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Employing Exploratory and Pooled-Confirmatory Factor-Analysis for the Reliability and the Validity of a Peer-Led Fun-Inspired Inquisitive Scale

Kho Chee Yuet Fanny* 

Sultan Idris Education University, Ministry of Higher Education, Malaysia

Khayri Zaid Z Alzait 

Libyan Authority for Scientific Research, Ministry of Higher Education, Libya

Abstract. This study focuses on pre-school teachers' initiative to lead their peers in fun-inspired instructions that suit the current educational ecosystem. Thus, the main purpose of this study is to determine the reliability and the validity of the newly developed Peer-Led Fun-Inspired Inquisitive (PeLFII) scale. Exploratory and confirmatory factor analyses were employed to test the scale. A total of 857 pre-school teachers from 3433 pre-schools in Malaysia completed the survey. The analysis yielded a four-factor PeLFII scale, namely, 'Leading through the Appreciation of Fun-Inspired Inquiry' (AFI), 'Leading, through Sharing Knowledge and Ideas of Fun-Inspired Inquiry' (SKI), 'Leading through Engaging and Fun-Inspired Inquiry' (EFI), and 'Leading through Short-Term Innovation Goals for Fun-Inspired Inquiry' (SIG), with a total of 25 items loaded, ranging from 0.54 to 0.87 for each item. The reliability of the Cronbach-Alpha coefficient for Factor 1 (AFI) and Factor 2 (SKI) is 0.92 respectively, 0.87 for Factor 3 (EFI), and 0.97 for Factor 4 (SIG). The findings show that the PeLFII Scale with 25 items offers a promising new measure for examining PeLFII. The results also show that it is significant to shift the paradigm from isolation to collaboration among pre-school teachers. It is also significant to mobilize the peer-leadership of fun-inspired inquisitive pedagogical strategies online or vice versa. The PeLFII model also inspired teacher-parent connection through the PeLFII Digi-Community, thereby paving the way towards Education 4.0 in Malaysia.

Keywords: exploratory-factor analysis; confirmatory-factor analysis; teacher-parent; peer-led; fun-inspired inquisitive

* Corresponding author: Kho Chee Yuet Fanny; fannykcy@fpe.upsi.edu.my

1. Introduction

Pre-school education, which is becoming increasingly vital in today's society, is extremely crucial to children's understanding and conceptualization of life. Receiving an effective and precise pre-school education in early life, when the child is developing rapidly, ensures that the child will grow up to be a successful adult. However, not many researchers placed a high value on the quality of early childhood education in pre-schools. Adding fun-inspired pedagogy into interactive lessons brings a happier and more enjoyable atmosphere for young children for years and years. It is a great way to develop curiosity and inquisitive minds among young learners. Educators, on the other hand, may innovate fun-inspired pedagogy that incorporates creative inquiries in both online and face-to-face modes of learning in all levels of academic disciplines. Likewise, creativity is essential in the innovative process of designing or conducting inspired-inquisitive lessons in distinct fun, and interactive environments that involve practicalities. The innovative processes can be brought into inquisitive minds, as within-process and cross-process skills that are needed in multiple creative-thinking skills.

Innovation in academic disciplines, on the other hand, can be kept in mind as new ideas, new alternatives, new initiatives, new means of seeing inspired inquisitive lessons, and new methods in delivering creative and interactive fun-inspired pedagogy. Consequently, the validated PeLFII scale, which aims to measure the newly developed PeLFII model, would be an eye-opener for pre-school teachers to polish their creative and innovative thinking in leading their peers in fun-inspired inquisitive pedagogy that would suit the changes of the global educational ecosystem. Creative thinking consists of generating ideas, followed by cognitive processes, which are directly linked with critical thinking that would promote individuals' potential to produce innovation (Nakano & Wechsler, 2018; Primi & Wechsler, 2018). Likewise, leadership and pedagogical technological skills are essential in the changes of the current global educational ecosystem. Nevertheless, one may still fail to perceive how creative and innovative thinking, leadership, and pedagogical technological skills are interconnected.

Teachers as educationists, for instance, need to take a second look at what they believe to be creative and innovative thinking, and how they could bring leadership and pedagogical technological skills closer together. Simply stated, teachers need to carefully identify creative and innovative thinking that does not overlook fun-inspired pedagogy. Rather, it contributes to the limitation in children's creativity and existing knowledge, which further inhibits the creativity of those who teach and lead them. Thus, this is where peer-led fun-inspired pedagogy comes into its own.

In the case of public pre-schools, the true measure of innovative engagement would largely depend on the effectiveness of blended and online-learning activities. Incorporating technology into interactive fun-inspired pedagogy is a great way to actively engage young learners in online-interactive sessions, particularly during the global pandemic situation. Teachers' technological knowledge and the quality of technological means and tools could be continued permanently in a borderless learning network for quality fun-inspired pedagogy.

The flexibility of schedules, too, enables teachers to take on shared leadership and innovative responsibilities, in order to openly share evidence-based and promising fun-inspired pedagogy (Vandavasi et al., 2020; Yuet et al., 2021) and to influence the mobilization of peer-led fun-inspired pedagogy across and beyond schools.

2. The Problem Statement

The Malaysian government, as also the rest of the world, is significantly aware of the importance of the paradigm shift towards Education 4.0, as a result of the imbalance of the education ecosystem globally. In a nutshell, the pre-school curriculum has switched to digital classrooms that underlie the basis of inspiring inquiry and peer leadership in Education 4.0 (Drosos et al., 2021; Verganti, 2020). It provides advantages for pre-school teachers to collaborate and lead each other in designing fun-inspired activities that might also require parents' involvement (Gerekli et al., 2021).

