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Abstract:

The purpose of this study was to examine the effect of augmented reality based- cards on developing vocabulary knowledge and retention among the pre-primary stage students. To achieve this goal, a one-group pre-test, and post-test design was used. A multi-dimensional test was designed for examining the main aspects of vocabulary knowledge. The study sample consisted of ٣٠ pre-school children aged between 5-6. Firstly, a vocabulary test consisting of four sections was conducted as a pre-test to determine the students' prior level. Then, the participants were taught ٣٠ words categorized into two types: animal- related words and everyday-related words. After the implementation which depended on using object-modeling augmented reality cards, the effect was examined by re-administering the instrument as a post-test. Statistical analysis was conducted and results were concluded. After a three-weeks interval, the researcher re- administered the test to the study group for gauging retention. The results showed that the majority of the students' scores significantly increased in the post-test as compared to the pre-test. The retention test showed that the majority of students still remembered most of the target vocabulary indicating that the intervention could achieve a positive impact in terms of developing vocabulary knowledge and vocabulary retention. Qualitative results indicated that most of the participants liked AR materials in general and felt that it had a positive effect on vocabulary learning.

Key words: Augmented reality, vocabulary learning, retention.

الملخص:

هدف البحث الحالي الى التعرف على فاعلية بطاقات النمذجة القائمة على الواقع المعزز في تنمية المعرفة بالمفردات اللغوية وبقاء أثر التعلم لدى تلاميذ مرحلة رياض الاطفال. ولتحقيق اهداف البحث استخدمت الباحثة منهج المجموعة الواحدة ذي التطبيقين القبلي والبعدي. قامت الباحثة بإعداد أدوات البحث المتمثلة في اختبار لقياس المعرفة بالمفردات اللغوية ومقابلة واستبيان مصور. قامت الباحثة باختيار عينة من تلاميذ الصف الثاني من مرحلة رياض الاطفال(ن=٣٠)، وبعد التطبيق القبلي لاختبار المفردات اللغوية تم تنفيذ التجربة. وعقب التطبيق البعدي لاختبار المفردات اللغوية والتتبعي أجريت التحليلات الإحصائية باستخدام البرنامج الإحصائي (SPSS V.25) والتي كشفت عن فاعلية المعالجة في تنمية

المعرفة بالمفردات اللغوية وبقاء أثر التعلم. كما أجريت المقابلة والاستبيان المصور؛ لاستكشاف انطباعات عينة الدراسة حول المعالجة واللذان كشفا عن نتائج إيجابية في هذا الصدد. وقد انتهى البحث بعدد من التوصيات التي أشارت إلى الاستفادة من صور التكنولوجيا الحديثة خاصة الواقع المعزز في تعليم الأطفال اللغة الإنجليزية كلغة اجنبية.

الكلمات المفتاحية: *الواقع المعزز، معرفة المفردات اللغوية، بقاء أثر التعلم.*

Introduction:

In the 21st century, English has increasingly become the worldwide link language used most often in communication among people who speak multiple languages in both local and global contexts. Proficiency in English as a requirement for international communication has received increasing attention and has become an ability that every citizen should have as early as possible. In the context of EFL, the key to mastering English is considered to be vocabulary learning. Strong performance of vocabulary learning helps develop language skills. In other words, for effective language skills, students need to be given adequate vocabulary mastery.

In this context, Günday and Atmaca (2016) and Yaacob et al.(2019). describe words as basic building blocks in the development of all basic language skills or, as indicated by Katemba (2021), they are nucleus components to learn a language. Further, Alqahtani (2016) states that many students become not confident in learning English just because they cannot improve their skill in learning English. A narrow vocabulary in a foreign language hinders successful communication. Without vocabulary knowledge, language learning is evidently inhibited and neither language production nor language comprehension would be possible as indicated by Hazar (2020), Ababneh (2020) and Binhomran (2021). This means that academic success depends on the comprehension of a language, which is linked to vocabulary learning. Also, Sadikin and Tsai (2020) assert that students must accumulate enough vocabulary to build their basic functional ability of foreign languages, or they will encounter learning obstacles in language skills.

Such argument was strengthened by Katasila and Poonpon (2022) saying that manifestation of the human mind is through the vocabulary one uses. That is why vocabulary knowledge is viewed as the beginning stage of language learning, especially for young learners. Due to the crucial role played by vocabulary learning, this variable has been accepted as a significant area of research at various stages. Experimentally, several studies have clarified the contribution of vocabulary repertoire to language skills.

For example, Roche and Harrington's (2013) finding showed that the vocabulary is associated with both academic writing and GPA. Vocabulary knowledge has been viewed as a prior ability or a precondition for most of other language abilities. The emergence of lexical approaches to language learning is an indicator of prominence of vocabulary teaching. Similarly, Calderon, August, Duran, and Cheung (2005) and Fecich (2014) found that being able to understand words and their associated meanings contributes to the ability to acquire appropriate comprehension skills, which in turn leads to greater reading and listening independence. In an early but related study, Cunningham and Stanovich (1997) reported that vocabulary assessed in first grade predicted over 30% of reading comprehension variance in eleventh grade. They recommended that vocabulary should be taught because it is the single best predictor of comprehension. Another important argument in favor of a concerted effort at teaching vocabulary is that learners in a typical integrated-skills classroom without a specific focus on vocabulary simply do not know enough of it (Kapelner, Soterwood, Nessaiver, & Adlof, 2018; Tsai, 2020).

In a review of the key components of reading, Lin et al. (2013) argues that if the reader's English vocabulary is improved in breadth and depth, students can understand the text content, and further the intended message with less effort. This means that the greater the learner's vocabulary knowledge, the less cognitive demands are placed on a learner. That's why Alqahtani (2015) suggests that vocabulary instruction should be incorporated as a main part in the curriculum. Accordingly, Tyson (2021) supports the idea that vocabulary proficiency can be correlated to greater academic success and cognitive outcomes throughout one's lifespan.

Some researchers have attempted to examine the link between vocabulary knowledge and reading comprehension. Anderson and Freebody (1981) proposed the instrumentalist hypothesis which posits that knowing more words makes someone a better reader. That is, there is a causal connection between vocabulary size and the ability to comprehend text. As one alternative to the instrumentalist hypothesis, the knowledge hypothesis emphasizes the role of readers' background knowledge in comprehension. Simply, it is not knowing the meanings of words that causes readers to understand what they read; rather, knowing the meanings of words is an indication of the readers' knowledge of a topic or concept. It is this knowledge that helps readers comprehend. It is one's store of concepts and the relationships among them that drives comprehension. According to the aptitude hypothesis, vocabulary knowledge and reading comprehension are

correlated with each other because both are impacted by a common set of aptitudes or abilities. What makes a person a good comprehender also makes a person a good word learner. This could be true even if knowing more words did not have a direct impact on reading comprehension. In conversations, the metalinguistic hypothesis posits that some clues like intonation, gestures, the ability to ask questions when necessary, a shared physical environment, and facial expressions exist outside the language itself and aid in constructing meaning. Unlike conversation, relatively few clues are found when reading texts.

These hypotheses clarify the link between both vocabulary and comprehension and also contribute to highlighting the essential role played by vocabulary knowledge in comprehension. To give more evidence in terms of communication, Dakhi and Fitria (2019) did a systematic review to studies related to the role of vocabulary and the results showed that the vocabulary was found to be more functional as a basis for communication, a reflection of social reality, emotion booster, and academic ability predictor. Mastering adequate vocabulary contributes to supporting the smoothness of oral communication. In the same vein, understanding the meaning of words can assist the student in conveying the message appropriately based upon the contexts in which it is used and enable him to communicate efficiently. Martyani (2020), Binhomran (2021) and Hashim, Yunus and Norman (2022) support the idea that without grammar very little cam be conveyed but without vocabulary nothing can be conveyed which reflects the outstanding role played by vocabulary.

This means that the lexicology which an individual obtains affects the capability of understanding and producing substantially in the target language. It is nearly impossible to acquire language skills without developing a strong vocabulary foundation. Thereby, vocabulary expansion is quite common in early childhood, and kindergarten is an essential part of young children's language learning.

However, vocabulary teaching and learning constitute a major problem for EFL instructors and students. Experimentally, there is a significant gap in the vocabulary knowledge that some students bring to the primary grades, and that gap widens as students' progress through the grades. Students who lack adequate vocabulary have difficulty getting meaning from what they read (Khafidhoh, 2018). Recently, Sukying (2022) indicate that primary learners do not possess the adequate level of English vocabulary. This inadequate vocabulary knowledge remains the most significant problem for EFL learners. Instructors and students usually

complain of insufficient knowledge of English vocabulary. Also, Katasila and Poonpon (2022) found that students with slow English vocabulary development are likely to perform poorly on comprehending text due to weak decoding skills and are at risk of being diagnosed as learning disabled. This gives support to the results of studies conducted by Rattanaseeha (2007), Cheng and Good (2009) and Chau, Tsoi, and Yang (2019) showing that the student's reading comprehension ability was low due to a lack of vocabulary knowledge that interfered with their reading comprehension.

Similarly, student's low level in oral communication may be due to lack of adequate vocabulary or inability to use vocabulary appropriately in spoken language. Experimentally, Al-Jarf (2022) found that even EFL freshman students have difficulty in pronouncing, recognizing the meaning of, and using English words appropriately, connecting the pronunciation of certain words with their written form, recognizing their part of speech, and categorizing words into groups sharing the same semantic feature. These studies revealed the obstacles for EFL learners caused by the lack of adequate vocabulary knowledge. This makes it necessary to view teaching vocabulary as a main priority as early as possible.

Accordingly, the question of how to strengthen children's English vocabulary ability has drawn attention. Numerous methods are employed in the cramming teaching content, so learners feel bored. Learners are always full of enthusiasm and interest when starting learning, but then their learning motivation disappears fairly quickly. Hence, educational systems need a change in the skills preparation provided to students, and the way the knowledge is transferred in formal settings to meet the challenges of the next decade. Nowadays, there are a variety of flash cards and English vocabulary learning books, but all of them are limited to words and graphics printed on paper and thus giving limited gain as indicated by many researchers such as Dalima, Sunarb, Deyd and Billinghurstd (2020) and Hashim, Yunus, and Norman (2022).

Factors that reduce the efficacy of the language teaching process, including lack of student motivation and interest in teacher-centered traditional methods (Lamrani & Abdelwahed, 2020) make the inclusion of multimedia in early language education needed for the process to be carried out efficiently (Chen, Zhou, Wang & Yu, 2017; Goksun & Gürsoy, 2019; Hameed, 2020). With the development of digital technology, teaching media have become more diversified. Today, Technology Assisted Language Learning (TALL) possibilities are part of an everyday learning routine of many second and foreign language classrooms. As a reaction to

the young learners' need to be given adequate vocabulary learning, education practitioners and researchers have devised technology- mediated interventions for teaching and learning English vocabulary in a fun and attractive way (Chen & Chan, 2019).

With the aid of digital technologies, traditional classroom tasks can be transformed into highly interactive learning experience (Liua, Holdena & Zheng, 2016; Akçayır & Akçayır, 2017; Hazar, 2020; Chang & Lai, 2021). Not only do they enrich the entire learning content and way of presentation, but they also bring new learning interaction. Children can experience the learning content in more abundant and interactive learning ways since multi-sensory stimulation especially with young learners can enhance learning outcomes. There is growing evidence in vocabulary research that many TALL interventions can facilitate vocabulary learning, affect the quality of understanding and provide optimal visual illustration- based experience.

As a concept gaining momentum especially in the last two decades, Augmented Reality (AR) is involved in the continuum of technological developments which can be adopted in the educational arena in general and language education in particular. It has emerged as one of the latest technologies that supplements the real world with virtual objects so that they appear to coexist in real space. In AR, the real world is augmented by extra information (videos, audio, images, 3D animations, and games) onto our surroundings. Virtual objects are generated from specific graphical markers, which are transformed into moving 3D images (Parmaxi & Demetriou, 2020). This way, the student becomes proximal to the contents without the learner losing perception of the real environment. This new type of information technology breaks away from the traditional image display method and is also a way to observe the world by combining virtualization technology. It can be viewed as a new source of innovation for today's digital learning that not only brings entertainment and fun but also facilitates the process of learning (Tsai, 2020).

AR technology is defined as a variation of Virtual Environments (VE), which allows the user to see the real world, with virtual objects superimposed upon or composited with the real world (He, Ren, Zhu & Cai, 2014; Shea 2014). As an innovative technological presentation method, AR can be used to bring virtual elements into real world, providing a pleasant, natural and interactive atmosphere. Compared to traditional learning environment, AR-based learning environment can improve learners' hands-on ability and promote their motivation because the real time images are

delivered in conjunction and synchronously. Ideally, these virtual objects are perceived as coexisting within a real- world environment.

Object modeling AR cards, as the name reveals, are learning materials that go beyond both traditional paper flashcards and virtual flashcards. They can concretize objects in a way that makes the AR experience so similar to the real world. Using lively 3D images, learners can interact with the virtual objects as if the objects are immersed into their environment. They can even take photos of the virtual object and control its size and position (Sim &Ismail, 2023). In addition, they can use a mobile device to trigger the virtual features by scanning the flashcards. Once the flashcards have been identified by the mobile device, their corresponding 3D virtual graphics can overlay onto the flashcards. For example, if an AR flashcard bird is triggered, a virtual bird will appear on the mobile device and come alive. The bird reacts by flapping its wings and chirping sweetly giving a semi-real experience to the learner.

AR educational applications can offer more benefits to learners than the conventional methods of using only text books, video tapes, or PCs such as visualizing abstract concepts that are invisible in the real world and allowing for interaction with this world (Lee, 2012; Santos, Lübke, Taketomi & Yamamot, 2016). Holding a similar perspective, Tulgar (2019) states that unlike the traditional education style in which language is presented in a two-dimensional format, AR design does not present the content only in the visual format; it also involves such other senses as hearing and touching. Dalima et. al. (2020) comment that the use of AR technology particularly in language classroom will provide richer learning due to variety of input channels. Admittedly, the cognitive development of young leaners makes their leaning sensory- based. The presentation of language materials through multiple senses and different sources promotes learning and goes in line with the different intelligence type students have. Exposed to the language through multi-sensory presentation, young learners can be more encouraged to be engaged in the process of learning.

To conclude, teaching vocabulary to young children can be difficult and requires an effective strategy to avoid boredom and detachment from the learning activities. The use of technology in the educational system has grown remarkably because of its flexibility, availability, authenticity, collaboration and effectiveness. The proper adoption of technological equipment in the teaching learning process can positively result in the best improvements and development of the quality of teaching and motivation of the students, and solve some students' learning problems. This is what makes researchers posit that Arin particular can offer an enhanced learning

environment which could potentially influence children's experience and knowledge gain.

Review of literature:

Vocabulary knowledge:

Learning a foreign language includes the memorization and practice of a sufficient amount of vocabulary. Generally speaking, EFL learners should know at least 5000 words in order to comprehend the meaning of an English text (Tsai, 2020), It can be assumed that teaching vocabulary is only possible when teachers become aware of what vocabulary knowledge refers to and use of effective vocabulary teaching strategies. Vocabulary is considered as the synonym of lexicon and lexis and defined as the stock of words in a given language (Yu, 2020). It should be noted that a word is not always equivalent to a leximе. Wangru (2016) points out that a lexical item is a unit of lexical meaning, which exists regardless of any inflectional endings it may have or a number of words it may contain. Lexemes can be regarded as groupings of one or more word forms, which are individuated by their roots (e.g. mother-in-low).

