



# **Ausubel Subsumption Learning Theory And Integration Of Emerging Technologies In Teacher Education In South- South, Nigeria**

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## **ABSTRACT**

A theory like Ausubel subsumption learning theory is relevant to today's education and a theory is an hypothesis that has been scrutinized, investigated, challenges and eventually found to be true and acceptable. Theory is used to explain events which have already occurred to predict probable future trends so as to plan effective control techniques or strategies before hand. Emerging technologies such as Artificial Intelligence (AI), Augmented Reality (AR), Virtual Reality (VR), Internet of Things (IoT) and Cyber Security hold immense potential to revolutionize, immersive learning environments, secure recording-keeping systems record-keeping systems, and remote learning opportunities. Integrating these technologies into teacher education programs can better equip educators to prepare students for global competitiveness. However, challenges like the digital divide and continuous teacher training requirement must be addressed to ensure equitable access and effective implementation. Despite these hurdles, the overall impact on global competitiveness is evident, empowering educators and students to excel in an interconnected, technology-driven world.

**Keywords:** Ausubel Subsumption, Learning Theory, Integration, Emerging Technologies, Teacher Education.

## **INTRODUCTION**

This paper, attempts to look into the work of David Paul Ausubel an American psychologist who propounded subsumption theory of learning and how the theory relates to the use of emerging technologies in teacher education in Nigerian context. David Paul Ausubel was born on October 25<sup>th</sup>, 1918 and grew up in Brooklyn, New York. He studied at the University of Pennsylvania where he graduated with honour to receive a bachelor's degree majoring in psychology in 1939. Ausubel later graduated from medical school in 1943 at Middle Sex University where he went on to complete rotating internship at Gouveneur Hospital located in the lower east side of Manhattan, New York.

Following his military service with the US public health service, Ausubel earned his M.A. and Ph.D in Development Psychology from Colombia University in 1950. Dr. Ausubel was influenced by the work of Jean Piaget. In 1950, Ausubel accepted a position with the Bureau of Educational Research at the University

of Illinois. He remained with the Bureau for sixteen years. While Ausubel was at the University of Illinois, he published extensively on cognitive psychology. Ausubel left the University of Illinois in 1966 in order to accept a position with the Department of Applied Psychology, Ontario Institute of Studies in Education. He was in Toronto for two years. Around 1966-68 he moved to become professor and Head of the Department of Educational Psychology; Graduate school and University Center, City University of New York, where he served until his retirement in 1975 (APA, 1977, p. 52) when Ausubel retired from University teaching, he returned to the practice of psychiatry and devoted himself to writing, with which four books resulted he had over 150 articles in psychological journals. In 1976, he received the Thorndike Award from the American Psychological Association for "Distinguish psychological contributions to Education" at the age of 75. Ausubel and his wife Pearl had two children, Fred and Laura. Professor David Paul Ausubel passed away on July 9, 2008.

Theory, according to Longman Dictionary of Contemporary English is defined as an idea or set of ideas that is intended to explain something about life or the world. A theory is an hypothesis that has been scrutinized, investigated, challenged and eventually found to be true and acceptable. However, a validated and widely accepted theory graduates into law. Theory is a set of interrelated ideas proposed in order to explain the dynamics of a given phenomenon. Theory is used to explain events which have already occurred and to predict probable future trends so as to plan effective control techniques or strategies beforehand.

### **Characteristics of a Theory**

**Accuracy:** A theory should be able to explain as clearly as possible the variables involved in its substance. For instance, in Stimulus and Response theory, the variables are food and bell.

**Generality:** This refers to the rate or spread of social phenomenon to which the theory applies.

**Parsimony:** This attribute of theory emphasizes the need for caution in drawing inferences from a given theory.

**Causality:** This is what brings about the theory

### **Teaching**

Teaching is an exercise that requires two different participants to be implemented, the teacher and the learner. The teacher organizes the learners' experiences, while the students or pupils receive knowledge.

Oluokun and Olayanju (2001) quoted by Adepoju and Okemakinde (2008) pointed out that teaching is a complex process whereby the learner is made to pay attention, make observation, associate ideas, remember previous experiences and reason. Onwuka (1996) quoted by Adepoju and Okemakinde (2008) was of the opinion that teaching is a polymorphous concept i.e. having different forms, which cover many and different forms of activities. The main focus of teaching from the above assertion is to assist learners to live fully at their present stage and in the future.