Parents' involvement that demands hands-on activities would pique young learners' attention and stimulate their curiosity, while allowing them to enjoyably explore creative and innovative ideas that should enhance their imagination and their inquisitive minds (Rudenko et al., 2021). The lack of consensus on the quality of the pre-school environment and pre-school leaders' pedagogical knowledge and their skills limits their competence to influence fun-inspired pedagogy among their peers (Supovitz, 2017).

Pre-school teachers may be unaware of how fun-inspired pedagogy can be improved, in order to determine which skills stifle creativity and, as a result, limit their innovative teaching and creative learning that would enable learners to apply their imagination to generating ideas, particularly in the basic science-process skills. It is also indisputable that not all pre-school teachers are capable of equipping themselves and leading peers in fun-inspired pedagogy, both in blended and online interactions.

The data obtained from the semi-structured interviews conducted with three pre-school personnel from the Perak State Education Department, Selangor State Education Department, and Sarawak State Education Department, as well as two personnel from the Curriculum-Development Centre, the Ministry of Education Malaysia, and the School of Inspectorate and Quality Assurance, Ministry of Education Malaysia, revealed that basic science-process concepts and skills were rarely revealed to young learners at the age of four to six years old in many pre-school classrooms in Malaysia (Ministry of Education Malaysia [MOE], 2019).

Most pre-school teachers from distinct pre-schools conduct similar nature-related activities, which comprise collecting dry leaves in the school compound, drawing and coloring the leaves (Dogan & Simsar, 2018). Young learners only observe their environment without developing their curiosity about the different colors, sizes, and textures of the leaves. Opportunities for young learners to ask questions and talk about the leaves were rarely offered. This might be because pre-school teachers, who always perform as 'lone rangers', had limited ideas to perform

effective and enjoyable observational activities. Consequently, pre-school teachers should work with their peers, in order to construct various fun-inspired activities that would inspire learners to improve their creative thinking.

Another common activity conducted was merely asking young learners to plant some seeds in various pots – and then placing them outside and inside the classrooms. The knowledge of the need to place the pots at the accurate spot where they could get direct sunlight was rarely defined. Instead, young learners were given the task to observe and measure the plants every day, without providing any opportunity for learners' 'voices' and flexibility, or for them to share their observations with their peers in the classrooms (Gratacós et al., 2021). Similarly, there was a limited opportunity for allowing young learners to speak their mind in the learning process.

Pre-school teachers, on the other hand, should create a learning environment that attracts and engages young learners. They should also place great emphasis on the inspirational value that requires every teacher and young learner to look at the school, as their second home, in order to feel safe and to spend most of their leisure time in school. Once, young learners feel safe to express their creativity, their minds are then fully and consistently engaged. At times, pre-school teachers should work with their peers and lead each other in fun-inspired pedagogical practices and provide young learners with the knowledge and skills, which they need to acquire for their future (Cahapay, 2020; DeJesus et al., 2020). The proposed Peer-Led Fun-Inspired Inquiry [PeLFII] Model in the current study, was developed to enhance peer leaders' leadership competencies in leading peer teachers to conduct various fun-inspired pedagogical activities, particularly in teaching basic science-process skills through: i) the appreciation of fun-inspired inquiry; ii) sharing knowledge and ideas of fun-inspired inquiry; iii) engaging and fun-inspired inquiry, and setting short-term innovation goals for fun-inspired inquiry.

3. An Empirical Review of the Peer-Led Fun-Inspired Inquisitive Model

The PeLFII model was developed to enhance peer leaders' major role in guiding peers for improved fun-inspired pedagogy. The PeLFII model serves as an essential initiative in guiding peer leaders in leading their peers to mobilize fun-inspired pedagogy in the new horizon (Harris et al., 2021). In other words, the PeLFII model was developed with the initiative to connect pre-school teachers in the 'PeLFII Digi-Community' [PeLFIIDCy], in order to enable them to lead each other in designing and implementing various fun-inspired inquiries in virtual classrooms, which are also flexible and adaptable in blended-learning environments. Similarly, pre-school teachers may also invite parents to join the PeLFIIDCy, and to contribute their creative ideas on how they could help enhance their children's learning at home, particularly in acquiring the basic-science concepts and skills.

To elaborate, the PeLFII model provides an opportunity for pre-school peer leaders to lead their peers in effective fun-inspired pedagogy, in order to enrich the learning environment with accessible recycled and natural resources to better

tune in to the learner's interests and to build up the learning process based on one's learning needs. Therefore, they should engage in the PeLFIIDCy and offer tasks and activities, which would allow young learners to explore and experiment with multiple ways of solving a problem, to ask their questions, as well as to answer their teachers, discover relationships, patterns, and make connections that are new to them, and conjecture about the results of making changes. Hence, with advances in contemporary trends' innovation, thus, the development of the PeLFII model remains crucial for pedagogical improvement (Andrews, 2019).

Pre-school peer leaders, also, should put in effort and commitment to guide their peer teachers to present to the parents the suggestion that fun-inspired pedagogy could make a significant difference. The presentation could highlight the need to allow young learners to step out of the classrooms and be with other learners in groups in any learning space provided. The parents were informed that when their children work outside the classroom, this does not mean that the teacher has lost control. In contrast, parents are welcome to become themselves involved in their children's work. They may apply their creativity and art skills to design ways that could stimulate learners to learn. Parents' involvement could have a tremendous impact on youngsters' learning. It would also assist pre-school teachers, in laying the framework for innovative thinking. Innovative pre-school peer leaders, therefore, could inspire their peers to accept new ideas for adopting digitalized pedagogical communities that are appropriate for the contemporary global epidemic. The influence of the aforesaid elements led to the establishment of the PeLFII model.