As for vocabulary knowledge, it goes beyond the meaning of words to entail more aspects. Consequently, teachers should be aware of its constituents and the scientifically-founded practices recommended in the literature. Generically, vocabulary knowledge refers the knowledge of words including their meanings (semantics), their structure and the rules of word formation such as compounding, derivation, conversion and blending (morphology), use (grammar), and links with other words (word semantic relationships) (İngilizce, Etkililiği, Paker and Özcan, 2017; Yu, 2020). The aforementioned aspects form the components of vocabulary knowledge.

Though some researchers such as Beck, McKeown and Kucan (2002) simply think of vocabulary knowledge as integration of both visual script (orthography) and audio (phonology), knowing a word does not solely involve form and pronunciation. Wangru (2016) indicates that learners need to learn not only the word but also learn related words such as Hyponymy (a relation of inclusion) Synonyms (different phonological words which have the same or very similar meanings), Antonyms (words which are opposite in meaning Meronymy (a part- whole relationship between lexical items). Wangru points out that these aspects should be commonly recognized as standards for widening vocabulary knowledge.

Further, vocabulary knowledge implies the word's definition and tells how to use the word appropriately based on a given context. Hence, learning vocabulary includes functions of words and applicability to

different contexts and situations. Supporting the same idea, a number of studies have shown that for vocabulary instruction to increase comprehension, it must be fairly intensive. This intensive vocabulary instruction requires giving students both definitional and contextual information in addition to opportunities to apply this information in ways that require creativity and connections with their existing knowledge.

Table (1): Aspects of vocabulary knowledge (Source: Nation, 2013: 49)

Form	**Spoken**	R	What does the word sound like?
		P	How is the word pronounced?
	Written	R	What does the word look like?
		P	How is the word written and spelled?
	Word parts	R	What parts are recognizable in this word?
		P	What word parts are needed to express meaning?
Meaning	**Form and meaning**	R	What meaning does this word from signal?
		P	What word form can be used to express this meaning?
	Concepts and references	R	What is included in the concept?
		P	What items can the concept refer to?
	Associations	R	What other words does this word make us think of?
		P	What other words could we use instead of this one?
Use	**Grammatical functions**	R	In what patterns does the word occur?
		P	In what patterns must we use this word?
	Collocations	R	What words or types of word occur with this one?
		P	What words or types of word must we use with this one?
	Constraints on use	R	Where, when and how often would we meet this word?
		P	Where, when and how often can we use this word?

As the table illustrates, vocabulary knowledge is required in both reception and production of language. Even with complexity of vocabulary knowledge, not all aspects are equally important and it is impossible and unrealistic to teach everything about a word at a time. Teachers can give priority to the special features of a particular word (Yu, 2020). Yet, Dakhi and Fitria (2019) state that the most significant aspect of knowing a word is being able to recall a meaning when meeting a word (in receptive language) and using it in the appropriate context (in production). Also, the student's

level of language learning and age determine how deep and wide the vocabulary knowledge should be.

Vocabulary types:

In order to have a better understanding of how to teach vocabulary effectively, the teacher should be aware of different types of vocabulary. A first consideration in delineating the construct of "vocabulary" in research and practice is that individuals have various types of vocabulary that they use for different purposes (Gámez et al., 2019), Failure to distinguish among the different kinds of vocabulary can lead to confusion and disagreement about both research findings and instructional implications. Words come in at least two forms: oral and print. Oral vocabulary is the set of words for which we know the meanings when we speak or read orally. Print vocabulary consists of those words for which the meaning is known when we write or read silently (Ficich, 2014; Sadikin & Marlyani, 2020). These are important distinctions because the set of words that beginning readers know are mainly oral representations. As they learn to read, print vocabulary comes to play an increasingly larger role in literacy than does the oral vocabulary. However, when individuals encounter these words, they recognize them, even if imperfectly. Therefore, without a similarly clear perspective on meaningful instruction, students' learning in school will not be optimal.

Accordingly, knowledge of words also comes in two forms, receptive and productive. The former is defined as the words which the readers and listeners use to comprehend given messages. In contrast, the productive vocabulary refers to the set of words used to produce the messages in speaking and writing (Phythian &Wagner ,2007). Hence, this form includes words that are well-known, familiar, and used frequently. Conversely, the receptive form includes words that are often less well known to students and less frequent in use. Individuals may be able assign some sort of meaning to them, even though they may not know the full subtleties of the distinction. Typically, these are also words that individuals do not use spontaneously, so learning vocabulary is needed to enable learners better comprehend received messages and expand their language production.

With reference to a word frequency use, it is more likely to group the vocabulary into active and passive vocabularies (Dakhi & Fitria, 2019). The active vocabulary is the words by which listeners and writer usually use as they are completely understood. They are the words that are recalled and used at will when a situation of speech and writing requires them. Practically, the active words are those we can automatically use when

writing and speaking without stopping and forcing ourselves to remember. In contrast, the passive vocabulary is meant as the words that are not completely understood, so that they are infrequently used when writing and speaking (Wangru, 2016). Therefore, it can be concluded that the passive vocabulary is a precondition of the active vocabulary. It is an optional step as people have different abilities and words have different degrees of comprehensibility, which has to be acquired anterior to the active vocabulary mastery.

Another way to classify vocabulary is based on usage and frequency. Beck, McKeown and Kucan (2002, 2008) identified three tiers of vocabulary words. Tier one words are simple words that occur in conversational turns and in early childhood books. They are described as basic, well-known and often used. The second tier includes words that are used across the curriculum. These words are favorable to teach and are found in printed texts, but not often in oral dialogue. These words require a deep understanding in order to use them properly. They are high frequency words used by mature language users across several content areas. Words like coincidence, absurd, hasty, and perseverance are examples. Tier three words are low frequency words that are subject-specific such as in science or social studies topics (Fisher, Bates, Gurvitz, & Blachowicz, 2013). Nucleus, osmosis, and archaeologist are examples of these words.

Some researchers have found it necessary to modify the approach because native English speakers know most Tier One words, but this is not the case for English-language learners. Consequently, a set of selection criteria for choosing words was developed. The four criteria include: (a) the nature of the word (i.e., is it concrete? Can it be demonstrated?); (b) cognate status; (c) depth of meaning (i.e., the number and richness of the ways a word is used); and (d) utility. The last criterion is considered the most important one because it is believed that only words that are of some use for students- words that they will see and use sufficiently often- should be taught explicitly. However, this criterion should be applied with the frequency criterion in mind.

Dimensions of Vocabulary Knowledge:

The two dimensions of vocabulary knowledge are supposed to be ‘depth’ and ‘breadth’ (Teng, 2014). Breadth of word knowledge is defined as the estimated number of root word meanings an individual can understand and use. Research has been primarily concerned with how many words children know, with an eye on how to expand the size of children’s vocabulary. Typically, intervention efforts to expand the breadth of

children's vocabulary involve embedded instruction, with brief definitions or explanations of words incorporated into existing oral language interactions or interactions around texts. In contrast, the depth of vocabulary knowledge refers to the level of understanding the various aspects of a given word. It is typically defined as the ability to define a word clearly or to use it appropriately in context (Hoffman et. al., 2013).

Interpretations of an individual's depth of word knowledge often rely on articulations of the relationships among words, as well as the understanding that word meanings rely heavily on context and thus are not constants. The long-term goal of vocabulary instruction is to expand and deepen children's general vocabulary and the entire repertoire of words a child understands (receptive vocabulary) and can use (expressive vocabulary). For developing width and/or depth, teachers need some knowledge about various approaches of teaching vocabulary. Such approaches give them the starting point of how to do so successfully and also options from which they can select the most appropriate one to the target audience.

Approaches of teaching vocabulary:

A consensus has been found that lexis is where we need to start from with young learners (Bozorova & Salixova, 2019; Tsai, 2020) and a prerequisite for communication (Ababneh, 2020). As a result, Aslan and Üstünel (2016) assume that unknown words pose obstacles while understanding a language. In order to eliminate these obstacles, vocabulary learning and enrichment is needed as an ongoing, continuous, and dynamic process. It is not a developmental skill or one that can ever be seen as fully mastered. The expansion and elaboration of vocabularies is something that extends across a lifetime.

In this respect, available literatures classify vocabulary teaching approaches into implicit and explicit vocabulary teaching (Dakhi & Fitria, 2019). The former supposes that language learners unconsciously, indirectly, and contextually learn the vocabularies. This Implicit form of learning occurs through a natural and simple procedure without any conscious operation. On the other hand, explicit vocabulary teaching is a conscious process of mastering the vocabulary. There has to be a direct and systematic procedure and awareness toward the objectives of vocabulary learning. This is more likely to be accomplished by cognitive strategies, note-taking, use of dictionary, and some other associational learning methods, such as semantic approach and mnemonic method.

Instruction efforts may focus on developing general vocabulary to expand breadth of children's vocabulary through implicit and embedded instruction with brief explanations of words incorporated into oral language interactions or texts. Alternatively, the focus may be on engaging learners in more sophisticated oral language interactions including direct and explicit instruction in the meanings of specific words.

The explicit vocabulary teaching, according to the natural entity of language, including form, meaning, and use contains three additional techniques that appears to be functional in learning. They are form-based (the process by which forms of the vocabulary, like its free morphemes, bound morphemes, and spelling are directly taught), meaning-based (a procedure where the meaning of an intended vocabulary is taught) and rule-based (teaching the rules of using a word including grammar and derivatives).

There is a debate concerning the effect of each perspective. For example, it is assumed that an unprepared spontaneous teaching may lead to less attractive interaction and confusion in the classroom, but it is more naturalistic and showed a positive association with a number of domains such as grammar learning and sequence learning (Dakhi & Fitria, 2019). Ficich (2014) points out that vocabulary words should be taught using direct methods when the words are complex and may not be a part of a student's everyday life. In addition, the direct manner is preferred when it is essential to understand the word to comprehend a passage. The explicit perspective is generally preferred when teaching EFL for two reasons. First, EFL learners usually have a limited chance of language exposure outside the classroom. Second, language learning rather than language acquisition is more associated to formal planning and intended purposeful endeavor.

Experimentally, Bozorova and Salixova, (2019) and Sukying (2022) point out that research on L2 vocabulary learning showed that deliberate vocabulary learning significantly outperformed the incidental group on vocabulary tests. Trying not to underestimate any one of them, Beck et. al. (2008) suggest that a student's vocabulary should increase by 2,000-3,000 words a year. In addition, about 400 of those words should be taught directly. This means that word knowledge should be taught both explicitly and implicitly.

Another view point is proposed by Yilmaz, Topua and Tulgar (2022). They believe that in pre-school years in particular, there are two basic approaches to vocabulary learning: expressive vocabulary and receptive vocabulary. The former expects children to say the English equivalent of an

object they see while the other one expects them to know the mother tongue equivalent of the same word. EFL beginners and young leaners may not have sufficient linguistic repertoire to learn new vocabulary based on equivalents. However, with more proficient learners, the expressive approach can be a tool for enriching and expanding the vocabulary they already have.

Due to complexity of vocabulary knowledge, the wide range of lexical items, and their diversity, it is not easy to consider learning vocabulary using one theory or method. This is supported by Binhomran's (2021) belief that there is currently no overall theory of vocabulary learning. The matter becomes in need of scrutiny particularly in early education for its essential role in establishing foundations for subsequent development in language learning and the unique characteristics of development and learning in this stage of life.

Vocabulary knowledge assessment in early education:

There are various perspectives in designing vocabulary knowledge assessment, namely breadth versus depth and general versus specific vocabulary (Teng, 2014). Some researchers believe that one feature is sufficient to indicate whether young learners know the word, but others prefer the multi- dimensional view that assesses more than one aspect of vocabulary knowledge (Ficich, 2014). Researchers usually select or design the instrument that is appropriate to the target participants themselves especially when they are young learners with limited linguistic knowledge.

Peabody Picture Vocabulary Test (PPVT; Dunn & Dunn, 2007) is the most common measure of receptive vocabulary used in early literacy research. The examiner shows the child a page with four separate illustrations and asks him/her to point to the picture portraying a target word. Almost all studies measuring general vocabulary use the PPVT. In other measures like the Expressive One Word Picture Vocabulary Test (EOWPVT; Brownell, 2000) and the Expressive Vocabulary Test (EVT; Williams, 2007), the child is asked to name the word portrayed in a picture. Measures like these have been used extensively with preschool students to measure the breadth of word learning from instruction.

Another way to assess vocabulary knowledge is used by Roche and Harrington (2013) focusing on the phonological aspect. The test presents a mix of frequency-banded words as well as phonologically-possible no words. The learner simply checks which words are known and which are not. Although the YN test does not directly elicit vocabulary knowledge, it has been shown to correlate highly with standard measures of vocabulary.

General vocabulary measures can provide valuable insights into the breadth of children's word knowledge. However, what is not so useful about general vocabulary measures for work with preschoolers is their inability to provide insights into children's knowledge of specific words.

In contrast, depth of word knowledge involves the question of what it means to ''know'' a word. Knowledge of word meaning ranges from completely unknown, to varying degrees of partial knowledge, to complete knowledge, which is typically defined as the ability to define a word clearly or to use it appropriately. Interpretations of an individual's depth of word knowledge often rely on articulations of the relationships among words, as well as the understanding that word meanings rely heavily on context (Hoffman, Teale & Paciga, 2013). Definitional measures provide information about depth of word knowledge in two ways: (1) they require the child to use their own language to describe word meanings, which provides rich qualitative data for insights into how the child understands a particular word in relation to other words and (2) they are typically scored on a scale (as opposed to correct/incorrect), which allows measurement of levels of word knowledge. Children's definitions can be analyzed for the number of information units specified: superordinate category (e.g. ''A cat is a kind of animal''), synonyms (e.g. ''A ship is a boat''), perceptual properties (e.g. ''A carrot is orange''), functional properties (action, ''A ship floats'', or use, ''You eat carrots'') or parts (e.g. ''A tree has branches''). Children earned one point for each information unit for each word.

Studies of depth of vocabulary knowledge, as indicated by Hoffman et al. (2013) typically employ integrated approaches to vocabulary instruction involving multiple instructional contexts and outcome measures that attempt to gauge more than one feature of word knowledge such as meaning and context or full versus partial knowledge. For example, Coyne et al. (2009) used a three-point system which simply indicated whether the word was unknown, partially known or completely known. Alternatively, vocabulary word depth can be measured based on four levels: unfamiliar (unable to provide a sample sentence using the targeted vocabulary word), emerging (repeated the sentence provided by the teacher), context-dependent expressive (sentences were strictly related to the context where the word had been used in) and unique expressive (sentences used the target vocabulary in a unique sentence that is not related to the context where the word had been used in). In Ficich's study (2014), data on vocabulary knowledge was assessed via a criterion-referenced vocabulary and

definition matching worksheets. Also, learners' vocabulary size has been assessed using traditional multiple-choice checklist formats involving yes/no judgments. Aslan and Üstünel (2016) used two tests: a pictorial matching test and a spelling test. In this way, two aspects namely: meaning and spelling were assessed. Similarly, İngilizce, Etkililiği, Paker and Özcan (2017) used fill in gaps items to assess depth of vocabulary knowledge.