Adewoyin (2001) defines teaching as a dynamic, open and cyclical process whereby the teacher as the agent of change tries to influence change in learner and he is in turn influenced by learner. Teaching according to Benedict (2005) can be likened to communication process which involves the transmission of information, ideas and messages from the teacher (sender) to the students (receiver). However, the main objective of teaching is to assist learners to realize themselves, and their environments, through meaningful learning materials given by the teacher to effect learning and responsible individual.

### **Learning**

"Learning has been regarded as a single factor which has proved indispensable for the progress of human civilization" (Okoye, 2022). In Metz's (2004) definition, "Learning consists of relatively persistent changes in possible behaviour in so far as they derive from experience. From Morgan's (2001) point of view "any relatively permanent change in behaviour which occurs as a result of experience or practice is learning". Gagne (1985) defines learning as a change in human disposition or capability; which can be retained, and which is not simply ascribable to the process of growth. Fontana (1981) while defining learning draws attention to three things.

- That learning must change the individual in some way.

- That this change comes about as a result of experience
- That it is a change in his possible behaviour

Learning is the relatively permanent change in behavior/potentiality as a result of reinforcement, practice and experience (Sotonade, 2022).

### **Ausubel Subsumption Theory**

Subsumption theory is concerned with how individual learners learn large amounts of meaningful materials from verbal, textual presentation in a school setting. Ausubel is of the view that the primary process of learning is subsumption in which new material is related to relevant ideas in the existing cognitive structure on a substantive, non-verbatim basis. To subsume is to incorporate new material into one's cognitive structure. When information is subsumed into the learner's cognitive structure it is organized hierarchically. According to him, cognitive structure represents the residue of all learning experiences i.e. the residual knowledge; learning material or information that remains in the cognitive structure to facilitate the reception of new learning materials.

According to Ausubel, learning is based upon the kinds of super-ordinate, representation and combinatorial processes that occur during the reception of information. David Ausubel made bold to say that "if he had to reduce all of educational psychology to just one principle, he would say this: the most important single factor influencing learning is what the learner already knows" (Cognitive Structure).

The theory emphasizes meaningful learning. Ausubel believes that external world acquires meaning only as it is converted into the content of consciousness by learner. For meaningful learning to take place, certain learning variables such as students' cognitive structures, advance organizer and general state of developmental readiness must be taken into consideration. In other words, potentially meaningful material must be biologically and psychologically appropriate to the needs and age of the child. He went further to emphasize meaningful verbal learning, where he explained that meaningful is created through some form of representational equivalence between language (symbol) and mental context. Speech, reading and writing were given as elements of verbal learning methods, while reception and discovery were observed as processes of meaningful learning.

The above can be summarized as follows: How do we ensure on the part of learner better understanding of what was taught and that learning only takes place when students are able to comprehend ideas, concepts and information to the extent of giving meaning to it based on their residual knowledge. This will be accompanied with internalization, retention and easy recalling of such information. However, this is best achieved with the ability of the mental context to relate with language/symbol.

Ausubel views knowledge as representing an integrated system. Ideas are linked together in an orderly fashion. The human mind follows logical rules for organizing information into respective categories. Ausubel (1960) contends, "that cognitive structure is hierarchically organized in terms of highly inclusive concepts under which are subsumed less inclusive subconcepts and information data." (p.267). mind, metaphorically, is like a Chinese puzzle box. All the smaller boxes, ideas and concepts are tucked away inside of largest boxes. The big box is the mental pyramid which subsumes the small boxes. Subsumers constitute the general categories around which we organize our thinking.

Subsumption allows us to absorb new information into our cognitive structure. Teaching and learning, therefore, are largely matters of erecting cognitive structure to hold new information. By placing new information into its proper box we are better able to retain it for future use. When a new idea enters consciousness it is processed and held/classified under one or more of the inclusive concepts already existing in the learners' cognitive structure. "New meaningful material becomes incorporated into cognitive structure in so far as it is subsumable under relevant existing concepts," (p.267) subsumers provide a basic structure around which information is organized. They are the intellectual linchpins holding the system together and at the same time facilitate both learning and retention.