The PeLFII model would also provide an opportunity for peer leaders to lead their peers to incorporate a few lessons, which focus on a single topic to a range of subjects that would help young learners to be physically and mentally, immersed in the topics taught. For instance, if the topic taught was on "bees", pre-school teachers could use music, cartoons, folktales, as well as experiments; and they could thread these, together with basic science, mathematics, and a bit of art on the "characteristics of bees". Consequently, the transition of conventional to contemporary pedagogy towards inspiring child-friendly learning environments needs to become acceptable in Malaysian pre-schools.

4. The Development of the Peer-Led Fun-Inspired Inquisitive Model

The PeLFII model was developed on the basis of Dobni's innovation theory (Dobni, 2008), Piaget's cognitive constructivism theory (Piaget, 1973), Vygotsky's social constructivism theory (Vygotsky, 1978), as well as an empirical review of an inquisitive framework and four pedagogical coaching models, and the integration of peer-leadership skills. The framework and the four models include: the Community of Inquiry Framework (Garrison et al., 2000); the Model of Instructional Coaching (Knight, 2004); the Community of a Practice Model (Bonk et al., 2004); the Model of Knowledge-Sharing (Ho et al., 2006); and the Model of Appreciative Inquiry (Cooperrider, & Whitney, 2001) respectively.

Garrison et al. (2000) revealed that the Community-of-Inquiry Framework has been the primary model for creative-inquiry development. They also revealed

that the Community-of-Inquiry Framework was developed as a tool for fostering and sustaining inspirational pedagogy, which can be blended with the current pandemic scenarios. It has been a highly influential paradigm that has served as the foundation for a variety of new pedagogical frameworks and models. In essence, the Community-of-Inquiry Framework serves as a leading model for the development of the PeLFII model, which are based on the various Malaysian educational settings.

Knight (2004), contrarily, has created an evidence-based collaborative-pedagogical-coaching program for pre-school teachers that serves as a significant added value of peer-leadership competency for effective fun-inspired practices. Other researchers, have also highlighted fun-inspired pedagogy; it has always been blended with the incorporation of innovative, constructive, collaborative teaching, group work, and accessibility (Hypponen et al., 2019; Murtenon et al., 2019). However, Mazur, et al. (2019) innovative, constructive, and inquiry-based pedagogy require value-added leadership, collaborative teaching, group work, and accessibility. Kurt (2017), too claimed that the effectiveness of inquiry-based pedagogy is enhanced through the incorporation of the Flipped-Classroom approach.

The Flipped-Classroom approach allows pre-school teachers to share their fun-inspired pedagogical experiences with their peers (Tomas et al., 2019; Gratacós et al., 2021). This notion has been highlighted in the Knowledge-Sharing Model (Ho et al., 2006). This model provides valuable insight into the accomplishment of pedagogical goals. Lastly the study's most important model, the Cooperrider-Whitney Model of Appreciative Inquiry (Cooperrider & Whitney, 2001) contributes significantly to the understanding of fun-inspired inquisitive practices.

As previously stated, the development of the PeLFII model was a multi-layered process. Each process necessitates innovative peer-leadership competencies in engaging pre-school peer leaders with their peer teachers in a variety of crucial roles, resulting in improving innovative, inquisitive fun-inspired pedagogy. In a nutshell, the researcher's initial purpose for determining the validity and the reliability of the PeLFII Scale was to identify the essential dimensions of the newly developed model (Kho, 2020; Yuet et al., 2021).

In sum, the offered concepts for producing peer-led fun-inspired pedagogy were based on an empirical review of the four models, respectively. Despite the models, there are sites of contact between them. In practice, all the identified areas of abilities, from identification through the evaluation of peer-led fun-inspired pedagogy, were expressed. Hence, four key dimensions have been proposed: i) 'Leading through the Appreciation of Fun-Inspired Inquiry', ii) 'Leading through Sharing Knowledge and the Ideas of Fun-Inspired Inquiry', iii) 'Leading through Engaging and Fun-Inspired Inquiry', and iv) 'Leading through Short-Term Innovation Goals for Fun-Inspired Inquiry'. The first dimension of the PeLFII model, which was highlighted as 'Leading through the Appreciation of Fun-Inspired Inquiry' (AFI) dimension was composed on the basis of the first phase of

the 4-D cycle (Discovery) in the Model of Appreciative Inquiry (Cooperrider & Whitney, 2001). The second and third basic dimensions in the Model of Instructional Coaching, the Community-of-Inquiry Framework, and the Community-of-Practice Model, also contributed to the development of the AFI dimension, respectively. AFI emphasized the importance of valuing creative and innovative ideas, while designing fun-inspired pedagogy for learning new concepts and abilities, such as early science-process concepts and skills, while having fun. Pre-school peer leaders, on the other hand, could guide their peer teachers in an effective approach to engage young learners in digital learning, which is growing in popularity (Hyypiä et al., 2019). The ability and flexibility of using digital technologies as an integral part of social interactions between a pre-school teacher and a young learner, as well as learner-to-learner via a virtual fun-learning environment, enhance personalized learning (OECD, 2016).