The review presented by Hoffman et al. (2013) indicates that depending only on pictorial tests appears straightforward, but in actuality problematic in terms of design and use for two reasons. There may be similarity in distractors and the test may include mostly nouns (because they are the easiest to portray), relatively few verbs and almost no adjectives. A balance is required when designing these measures. Yes/no questioning format is an alternative to representing words pictorially. In this form of assessment, each target word has one question for which the correct response is yes and another with the correct response no. To demonstrate knowledge of the target word, both questions must be answered correctly. For example, for the target word trail, the child should respond yes to, ''Could you walk along a trail?'' and no to, ''Could you send a trail to your friend?'' in order to be considered as knowing trail. Because these forms of assessment do not require pictorial representation, it is probably easier to assess a wider variety of target words. Variations of this design can indicate children's depth of word knowledge.

The overview of the benefits and challenges of each form of assessment leads to the conclusion that only a careful design of complementary assessment approaches can achieve valid and reliable measures of preschool children's vocabulary learning. Teachers and researchers should examine their purposes and needs (breadth or depth, general or specific vocabulary knowledge) for vocabulary assessment in order to choose or design the appropriate instrument.

Developing vocabulary knowledge via technology- based interventions:

With the advancement of technology and development of information, the 21st century should be defined as an electronic century. Representatives of the modern pedagogy for the last five decades are emphasizing the fact that education needs transformation in order to meet the demands of the contemporary living. Modern students are digital natives who use technology in their everyday life (Jones 2016 & Binhomran, 2021). Currently, they are constantly engaged with technology or social media, both inside and outside the classroom, while traditional teaching has kept the tendency to treat the students as receivers in the teaching process,

without any active role- which is contradictory to the main objective of the lifelong learning process.

With the accessibility of various apps, digital technologies are making their way into the educational framework. Educators have started to examine the potential of apps that support language teaching and learning. As evidenced by L2 vocabulary research in particular, vocabulary learning is positively affected by various forms of technology-mediated interventions including mobile dictionaries in vocabulary teaching (Aslan & Üstünel, 2016), corpus-based vocabulary teaching activities (İngilizce, Etkililiği, Özcan & 2017), use of pictures (Khafidhoh, 2019), digital games (Hazar, 2020; Genç & Belet, 2021), dynamic images (Tsai, 2020), MALL (Katemba, 2021), a variety of online vocabulary tasks and technologies such as e-books, online dictionaries, e-portfolios, multimedia annotations and social networks (Al Jarf, 2022), digital flashcards (Sukying, 2022), and blended learning instruction (Katasila & Poonpon, 2022).

Use of computer technology provides most of the demands of vocabulary instruction such as repetition and multiple exposure to vocabulary items, direct instruction, entailing active engagement in learning, richness of context, and motivation tasks. That is why technology- based interventions seem to be optimistic in the area of vocabulary. These points lead to the fact that it is the teacher's responsibility to find the optimal method and tools that young learners find interesting when teaching vocabulary. One of the promising technology- based interventions is Augmented reality, the focus of the current research.

The technology of Augmented reality:

Over the past few decades, digital communication and learning tools have been merged into our life to be routine occurrences. The emergence of advanced technologies has led to a significant breakthrough in education. In contemporary educational contexts, which are mainly oriented towards active methodologies and student-centered approaches, educational technologies present numerous advantages. Adams et al. (2018) highlight a key obstacle for traditional education: authentic learning experiences. This challenge can be overcome with a specific type of emergent technology, Augmented Reality (AR) which allows virtual elements to seem to coexist in the same time and space as objects in real environments. Currently, (AR) also called Enlarged Reality or Extended Reality is gaining popularity and becoming more ubiquitous in nature especially when virtual objects and scenes become overlapped in the real world. This allows users to feel being personally on the scene (Sim & Ismail, 2023).

Researchers have defined AR diversely. Most researchers define it based on its features or characteristics. According to Klopfer and Sheldon (2010), Bonner and Reinders (2019), AR could be broadly defined as a situation in which a real world context is dynamically overlaid with coherent location or contextual virtual information. In this situation, AR could provide users with technology-mediated immersive experiences in which real and virtual worlds are blended and users' interactions and engagement are augmented. Therefore, this technology allows real and virtual objects to coexist in the same space and be interacted within real time. The process of combining virtual data with real-world data can provide users with access to rich and meaningful multimedia content that is contextually relevant and can be easily and immediately acted upon (Solak & Cakır, 2015).

That's why AR technology can be thought of as a bridge between virtual and real worlds as it enables learners to interact with objects, events and information in natural ways thanks to the 3D graphic in addition to audio, video, animation, and/or text. Such computer- generated enhancements are superimposed over real-world objects to augment them and give the user the appearance that the virtual object is co-existing with them in the physical world. The same view is adopted by Safar, Al-Jafar and Al-Yousefi (2017), Chau, Tsoi and Yang (2019) and Dalima, Sunarb, Deyd and Billinghurstd (2020) who view AR as the technology that dynamically overlays virtual objects or coherent location in the real world.

Huang, Zou, Cheng and Xie (2021) and Len and Dinh (2021) add that AR is an emerging technology that can enhance users' visualization of the real-world with virtual objects through object recognition technologies and computer-generated perceptual information. Also, the interactive simulation of a real-world environment can involve multiple sensory modalities, including visual, auditory, haptic, somatosensory, and olfactory. Hence, AR technology, as a medium for immersive collaborative simulation, technology-mediated narrative, and situated problem solving affordance, can positively transform the scenario of a traditional English language classroom.

Object-Modeling augmented reality, as a form of this technology, utilizes model objects to allow learners to visualize how a given item would look from different viewpoints. Such applications allow learners to explore the physical properties and execute interactions with objects. For example, the 3D model generated by this technology can be rotated or changed in color, style, and transparency to give the learner a range of views and to

explore their ideas in greater depth. This can be beneficial in teaching vocabulary to young learners who depend on sensation and object- based leaning.

The above overview shows that through AR technology, appropriate information from the external environment is juxtaposed with a digital world to simulate reality. The goal of this technology is to reduce the difference between reality as witnessed by the user and the content provided by AR technology. Thus, Augmented Reality can be seen as a conduit for bringing together education in virtual environments and the real world. Therefore, AR supplements reality, rather than completely replacing it. The seamless addition of digital content can expand the user's perception of the real world in a way that develops the learner's knowledge and comprehension. Moreover, this technology is the type of "mixed reality" whereby digital content is infused into the real environment, as opposed to Augmented Virtuality where real-world content is transplanted into a virtual environment. The two technologies need to be differentiated to avoid confusion.

Augmented reality and virtual reality:

While these terms are increasingly used as synonyms, controversies and confusions prevail, which are attributable to their varied usage in the academic venues. Both AR and VR use similar hardware technologies and share lots of factors like computer generated virtual scenes, 3D objects and interactivity (Jalaluddin et al., 2020). However, the main difference between them is where virtual reality aims to replace the real world , augmented reality respectfully supplements it. In other words, VR "brings" the users to an immersive artificial world (Solak & Erdem, 2015), or as described by Safar, Al-Jafar and Al-Yousefi (2017), the VR user enters a virtual computer generated environment. While immersed, the user cannot see the surrounding real world, whereas AR permits the user to perceive the real world enhanced or augmented by virtual objects superimposed upon or composed with the real world (Le & Dinh, 2021). Unlike VR which completely immerses the user's senses in a synthetic environment, the virtual objects used in AR systems are perceived as coexisting within the real-world (Frazier, Asquith & Worden, 2019).

To describe to what extent reality is supplemented or augmented, related literature has developed several taxonomies of AR. Milgram et al. (1994) proposed the widely recognized taxonomy called Reality-Virtuality continuum, ranging from a completely real environment to a completely virtual one. Mixed reality includes augmented reality and augmented

virtuality (AV). AR is a combination of the real and the virtual and contains more real than virtual, whereas AV refers to adding elements of reality to a virtual environment and includes more virtual information. Many researchers like Bower et al. (2014) and Bonner and Reinders (2019) support this division.

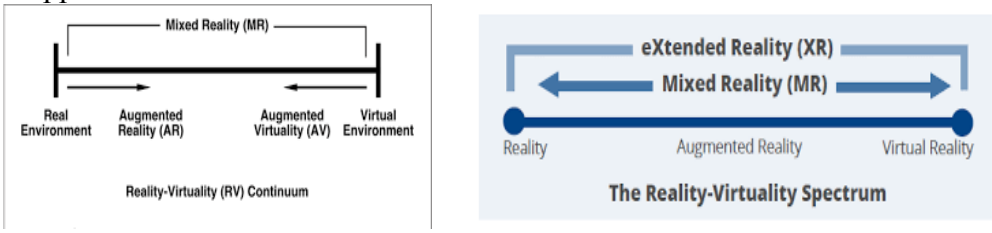

Figure (1) Milgram's reality- virtuality continuum (Source: Milgram et al.,1994) and the reality virtuality spectrum (Source: Tuglar, 2019)

As shown in the continuum, Mixed Reality (MR) refers to everything in the reality-virtuality continuum, including AR and VR. In principle, AR-based applications allow learners to relate efficiently the contextualized information to the real objects upon which it is overlaid, resulting in a deeper understanding of the topic and thus better learning outcomes. AR signifies a variation of MR that plays a supplemental role rather than a replacement of reality (Wu, Lee, Chang & Liang, 2013; Chang & Lai, 2021). Similarly, Tulgar (2019) indicates that AR sits in the middle of two extremes (reality and virtuality) in a space called "mixed reality." At its core, augmented reality is a predominantly real-world space in which virtual elements are inserted in real time." This means that AR is the combination of real and virtual objects integrated into reality and it offers real-time experience between reality and virtuality. Similarly, Dalima et. al. (2020) state that the merging (blending) of real worlds and virtual worlds that includes both real and computer-generated objects is MR or MxR (merged or mixed reality, respectively). It combines aspects of AR (a semi-digital experience in the real, physical environment) and VR (a fully digital experience) in a computer-generated, 3D environment to produce new environments and visualizations, where physical (real) and digital (virtual) objects coexist and interact in real time.

In addressing the issue of distinction between AV and AR, Klopfer (cited in: Ficich , 2014) further used a spectrum to emphasize the weight of the augmentation provided in AR and show that how much virtual information provided to the users determines the weight. A lightly augmented reality refers to a situation in which users utilize a large amount of information and physical materials from the real world, and have access

to relatively little virtual information. On the other hand, a heavily augmented reality contains frequently accessible virtual information and needs immersive technologies (Babkin et. al., 2021).

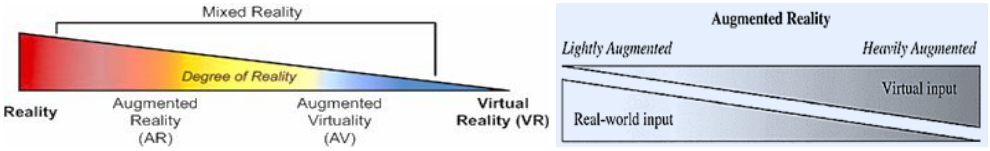

Figure (2) Spectrum of augmented reality environment by the amount of real-world and virtual input (Source: Klopfer, 2008)

It can be concluded that both AR and VR are helpful technologies that can facilitate and enhance learning in a way that merges the virtual world and real world environments. However, the two environments differ in terms of the learner's perception of the real world. Without being fully immersed into the virtual world, the learner with AR can promote live interaction in an augmented environment combining real and virtual aspects.

Theoretical frameworks underlying the use of AR:

The onset of AR technology can be traced back to the 1990s, when it was used mainly for training purposes in aircraft, engineering and surgical training. The use of AR in educational contexts presents their potential to revolutionize learning and improve learning performance. Sim and Ismail (2023) state that through its ability to use add-on digital assets to explore and expand scenes from the real world, AR could be associated with current theories of second language acquisition which emphasize localized, contextual learning and meaningful connections to the real world. Aiming at capturing a wide overview of the theoretical frameworks of AR, Parmaxi and Demetriou (2020) conducted a meta-analysis and the results showed that the most referred theoretical perspectives are the sociocultural, situated, experimental and constructivist learning theories which are all closely linked to the learning-by-doing paradigm. In another study, Len and Dinh (2021), AR technology has been grounded by three theories: situated, dual-coding, and constructivist learning theories. However, other researchers add more theories as illustrated in the following figure.

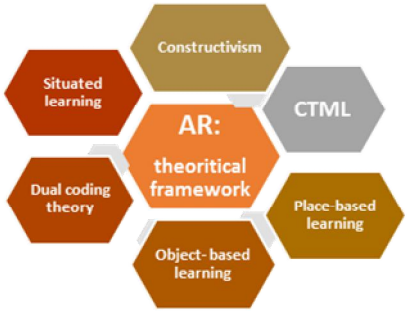

Figure (3): The theoretical foundations of AR (Source: authentic)

The situated learning theory which has been built upon the sociocultural theory, asserts that language learning in AR creates a mixed-reality learning condition in which the learners experience, interact, complete learning tasks, solve problems, and apply what they have learned to other similar situations, an ability referred to as transfer (Dunleavy & Dede, 2009). Liu (2019) points out that AR initiates a context-aware immersive activity, weaving authentic real-world scenarios with controlled designated digital ones, which in turn engages the learner's cognitively, emotionally, and physically. Karacan and Akoğlu (2021) allege that AR technology has strong ties to situated learning theory because "it positions the learner within a real-world physical, and social context during guiding, scaffolding, and facilitating participatory, and metacognitive learning processes". Situated learning – authentic and contextualised learning- is enabled by embedding educational experiences within the real-world environment and by bringing the real world into the classroom (Hsu, 2019 & Zhao; Li & Wang, 2020).

Theoretically, language is best learned when situated in, and based on, real-life experiences (Santoset.al., 2016). As stated by Len and Dinh (2021), visualizing the information in context-rich environments using AR can aid students in creating meaningful associations between the content and the real environment. This promotes having a more elaborated knowledge and having more memory retrieval cues. In the case of situated vocabulary learning, instead of displaying names and directions, words can be displayed with animations to teach new vocabulary words that are relevant to the objects found within the environment. Situated multimedia aid in the cognitive process of integrating incoming information with prior knowledge and contribute to reduce the cognitive loads during information processing by engaging learners in a supportive, context-rich environment for conceptual understanding. This is consistent with the findings of Fujimoto et al. (2013, 2012). Also, Lin and Yu (2013) investigated the cognitive load induced by

four multimedia modes, namely, text, text with audio, text with picture, and text with audio and picture. The participants (eighth graders) rated the combined text-audio-picture as the mode that induced the least cognitive load. Also, the participants who used this mode performed best in listening tests followed by the text with sound group. This indicates that the use of authentic multimedia and multimodal materials which combine words, graphics, sounds, and animations provides an ideal learning environment.

Tsai (2019) comments that these findings add to the link between AR and situated learning and also refers to the term AR-based Situated Learning (ARSL) used by Chen, Zhou, Wang and Yu (2017). The term means a perspective that views learning as context-bound and occurring when people participate in ongoing activities using AR technology. Based on such a perspective, AR characteristics of immersion, interaction and imagination ,as indicated by Zhao, Li and Wang (2020), provide excellent support for language learning and give it great potential and advantages.