### **Types of Subsumption**

Two types of subsumption are given as

- i. Derivative subsumption

- ii. Correlative subsumption
- i. **Derivative Subsumption**

The point in derivative is that: new material or relationship can be derived from the existing structure. Information can be moved in the hierarchy, or linked to other concepts or information to create new interpretations or meaning.

Lets assume I have acquired a basic concept such as “car”, I know that car has, four types, two or four doors and a steering, it moves and carry passengers. Now I learn about a kind of a car that I have never seen before, for instance, a jeep prado, which equally confirms to my previous understanding of a car, but with a big and elegant size. My new knowledge of prado jeep is attached to my concept of a car without substantially altering that concept in any way, so an Ausubelian would say that I have learned about a jeep car through the process of derivative subsumption.
- ii. **Correlative Subsumption**

The central point here is that – new material is an extension or elaboration of what is already known. Lets suppose I encounter a new kind of car that has more than four tyres, six doors, with a very long size, to accommodate this new information/concept, I have no alter or extend my concept of a car to include possibility of having; longer size, six doors six types etc. This means I have learned about this new kind of car through the process of correlative subsumption. In essence, one might say that this is more “valuable” learning than that of derivative subsumption, since it enriches the higher – level concept.

### **Some Concept that Aids Meaningful Learning (Subsumption)**

1. **Cognitive Structure:** The influence of Piagets,’ cognitive development theory on Ausubel made him to develop his instructional models on cognitive structure. According to Ausubel (1963), cognitive structures represent the residue of all learning experiences, which facilitate the acquisition of new materials/information. Ausubel submit that the most important single factor influencing learning present experience is always fitted into what the learner already knows. Existing cognitive structure, that is an individual’s organization, stability and clarity of knowledge on a particular subject matter or field at any given time, is the principal factor influencing the learning and retention of new meaningful materials (p.217). A cognitive structure that is clear and well organized facilitates learning and retention of new information while a confused and disorderly, on the other hand, inhibits learning and retention. So putting the mind in order is one of the principal objectives of all education.
2. **Hierarchy:** This simply means, how is knowledge organized? Ausubel’s and Robinson’s (1969) theory of learning assumes the existence of a hierarchical structure of knowledge. Fields of inquiry are organized like pyramids, “with the most general idea forming the apex, and more partial or ideas and specific details subsumed under them.” (p. 47). The most inclusive ideas – those located at the top of the pyramid – are the dominant and most enduring elements in the hierarchy they possess a longer life span in memory than these facts, details at the base of the pyramid. “Learning occurs as potentially meaningful material enters the cognitive field and interacts with and is appropriately subsumed under a relevant and ore inclusive conceptual system.
3. **Advance Organizer:** The advance organizer is a tool or mental learning that help students to integrate new information with their existing knowledge, leading to meaningful learning as opposed to rote memorization. It is a means of preparing the learner’s cognitive structure for the learning experience about to take place. It is a device to activate the relevance schema or conceptual patterns so that new information can be more readily subsumed into the learner’s existing cognitive structures. Organizers are abstract idea presented in advance of the lessons; they help to bridge gap between what is already known and what is to be learned. The learning and retention f unfamiliar but meaningful verbal material can be facilitated by the advance introduction of relevant subsuming concepts. Organizers are particularly useful when learners do not already possess the relevant concepts needed in order to integrate new information into their cognitive systems. Advance organizer entails the use of introductory materials with a high level of generality that introduce new material and facilitate learning by providing an anchoring idea to which new idea can be attached. Teacher can facilitate learning by organizing information presented so that new concepts are easily

relatable to concepts already learned. Examples of devices that may be used include: pictures, titles of stories, short video, segment, a paradigm, reviews of previously learned concepts etc. (direct quote from David Ausubel's cognitive leaning theory).

4. **Anchorage:** The major concepts (subsumers) in cognitive structure act as anchoring posts for new information. The availability of anchoring ideas facilitates meaningful learning. Antecedent learning usually facilitate meaningful learning when it is clear, stable, and well organized. So the cognitive stability provided by anchoring ideas helps to explain why meaningful learning is retained longer than rote learning.

