identity. Language development: Episodic memory helps children develop vocabulary and storytelling skills. Social learning: By remembering past social interactions, children learn about social rules and how to interact with others. Cognitive development: Episodic memory becomes the basis for abstract thinking and problem solving.

Episodic memory in children can be measured through tasks that require participants to recall specific events and their contextual details. For instance, children may be asked to memorize objects presented against varied color backgrounds and subsequently identify if they have previously encountered these objects. Researchers can quantify the contribution of episodic

memory to performance by instructing participants to characterize their subjective memory experiences and employing estimation methods to isolate episodic memory from familiarity. [9].

This study aims to determine the various factors that are formed from various indicators of episodic memory development in early childhood. Instrument development is a crucial process in research and evaluation. A good instrument is an instrument that is able to measure accurately and precisely the construct or variable to be studied. The instrument development process involves several stages, starting from the formulation of instrument items, testing, to item analysis. A very important initial stage is determining the concept or variable to be measured. After that, researchers need to compile relevant instrument items that represent the concept. Instrument trials are conducted to determine the validity and reliability of the instrument. Validity refers to the extent to which an instrument measures what it is supposed to measure, while reliability refers to the level of consistency of measurement results. After analysis, the instrument can be revised and improved if necessary.

2 Method

A quantitative research approach was employed in this study, focusing on early childhood children aged 4-6 years in Medan City. Simple random sampling was utilized to select a sample of 109 children from this population. Data collection was conducted using a questionnaire specifically designed to measure episodic memory, developed by the researcher. The collected data was analyzed through exploratory factor analysis using SPSS software.

3 Result and Discussion

Development of Episodic Memory Development Detection Instrument in early childhood at the stage was carried out using the IBM SPSS application using exploratory factor analysis. The results of the analysis can be seen in Table 1.

Tabel *1*. KMO and Bartlett's Test

	Test 1	Test 2	Test 3
Kaiser-Meyer-Olkin Measure of Sampling Adequacy.	0,631	0,666	0,661
Bartlett's Test of Sphericity	0,000	0,000	0,000

Based on Table 1 on the results of the analysis of the episodic memory development detection instrument in early childhood. In Test 1 (first) obtained KMO> 0.5 which is 0.631, then the sample adequacy requirement is met to be analyzed further. The Bartlett Test indicated a significant correlation ($p < 0.05$) between the variables, warranting further analysis. However, an anti-image correlation analysis revealed that two indicators, P24 and P25, had correlation values below 0.5. These indicators did not meet the required criteria and were therefore

excluded from further analysis. Additionally, the Communalities output showed that P11 explained less than 50% of the factor variance, suggesting it was not a strong indicator. Consequently, the researcher conducted a second analysis excluding these three indicators.

In the next Test 2, the analysis results obtained a KMO value of >0.5 of 0.660 with a Sig value of <0.5. All anti-image correlation values showed >0.5. However, in the communalities results, a P26 value of <0.5 of 0.475 was found, which means it cannot explain the factor, so Test 3 (third) was carried out without including the P26 indicator.

Test 3 results show KMO of 0.661 and sig <0.5. The anti image correlation table produces a value of >0.5 on all indicators. The communalitis output also shows a value of >0.5 so that all variables can explain the factor. The next step is to see the many factors that may be formed in the factor analysis with a sample size of 109 children. After conducting an exploratory factor analysis with the help of the IBM spss 25 application, the following is a table of the Total Variance Explained results.

Table 2. Results of Total Variance Explained Test 3

	Initial Eigenvalues		
Component	Total	% of Variance	Cumulative %
1	5.589	19.273	19.273
2	3.263	11.252	30.525
3	2.315	7.984	38.508
4	1.781	6.142	44.650
5	1.622	5.594	50.244
6	1.394	4.808	55.051
7	1.282	4.422	59.473
8	1.203	4.147	63.620
9	1.097	3.783	67.403

Table 2 shows that there are 9 components formed and can represent the number of indicators used. The 29 indicators analyzed turned out to have eigenvalues >1, meaning that the 29 indicator items can be grouped into 9 factors.

1. Factor 1 has an eigenvalue of 5.589 and can explain 19.273% variance.
2. Factor 2 has an eigenvalue of 3.263 and can explain 11.252% variance.
3. Factor 3 has an eigenvalue of 2.315 and can explain 7.984% variance.
4. Factor 4 has an eigenvalue of 1.781 and can explain 6.142% variance.
5. Factor 5 has an eigenvalue of 1.622 and can explain 5.594% variance.
6. Factor 6 has an eigenvalue of 1.394 and can explain 4.808% variance.
7. Factor 7 has an eigenvalue of 1.282 and can explain 4.808% variance.
8. Factor 8 has an eigenvalue of 1.203 and can explain 4.147% variance.
9. Factor 9 has an eigenvalue of 1.097 and can explain 3.783% variance.

To determine how many components/factors are used to explain the total diversity, it is seen from the large eigenvalue value, the component with eigenvalue >1 is the component used. Overall, the total variance results can be seen in Figure 1.

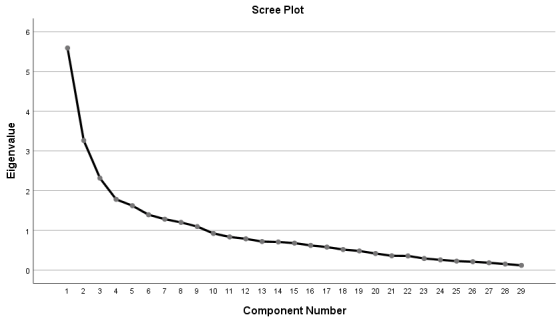

Fig. 1. Scree Plot of Eigenvalue Test 3.