The dual coding theory forms another theoretical foundation to AR. According to this theory, information is encoded in verbal and non-verbal cognitive processes. When learners need to learn new vocabulary, AR can pair inanimate objects in the environment with interactive annotations in different formats (Ashely-Welbeck & Vlachopoulos, 2020). On that context-rich synthetic 3D environment, students can visualize information through an explicit illustration and see through the relationships of these virtual elements with those found in the current environment (Santos et al., 2016). In this way, the brain is activated in a different way compared with a 2D image, and students find the vocabulary more stimulating and memorable while linking vocabulary with real world objects.

In addition, constructivist advocates posit that the individuals' prior knowledge and sociocultural background play a more critical role than the context by itself. In an AR environment, learners not only establish their personal interpretations of the immersive interfaces but also negotiate the meaning of the multimedia presentations and construct new context-appropriate comprehension (Dunleavy & Dede, 2014). According to constructivists, learners actively build their own knowledge by extracting meaning from the sensorial experiences they have in the world (Natale et al., 2020), allowing them to be actively engaged in the learning process and motivating them to pursue their educational goals. Toe et al. (2022) admit that AR provides learners with the first-hand experiences and promotes their active engagement with different learning tasks especially when educational AR applications act as multimedia meaning providers. Such apps either

transform the static image on the page to a video/ audio/3D object or place 3D objects on a visual angle. Straight (2015), Johnson et al.(2016) and Karacan and Akoğlu (2021) admit that AR resides firmly within constructivist theories of learning, because its responsive interactivity with virtual objects enables students to construct broader understandings and brings them to deeper levels of cognition through authentic tasks in meaningful realistic situations.

Furthermore, Horst & Doerner (2022) state that object-based learning is considered another constructivist approach that is widely used in early education. Here, the hands-on experience is tightly coupled with engaging many senses simultaneously for a better learning outcome. The value of direct sensations which is at the core of the overall AR methodology cannot to underestimated especially at kindergarten. As indicated by Tsai (2018), Sirakaya and Sirakaya (2018) and Tulgar (2019), the experience and the perception associated with using these immersive technologies cannot be conveyed appropriately with just textual or oral descriptions. By the same token, placed-based learning calls for the learners' interactions with physical locations. One of the potential benefits of such theory is to bring a sense of authenticity to students. They may feel more grounded in "reality" as they work in a physical area or move through an actual environment. However, a common challenge of place-based learning is that students need to cope with the constraints of the actual environment.

Furthermore, according to the experiential learning theory, knowledge is supposed to result from the combination of grasping and transforming experience. Students are facilitated by teachers to experience in a direct and personal way the intended content (experimentation and observational skills).AR provides learners with semi- realistic experiences with the possibility of direct interaction with the digital 3D object (Rodgers, 2014).

Cognitive theory of multimedia learning (CTML) is another theory supported in AR. It posits that there are two separate channels (auditory and visual) for processing information and that learning entails active cognitive processes of filtering, selecting, organizing, and integrating information (Dunleavy & Dede, 2014). Based on extensive empirical evidence, people learn and retain better from a combination of words and pictures than from words alone. CTML also posits that easy integration of verbal and visual information causes less cognitive load on working memory, thereby facilitating learning (Koutromanos, 2015). The use of AR extends the

CTML by simultaneously displaying information next to physical objects, allowing learners to further integrate spatial information of the object and its surroundings. In this context, Tyson (2021) adds that information needs to be presented in multiple ways for attention getting and keeping especially because 21st century students thrive on the instant gratification. This is urgently needed with young learners in particular for their limited attention span. AR students are not only exposed to a multi-modal message, they are also able to anchor their learning to a game scenario, prior knowledge, a 3D environment, and a new visual location/experience (Cakir, 2016; Liu, Chen, & Hang, 2019).

literature indicates that there is an obvious connection between AR and current theories of language teaching. Based on the most salient features of these theories, it can be assumed that they may somehow share some principles and a similar philosophical ground such as tendency of engaging the learners through participatory simulations, and presenting context-rich environment to help understanding among others. AR can put assumptions of these theories into practice in case of systematic planning and implementation of the teaching process.

The theory to be embraced is consistent with the kind of instructional strategy to be used. Upon reviewing the related literature, Fan et al. (2020) group AR-based instructional strategies into three, namely, instruction through presentation, discovery, and collaborative learning. The first refers to presenting the lesson content through AR by teacher-led instruction with advanced organizers followed by student experimentation under the teacher's guidance. This type of instructional strategy perceives learning as a progressive endeavor accompanied by engagement of the students in a meaningful learning activity. The instruction through discovery strategy refers to the construction of knowledge upon previous experiences by independent discovery (i.e., learner-centered comprehensive instruction). Such a strategy is accompanied by gradual release of responsibility. The strategy begins with employing AR to present the content followed by students' experiencing the platform to practice extant information and search for new knowledge (Ashely-Welbeck & Vlachopoulos, 2020). Collaborative learning strategy makes use of small group instructions with students working for problem-solving. AR cannot be used as a stand-alone learning tool; however, it can provide extra support for the content. The current research tried to make good use of these types of instruction to achieve the maximum benefit to the young learners.

Types of Augmented Reality:

There are different types of augmented reality technology that can be used properly for different types of tasks. For example, the two main types of AR as indicated by Babkin, Sharavara, Bilous and Voznyak (2021) are: marker-based and markerless AR.

1. **Marker-based AR:** This type is also known as recognition based AR or image Recognition. These applications are triggered by specific physical images (markers) captured by the camera to position the digital content on top of it. A marker can be an object or a visual such as logos, posters, or Quick Response Codes and is used to identify objects or images. The marker can be printed and placed in front of a webcam so that the camera can capture and integrate the tags, allowing learners to see the three-dimensional integration and to view the related information. That's to say, marker-based AR leans on a visual marker to activate the altered, interactive experience. On the basis of marker tracking, AR showcases superimposed content in the form of video, image, 3D models, animation clips, or scenes.
2. **Markerless AR:** As the name says, it depends on no markers and lets users decide where to display the digital content. Markerless AR allows users to place the virtual object anywhere they want without having to move anything else in the environment. It detects a surface in the camera image and produces the virtual 3D objects on top of the detected surface as described by Fleck, Hachet and Bastien (2015) and Chau, Tsoi and Yang (2019). It includes projection-based AR and location-based AR among others. The former does not need a display device as it projects light onto a surface to display digital objects. The user can control the object's orientation, depth, and position with this type of AR. This type can be used to create holograms for many purposes.

Location-based AR provides augmentation in specific places. It primarily depends on GPS, Digital Compass, smartphone cameras, and other technologies to identify the location. It maps the real-world environment and defines visual positions in the surroundings (Richardson, 2016). It allows developers to show creative, interactive, and useful digital content to geographical points of interest in the app. It also adds benefits to travelers to know the whereabouts of any particular area using virtual 3D objects, videos, texts, links, and audio.

However, Cheng and Tsai (2013), Boonbrahm, et.al (2015) and Karacan, and Akoğlu (2021) differently divide AR systems into location-

based AR and Image based AR and indicate that the latter can be divided into two categories: marker-based and markerless tracking as mentioned above. The same types were included in the division suggested by Masmuzidin and Abdul Aziz (2018) but as separate ones. They state that there are three types: marker-based, markerless and location based.

Figure (4) Examples of marker based (A) and markerless AR (B)

The figure gives examples to the marker based and markerless AR. Huang, Zou, Cheng and Xie (2021) use another term. It is creation-based AR. The name may be attributed to the feature that lets users create their own customizable AR experience. Through such applications, users can connect a picture to a video, music, 3D object or even a video of their choice.

To conclude, debate still exists with regard to classification of AR. Through this overview, it becomes evident that marker- based and markerless AR are the most common types. Based on the review conducted by Masmuzidin and Abdul Aziz (2018), it has been found that most of the research used marker-based augmented reality (95.8%). Meanwhile, the least type of augmented reality has been used is 'Markerless augmented reality' and 'Location based augmented'. The possible explanation for this finding is that marker-based augmented reality is easy to use and develop compared to other categories. Developing markerless AR is undoubtedly complex. This type of augmented reality was used less due to the lack of technical skills on the part of researchers in developing these applications Still, the technology is quickly eclipsing its marker-based as the top choice among researchers. The existing softwares like Vuforia and Aurasma simplify the process of creating marker-based augmented reality. It can be concluded that the user's selection of the AR type depends on the technical skills, needs of the target audience and the desired learning outcomes. The most preferred delivery technology in educational AR studies is mobile devices (57%) This is due to availability and simplicity of use (Liu et al., 2019).

Based on the educational uses of AR, Yuen, Yaoyuneyong and Johnson (2011) categorize types of AR into the following areas: (a) discovery-based learning where AR is employed for finding out more about places or objects, (b) object modelling where AR is used for visualizing

virtual objects in real-world environments, and/or to create virtual objects,(c) AR books in which AR is employed for activating an overlay in the form of text, audio or video), (d) skills training and (e) AR gaming. Parmaxi and Demetriou (2020) support this division which clearly displays the potential purposes of using AR.

The aforementioned overview expounds that in spite of the various classifications of AR, all of them have the same view that AR will be one of the indispensable components in the teaching/ learning process Also, the experimental evidence gives support to the wide spread of this technology thanks to its unique features leading to various affordances in education and language in particular.

Features of augmented reality technology:

In education, researchers have identified augmented reality as having immense potential to enhance learning and teaching due to its features that can be listed as follows (Yuen, Yaoyuneyong, and Johnson ,2011; Sheehy et al. ,2014 ; Ati et al. ,2018 &Yoon and Kang ,2021).

- Interaction and collaboration: learners can have discussions about the augmented content. AR entails that educational experiences are closer to face-to-face interactions than screen-to-screen ones.
- Multi-sensory experience: The 3D real-time model helps them enter the space formed by virtual objects and the real environment as a way of immersion.
- Spatial association: An association between each virtual object, each real object, and the environment can be easily identified.
- Learning novelty: AR can trigger learning motivation and interest because of its novelty and intuitional interaction.
- Modelling objects into the classroom: AR can virtually transport objects that would be difficult to accomplish in real life into the classroom such as animals.
- Student-centered: It allows highly situated, personal, and long-term experience.
- Exploration: It provides opportunities for exploration in safe environments.
- Authenticity: The AR experience seems to be as authentic as the real world.
- Customization: Learners can simply adjust the position and scale of the AR object vertically and horizontally using one- and two-finger drags, respectively.

- Immersion: AR can provide learners with a sense of immersion, which is the subjective impression that one is participating in a comprehensive, realistic experience.

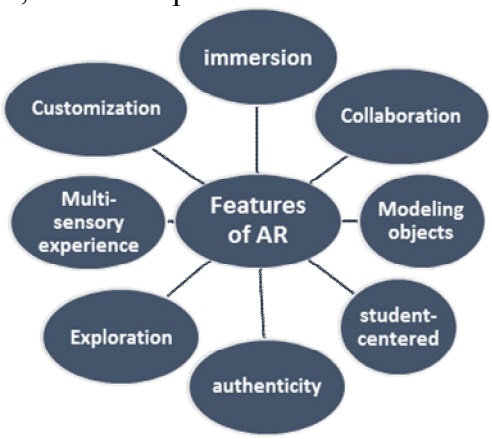

Figure (5): Features of AR (Source: Adapted from Sheehy et al., 2014; Ati et al., 2018; Yoon & Kang, 2021)

As shown in the table, such features provide wider opportunities for better learning outcomes. The potential cause- effect relationship between these features and affordances of this technology includes education in general and language learning in particular. The rationale behind this relationship is that these features meet a real need to have enjoyable experience during learning especially with young learners.

Preparing the object modeling AR -based cards:

There are two ways to use the AR in teaching vocabulary in particular. The first is called "Augmenting the content", in which the cards are designed and developed by the researcher or teacher based on the target vocabulary. The first step is to have a picture for each word which will be the trigger image later on. Each image is uploaded and named accordingly. Next, one of the AR app is logged into and the augmented content is created using the uploaded images. To access this augmented content, students would scan the trigger image (printed on the cards) with their devices (iPad or mobile). Then the application recognized the trigger image and linked to the device specified link. Babkin, Sharavara, Bilous and Voznyak (2021) point out that by creating AR products on their own, students will find learning meaningful and develop their higher-order thinking skills as well.

The second is adopting a group of AR apps suitable to the needs of the research or teacher. These apps have ready- made augmented content that is tailored for a wide range of audience (El Filali & Krit, 2020).The

second scenario was preferred in the current research for three reasons: to make the research beneficial to teachers with limited technological experience, to make good use of the apps that are free, revised and well designed, and finally to have a wider range of vocabulary in the research. Having more than way to have the content augmented adds to flexibility of this technology.

The affordances of AR for language education:

With the penetration of AR into education, numerous studies have been conducted to see its impact, affordances and disadvantage as well. Horizon Report, an annually published report covering notable trends and emerging technologies in education, highlights that VR, AR, XR, and MR technologies are now part of education due to their affordances in the field (Brown et al., 2020; Karacan & Akoğlu, 2021). It has been established that the most reported advantages of AR in particular as indicated by Chen (2019) and Tsai (2020, a & b) and Ashely-Welbeck and Vlachopoulos (2020) are that it: (1) increases the understanding of scientific content and leads to longer retention of information, as the content acquired is more deeply rooted in the memory compared to that learned conventionally, (2) generates high enthusiasm and motivates students to explore educational materials and information from different perspectives, (3) helps students learn subjects that cannot be accessed or easily recognized except through direct experience and (4) spurs student creativity and imagination. This was supported by Parmaxi, and Demetriou (2020) who analyzed research published between 2014 and 2019 systematically and identified that AR can positively affect motivation, learning outcomes, interactions and creation of opportunities for authentic language tasks.

With regard to content learning, the properties of this technology represent a strong opportunity to support the effective learning experiences. In their meta-review, Akçayir and Akçayir (2017) emphasized that learner achievement was one of the most frequently mentioned educational affordances of AR. Experimentally, AR was found effective in helping students in content understanding, and knowledge acquisition (Rosli, 2013; Lin et al., 2016), improving retention of information (Dünser et al., 2012; Wu et al., 2013), increasing interest, understanding and interiorizng the learning material (Rizov, Methodius & Rizova, 2015; Huang et al., 2019; Dalima, Sunarb, Deyd & Billinghurstd, 2020; Huang, Zou, Cheng & Xie, 2021), decreasing support time than anticipated and improving students' learning motivation as well as their frustration tolerance (Tegoan, Wibowo & Grandh, 2021).

The sense of authenticity offered by an AR learning environment promoted learners' understanding of dynamic models and complex causality (Len & Dinh, 2021).Experimentally, Pérez-López and Contero (2013) used AR technology to deliver multimedia content to support learning the digestive and circulatory systems at the primary school level. Similarly, Rosli (2013) used it to dealt with topics that were difficult for students such as geometry, the internal organs of human body and the muscular system. Both studies found that the sense of authenticity offered by an AR learning environment promoted learners' understanding of dynamic models and complex causality. Furthermore, AR provides cognitive support needed for difficult tasks and enables interaction between virtual content and users by superimposing contents on the real world (Sim & Ismail, 2023). Babkin et al. (2021) and Karacan and Akoğlu (2021) state that building a bridge between theory and practice that is provided with its feature of integrating virtual objects onto real-world can account for this impact.