#### **Some Principles to be Considered in the use of the Organizer**

- i. To effectively present a new material, we must increase the stability and clarity of our students cognitive structure.
- ii. The sequence of the curriculum should be organized such that each successive learning is carefully related to what has been learned before.
- iii. Introductory material should be presented ahead of the learning task and at a higher level of abstraction and inclusiveness than the learning task itself. Ausubel's theory of advance organizer fall into two categories:

**Comparative and Expository organizer:** Its main goal is to active existing schemas, similarly they act as a reminders to bring into the working memory of what one may see as relevant. A comparative organizer is used both to integrate as well as discriminate. It integrate(s) new ideas with basically similar concepts in cognitive structure as well as increases discrminability between new and existing ideas which are essentially different but confusably similar.

**Expository Organizer:** In contracts, expository organizer provide new knowledge that students will need to understand the upcoming information. It is often used when the new learning material is unfamiliar to the learner. They often relate what the learner already knows with the new and unfamiliar material – this in turn is aimed to make the unfamiliar material more plausible to the learner.

**Retention:** Retention can be defined as ability to recall information Ausubel (1062) view of retention was linked to his theory of subsumption. Subsumption and anchoring ideas, help to facilitate learning and retention. According to him, retention is influence by three factors.

- a. The availability in cognitive structure of relevant subsuming concepts at an appropriate level of inclusiveness.
- b. The stability and clarity of these concepts and
- c. Their discriminability learning task. Learners who possess well organized cognitive structures tends to retain information affectively while learners who have poorly organized cognitive system tend to forget information rapidly.

#### **Concept of Emerging Technologies**

The word 'emerge' or 'emergent' means "the process of coming into being or of becoming important and prominent" (New Oxford American Dictionary) or "to rise up or come forth, to become evident, to come into existence" (The American Heritage Desk Dictionary and Thesaurus). The understanding of emerging technologies also depends on the analyst's perspective. An analyst may consider a technology emergent because of its novelty and expected socio-economic impact, while others may see the same technology as a natural extension of an existing technology. In addition, emerging technologies are often grouped together under 'general label's (e.g. nanotechnology, synthetic biology), when they might be better treated separately given their different sociotechnical features (e.g. technical difficulties, involved actors, applications, uncertainties).

Often on definition of the central concept of an emerging technology is provided. It is no surprise therefore that approaches to the detection and analysis of emergence tend to differ greatly even with the use of the same or similar methods. The operationalization of emergence is also in a state of flux. It changes as new categorizations (e.g. new terms in institutionalized vocabularies, new technological classes) are created within

databases. However, Emerging Technologies according to Bozalek (2018) are those technologies, which are likely to have a large impact on teaching and learning or creative inquiry on learners or those technologies which are on the rise.

An Emerging Technology is one that is not in 'common' use currently in education, but which has the potential to be more widely adopted to support improvements in teaching and learning. Many of these technologies have been emerging for a number of years. Many continue to evolve at pace and will be in a state of continuous 'emergence' (Education Scotland, 2023).

Emerging Technologies (ET) are innovative tools, applications, or advancements that are currently developing or will be developed in the near future, which have the potential to change the current state of affairs in teacher education.