Figure 1 displays a scree plot illustrating the eigenvalues of the extracted factors. Nine factors exhibited eigenvalues greater than 1, indicating their significance. The remaining factors had eigenvalues below 1, suggesting they were less important. To determine the factor loading of each item, the researcher analyzed the rotation component matrix. Factors with loadings greater than 0.3 were considered significant, and items were grouped accordingly. This analysis allowed for the identification of distinct factors and their associated items.

Table 3. Results of Rotation Component Matrix Test 3

	Component								
Items	1	2	3	4	5	6	7	8	9
P1	**.729**	.056	-.001	-.001	-.132	.037	.260	-.042	-.265
P2	**.681**	-.096	.100	-.024	.012	.076	-.106	.191	.361
P3	**.838**	.062	.142	-.112	.006	-.026	-.015	.020	.085
P4	**.868**	.001	.063	-.040	-.046	.074	-.038	-.002	.143
P5	**.667**	.206	-.134	.084	.070	.054	.047	-.087	-.092
P6	-.028	**.878**	.070	.002	.066	.083	.008	-.040	.128
P7	.205	**.763**	.221	.052	-.010	-.095	.034	-.048	.275
P8	.132	**.735**	.081	-.024	.068	.371	-.121	.200	-.031
P9	.024	**.656**	-.032	.032	.355	.162	.142	.181	-.298
P10	.105	.208	.003	-.026	.216	.088	.267	.014	**.632**
P12	.079	.019	.107	.043	.157	-.112	**.825**	-.056	.023
P13	.171	-.090	.227	.162	**.672**	-.080	.149	-.014	.263
P14	-.068	.140	.188	.080	.305	**.428**	.374	-.086	.186
P15	-.040	.206	.197	.220	.294	.042	.081	**.552**	-.207
P16	-.001	-.059	.052	.127	-.119	.297	**.726**	.274	.143
P17	.054	.207	**.568**	-.007	.357	.185	.182	.023	-.072
P18	.002	.025	**.708**	.211	-.034	.117	.001	.096	.131

P19	.078	.054	**.790**	-.015	.213	.102	.182	.025	-.075
P20	-.007	.055	.107	**.849**	-.003	-.036	.053	-.033	.074
P21	-.062	-.026	-.099	**.766**	.128	.242	-.070	-.104	-.128
P22	-.036	-.101	.180	**.593**	.151	.043	.094	.190	-.399
P23	.002	.075	.198	**.658**	.083	-.073	.140	.243	.191
P27	.033	.002	.115	-.003	.029	.055	.050	**.843**	.080
P28	.129	.172	.365	-.119	.131	**.627**	.287	.045	-.194
P29	.028	.093	**.610**	.113	-.143	.255	-.073	.182	.013
P30	.217	.095	.106	.134	.081	**.566**	-.046	.266	.306
P31	.015	.122	.290	.082	.147	**.732**	-.017	-.017	-.023
P32	-.094	.142	-.001	.107	**.785**	.209	.033	-.004	.032
P33	-.131	.200	.005	.033	**.700**	.171	-.063	.371	-.043

Based on Table 3, it can be seen that each indicator is grouped according to the factors formed. Indicators P1, P2, P3, P4, and P5 are grouped in factor 1. Indicators P6, P7, P8, and P9 are grouped in factor 2. Indicators P17, P18, P19, and P29 are grouped in factor 3. Indicators P20, P21, P22, and P23 are grouped in factor 4. Indicators P13, P32, and P33 are grouped in factor 5. P14, P28, P30, and P31 are grouped in factor 6. Indicators P12 and P16 are grouped in factor 7. Indicators P15 and P27 are grouped in factor 8. Indicator P10 forms factor 9.

Table 4. Factor Naming

Items	Indikator	Factor naming
P1	Asking whether the child has ever celebrated a birthday	Birthday event memory
P2	Asking what birthday it is when it is celebrated.	
P3	Asking where the birthday party is being held.	
P4	Asking who to celebrate a birthday party with	
P5	Ask the child to tell what happened on his/her birthday.	
P6	Asking whether the child has ever been on holiday	Vacation event memory
P7	Asking the child where they are on holiday	
P8	Asking who the child is going on holiday with	
P9	Ask your child to tell you what happened during the holidays.	
P17	Asking what is learned at school	Spatial information memory
P18	Ask your child to say where he likes to put his toys at school	
P19	Ask the child to name where he puts his bag at school.	
P29	Ask the child to name where he keeps his favorite items.	
P20	Asking the title of a book he has read	Storybook memory
P21	Asking what the book he/she is reading is about	
P22	Asking the child to retell the story book he/she has just read	
P23	Asking the child to mention where he/she likes to put his/her favorite book	
P13	Asking who he/she sits with when he/she starts school	Time-based temporal information memory
P32	Asking what the child has done during the rainy season	
P33	Asking what the child has done during the dry season	
P14	Asking what the child has felt when he/she starts school	Family-based

P28	Ask your child to name who he or she often sits next to when eating with the family.	temporal information memory
P30	Asking what day they usually do something like accompany their parents shopping or something	
P31	Asking what they usually do on Sundays	
P12	Asking who takes them to school first	School event memory
P16	Asking what activities they like to do at school	
P15	Asking their child to tell them about when they first started school	Memory of Sequence of Events
P27	Asking their child to tell them about events that have happened at home	
P10	Asking what days they go on vacation	Recurrent event temporal information memory

Conclussion

The study concludes that the instrument assessment of episodic memory impairment in early childhood consists of nine factors. (1) Birthday event memory, (2) Vacation event memory, (3) Spatial information memory, (5) Storybook memory, (5) Time-based temporal information memory, (6) Family-based temporal information memory, (7) School event memory, (8) Memory of Sequence of Events, and (9) Recurrent event temporal information memory.

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