Personalized learning could be further enhanced through the second composed dimension of the PeLFII model, the 'Leading-through-Sharing Knowledge and Ideas of Fun-Inspired Inquiry' (SKI). SKI was composed on the basis of the Knowledge-Sharing and Community-of-Practice Model through its third dimension, 'Sharing places for idea negotiation.' It also demonstrates the importance of being open-minded, collaborative problem-solving, and knowledge-building in the cross-boundary PeLFIIDCy, which involves teacher-parent collaboration from school-based to home-based fun-inspired pedagogical platforms. Actually, teachers could share effective multi-focused and authentic fun-inspired pedagogy with the parents and vice versa, in order to boost young learners' creativity in the process of acquiring new skills, such as collaborative problem-solving skills in cross-boundary blended and online-fun learning (Mehtaa et al., 2014; Vuojärvi et al., 2019).

Garrison et al. (2000), suggested that problem-solving skills could be enhanced through deep thinking and collective reflection, collaboration with various stakeholders, and learning to use digital technology in meaningful ways. These ideas are also supported by Vuojärvi et al. (2019), which is highlighted in the third dimension of the PeLFII model. The third dimension, 'Leading through Engaging and Fun-Inspired Inquiry' (EFI) promotes pre-school peer leaders' competence in conceiving effective reflection on those activities conducted for young learners at the age of six years old – either via blended learning, or by virtual interactions. The concern was to reflect on the effectiveness of the fun-inspired pedagogy in giving exposure for young learners to learning new scientific concepts and skills. It was also concerned with pre-school peer leaders' competence in sharing the output of their observation with their peers and parents via the PeLFIIDCy platform.

Peer teachers are also encouraged to share their collective reflections on fun-inspired inquiry activities in enhancing young learners' learning (Gratacós, et al., 2021), which in turn, focuses on peer-to-peer leadership for learning. Peer-to-peer leadership is also integrated into the fourth dimension of the PeLFII model, 'Leading through Short-Term Innovation Goals for Fun-Inspired Inquiry' (SIG). It describes the factors that influence peer leadership, the possible influence on

peer leadership in pedagogical improvement, a typology of roles that peer leadership performs, and how they might perform them (Nobile, 2017). SIG was constructed on the basis of the second phase of the 4-D cycle, which is known as 'Dream' in the Model of Appreciative Inquiry (Cooperrider & Whitney, 2001).

In a nutshell, SIG provides an opportunity for peer leaders to stay connected with their peers and parents via the PeLFIIDCy platform within a short period, for achieving short-term fun-innovation visions in the new horizon. Hence, the purpose of this study is to determine the validity and the reliability of the PeLFII Scale (Appendix 1) in Malaysian pre-schools. Exploratory-factor analysis is employed to produce the most reliable items to measure each factor in the PeLFII model. The factors were later confirmed through pooled confirmatory-factor analysis. The major concern of the study was to develop an empirically verified PeLFII model, and secondly, to develop and validate the PeLFII Scale (Appendix 1) The specific research question (RQ) and the research hypothesis (RH) was to measure these phenomena. These are:

RQ1. Is the Peer-Led Fun-Inspired Inquisitive Model construct-valid?

RH1. The Peer-Led Fun-Inspired Inquisitive Model can be described by the following four factors:

i) Leading through the Appreciation of Fun-Inspired Inquiry' (AFI), ii) 'Leading through Sharing Knowledge and the Ideas of Fun-Inspired Inquiry' (SKI), iii) 'Leading through Engaging and Fun-Inspired Inquiry' (EFI), and iv) 'Leading through Short-Term Innovation Goals for Fun-Inspired Inquiry' (SIG).

5. The Methodology

5.1 Population and Sampling Procedures

The population for this study consisted of 9,685 (N = 9,685) trained pre-school teachers from 2,165 pre-schools (MOE, 2021). Likewise, pre-school teachers were the unit of analysis for the current study. They play an essential role in expressing their sincere views on the effectiveness of the proposed PeLFII model in the new horizon. A multiple-staged stratified random-sampling procedure was employed in this study, due to its highly recommended efficiency. Notably, it is the most efficient technique compared to other sampling procedures.

The desirable feature of multi-stage stratified random sampling is that each essential component of the population is represented in the sample. It raises the possibility of representation and the probability for sample bias; and it offers the likelihood of greater precision. Essentially, there were three strata in the study population: Perak State Public Pre-schools [PeSPP], Selangor State Public Pre-schools [S-eSPP], and Sarawak State Public Pre-schools [SaSPP]. Among 3433 public pre-schools in Malaysia, there were 876 in PeSPP, 1059 in SeSPP, and 1498 in SaSPP. Similarly, a proportional stratification procedure was employed to stratify the concerned schools, in order to ensure that schools in each stratum were proportional to the total number of schools in the relevant stratum of the total population. Thus, the researcher had assigned 25 per cent of each stratum for the study.

Table 1: Number of public pre-schools involved in the final survey

Public Pre-school	Number of Pre-schools	Number of Pre-schools for Survey
PeSPP	876	219
SeSPP	1059	264
SaSPP	1498	374
Total	3433	857

Subsequently, a purposive-sampling procedure was employed. Each pre-school was represented by a pre-school teacher respectively. Likewise, 219 pre-school teachers from PeSPP, 264 from SeSPP, and 374 from SaSPP, with a total number of 857 respondents, were identified for the survey. The total number of 857 public pre-school teachers was also sufficient to perform confirmatory-factor analysis for the newly developed measurement model (Hair et al., 2019).