Parmaxi and Demetriou (2020) and Chang and Lai (2021) add that peer interaction and communication among students themselves, content and knowledgeable others improved due to use of AR leading to better learning performance. Also, various teacher-student interaction scenarios could also be supported by AR systems, thus maximizing transfer of learning. Therefore, the real-world environment of users is augmented using new information .Such augmentation can enhance the perception of the real world without hindering interaction with synthetic objects in an augmented reality environment.

The affective variables were well considered in literature. Parmaxi and Demetriou (2020) listed four clusters of benefits arising from the AR dataset, that is: increased motivation, satisfaction, attention, and enjoyment. Studies under this category demonstrate the success of AR in providing the kind of demanding yet motivating, enjoyable and engaging tasks to students. Hashim, Abd Majid, Arshad and Obeidy (2018) and Huang et al. (2021) indicate that learner motivation is one of the most mentioned outcomes of AR in the literature. Koutromanos (2015) assumed that maintaining motivation is crucial in young learner classes. Since their attention is easily distracted which may cause them to get lost in the process of learning, they are in need of innovative ways like AR with its unique characteristics to be a motivating force.

In this respect, He, Ren, Zhu and Cai (2014) and Solak and Cakir (2015) used AR technology with pre-school children and undergraduate students respectively. Both studies found that the AR based materials had

positive impact on increasing motivation and achievement in the language classroom. The effectiveness of AR in optimizing students' motivation has been reported in many studies such as Kaufmann and Dünser (2007), Di Serio et al. (2013), Zainuddin, Sahrir, Idrus and Jaafar (2016), Liua, Holdena and Zheng (2016), Yilmaz et al. (2017), Kaenchan (2018), Masmuzidin and Abdul Aziz (2018), Chen and Chan (2019), Binhomran (2021), Huang, et al. (2021) and Karacan and Akoğlu (2021).The following figure illustrates other motivation- related variables as examples of the AR affective affordances.

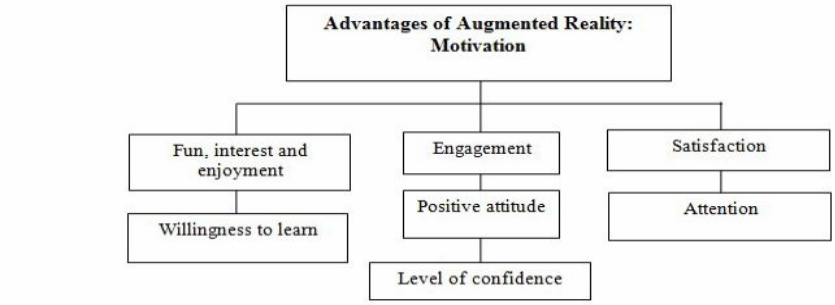

Figure (6) Affordances of AR from motivational perspectives (Source: Masmuzidin & Abdul Aziz, 2018).

Accounting for the impact of AR on motivation, Tulgar (2019) refers that the combination of the advantages of multi-sensory exposure, exploring the language, interaction with the material, and their rich presentation of language content can all contribute to visible increase in the motivational levels of young learners. Furthermore, research also found that AR kept them involved in the learning process for extended periods of time. Touchscreen technology, at its best, provides an interactive experience that closely resembles a child's natural constructivist learning (Hashim, Yunus & Norman, 2022). Further results were obtained by the quasi experimental study conducted by Redondo et al. (2020). It was observed that AR-supported English teaching increased motivation which in turn enabled children establish social relationships more easily.

In addition, results of many studies showed the superiority of the experimental group using AR to the control group with regard to improving language learning outcomes. AR was experimentally researched with writing and the results showed that students employing AR had better results in enhanced information expressions, visual information descriptions and increased information accessibility (Liu &Tsai, 2013), self-regulation of cognitive processes in writing (Lin et al., 2020), organizing the produced

text at both a word and sentence level and higher productivity, content control (Karacan, & Akoğlu, 2021).

It is reasonable to suggest that the incorporation of AR and its animated illustrations instead of static illustrations could possibly have a positive effect on how learners perceive and enjoy literature and constructing meaning from narrative texts (Rodgers, 2014). Research also suggests that comprehension improves when 3D characters and images emerge from the pages of the book and allow the reader to have a much richer reading experience with the integration of this new technology. (Gündoğmuġ, Orhan, & Sahin, 2016). Experimental studies proved that students in the group using AR materials outperformed their counterpart in WTC among higher education students (Shea,2014), reading comprehension, self-efficacy, autonomy and attitudes (Alsowat's, 2016), and reading motivation (Binhomran, 2021).The majority of participants in the studies conducted by Ntagiantas, Konstantakis, Aliprantis, and Manousos (2022) and Xu (2023) believed that The AR content was a positive educational experience. Fusing learning and fun in an immersive environment, for them, could entice them to continue reading the narrative.

In a more comprehensive view, Liu et al. (2010), Silva et al. (2015) and Suwadi and Abd Majid (2021) found that AR oriented English teaching enabled learners to acquire reading, speaking and listening abilities much more successfully than they could before, due to the increasing opportunities to practice language. The impact of AR on oral skills was also reported. AR could develop listening skills and attitudes toward listening (Gündoğmuġ et al., 2016), comprehension and the description ability after recognizing an object the participants listened to (Taskiran, 2019). Children who experienced augmented storybooks were much better at retelling stories and answering the questions (Tegoan, Wibowo & Grandhi, 2021), and pronunciation and willingness and satisfaction (Huang et al., 2021). The latter also showed that this technology empowered students with self-directed learning and, more importantly, lowered anxiety levels when learning a new language.

Based on the empirical evidence on the use of this technology, it can be argued that AR technology is capable of aiding language teachers in delivering contents innovatively in various areas of language learning. Vocabulary learning is another outstanding aspect of language learning that has been an area of interest for some researchers especially with the preschoolers. Vocabulary is supposed to develop as early as possible using

innovative methods to be the base for further language skills development in subsequent stages.

Object modeling AR and vocabulary development of young learners:

Education seeks a variety of approaches to avoid traditionalism, provide a different image of educational thought, and produce improved benefits from the technological tools (Liua, Holdena & Zheng, 2016; Hashim, Yunus & Norman, 2022). Related research shows that the pre-school stage, ranging from three to six years old, is the best period for language learning because children in this stage are good at simulation and have a high enthusiasm for language learning. During pre-school years, children's brains form a second language learning mechanism, allowing them to learn more than one language (Goh, 2019). As a result, opportunities for language learning in this period must be created while keeping brain flexibility (Yilmaz et al., 2022). Accordingly, the European union countries have moved foreign language education from primary school to the 3-6 age group, known as the lower critical threshold (Kimsesiz, 2017). At the national level, English has been introduced in pre-primary schools in Egypt as a result of modernization efforts. The idea of bilingual education in kindergarten has been put forward by the Ministry of Education. Therefore, more children begin to learn English before the age of five. In order to make early childhood education successfully support English learning in primary school, simulated environment that inspires the learning interest of young learners and improves their language sensitivity is needed. Pre-school foreign language education starts with learning sounds and vocabulary which are a prerequisite for language learning in subsequent stages. Children must increase their vocabulary in the target language in order to comprehend and communicate effectively (Chen, Zhou, Wang & Yu, 2017).

Taking the young learner profile into consideration, AR applications offer young learners a great chance to observe language presented in an attention-grabbing way compared to the traditional teaching tools. The provision of new language with a design following current technology is expected to increase the sense of exploration in young learners to learn more about the language. In order to keep the joy, enthusiasm and ambition of young learners alive, it is important to provide them with more opportunities to discover and experiment with the language. In this sense, AR designs can promote active and inquiry-based learning (Chiang et al., 2014). In teaching English to young learners TEYL classes, the opportunity to experiment and observe through a 3D channel is reported to be an essential condition for

young learner language development and a main factor in enhancing learner performance and achievement. (Becker & Ross, 2016).

The pre-schoolers' kinesthetic learning tendencies and depending on tactile senses should define the resources and materials used in teaching vocabulary. They are expected to promote active learning and present the words by concretizing them. The teacher presents the new vocabulary while still contributing to develop children's senses (Godwin-Jones, 2016; Karabulut & Dollar, 2016; Hagen, 2018). Furthermore, children at this stage have only a small amount of life experience, and they need real or simulated realistic situations to help them learn language. Furthermore, 80% of human knowledge is sourced through vision, so students' learning effect varies based on different sensory memories (Bozorova & Salixova, 2019; Tsai, 2020) and learning styles (Hsu, 2017). In other words, learners are less likely to understand unfamiliar languages or contents, but visual assistance helps their understanding and memory. The cognitive activities are not limited to perceived activities, but thinking is still bound by the specific perception of appearance. There are many concepts that cannot be directly perceived in early childhood. Therefore, intuitive and visual methods are applied to illustrate the target vocabulary that young children cannot directly perceive.

Recently, AR has gained attention because it ensures concretization and brings a real physical world context together with an overlapping layer of augmented, virtual information. In this way, it allows an individual to become fully engaged within a real environment associated augmented virtual reality simultaneously (Suwadi & Abd Majid, 2021). The concrete visual connection to the item is likely to help in vocabulary learning and retention. According to Hung, Chen and Huang (2017) and Nelissen and Van (2018), the potential of AR to create an enhanced reality offers new possibilities for language teaching and learning and offers plentiful opportunities for learners to learn and interact through various communication- based channels.

The realistic situation created by AR technology has the characteristics of intuition, diversity and interest that are a good fit for the psychological development of children and arouse their learning interest. For example, young children have a strong interest in and curiosity about brightly colored and vividly described language stimulation materials. Sadikin and Martyani (2020) and Binhomran (2021) agree that in vocabulary learning, it is relatively difficult to keep new words in memory and to recall them when they are needed. It seems difficult to learn a bulk of

words just by looking words up in dictionaries or keeping word lists by heart. AR-based learning resources, characterized by dynamic interactions and visualization, can express esoteric knowledge in a form that is developmentally appropriate to young children. Furthermore, it can interact with young children in ways that make it easier for them to understand (Dalim et al., 2020). The integration of pictures, videos and other media enables young children to obtain a better learning experience and improves their cognitive function and memory efficiency.

For early childhood English teaching, using an AR-based flashcards should include an interactive mode to become different from the traditional flashcards. However, it should not be too complicated. Existing screen-based interaction includes four basic interactive modes: click, drag, rotate and resize. These operations are the most common and the easiest interaction method that can be used with minimal technical skill.

Hameed (2020) and Katemba (2021) state that the design for AR based interventions mainly relies on three main principles, namely, repetition, engagement, and context. Acquiring new words requires repeated exposure to those words. This includes both memory rehearsal and spaced exposure (Santos, Lübke, Taketomi and Yamamot, 2016). Context is important to vocabulary learning because students can use it for forming stronger associations between the new word and the objects in the real world. Researchers have also built vocabulary applications that have capitalized on external, physical contexts, such as studying in a libary or eating in the cafeteria. This may give a rationale to Ficich's (2014) assumption and Makoe Shandu's (2018) support that child-friendly definitions are preferred to dictionary definitions because these definitions give isolated instances. They do not take into account the context of a vocabulary word, nor do they provide information regarding how to use the word properly and accurately.

The efficacy of vocabulary teaching was investigated using AR-supported methods and applications in previous studies. Many studies yielded encouraging results and thus emphasized the importance of multimodal presentation in language learning. For example, Santos, Lübke, Taketomi, and Yamamot's study (2016) indicate that scaffolding strategies embedded into AR to support learners in their vocabulary development provide them with supplemental conceptual support. Solak and Cakir (2016), Tsai (2018), Rozi, Larasati and Lestari (2021) and Huang, Zou, Cheng, Xie (2021) studied the effects of AR 3D educational materials on vocabulary expansion with primary stage students. The same variables were

researched by Tyson (2021) but among high school students. It was found that incorporating AR apps into English vocabulary learning can significantly improve English vocabulary learning performance of both stages. Similarly, participants in Tyson's (2021) study, scored better in the AR unit as compared to the traditional unit and also reported greater satisfaction with the AR method because it held their attention, gave them something to focus on, and was more engaging. Surprisingly, participants found they were more comfortable with the traditional method because it was what they were familiar with in the classroom. Thus, there exists a question about whether unfamiliarity can be a potential challenge when using AR. A group of researchers developed AR- supported applications and found that using AR was helpful in teaching the alphabet (Safar et al., 2016; Pan et al., 2021), increasing interest in basic-level English vocabulary learning and students' participation (He et al., 2014; Lee et al., 2017; Cevik et al., 2017; Chen & Chan, 2019; Hudaya & Irma, 2019; Hsu, 2019; Tsai, Yilmaz, Topu & Tulgar, 2022) and increasing enjoyment when learning vocabulary (Dalim et al., 2020).

Based on the current literature, most of the above works have made significant contributions to the implementation of AR techniques in educational methods, focusing on AR books and evaluating new ways of combining education and entertainment for the students. This indicates that AR could be beneficial to preschoolers in particular due to its ability to maintain their motivation in foreign language learning, hold their naturally short span attention, and allow them to participate more actively and thus become more engaged.

There has been a growing number of studies on the effectiveness of AR flashcards in learning vocabulary. However, there is still debate about this area of research. Superiority of the experimental AR group when compared to the control group was not found in some studies. For example, Jameson et al. (2012) found that the iPod touch device with a flashcard application was as effective as paper flashcards to teach vocabulary words to students diagnosed with a cognitive disability. The same results were obtained by Sadikin and Martyani (2020) and Le and Dinh (2021). The results showed that both AR and conventional flashcards could significantly improve young learners' vocabulary. Unexpectedly, there is existing work showing contrasting results. The experimental group did not show any improvement in reading motivation (Rodgers, 2014), linguistic knowledge (Koutromanos, 2015) and vocabulary learning (Chen & Chan, 2019; Binhomran, 2021). Bower's (2014) study revealed that unlike students with

lower academic success, academically good students did not show a sign of improvement in vocabulary learning. Surprisingly, Retter, Anderson, and Kieran (cited in: Huang, 2021) conducted a study with thirteen ninth graders. The researchers found six students increased their scores, two students' scores remained the same, and five had decreased scores in vocabulary word knowledge. However, they also noted improvements in engagement.

Though participants in some studies expressed their tendency to repeat the experience, the results led to the conclusion that there were no consensus concerning the role of AR in teaching some language aspects. The contrasting results the related literature unfolds create a state of debate which in turn may substantiate the need to conduct more research for finding out the potential effect and identifying possible challenges. Such challenges, in case of being overlooked by researchers and teachers, are capable of blurring the real impact of AR and losing the outstanding affordances it can allow.

Potential Challenges in Using AR:

Research findings suggest that learners found considerable value in AR, but also highlighted a few challenges in its application. Babkin (2021) identified visual problems especially with young learners, usability issues and frequent technical problems as the main restrictions of using AR. As indicated by Rozi, Larasati and Lestari (2021), resistance, unfamiliarity may be possible reasons for ineffectiveness of AR. Some other researchers such as Lee (2012) and Frazier, Asquith and Worden (2019) clustered these obstacles into human, physical and social.

The human obstacles include the specialized roles of teacher and student and the copyright issues. Such challenges can be resolved by training and qualifying all those who take part in this technology. The physical and technical obstacles are related to hardware and software infrastructure, the level of penetration of computers and other ICT tools, apps, and services, as well as the use and speed of the internet. Also, the digital content including tracking the appearance of digital content and the improper appearance of objects, file sizes, and voice input belong to this group. Objects may also appear optically deformed and then hinders the process of learning (Wu et al., 2013). All these factors should be well considered when planning an AR content for young learners.