### **Emerging technologies and their integration in teacher education**

1. **Virtual Reality (VR):** Virtual Reality is an Emerging Technology that delivers a computer-generated simulation of an environment that may be interacted within an apparent real-time manner (Marougkas, Troussas, Krouska & Sgouropoulou, 2023). Virtual Reality is an artificial environment or an electronic simulation created with computer hardware and software and presented to their user in such a way that it appears and feels like a real environment. Virtual Reality (VR) is any media system that provides "synthetic, highly interactive Three Dimensional (3D) spatial environments" that simulate real or non-real situations using a mosaic of technologies (Mikropoulos & Natsis, 2011). Virtual Reality offers Three Dimensional (3D) computer environments with advanced forms of interaction that can provide motivation to the learning process. Virtual Reality (VR) comprises of collection of technologies: 3D displays, motion tracking hardware, input devices, software frameworks and development tools. For example, Google's Expeditions platform allows teachers to take students on virtual field trip to explore historical sites, museums, and natural wonders (Google, 2021). Additionally, AR applications like HP Reveal enable teachers to create interactive learning experiences by overlaying digital content onto physical objects or environments (HP Reveal, 2021).
2. **Augmented Reality (AR):** Augmented Reality (AR) is an Emerging Technology that can provide immersive learning experiences for students. AR overlays digital content onto the real world, allowing students to interact with virtual objects in a real-world environment. VR, on the other hand, creates a completely immersive environment that students can explore and interact with. Within all the resources that technology provides to teachers, Augmented Reality is positioned as a technology with enormous potential (Lorenzo & Scagliarini, 2018). Augmented Reality (AR) enhances teaching and learning with virtual information added to real-world objects. This technology has been successfully integrated to enrich education at different levels of education and fields of education. Virtual Reality (VR) as the digital technology that recreates lifelike experiences in virtual environments has opened up new possibilities and more opportunities for situated practice in teacher education (Billingsley, Smith & Meritt, 2019).
3. **Artificial Intelligence (AI):** Artificial Intelligence (AI) has the potential to revolutionize education by providing personalized learning experiences for students. AI can help teachers create assessments, provide feedback, and adapt lessons to meet the needs of individual learners. For example, AI powered platforms like Content Technologies can analyze student work and provide personalized feedback, helping them to improve their skills and understanding. The integration of artificial intelligence (AI) holds promise for personalized learning experiences tailored to individual student needs (Brown & Jones, 2021). In teacher education, AI can assist in designing adaptive instructional strategies, offering targeted feedback and identifying areas for professional growth. AI can help teachers manage their workload by automating administrative tasks such as grading and scheduling. This allows teachers to focus on more important tasks such as developing lesson plans and providing support to students. According to a report by EdTech Magazine, AI can help teachers save up to 20 hours per week on administrative tasks (EdTech Magazine, 2020).
4. **Internet of Things (IoT):** The Internet of Things (IoT) is an emerging technology that involves connecting everyday objects to the internet, allowing them to communicate and exchange data. In

education, IoT can be used to create smart classrooms that are equipped with sensors and devices that can monitor student engagement and performance. IoT has the potential to transform education with technological integrations that will increase the interconnectivity of divisions within academic institutions. Over the years, academic have undertaken substantial research on the desire for student performance improvement. Initially, teacher-centred pedagogy was the norm with the instructor as the master of knowledge and the learner as the receiver (Serin, 2018). For example, IoT devices like smart boards and interactive whiteboards can be used to create interactive lessons that adapt to the needs of individual learners. Smart sensors can be used to monitor student engagement and behaviour in the classroom, providing teachers with real-time data that they can use to improve their teaching practice.

5. **Cyber Security:** With the increasing use of technology in education, Cyber Security has become an important issue for schools and universities. Cyber Security is an emerging field that focuses on teaching students how to protect themselves and their institutions from cyber threats. According to a report by Cyber security Venture, the global Cyber Security workforce shortage is expected to reach 1.8million by 2022 (Cyber Security Ventures, 2018). Cyber Security education can help address this shortage by preparing students for careers in this field. Cyber Security education can be integrated into teacher education programs by providing training on Cyber Security best practices for educators. This includes training on how to present student data, how to identify cyber threats, and how to respond to cyber incident. Cyber security education can also be integrated into curricula by teaching students about cyber safety and cyber ethics.

### **Benefits of Integrating Emerging Technologies in Teacher Education**

The benefits of integration emerging technologies in teacher education are multifaceted. Firstly, it enhances the quality of teaching and learning experiences by providing access to a wide range of digital resources and tools (Selwyn, 2016). Secondly, it fosters the development of digital literacy skills among teacher, enabling them to navigate the ever-evolving digital landscape confidently (Lawless & Pugh, 2015). Thirdly, it promotes collaboration among educators, students, and stakeholders, facilitating the sharing of best practices and innovative teaching strategies (Cuban, 2001). Lastly, it empowers teachers to become lifelong learners, constantly seeking opportunities for professional growth and development (Hsu, Hwang & Wang, 2019).