5.2 Pre-Testing the PeLFII Scale

The newly designed PeLFII Scale had undergone five distinct pre-test approaches to minimize any measurement error or bias before the final administration. Pre-testing approaches would also provide the foundation for instrument reliability and validity (Ikart, 2019). It also reflects theoretical model development by the participants. First, the PeLFII Scale was distributed to six experts from several institutions for content validity. The experts were from the Early Childhood Education Unit, the Curriculum Development Centre and the School of Inspectorate and Quality Assurance, the Ministry of Education Malaysia, and the National Child Development Research Centre, and the Sultan Idris Education University, Malaysia. All the experts agreed on the 34 items that determine the pre-school teachers' peer leadership competence in mobilizing the fun-inspired pedagogy towards Education 4.0. This approach is crucial; since the items were self-developed on the basis of five distinct models. Next, the PeLFII Scale was further validated for face validity by two experts from the Language Department, Faculty of Language and Communication, Sultan Idris Education University, and the Institute of Teacher Education Malaysia. Experts had commented on the ambiguous terms utilized in the instrument. Validation for the PeLFII Scale dimensions was also required.

Furthermore, the PeLFII Scale was validated by the eight experts from School Improvement in respective state education departments for item-clarity evaluation based on a scale from 1 to 10. The item-clarity procedure is crucial to assess the validity of each newly developed item, and to ensure that the items could measure the desired dimensions. The average score of the construct (9.47) (Table 2), confirmed the validity and the reliability of the PeLFII Scale for assessing Malaysian pre-school teachers' leadership accountability in leading peers on creative and innovative fun-inspired pedagogy that suits the 21st century learning towards Education 4.0.

Finally, the PeLFII Scale was distributed to 20 respondents, in order to check on the format, syntax, or design, as well as the length of time allocated for the respondents to provide genuine responses. The input from the respondents reveals that the PeLFII Scale is a reliable instrument to measure pre-school peer

leaders' leadership competence in leading their peer teachers to mobilize fun-inspired pedagogical practices, while empowering peer teachers, parents, and young children to lead.

Table 2: Item clarity average scores of the PeLFII Scale construct and dimension

Construct	Dimension	Average Score of the Dimension	Average Score of the Construct
Peer-Led Fun-Inspired Inquisitive Scale	Leading through Appreciation of Fun-Inspired Inquiry	9.52	
	Leading through Sharing Knowledge and Ideas of Fun-Inspired Inquiry	9.42	
	Leading through Engaging and Fun-Inspired Inquiry	9.60	
	Leading through Short-Term Innovation Goals for Fun-Inspired Inquiry	9.33	
Total Average Score			9.47

5.3 The Pilot-Study Process

5.3.1 The Cronbach Alpha-Reliability Estimate

The PeLFII Scale (Appendix 1) was subjected to a pilot-field test, in order to assess the internal consistency for all 34 items. The ideal value for this study's threshold was set at 0.75. The items for the PeLFII Scale were measured on the basis of each construct. The PeLFII scale is a valid instrument with a Cronbach's alpha of 0.87 for the 34 items and 0.86 to 0.96 for all the four dimensions (AFI, EFI, SKI, and SIG), and more than 0.7 for the item scale of all the PeLFII items. As a whole, the Cronbach alpha value obtained indicates that the PeLFII Scale has a high level of internal consistency.

5.3.2 Exploratory-Factor Analysis on the PeLFII Scale

The assessment of construct validity for the newly developed PeLFII model in the study has undergone the exploratory-factor analysis process; since this is crucial for self-developed instruments. The data gathered from a sample of 145 pre-school teachers was sufficient to perform an exploratory-factor analysis based on the commonality cut-off value (>0.5) (Hair et al., 2019). The Kaiser-Meyer-Olkin (KMO) test indicated that the study's sampling was adequate, with a value of 0.94. The correlation matrix output ($p < 0.05$) demonstrated that the PeLFII Scale was fit for exploratory-factor analysis (Table 2); and it was employed for bi-purposes. Firstly, it aimed to plot the proposed items into four dimensions. Secondly, each item was loaded onto each dimension by using the principal-components analysis (PCA), which is less challenging than the factor analysis (Hair et al., 2019). Data cleaning will be employed before PCA, in order to remove any severely skewed variables. Four dimensions were successfully loaded, ranging from 0.54 to 0.87. Six items (AF2, AF3, AF4, AF5, AF6, and AF8) were loaded onto Factor 1 [Dimension 1: Leading through the Appreciation of Fun-Inspired Inquiry (AFI)].

Items AF1 and AF7 were deleted, as being the items cross-loaded with Factor 2. Four items (FL2, FL3, FL5, and FL8) were loaded onto Factor 1 [Dimension 1: *Leading through the Appreciation of Fun-Inspired Inquiry (AFI)*] after being plotted onto Factor 2 [Dimension 2: *Leading through Sharing Knowledge and Ideas of Inspired Inquiry (SKI)*]. Item FL1 was deleted; since it was loaded onto more than 1 factor.

Three items (FL4, FL6, and FL7) were also deleted due to zero loading. In contrast, EFA allows all the nine items (KI1, KI2, KI3, KI4, KI5, KI6, KI7, KI8, and KI9) to be loaded onto its initial Factor 2 (SKI). Items FL9, FL10, and FL11, which were originally plotted onto Factor 2, were loaded onto Factor 3 (EFI). Another five items (IG1, IG2, IG3, IG4, and IG5) were loaded onto Factor 4 (SIG). In sum, exploratory-factor analysis had significantly extracted 27 out of 34 items highlighted in the PeLFII Scale. All the 27 items were loaded greater than 0.5, as shown in Table 2. This implies that the variation across and within these factors is significant.