Yoon and Kang (2021) state that the issue of usability and practicality is one of the possible challenges which can be experienced with the adoption of AR technologies. Tulgar (2019) states that since the

technology necessitates high user engagement and interaction, this issue must be well-addressed in the design process. Otherwise, the difficulties in using the design would result in time loss for teachers and learners. As for the social obstacles, resistance coming from schools, teachers, and parents results from unfamiliarity with the emerging technology. That's to say, the learning- centered activities and the exploratory nature of learning engendered by AR systems are usually quite different from the teacher-centered, delivery-based focus in conventional teaching methods. Also, covering a certain amount of content within a given time frame causes difficulties in implementing innovations. Therefore resistance needs to be faced by clarifying the role that technological tools can play in this arena and the possible impact they may have in training courses.

Learning issues may add another challenge. The enriched sensory experiences enabled by AR-based educational applications, which are mostly multimodal and interactive, can elicit positive emotional responses contributing to stronger learning effects. Nevertheless, deploying such applications can have negative effects. In an AR learning environment, students could be cognitively overloaded by the large amount of information they encounter, the multiple devices they are required to use, and the complex tasks they have to accomplish. Supporting this idea, Yoon and Kang (2021) reported that students often felt overwhelmed and confused when they were engaged in a multi-user AR simulation. Particularly for younger learners, AR provides a situation where reality and fantasy are blended and this mixed reality could cause students' confusions. In Klopfer's (2008) study, it was found that some students lostsight of where the virtual environment eneds and reality began. Even though such confusion signals the authenticity of an AR system, losing track of the real environment may not be productive for learning and could result in a threat to students' physical safety. The overlapping of virtual and real objects in the AR systems is referred to as occlusion (Rizov, Methodius & Rizova, 2015; Chen & Chan, 2019). Accordingly, adopting AR technology to the class inevitably needs changes in the structure of the class

Furthermore, prior studies investigating these obstacles showed that they may be attributed to the learners' feelings. Experimentally, Tulgar (2019) found that shyness, fear of negative criticism, and fear of insufficient knowledge led to difficulties in using the technology and achieving the expected results. Tegoan, Wibowo and Grandhi (2021) observed that plenty of students found it difficult to grasp the language using this technology due to lack of motivation and lack of teaching methodologies. Discomfort and

fatigue arising from frustrations were mentioned by the participants. Poor usability and other technical shortcomings were also observed as reported by Yoon, Kang (2021).

The advantage of AR technology providing young learners with the chance of learning language content by exploring it through multi-senses may turn into a disadvantage when young learners are too much directed for self-learning with limited interaction with others. Therefore, while adopting AR technology, language teachers should be careful and conscious about the engagement levels of young learners with the design (Huang et al., 2021). Above all, visual problems experienced when keeping eyes at a set focal length is another challenge. So, teachers should set limits to use in terms of time and distance.

Accordingly, the ultimate goal is to bring advantages of AR technology to the class while alleviating the shortcomings. However, AR developers and users willing to confront these challenges can nonetheless orchestrate AR-infused worlds wherein learning independently is maximized and engagement through purposeful utility or edutainment is optimized. Armed with easy-to-follow tutorials, all such perceived challenges are easily surmountable with some investments in time and effort. Teaching based on the AR technology should be effectively designed taking the young learner characteristics into account.

Recent literature reviews of AR usage across a range of disciplines demonstrate gains in various areas, however, the volume of published studies that explored the impact of AR on vocabulary learning was simply not sufficient to make substantive conclusions especially about early levels. Even though existing research findings point to positive outcomes from the use of augmented reality in education, a number of research areas remain unexplored and several questions remain unanswered. In addition, research on language learning experiences at early education appears limited, even though it can be enhanced using modern technologies, which immerse multiple users in a digital environment with extended learning capabilities. Integrating AR methods in collaborative education is a field that has not been exploited sufficiently yet. Therefore the effectiveness of AR is in need of more research efforts with the aim of clarifying the real impact of AR and how far it can benefit students in vocabulary learning. That's why the present research was conducted.

Context of the problem:

Based on the fact that the vocabularies of preschoolers predict later achievement and support their formal English learning in primary school

(Chen, Zhou, Wang & Yu, 2017), inadequate lexical knowledge may obstruct students in enhancing their English proficiency (Hudaya & Irma, 2019). Even though expanding children's vocabulary is increasingly being recognized as critical to learning, research indicates that learning English vocabulary is the most challenging task. EFL students commonly face difficulties in vocabulary learning as indicated by Tsai (2020). Learners are always full of enthusiasm and interest when starting learning, but then their learning motivation disappears fairly quickly. This may account for the research finding presented by Lin, Wang & Du (2013) and Chen, et al. (2017) that teachers often encounter difficulty when trying to enlarge their students' vocabulary size. In addition, teachers in kindergartens are unable to inspire learning interest of young children. They usually adopt traditional classroom methods, and young children receive the contents passively. They may be unable to attract children's attention or interact effectively with them (Rozi et al., 2021). In this respect, Hudaya and Irm (2019) emphasize that the real problem is the technique that teacher uses in teaching vocabulary. Typically, teaching depends on translating words into L1 then the teacher gives example of how to produce the words. Supporting the same idea, Khafidhoh (2019) and Al Jarf (2022) indicate that teachers often employ traditional vocabulary teaching techniques such as first language (L1) equivalents, pictures, word formation rules and word lists. Teachers ask students to read the new words aloud repeatedly and copy them as homework in order to reinforce students' retention of the words. Also, they are typically asked to complete lots of rote learning vocabulary activities. In this way, learners, especially growing up in the digital age, get bored due to monotony of the process depending on means of boring recitation and repetitive practice. This mechanical method greatly reduces learners' curiosity and sense of novelty about learning a foreign language, making their original learning interest and motivation disappear quickly (Tegoan et al., 2021).

Most of young EFL learners struggle to comprehend language, mainly when there is no visual illustration. Therefore, a number of learning materials and resources are provided for children to enhance their vocabulary learning ranging from traditional course books to digital technologies (Karacan & Akoğlu, 2021). Nowadays, there are a variety of flash cards and English vocabulary learning books, but all of them are limited to words and graphics printed on paper. Though traditional paper flashcards were helpful in teaching vocabulary as indicated by some researchers such as Herlina and Dewi (2017) due to simplicity and word-

meaning connection, they have some limitations. For example, children may find it hard to associate the meaning of a word with its pronunciation because this aspect remains absent in the visual clues. Also, not offering an interactive space for learners and being 2-D static images give more limitations to the physical materials. That's why Koonsanit and Lan (2017) indicate that although traditional books and flash cards are tangible (having a texture and sense of holding and turning pages), easy to be navigated, portable, flexible, available, and easy to take notes, children's engagement is still limited.

These traditional flashcards in particular need to be dramatically modernized to be more vivid and realistic by allowing learners interact with the 3D object. This conclusion also means it is the educators' creativity and initiative to design more interesting multi-faceted learning experiences, otherwise children will easily lose their attention as they become bored and finally lose interest to proceed with the learning process. (Jalaluddin, Ismail & Darmi, 2020). Such traditional methods are not keeping pace with modern ICT tools, apps, and services, and they do not encourage the learner or deliver information to him/her efficiently. Therefore, it is necessary to develop educational tools that are commensurate with the technologically advanced society in which we live, especially because these techniques contribute to improving the productivity of the teacher and the learner alike (Koonsanit & Lan, 2017; Tegoan et al., 2021).

The accelerated progress of new technologies is offering new opportunities to improve educational strategies, but such technologies either immerse learners in a virtual world, provide static images, or give animated images without a room for interacting (Tulgar, 2019). In the last two decades, the development of AR technology has provided a new approach to solving the difficulties of the early childhood English teaching environment and methods. The characteristics mentioned above make AR one of the most impactful technologies in the area of vocabulary learning. If the to-be-learned English vocabulary is not only made into flash cards but also integrated into Augmented Reality, the meanings of words with images and voices can be expressed more vividly and interestingly, and memorizing the words can be more easily (Huang et.al ,2021). In addition, it has the potential to revolutionize the way kids learn vocabulary as well as increase their interest and enjoyment due to the innovative experience it provides.

The rationale behind selecting this intervention in particular lies in the following. First, AR technology's rapid development has made it suitable for many subjects. Second, its characteristics that are in conformity

with the young learners' developmental principles make it optimal to these learners in particular. Third, AR works in tandem with the contemporary educational contexts, which are mainly oriented towards active methodologies and student-centered approaches. Furthermore, educational technologies have led to a significant breakthrough in education. In this way, AR supports required educational goals and innovation.

With regard to this research area, AR applications for education are steadily increasing since 2010 and have effectively taken root in educational settings. Many studies have been conducted to establish the tendencies, affordances, and challenges of this technology for education. As asserted by Tegoan, Wibowo and Grandhi (2021), research into the use of AR in language education is still in its infancy, with most reports being of exploratory studies designed to investigate possibilities and student perceptions. Recently, Alfadil (2020) and Len and Dinh (2021) point out that there is limited research on teaching language vocabulary through XR technology in general. This presents an opportunity to conduct further research on the use of new technologies for English learning.

As for the sample, Chen and Chan (2019) reported that most researchers exploring the effectiveness of AR technology were focusing on adolescent and adult learners. Sirakaya and Sirakaya's (2018) study aimed to identify the trends in the studies conducted on Educational AR (EAR). The reviewed articles showed that "undergraduate students" were used as samples for most of the time. Analyses displayed that the number of these studies has increased over the years. However, EAR was often found to be used in science education (physics, chemistry and biology), engineering education and medical training. This finding indicates a gap in this research area which is in need to be filled in research. Giving more support, Karacan and Akoğlu (2021) state that studies on AR integration in language education during the pre-school period which is a critical period for language development are quite scarce. That is why more research on AR applications for developing pre-school vocabulary learning as one of the most challenging tasks is called for.

The pilot study: To document the problem, a group of pre-primary stage teachers (N= 9) working at Ahmad Orabi and Al Tahreer schools in Damnhour, Beheira Governate, was observed while teaching English vocabulary to young learners (ranging from 5 to 6 years old). The main dimensions of observation were: the tools used by the teacher, the activities, and the student's responsiveness. It was found that the majority of teachers commonly used traditional methods depending on either the bilingual word

list which included only the new word and its Arabic equivalent or pictures. In both situations, learners felt bored. Two less enthusiastic teachers believed that mentioning the new word with its Arabic translation was enough. They just said the word and its Arabic equivalent, then asked learners to say it repeatedly. Learners there lacked the necessary combination between the new word and meaning through visual illustrations. Even when the teachers (N=5) used colorful pictures to attract the learners' attention, students felt enthusiastic at the beginning, then they quickly tried to shift their attention to something else for many reasons. First, they are made of paper and does not allow any potential for communication. Second, they were 2D pictures lacking the feature of semi-realistic experience. Third, having basic information, namely a word and the associated picture gave the false impression that vocabulary knowledge is restricted to these two aspects.

Furthermore, learners lost their interest quickly because the teaching situation overlooked the multi-sensory environment that young learners developmentally depend on in learning. Activities were boring and monotonous including mechanical repetition and writing the word in a list. Only one teacher used models of animals when teaching animal- related vocabulary. Though the models were better than the pictures in terms of being tangible, they also have some limitations such as inappropriate size and being static. A more energetic teacher used a video to teach vocabulary. Learners' interest vanished after a short period of time. Generally, students' need for multi-modality, multi-sensory experience, attention getting activities were not well considered. Learners were in need of more innovative interventions to facilitate the process of learning and help them retain information easily. As indicated before, AR could be hopefully helpful in this context. Therefore, the current study was conducted to examine the impact of AR in developing the preschoolers' vocabulary learning and their retention.

Additionally, a group of preschoolers enrolled in KG2 (N=30) were piloted at the beginning of the second semester. The four aspects of vocabulary knowledge were examined using a pictorial test including ٣٠ words with totally 120 items. Results showed that the majority of the children had poor vocabulary learning. No learners had full knowledge with the four aspects, nor partial knowledge with three aspects. The partial knowledge with two and one aspects were 8% and 11% respectively. The majority of students (71%) did not remember anything about the words referring to ineffectiveness of the conventional methods of teaching

vocabulary and the need of these young learners to more innovative interventions

Based on a review of existing literature, this study has identified three research gaps. Firstly, there is limited literature on the use this technology to enhance students learning experience especially vocabulary learning. In addition, studying the potential benefits of using AR technology in teaching EFL partially overlooked the preschoolers who are in need of tools that can draw their attention. Also, the results concerning the effect of using AR are not still decisive. These factors in addition to the poor level of the preschoolers' vocabulary learning as proved by the pilot study give a logic rationale to conducting the present study. Accordingly, the purpose of this study was to teach a group of basic vocabulary in English to children aged 5-6 using cards supported by AR technology. The current study seeks to contribute to the small, but growing area of research regarding technology potential in the field of vocabulary research.

Problem of the Research:

Based on review of related literature and results of the pilot study, the preschoolers' vocabulary knowledge was limited due to the traditional methods. Therefore, this research contends that using object modeling AR cards with preschool students can enhance their English vocabulary learning and retention.

Questions of Research:

Based on the literature review and the rationale of the study, the following questions need to be answered:

1. What is the impact of implementing object modeling AR based cards on developing the preschoolers' vocabulary knowledge?

   The question branches out to four sub-questions corresponding to the dimensions of vocabulary knowledge (meaning, pronunciation, context and form).
2. What is the impact of implementing AR technology on the preschoolers' vocabulary retention?

   Similarly, retention includes the dimensions mentioned above.

Hypotheses of the Research:

The research aimed to verify the following hypotheses:

1. There are statistically significant differences at the .05 level between the mean scores of the pre assessment and post assessment of the study group in vocabulary knowledge (form, pronunciation, context and meaning) in favor of the post assessment.

2. There is no statistically significant difference between the mean scores of the post assessment and delayed assessment of the study group in vocabulary knowledge.

Significance of the research: The importance of this study lies in its focus on a modern and emerging trend for the development of vocabulary among the kindergarten students. It can be significant to the following:

- **EFL Researchers:** It encourages them to implement the AR technology in further research in the language learning area. The current study represents an addition to the literature in the field of AR technology and vocabulary teaching as well, especially in light of the scarcity of studies in this area with young learners.
- **Teachers of Preschoolers:** It provides them with an innovative vocabulary teaching technology which is able to draw students' attention, provide a living experience and increase teachers' awareness of the role of technology in teaching the child. Thus, it may contribute to the adoption of new methods that can improve the quality of education.
- **Course Designers:** It encourages them to consider the recent technological tools in curriculum design and thus prepare children as digital natives. The results of the study can help decision makers provide AR software as a new educational teaching and learning method in kindergarten.

Method of the Research:

1. **Participants of the Research:** Since an early start in language learning is encouraged both in Egypt and around the world, a random sampling was used to draw one class of preschoolers as the study group conducting the English vocabulary teaching experiment with AR- based cards. Their social and educational backgrounds exhibit similar characteristics. Children with learning disabilities or severe behavior difficulties were not included in the study. Participants of the study (N=30) were enrolled in the second level (KG2) of kindergarten in the public educational system in Ahmad Orabi school, Beheira governate, Egypt. The experiment was conducted in the first semester of the 2023 academic year. Parental consent forms were distributed to all participants before the experiment.
2. **Data Collection Instruments:** For answering the research questions, some quantitative and qualitative instruments were prepared.