The impact of integrating Emerging Technologies on global competitiveness is substantial, as education becomes a key determinant in preparing students for the demands of an interconnected and technologically driven world (P21, 2021). The development of 21<sup>st</sup> century skills through technology-infused pedagogy positions students and educators alike to meet the challenges of the future (OECD, 2018).the competitive edge gained through these advancements is essential not only for individual success but also for the collective advancement of societies in the global arena.

The rapid evolution of technology necessitate a dynamic and responsive approach to teacher preparation (Niess, 2017). Looking forward, the future of teacher education lies in continued research and innovation. For instance, Chen and Wang, (2018) opined that Virtual Reality (VR) and Augmented Reality (AR) can create immersive environments that simulate real-world scenarios, allowing teachers to demonstrate complex concepts or historical events in a more engaging manner. According to a report by Goldman Sachs, the global market for Augmented Reality (AR) and Virtual Reality (VR) in education is expected to reach \$700 million by 2025 (Goldman Sachs, 2019). These technologies can be used in a variety of subjects including science, history and mathematics. For example, AR can be used to create interactive 3D models of molecules in chemistry classes or historical artifacts in history classes. Virtual Reality (VR) can be used to create immersive simulations of historical events or natural phenomena.

### **Challenges of Integrating Emerging Technologies in Teacher Education**

1. **Inadequate Infrastructure and Resources:** One significant challenge in integrating emerging technologies in teacher education is the lack of adequate infrastructure and resources, particularly in underprivileged schools and regions (Cuban, 2001). This issue can limit the accessibility and effectiveness of technology-based learning experiences for both teachers and students. In

underfunded schools, outdated equipment and slow internet connections can hinder the successful implementation of innovative teaching methods.

2. **Digital Divide between Urban and Rural Areas:** The digital divide between urban and rural areas can also hinder equal access to technology, creating disparities in educational opportunities (Lawless & Pugh, 2015). Teachers and students in rural areas often have less access to high-speed internet and modern technology compared to their urban counterparts. As a result, they may struggle to keep up with advancement in education and miss out on valuable learning experiences.
3. **Limited Training and Support for Teachers:** Teachers may face difficulties in adapting to new technologies due to limited training and support (Mishra & Koehler, 2006). Many educators feel overwhelmed by the rapid pace of technological advancements and may struggle to integrate them into their teaching practices effectively. Providing ongoing professional development opportunities and support for educators is crucial to overcoming this challenge and ensuring that they feel confident and prepared to incorporate emerging technologies into their classrooms.
4. **Data Privacy, Security, and Digital Citizenship Concerns:** Lastly, concerns regarding data privacy, security, and digital citizenship must be addressed to ensure a safe and responsible use of technology in educational settings (Ricber-Eisenbach, 2015). With the increasing use of online platforms and digital tools, it is essential to teach both teachers and students about the responsible use of personal information, cyberbullying prevention, and online etiquette. Ensuring that educators and students understand the potential risks associated with technology use can help mitigate these concerns and promote a positive and secure learning environment.

## RECOMMENDATIONS

From the foregoing discussion, the following recommendations have been made:

1. Governments and educational institutions should prioritize investing in infrastructure improvements in underprivileged schools and rural areas to ensure equal access to technology for all students and teachers.
2. Develop comprehensive training programs that equip teachers with the skills and knowledge needed to effectively integrate emerging technologies into their teaching practices. These programs should be ongoing to support continuous professional development.
3. Incorporate digital literacy education into teacher training programs to address concerns related to data privacy, security, and digital citizenship. Educating both teachers and students on responsible technology use is essential for creating a safe online learning environment.

## CONCLUSION

Emerging technologies such as; Artificial Intelligence (AI), Augmented Reality (AR), Virtual Reality (VR), Internet of Things (IoT), Cyber Security etc, have the potential to transform teacher education by enhancing personalized learning experiences, facilitating data-driven instruction, enabling immersive learning experiences, promoting secure record-keeping systems and supporting remote learning initiatives. By integrating these technologies into teacher education programs, educators can better prepare students for the global competitiveness of the 21<sup>st</sup> century. Despite these positive impacts, challenges such as the digital divide and the need for continuous teacher training must be addressed to ensure equitable access and effective implementation (Garcia-Sanchez, 2022). Nevertheless, the overall impact on global competitiveness is undeniable, positioning educators and students to thrive in an increasingly interconnected and technologically-driven world.



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