Table 2: Exploratory-factor analysis output of the PeLFII construct

Item	Factor 1	Factor 2	Factor 3	Factor 4
AFI2	0.66			
AFI3	0.75			
AFI4	0.81			
AFI5	0.77			
AFI6	0.54			
AFI8	0.78			
EFI2	0.67			
EFI3	0.70			
EFI5	0.61			
EFI8	0.61			
SKI1		0.67		
SKI2		0.62		
SKI4		0.66		
SKI5		0.74		
SKI6		0.76		
SKI7		0.71		
SKI8		0.82		
SKI9		0.73		
EFI9			0.65	
EFI10			0.68	
EFI11			0.74	
SIG1				0.86
SIG2				0.87
SIG3				0.71
SIG4				0.85
SIG5				0.84
Eigenvalues	6.04	5.64	2.44	2.12
KMO	0.94			
Barlett's test of sphericity*	*4000.39			
dfTotal of Variance explained	561			
	24.17			

* $p < 0.0$

5.3.3 Pooled-Confirmatory Factor Analysis on the PeLFII Scale

In general, first-order confirmatory-factor analysis (CFA) yields the presence of four latent variables. The variables were computed as Factor 1 (AFI), Factor 2 (SKI), Factor 3 (EFI), and Factor 4 (SIG). Factor 1 (AFI) was measured by ten observable variables, nine observable variables for Factor 2 (SKI), three observable variables for Factor 3 (EFI), and five observable variables for Factor 4 (SIG). The observable variables were measured on the basis of the rule-of-thumb of at least three indicators for each factor (Hair et al., 2019); and the threshold value of more than 0.5 (>0.50) for the newly developed items (Hair et al., 2019). Likewise, an item (AFI10) with factor loading 0.48 was deleted during the first-order analysis; since it does not meet the basic requirement of the newly developed item. To ensure compliance with the model fitting in SEM, the PeLFII Scale (Appendix 1) was further measured by using a second-order measurement model. The second-order measurement model is one of the phases in SEM, which is widely used to test the reliability of the newly developed model in a step-wise manner. It starts with exploratory-factor analysis (EFA); and it subsequently moves towards a confirmatory-factor analysis (CFA), highlighting the best practices, while using structural-equation analysis. Consequently, an item (SIG1) with factor loading 0.45, which was lower than the threshold value of more than 0.5 ($>.5$) (Hair et. al, 2019), was deleted during the final stage of the second-order measurement model (Figure 1). Three categories of fit indices were utilized to assess the construct validity of the PeLFII Scale. The categories of the fit indices included: i) absolute fit indices; ii) incremental fit indices; and iii) parsimonious fit indices. The absolute fit indices (RMSEA = 0.056), the incremental fit indices (CFI = 0.958), and the parsimonious fit indices (Chisq/df = 2.999) have surpassed the required level for the fitness indices for the new measurement model, thereby indicating that the PeLFII Scale is valid.

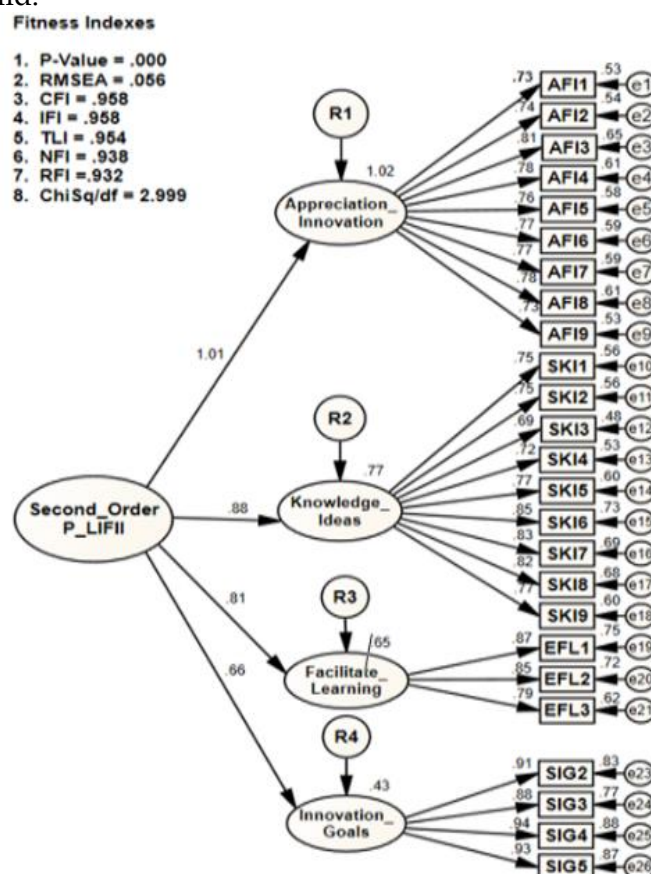


Figure 1: The Second-Order CFA for the PeLFII construct

5.3.4 Convergent Validity and Composite Reliability Estimate

The individual item loadings displayed in Table 3 were significant as all of the items loaded above 0.50 (Hair et al., 2019), ranged from 0.69 to 0.94. The critical ratios of the estimates fall beyond the ± 1.96 z-value range, and the p-value was below 0.05, as depicted in Table 4, thereby, providing initial evidence of convergent validity (Hair et al., 2019). The average variance extracted (AVE) exceeded the threshold value of 0.50 (Owolabi et al., 2020), and 0.60 for the composite reliability (CR) (Hair et al., 2019), supporting the composite reliability of the PeLFII model (Table 3). In short, the PeLFII model represents the true score of the population.