- A vocabulary knowledge test.
- A pictorial survey.
- A semi- structured interview for triangulating data.

The vocabulary knowledge test:

The Purpose: The aim of the test was to measure the participants' vocabulary knowledge (see Appendix A). The aspects of this knowledge were: form, meaning, context and pronunciation. Use was not examined because of novelty of the experience with young learners (Loftus & Pullen, 2010).

Description of the test: Based on aspects of vocabulary knowledge mentioned above, a test consisting of four subtests was designed in a way that suited the target participants. The level of the selected words was a beginner level. The questions included the words that the children had been taught during the study and were used in both the pre, post and delayed tests, but the items and the item options were presented in a different order. The test was prepared by the researcher taking into consideration the aims and the gains of the English language syllabus of second kindergarten year. In each section, there were instructions to be followed by the examiner and the examinees to ensure accuracy. In total, there were 30 images that the learners had to recognize the meaning, the spoken and written forms and context correctly.

The pictorial vocabulary test has a total of ١٢0 questions with one score for each question. The researcher used measures to assess vocabulary knowledge because these measures could be sensitive to gains achieved through instruction. The combination of these measures is based on a theoretic framework of vocabulary learning that suggests that students' knowledge of word meanings varies along a continuum from partial word knowledge including from one or three components to full and complete word knowledge including the four components (Nagy, 2007).

1. **Meaning recognition:** This part assesses the children's ability to recognize the picture that represents the English word. Using words and associated images is a common type of preschool activities, therefore, participants had no problem to understand the instruction. This part is a one-to-one test and can be used to assess a child's receptive vocabulary level. After listening to the target word, the children selected an appropriate representation from four pictures. For this test, no reading was required and thus, it could be used to evaluate language development in non-readers. Also, no spoken response was required in this aspect. The tests had 30 items, with

four choices for each item. Picture choices were selected from the same category to provide reasonable distracters that could represent the meaning of the target word.

2. **Form recognition**: The orthographic form of the new word is a main factor for further language development. Thus, the purpose of this part was to assess how far the students knew the forms of the target words, in other words, to identify the learners' accuracy in writing the words. For each word, the learners were asked to put the letters in the right order to form the word representing the picture.
3. **Context recognition:** This part assesses the learners' ability to identify the context where the target word is used. The learners were asked to draw a line between the word and its context. This part reflects deeper knowledge of the word and contributes to create a web of relationships among words.
4. **Spoken form recognition:** This part examines the student's ability to pronounce the target words correctly. The student's oral response was recorded verbatim. The researcher showed the students pictures representing the target words and they were asked to say the words. To avoid the factor of remembering the experience they had passed, this subtest was administered a day after the meaning recognition subtest. The written form was not used in this part because the aim was pronouncing the word not reading it.

Validity of the test:

The researchers relied on "face validity", which reflects the extent to which the tool appears to be appropriate and suitable for measuring what it is intended to measure. Hence, the test was submitted to a group of EFL specialists and professors to evaluate the test in terms of correctness, suitability and appropriateness. All jurors agreed that the questions could assess the aspects of vocabulary knowledge. They also agreed that the questions were clear and relevant to the study sample. Modifications were considered and the final version of the test was approved by the jury. In addition, the construct validity of the test was obtained by measuring the correlation coefficients for its dimensions.

Table (2) Construct validity of the vocabulary knowledge test

Dimension	Correlation Coefficient	Level of Sig.
Form	0.909	0.01
Meaning	0.856	0.01
Context	0.844	0.01
Pronunciation	0.867	0.01

As shown in the above table, the correlation coefficients for the four dimensions of the test are high at the 0.01 level of significance indicating validity of the test.

Reliability of the test: Reliability was statistically carried out by using the test re-test method. Correlation coefficients between results of the two tests were calculated using SPSS (V.25). The table below illustrates the reliability coefficients.

Table (3) Reliability coefficients of the vocabulary knowledge test.

Dimension	Reliability coefficients	Level of Sig.
Form	0.811	0.01
Meaning	0.930	0.01
Context	0.869	0.01
Pronunciation	0.898	0.01
Total Test	0.891	0.01

As shown, the reliability coefficients for the all dimensions of the test are high, therefore the test was considered reliable for the purpose of the current study.

- **Timing of the test**: The time was calculated through getting the mean between the fastest student and slowest one in answering the test. It was found that the appropriate time was 30 minutes for each part of the test.
- **Piloting the test:** A week prior to the experiment, the test was piloted on a group similar to the research sample. The purposes were to investigate suitability of the test items to both the target audience and the research aims, check clarity of pictures and instructions, and measure the time the pupils would take in answering the test.
- **Scoring the test**: It was scored based on a model answer (prepared by the researcher) to gauge the participants' performance. The model depends on the one to one method in which the response is given one mark if correct and zero if incorrect for a maximum of 120 total points (30 points for each dimension).
- **The delayed post-test:** The same version of the pre-post vocabulary test was used three weeks after implementing the posttest. The aim of this test was finding out how far the intervention was able to help memory in terms of the target vocabulary. In other words, this test answers the question related to the role of the intervention in retaining the target vocabulary.

- **Sources of the test:** The test was constructed after reviewing related literature concerned with vocabulary knowledge tests such as Tyson (2021) and Hoffman et al. (2020).
- **The pictorial survey:** The participant's impression was so valuable. Due to the students' age and their immaturity in expressive abilities, they were not traditionally interviewed. A total of ten students in the research group were selected as interviewees based on random sampling. The researcher said ten sentences (five positive and five negative) that expressed the impression about use of AR in vocabulary learning. The students were asked to respond based on the Smiley meter, which is a pictorial representation of three faces with three facial expressions (happy, neutral, and sad) to replace the answer category of Likert scale. During administering the survey, no verbal response was required, but the learners were then given the chance to comment freely. The students were told about the meaning of each face and the importance to show the face that expressed their impression. To avoid fear of being evaluated, the children were informed that the questions were for research purposes not for assessment.
- **The semi-structured interview:** For triangulating the data, a semi-structured interview was conducted with the teachers (N=2) who took part in implementing the experiment. The aim was to probe their opinions about the object modeling AR cards to support vocabulary in particular and whether it provided a supportive environment for EFL learning. The interviews were conducted face-to-face and were recorded for data analysis purposes. Once completing the interviews, the researcher started sorting transcripts. Then, patterns were categorized and compared repetitively.
- **Research Design:** The current study utilized the pre-test post-test one group design of the quasi-experimental research method.

Material of the Research (The object modeling AR- based cards):

In this study, 3D educational materials were used to create an appropriate language learning environment via augmented reality technology, taking into consideration the young learners' learning characteristics. The main elements of vocabulary learning were included: the orthographical form of the word and the image representing it. In addition, the learners could listen to the pronunciation and interact with the object. Also, the image can be the trigger for a video that would repeatedly play allowing the student to listen to a single word multiple times and watch

the object moving vividly in its context. The multi-modal content was organized in a way that keeps sequence and integration. Also, it was available to touch, rotate the object, minimize and maximize the size. These functions enabled students to customize their learning materials according to their requirements, and offered hands-on learning using AR content.

After reviewing a wide range of AR software available at the online App Store and designed to be viewed using iPad tablets, Arloopa, Fectar, UniteAR in combination with the 3 D viewer apps were selected to conduct the study. These free apps were chosen for many reasons: availability to android in particular (so all users can download them), simplicity in use, and suitability (to the target sample and the research objectives). In addition, the selected applications do not need an internet connection to function, which might be more practical for implementing the experiment in the Egyptian schools with their limited technological infrastructure. The adoption scenario was preferred to designing cards in the current research for three reasons: to make the research beneficial to teachers with limited technological experience, to make good use of the apps that are free, revised and well designed, and finally to have a wider range of vocabulary in the research.

The content: The target vocabulary in the study was compatible with the school syllabus. The 30 vocabulary items which are at the basic level were divided into groups as indicated in the table.

Table (4) The selected vocabulary in the research

Animal- related words	Farm animals:	cow, dog, duck, sheep, horse, rabbit	6
	Forest animals:	lion, bear, wolf, tiger, monkey	5
	Insect:	bee, fly, ant, bug, spider	5
Everyday life	Food:	apple, cake, carrot, milk, egg	5
	Means of transport:	car, bus, bike, train, plane, boat	6
	others	Kite, ball, star	3

The display method: In this study, the mobile device screen and monitor-based augmented reality were used. These two display methods are highly accessible and familiar to the students if compared to AR head-mounted display or AR glasses that are too expensive and unfamiliar especially in everyday class. The rationale behind this combination comes in three points: not allowing children to use their personal or parents' phones at school, difficulty for schools to bear the burden of providing mobile devices, maintaining these devices, and managing the storage of cell phones for augmented reality simulations, and finally the view of some educators

that phones are a source of distraction and some problems in the preschool learning environment.

Principles of preparing the materials and activities:

(1) Diversity in activities and using multimodal forms (sounds, animation, colors,etc.) for creating interesting and attention grabbing atmosphere and overcoming the aspects of short attention span and getting bored quickly.

(2) Considering the unique characteristics and needs of the preschoolers especially their tendency to play with language through colors and pictures, their desire to learn based on senses, and their need for infusing learning and fun .

(3) Providing an interactive atmosphere that ensures keeping the learners' interest and allowing them have a role in their learning.

(4) Combining both depth and width for better vocabulary learning.

The learning activities :

A variety of activities was prepared to meet the needs of the young learners. The activities were mostly organized in the following types: (a)free playing with the objects, (b) recognizing the target vocabulary word from the images, (b) matching the images with their respective names; (c) sorting vocabulary according to the correct context like farm and forest, (d) forming the target word from a puzzle, and (e) saying the word correctly after listening to a song or watching a video. (f) playing in groups, where two groups were formed and points were scored after answering each question or doing a task related to the target word like drawing, describing in a word, imitating, etc.

References of the treatment:

Steps of conducting the experiment were guided by some references like Santos et al. (2016), Cakir (2016), Chen et al. (2017), Koonsanit et al. (2017), Chen et al. (2019), Hsu (2019), Jalaluddin et al. (2020), Dalim et al. (2020) and El Filali and Krit (2020).

Duration of the intervention:

The intervention was implemented in the first semester of the academic year 2022/2023. The treatment consisted of 12 sessions and lasted for 6 weeks with 50 minutes for each session twice a week. As a whole, the experiment lasted for 11 weeks; two sessions for the pre and post test, the treatment, the delayed post-test three weeks later and the interviews .

Procedures of the research: They included three phases as follows:

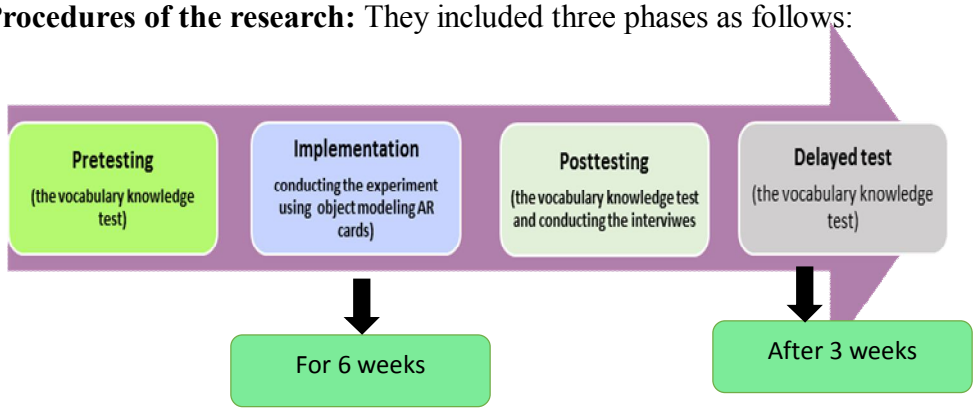

Figure (7): The research procedures

[1]The pre- implementation phase:

After listing the target vocabulary, the pre-test was designed to assess the students' prior level at vocabulary learning before the treatment and compare it to the post level. The results showed that the prior level was poor. Scores on the four dimensions of the vocabulary test administered prior to the start of the intervention were analyzed to ensure normality. For this purpose, numerical (skewness and kurtosis test) and graphical methods were used. The results of the normality test are shown in the following table.

Table (5) skewness and kurtosis Test for normality distribution of the vocabulary knowledge test

Aspects of the test	N	Mean	Median	St. D	Skewness	Kurtosis
Form	30	3.90	3.50	1.32	0.19	1.27
Meaning	30	4.06	4.00	1.11	0.30	0.62
Context	30	4.36	4.50	1.12	0.18	0.91
Pronunciation	30	4.33	4.00	1.18	0.04	1.11
Total	30	16.66	16.50	3.38	0.02	1.03

The table shows that results of the skewness and kurtosis test are smaller than (3), which indicates normal distribution of the participants' scores.

The content which depended on object modeling AR was prepared and piloted for modification. For the teachers, they were provided with application usage guide and free practice time to familiarize themselves with the apps. Subsequently, they were provided with a training session followed by a typical lesson in a small group for approximately 45 minutes. They were informed about the objectives, materials, tasks and apps. The aim

was to help them to set up the device, get used to the apps and reduce the novelty aspect while interacting with virtual objects. After answering a set of background questions, it became clear that they were enthusiastic to take part in the experiment.

[2] Implementation:

It was preferred to make the class teachers conduct the experiment for familiarity with the children after giving them sufficient information about the treatment, potential impact, and possible challenges. After getting the school permission, the teachers gave an informal 'ice-breaking session' with the participants in the experimental group in order to build trust with the students prior to the experiment. This process was important to ensure that children felt comfortable during the experiment and were willing to cooperate. At the introductory session, the students were told some details including the objectives and materials of experiment. The learners moved on to the learning process, which consisted of three learning phases: preparing, presenting, exploring and playing (see the teacher's guide).

After warming up the learners, the teacher presented the new words using the object modeling AR cards. Slide presentation was used as an effective complementary tool directly applied without requiring major changes to the class structure. After the teacher's presentation, the students sat in circles of five and used tablets to live the experience themselves. In the "explore" step, every group of students was equipped with a tablet so they could watch the information on their own screen and hear the pronunciation and spelling of the English vocabulary. In the 'play' step, learners did a group of activities for consolidating their learning.

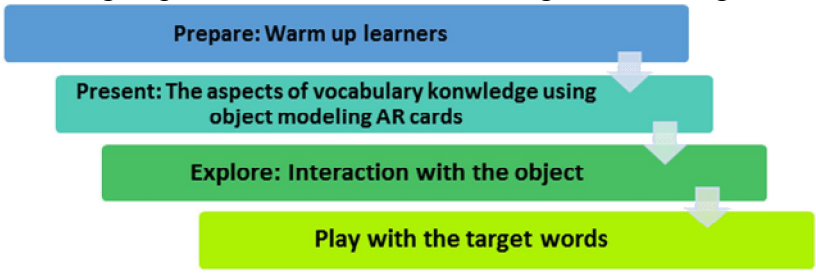

Figure (9): Steps of the intervention

The post- implementation stage:

After the experiment, the posttest was administered to the study group to examine the effect of the intervention on vocabulary learning. After a three-week interval, the test was re- administered for gauging retention. Analysing the data statistically and interpreting findings were the next steps. For more understanding, the teacher's and students' viewpoints

of the intervention were investigated using a semi- structured interview and a pictorial survey using smiley meter respectively. Finally, the research recommendations and suggestions for further research were concluded.

Statistical analysis:

Paired samples T-test was used to determine whether any difference between the two time points (i.e. preschool students' vocabulary knowledge before and after a 6-week learning using object modeling augmented reality) is statistically significant. 30 students' performance in vocabulary test was measured before and after the intervention. Also, Eta Square $\eta 2$ was calculated for measuring the effect size. A delayed test was conducted three weeks after the posttest for examining vocabulary retention.

Findings of the Research:

For achieving the research aims, the t-test for paired samples was used to compare the mean scores of the experimental group pupils in the pre, post and delayed test. Data was triangulated quantitively and qualitatively for more thorough understanding of treatment effect. Quantitative findings are reported according to the study hypotheses as follows.

[1] The quantitative findings:.

*** Findings of Hypothesis (1):** This hypothesis states "There are statistically significant differences at the .05 level between the mean scores of the pre assessment and post assessment in vocabulary knowledge in favor of the post assessment". As shown in table, the t-values were (60.90) for form, (58.75) for meaning, (49.86) for context , (57.17) for pronunciation and (95.65) for the total scores which were all significant. Consequently, the first hypothesis was supported.

Table (7) The "t" values for the pre-post assessment of the experimental group in the vocabulary knowledge test.

Aspect	Testing	N.	Mean	St. D	T	D.F	Sig.	$\eta 2$
Form	Pre-	30	3.90	1.32	60.90	29	0.01	0.98
	Post-	30	21.90	1.24				
Meaning	Pre-	30	4.06	1.11	58.75	29	0.01	0.97
	Post-	30	22.66	1.58				
Context	Pre-	30	4.36	1.12	49.86	29	0.01	0.95
	Post-	30	22.33	1.44				
Pronunciation	Pre-	30	4.33	1.18	57.17	29	0.01	0.96
	Post-	30	21.83	1.51				
Total Score	Pre-	30	16.66	3.38	95.65	29	0.01	0.99
	Post-	30	88.73	2.79				

The table shows that there are statistically significant differences at 0.01 level between the mean scores of the experimental group in the pre-and post-administration of the vocabulary knowledge test in favor of the posttest. In addition, values of η2, as shown in the table, indicate high effect size. This means that the intervention was effective in developing vocabulary knowledge among the preschoolers in terms of form, meaning, context, pronunciation and the total score.

*** Findings of hypothesis (2):**

This hypothesis states " There is no statistically significant difference between the mean scores of the post assessment and delayed assessment of the study group in vocabulary knowledge. The t-test for paired samples was used to compare the post -and delayed scores of the vocabulary knowledge test.

Table (8) The "t" values for the post -delayed assessment of the experimental group in the vocabulary knowledge test.

Aspect	Testing	N.	Mean	St. D.	T	D.F.	Sig.	η2
Form	Post -	30	21.90	1.24	0.79	29	0.43	0.02
	Delayed -	30	22.10	1.15				
Meaning	Post -	30	22.66	1.53	0.98	29	0.33	0.03
	Delayed -	30	22.90	1.18				
Context	Post -	30	22.33	1.44	0.36	29	0.71	0.01
	Delayed -	30	22.20	0.96				
Pronunciation	Post -	30	21.83	1.51	0.42	29	0.67	0.01
	Delayed -	30	21.83	0.98				
Total Score	Post -	30	88.73	2.79	0.35	29	0.72	0.01
	Delayed -	30	88.90	1.84				

As shown in the table , the t-values were (0.79) for form, (0.98) for meaning, (0.42) for pronunciation, (0.71) for context and (0.72) for the total score. Therefore, the results show that there is no a statistically significant difference at 0.05 level between the mean scores of the experimental group in the post and delayed assessment. Consequently, hypothesis two is supported. Comparing the students' scores in the post and delayed tests revealed that the students could retain the majority of the vocabulary they had learned using AR. This indicated that the study showed encouraging results concerning the effect of the intervention on both vocabulary learning and retention.

[2] The qualitative findings:

These findings were obtained from both students and teachers participating in the experiment for getting a more comprehensive view of the intervention impact.

The teachers: A semi-structured interview was conducted with the teachers who took part in the experiment after the post assessment to find out their impression about the use of AR for developing vocabulary. The teachers' responses showed that there was a consensus between them concerning the effective role of the intervention in developing vocabulary and its ability to attract the children's attention and increase their attention span. The teachers classified the tool as excellent and coherent with student's developmental characteristics. One of them highlighted that it was a different way to present language, particularly vocabulary. She reported that students interacted well with the tool. She mentioned that they loved the exercise and were excited and enthusiastic to take part in the activity.

In the section of free comments, one of the teachers said that the intervention and the activities were different from what the learners were used to. The following experts show this finding: "I think it was very helpful that they got to play with it", "They enjoyed while learning especially because they could interact with and control the objects". Their attention span increased, because the pictures were moving vividly. They also favored the multimodal display manner involved in the intervention.

As for the main challenges, they can be summarized in distraction, overload and order. One of the teachers noticed that the children were more attracted to the animation than the word itself. The teachers also expressed their worry that some of the children were distracted by the technology, and argued that the animation would not be effective for non-visual learners. One of them stated that they might experience information overload and believed that it would be more effective if there were fewer objects. "The fewer objects you present, the better their retention", she said. In terms of classroom management issues, both teachers responded that managing a whole class was not easy when using AR. It was noisy and order was regained only by rules. She added that they had to have a clear plan in mind so that they could get a better result. The other teacher believed that these slight challenges could be overcome as long as the learners were interested in this innovative way of learning. In terms of the intention to use AR flashcards, both teachers who took part in the experiment expressed willingness to use AR when teaching vocabulary especially if there was curriculum-related material available. This means that in spite of the

difficulties they experienced, the two teachers expressed satisfaction with the intervention.

The Students: Some students (N=10) were asked about their AR experience using smiley meter for the reasons mentioned above. 84% of their responses were positive, while 13% were neutral and only 3% were negative referring to the conclusion that the majority of students had positive impression toward the intervention. Their satisfaction with the experience became clear in their comments like "we played with them" referring to the objects, "It was enjoyable "and "we want it again". Only one participant commented that she liked AR but she did not like to share the tablet with other students which indicates that some students did not prefer collaborative work. This means that they did not like the display manner not the technology itself. It is normal for some preschoolers to become selfish and ego-centric. That's why they tend to avoid working together.

Generally, the children apparently found the experience highly enjoyable. The findings are in line with previous studies conducted by Juan et al.(2010), Çakır et al.(2016),Hwang et al.(2016) and Santos et al.(2016) where the participants liked the experience of learning via AR technology. Furthermore, the results give support to their scores in the post and delayed test which means positive impressions can lead to better achievement.

Discussion :

Based on the results, using object modeling AR cards was helpful in developing vocabulary knowledge and retention. The positive effect can be attributed to a group of factors related to the treatment characteristics and the experience it provides. First, the affordances of AR are a form of combination of physical affordances (e.g., look and feel of real objects; size, shape, texture, color, weight; environment location, angle and positioning) and virtual affordances (e.g., copy of real objects, three-dimensional space, scene-setting, placement of digital objects within the real world and video-animation) that redefines and repurposes the lived experience with such advanced technologies.AR provides a vivid scene, creates a relaxed and harmonious emotional atmosphere, and encourages young learners to participate actively in the teaching process. Additionally, AR holds the potential to engage learners in authentic, real-life learning scenario, that's why the AR dataset reported a wide range of benefits for many aspects in language learning. This is consistent with the findings of Chen and Su (2013) Safar et.al (2017), Sadikin and Martyani (2020) which reported that students in the AR group had a better learning experience.

Second, young leaners' characteristics are well considered in the AR technology in terms of sensory learning and depending on concretization in addition to their desire to interact with the object and customize their own learning content presentation. The educational experience provided by AR technology which depends on concretizing concepts appeals to multiple learning styles, facilitates comprehension by visualizing, (Núñez et al., 2008) and makes learning more responsive and enthusiastic. The possibility of concertizing the content and allowing learners to observe and explore in the learning process bring another advantage to the scene (Behzadan et al., 2015; Di Siero et al., 2013; Dunleavy et al., 2009). Natale et.al (2020) point out that it can promote sense of presence, sense of embodiment, while supporting attentional and emotional engagement. Children in particular prefer this environment to real environment for visualization of content. Using AR, teachers can "animate" almost any educational materials, and explain the phenomena, the demonstration of which is difficult to organize in the classroom due to some challenges like lack of equipment, inability to show in real life, and danger. In the present study, this could be applied to wild animals and farfetched objects like plane and star. Consequently, visualization and direct interaction situations that are barely reproducible in the real world can all interpret the facilitative role of the AR technology in better learning and retention. Overall, the hands-on experience and inclusion of immersive experiences for all students could make a valuable contribution. This was supported by Parmaxi and Demetriou (2020), Chang and Lai (2021), Karacan and Akoğlu (2021) Babkin, et al. (2021) and Sim and Ismail (2023).

Third, the feature of learning interactivity (i.e., embodying interactions with virtual content) adds another reason for this effect. It is advantageous in that it provides students with a 3D space in which they can experience their own learning. The ability for physical interaction with the application is providing them additional assistance in exploring the objects (Yilmaz et. al., 2022). AR designs have been shown to stimulate three types of interaction in the learning context: interaction with the material, among the students and between teacher and students. Research studies by Zarraonandia, et. al. (2013), Babkin et.al.(2021) support the same idea. This result was in line with the findings of the study conducted by Karacan and Akoglu (2021) who emphasized that educational AR applications improve teacher-student and student-student interactions. Similarly, Chang and Lai (2021) found that improved peer interaction and communication among fourth-grade students thanks to AR technology. Theoretically, interaction

with peers and knowledgeable others is of paramount importance as proposed by sociocultural theory. Based on the contextual learning theory, knowledge is related to the learning context through interaction and effective participation in the learning process (Tsai, 2018).Also, AR-initiated student-content interaction improved the teaching and learning process leading to better learning performance.

One more reason for this effect was incorporating a lot of AR related activities that presented the four aspects of vocabulary knowledge in a simple interesting way. The rich environment was an additional motivational factor. The positive effect found in this study is theoretically substantiated. AR gives experience in a way that appeals to constructivist notions of education where students take control of their own learning. Today's students respond well to the instant gratification of a game-like learning setting that AR can offer (Law &Heintz, 2021). AR technology, indeed, has been shown to "break" the class restricted walls and provide learners with simulated immersive interfaces for effective situated learning and thus enhance their linguistic knowledge transfer.

Furthermore, the apps selected by the researcher provided the learners with ready- made augmented content that was tailored for the target population. Through these apps, the learners had rich experience including all aspects of vocabulary learning instead of the limited and dull traditional method used before. In this way. The object modeling AR cards offered an element of thrill and provided the child with new experiences that motivated and deepened their understanding of the content.

Unlike the previous studies, the ultimate goal was to bring advantages of AR technology to the class while alleviating the shortcomings of AR head-mounted display or AR glasses that are too expensive and unfamiliar for students to use in everyday class. In this study, the monitor-based then mobile device screen augmented reality were used to be simple and affordable. That is why the display methods contributed to making AR feasible especially when integrating the whole class presentation through the slide projector and the group and individual exploration afterwards. On other words, viewing content from different perspectives, flexibility and accessibility of this technology are further reasons. This is consistent with the results of the studied conducted by Le and Dinh (2021), Huang, et. al. (2021) and Tegoan,Wibowo and Grandhi (2021).

With regard to retention, it is emphasized that AR applications help children remember the information they learned more easily due to the audio-visual connection (Liu, 2009; Wu et al., 2013 & Akcayir & Akcayir,

2016). In this way, the effect of the intervention is theoretically substantiated. According to Dual-Coding Theory (DCT), a learner's memory consists of two separate but interrelated verbal and visual codes for processing information. In the intervention there exists an interconnection between the two separate systems which facilitates dual coding of information if not activated independently. Being exposed to the language content through different channels and having the chance of experimenting with the language, young learners can be more actively involved in the process of learning the target language. AR allows for different multimedia modes such as text, picture, video, audio, and 3D object (Cabero & Barroso, 2016) which in turn helps memory(Karacan& Akoğlu ,2021). As for the limited loss of information shown in the results, literature indicated that this was due to the natural loss of memory over time. This loss may continue in case of not refreshing the learned items through contextualized activities.

Conclusion:

Language is learned best when learners learn it through real experiences situated in the learning environment. AR technology makes this process possible as it introduces dimensionality into language classroom through which learners can have a real sense of experiencing the language. The current research revealed that object modeling augmented reality cards could develop vocabulary knowledge of the preschoolers and help them retain vocabulary items. It is an inevitable fact that various forms of technology especially augmented reality will be an indispensable part of the educational setting in general and language teaching in particular.

Recommendations:

Based on the research results, the following recommendations can be presented:

- The developmental characteristics of young learners should be considered in all teaching- related decisions including methods, devices and activities to help them develop various aspects of language.
- The conventional methods should be revolutionalized using modern technology. This requires training teachers to use innovative teaching tools and changing the pessimistic attitudes toward using technology in education.
- EFL language policy makers and syllabus designers should customize textbooks so that they are suitable, engaging, related and authentic to students' real lives, and adaptable for technology use.

Similarly, teachers should consider implementing technology within their teaching for better learning experience.

- Awareness among students and parents about the role played by technology in the teaching-learning process and how to employ technology-based
- apps and tools efficiently and wisely in language learning is needed.
- The view to vocabulary learning should be widened to include width and depth to help preschoolers in further language learning.

Suggestions for Further Research:

Based on the research findings, the following implications for further research were suggested:

- Doing research on the challenges experienced by learners and teachers when implementing technological devices in the language teaching process.
- Investigating the issue of contexualized versus decontextualized vocabulary teaching through AR.
- Exploring how far the cognitive load resulting from the multimodal rich environment provided by AR can affect learning performance.
- Exploring the effect of AR on vocabulary depth and width in the primary stage.
- Using AR for developing the young learners' pre-literacy skills.
- Exploring the teachers' attitudes towards the adoption of technology in the educational system
- Using other technological devices such as VR for teaching stories and examining its effect on comprehension.
- Creating and developing more XR applications and equipment that can be connected with smart devices to make them more available, accessible, secure, cheaper, and easier to use in teaching and learning.
- Exploring the technical capabilities of the pre-service teachers including designing and implementation and their opinions about usability and preferences regarding AR in EFL education.
- Suggesting design principles and models that were empirically proven in order to provide teachers with a general framework for the adoption of XR technology for language teaching. This would be directly connected to teacher training.
- Studying the impact of using AR technology to fosters deep conceptual understanding, self-learning, analytical thinking across all academic content areas.

- Exploring different learning strategies in parallel with different cognitive styles while using AR.
- Investigating the relationship between enjoyment, engagement, motivation and learning performance in AR activities.
- Conducting more research on less studied sample groups such as special needs students, students with learning difficulties, parents and graduate students.
- Employing location- based AR which has been overlooked in almost all related studies.

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