Table 3: The CFA results for the PeLFII construct

Construct	Dimension / Item	Factor Loading	CR (> .6)	AVE (> .5)
Peer-Led Fun Inspired Inquisitive Scale	Leading through Appreciation of Fun Inspired Inquiry	1.01	0.93	0.58
	Leading through Sharing Knowledge and Ideas of Fun Inspired Inquiry	0.88		
	Leading through Engaging and Fun Inspired Inquiry	0.81		
	Leading through Short-Term Innovation Goals for Fun Inspired Inquiry	0.66		
Leading through Appreciation of Fun Inspired Inquiry	AFI1	0.73	0.93	0.60
	AFI2	0.74		
	AFI3	0.81		
	AFI4	0.78		
	AFI5	0.76		
	AFI6	0.77		
	AFI7	0.77		
	AFI8	0.78		
	AFI9	0.73		
Leading through Sharing Knowledge and Ideas of Fun Inspired Inquiry	SKI1	0.75	0.93	0.60
	SKI2	0.75		
	SKI3	0.69		
	SKI4	0.72		
	SKI5	0.77		
	SKI6	0.85		
	SKI7	0.83		
	SKI8	0.82		
	SKI9	0.77		
Leading through Engaging and Fun Inspired Inquiry	EFI1	0.87	0.88	0.70
	EFI2	0.85		
	EFI3	0.79		

Leading through Short-Term Innovation Goals for Fun Inspired Inquiry	SIG2	0.91	0.95	0.84
	SIG3	0.88		
	SIG4	0.94		
	SIG5	0.93		

CR=Composite Reliability; AVE=Average Variance Extracted

Table 4. The Summarized Assessments of Convergent Validity for the PeLFII Scale

Construct	Item	Critical Ratio	Unstandardized Factor Loadings	SMC	CR	AVE	Final Decision
Leading through Appreciation of Fun Inspired Inquiry	AFI1	√	√	√	√	√	Retained
	AFI2	√	√	√			
	AFI3	√	√	√			
	AFI4	√	√	√			
	AFI5	√	√	√			
	AFI6	√	√	√			
	AFI7	√	√	√			
	AFI8	√	√	√			
	AFI9	√	√	√			
Leading through Sharing Knowledge and Ideas of Fun-Inspired Inquiry	SKI1	√	√	√	√	√	Retained
	SKI2	√	√	√			
	SKI3	√	√	√			
	SKI4	√	√	√			
	SKI5	√	√	√			
	SKI6	√	√	√			
	SKI7	√	√	√			
	SKI8	√	√	√			
	SKI9	√	√	√			
Leading through Engaging and Fun Inspired Inquiry	EFI1	√	√	√	√	√	Retained
	EFI2	√	√	√			
	EFI3	√	√	√			
Leading through Short-Term Innovation Goals for Fun Inspired Inquiry	SIG2	√	√	√	√	√	Retained
	SIG3	√	√	√			
	SIG4	√	√	√			
	SIG5	√	√	√			

SMC=Squared Multiple Correlations; CR=Composite Reliability
AVE=Average Variance Extracted

6. The Results

The findings for the first dimension of the PeLFII model - 'Leading through Appreciation of Fun-Inspired Inquiry' (AFI) were similar to those of the Appreciative-Inquiry Model (Cooperrider & Whitney, 2001), Model of

Instructional Coaching (Knight, 2004), Community-of-Inquiry Framework (Garrison et al., 2000), and Community-of-Practice Model (Bonk et al., 2004). This conveyed a similar message about the importance of respecting and appreciating others' efforts in bringing fun-inspired inquiry into the learning of basic science-process concepts through blended or online interactions, which would indirectly enhance peer-leadership competency and commitment.

The pre-school peer leaders should continually show their appreciation to their peers' efforts in conducting fun-inspired inquisitive activities that are blended with the current epidemic circumstances (Heng & Sol, 2020). Peer leaders should also encourage their peers to collaborate with parents and peer teachers through cross-boundary digitalized collaboration, such as the PeLFIIDCy (Graafland, 2018). The cross-boundary collaborative effort is believed to promote creative education; and, as a result, to integrate the needs of the 4th Industrial Revolution in Malaysian pre-schools (Jemimah & Suziyani, 2019). The second dimension of the PeLFII model - '*Leading through Sharing Knowledge and Ideas of Fun-Inspired Inquiry*' - was then explicitly linked to the third dimension of the Model of Knowledge Sharing - 'Functions of ICT Platforms in Knowledge Sharing' and the third dimension of the Community-of-Practice Model - 'Sharing spaces for idea negotiation'. Similarly, this dimension highlighted the importance of polishing imaginative and creative thinking skills, knowledge, and values, while leading and engaging peers' teachers to plan and conduct fun-inspired inquiry activities effectively in integrated subjects, such as science, mathematics, and arts.

Likewise, the third dimension of the PeLFII Model - '*Leading through Engaging and Fun-Inspired Inquiry*,' corresponded to the Community of Inquiry Framework's, the third phase, 'Integration' (Garrison et al., 2000). This dimension urges pre-school teachers to engage with the pre-school community, parents, and young learners in planning and in the implementation of various fun-inspired inquiry activities effectively through blended and online interactions. Hence, pre-school teachers may brainstorm ideas with their peers, parents, and school communities on various fun-inspired pedagogical strategies that are more flexible and engaging from school to home-based learning.

Finally, '*Leading through Short-Term Innovation Goals for Fun-Inspired Inquiry*' was revealed as the fourth dimension in the PeLFII model. The outcome was in line with 'Discovery', the first phase in the Appreciative-Inquiry Model, 'Discovery' (Cooperrider & Whitney, 2001). Although '*Leading through Short-Term Innovation Goals for Fun-Inspired Inquiry*' was the least dominant factor, it was allied with '*Leading through the Appreciation of Fun-Inspired Inquiry*', '*Leading through Sharing Knowledge and Ideas of Fun-Inspired Inquiry*'. In contrast, '*Leading through Engaging and Fun-Inspired Inquiry*' was the most dominant factor (Figure 1).

'Leading through Short-Term Innovation Goals for Fun-Inspired Inquiry' for peer leaders had been recognized in the first phase of the 4-D cycle in the 'Appreciative-Inquiry Model. Peer leaders would need to take the first move of sharing their views, feelings, and experiences before their effort in leading pre-

school peer teachers, particularly novice pre-school teachers in planning and conducting fun-inspired pedagogical practices (Namysova et al., 2019). Peer teachers, too, should consistently be informative and accountable; as they provide an opportunity for young learners to enjoyably share their 'voice' through blended or online interactions. Incorporating the learners' 'voices' would contribute to their performance and empower them to lead (Banner et al., 2019).

7. Conclusion

In particular, the study had highlighted the novelty in the development of the PeLFII model, based on the combination of instructional-coaching models and inquiry framework, as well as the integration of peer-leadership skills. PeLFII is the first model to be practically and theoretically examined, in order to better understand pre-school teachers' peer leadership competencies in mobilizing fun-inspired pedagogy, based on local educational context. The underpinning theories contribute to the body of knowledge on teachers' peer leadership in leading peers on fun-inspired pedagogical practices and a framework for further investigations. It also yields teacher-parent collaboration in any context of learners' learning. Schools, teachers, and policymakers can adopt one or more of these fun-inspired strategies to ensure that schools reflect the interests and needs of the school community they serve.

It should also aid scholarly knowledge and provide a new perspective in a pre-school curriculum that focussed on Higher-Order Thinking Skills (HOTS) for problem-solving, the incorporation of students' voices, and the innovation values towards Education 4.0.

8. Limitation and Recommendations for Future Work

There is one major drawback to the generalizability of the PeLFII scale. Although the PeLFII scale's psychometric qualities were pilot-tested and found to be satisfactory, the data were collected from a small number of public pre-schools; therefore no demographic influence could be determined. As a result, future studies will require more thorough samples. A more comprehensive and systematic research approach, such as that of the Design and Development Research (DDR) could be employed to develop innovative, fun, and inspiring research instruments. Secondly, future research could involve more thorough samples from the private kindergartens, in order to determine robust demographic effects; since the research samples of this study involved only public pre-school teachers.

Thirdly, a follow-up study could focus on individual elements that influence creativity in leading peers on innovative fun-inspired activities that suit the education ecosystem in the new normal. Fourthly, future research could focus on those factors that polish imagination and creativity in teaching science-process skills in early childhood classrooms. Last but not least, the newly developed PeLFII Scale could be validated with lower primary school teachers for content and construct validity.

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Appendix 1: *Peer-Led Fun-Inspired Inquisitive Scale*

As a peer leader, please circle your response in the box provided based on the following scale:

STRONGLY DISAGREE	DISAGREE	AGREE	STRONGLY AGREE	
1	2	3	4	
1. I value peers' innovative ideas in performing new fun-inspired inquiry pedagogy.	1	2	3	4
2. I appreciate peers' effort in determining the effectiveness of fun-inspired inquisitive pedagogy periodically.				
3. I value peers' efforts in performing fun-inspired inquisitive pedagogy in teaching basic science concepts.	1	2	3	4
4. I appreciate peers' attempt in practicing effective fun-inspired inquisitive pedagogy.	1	2	3	4
5. I value pedagogical development programs in sustaining peers' fun-inspired inquisitive inquiry pedagogical skills.	1	2	3	4
6. I appreciate peers' effort in collaborating with other peers for fun-inspired inquisitive pedagogy.	1	2	3	4
7. I value peers' fun-inspired inquisitive pedagogical ideas.	1	2	3	4
8. I appreciate peers' effort in integrating the narrative approach into fun-inspired inquisitive pedagogy.	1	2	3	4
9. I value peers' effort in practicing pair-reflection with parents on home-based fun-inspired experiments.	1	2	3	4
10. I encourage peers to share fun-inspired inquisitive pedagogy with peer teachers within the schools.	1	2	3	4
11. I share a fun-communicative approach with peers.	1	2	3	4
12. I encourage peers to exchange ideas on fun-inspired inquisitive pedagogical strategies with parents.	1	2	3	4
13. I facilitate the dissemination of fun-inspired inquisitive activities with peers.	1	2	3	4
14. I encourage peers to attend cross-boundary meetings with other teachers from other sub-units to discuss fun-inspired inquisitive pedagogy.	1	2	3	4
15. I share inspiring ideas on fun-inspired inquisitive strategies with peers.	1	2	3	4
16. I guide peers to transform various sources into fun-inspired pedagogical materials.	1	2	3	4
17. I guide peers on techniques to search for fun-inspired inquisitive pedagogy in the database.	1	2	3	4
18. I guide peers to implement various digital-educational technologies for fun-inspired inquisitive pedagogy.	1	2	3	4
19. I talk openly via Innovative Digi-Community on steps to conduct fun-inspired inquisitive pedagogy in learning basic science process concepts.	1	2	3	4
20. I invite peers to contribute ideas on new ways of teaching.	1	2	3	4
21. I engage peers in exchanging fun-inspired ideas via an Innovative Digi-Community.	1	2	3	4
22. I set innovation goals for peers to practice online fun-inspired inquisitive pedagogy daily.	1	2	3	4
23. I set a schedule for peers to review young learners' fun-inspired inquisitive projects at least once a week.	1	2	3	4
24. I set monthly innovation goals for peers to initiate fun-inspired pedagogy.	1	2	3	4
25. I collaborate with parents to set fun-inspired goals fortnightly.	1	2	3	4