




FEDERAL UNIVERSITY OF TECHNOLOGY,  
MINNA, NIGER STATE, NIGERIA  
SCHOOL OF SCIENCE AND TECHNOLOGY EDUCATION

**8<sup>TH</sup> SSTE**  
**INTERNATIONAL**  
**CONFERENCE**

THEME  
**Emerging**  
**Trends**  
**in STEM and TVET**  
**in the** **21<sup>ST</sup>**  
**Century**



6TH - 8TH OCTOBER, 2021  
VIRTUAL CONFERENCE

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FEDERAL UNIVERSITY OF TECHNOLOGY, MINNA

**8<sup>th</sup>**

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THE 21<sup>ST</sup> CENTURY**

**DATE 6<sup>th</sup> – 8<sup>TH</sup> OCTOBER, 2021**

**FEDERAL UNIVERSITY OF TECHNOLOGY, MINNA**

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FEDERAL UNIVERSITY OF TECHNOLOGY, MINNA

8<sup>th</sup> INTERNATIONAL CONFERENCE OF SCHOOL OF  
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## VIRTUAL CONFERENCE

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### ACKNOWLEDGEMENTS

Local Organizing Committee of the 8th International Conference of School of Science and Technology Education (SSTE), Federal University of Technology, Minna, appreciates the Management of the University for the Unflinching Support given to the team which led to the success of this Conference. We also wish to express our profound gratitude for the assistance rendered by the University Management especially in disseminating information relating to this Conference using the University website, Campus News, and FUT Search FM.

Thank the Dean, School of Science and Technology Education (SSTE) for hosting this Conference despite the economic situation and the COVID-19 Pandemic in the country. His encouragement, advice, and moral support gave the Local Organizing Committee the strength to complete this task and make sure the Conference is successful.

Sincerely thank the academic staff of the School and University Community for their essential roles played towards the success of the Conference. We thank the non-teaching staff for their roles which contributed to the success of this Conference.

Efforts of the Editorial Board are commendable for making sure that the Book of Proceedings was ready. We appreciate the efforts of the Keynote presenter, Lead Paper presenters, and others for attending this Conference despite their tight schedule.

We also commend the undergraduate and postgraduate students of the School for sparing their time for participating in all the events. Above all we thank God Almighty for the strength given to the LOC members to discharge their enormous tasks.

### PREFACE

Science, Technology, Engineering and Mathematics (STEM) and Technical and Vocational Education and Training (TVET) are very relevant in the 21st-century education. 21st-century education is about giving students the skills they need to succeed in this new world and helping them develop the confidence to practice those skills. The 21st-century skills focus more on making sense of that information, sharing and using it in smart ways. A focus on STEM and TVET could help in equipping students for life and work in the 21st Century.

STEM and TVET are considered critical as they tend to remove boarder between the disciplines by making the students to comprehend the world as a whole rather than in parts. STEM is interdisciplinary approach to learning where rigorous academic concepts are coupled with real world lessons while TVET takes individuals into account by providing all kinds of skills (or jobs).

Hence, the theme of this conference is apt and provides opportunities where experts brainstorm so that international communities can benefit from one another and also respond to emerging trends in *STEM* and *TVET* in the 21<sup>st</sup> Century. It is worthy to note that, proper implementation of the 21st-century STEM and TVET issues would have a greater influence on the quality of manpower injected into the labour market which may determine the economic growth of any nation.

The theme and sub-themes of this conference, "Emerging Trends in *STEM* and *TVET* in the 21<sup>st</sup> Century" are based on the prevailing circumstance in education sectors in developing nations. I am sure this conference has provided an avenue for researchers and educators to share their ideas on the 21st-century emerging trends in STEM and TVET that can enhance quality education and self-reliance in underdeveloped and developing nations across the world. I hope the theme and sub-themes meet the needs of the stakeholders in education.

The sub-themes are:

- STEM and TVET for Economic Diversification
- STEM and TVET for Human Resource Development
- STEM and TVET for National Security
- Curricular and Assessment issues in STEM and TVET
- Entrepreneurship in STEM and TVET
- Gender Equality/Issues STEM and TVET
- STEM and TVET for Life-Long Learning and Skills
- STEM and TVET for Special Education
- Instructional Approaches in STEM and TVET
- ICT in STEM and TVET
- Communication in STEM and TVET
- STEM and TVET for Global health Challenges
- STEM and TVET for Innovative Technology and Engineering Education
- STEM and TVET as Solution to COVID-19 Pandemic

The Local Organizing Committee is thankful to the participants of 2021 conference for their contributions. God bless you all.

**Dr. I. Y. Umar**  
**LOC Chairman**

**A WELCOME ADDRESS GIVEN BY PROF. AMOSA ISIAKA GAMBARI,  
DEAN, SCHOOL OF SCIENCE AND TECHNOLOGY EDUCATION,  
FEDERAL UNIVERSITY OF TECHNOLOGY, MINNA, NIGERIA, AT  
THE OPENING CEREMONY OF THE 8<sup>TH</sup> INTERNATIONAL  
CONFERENCE OF THE SCHOOL.  
1<sup>ST</sup> – 5<sup>TH</sup> OCTOBER, 2021**

**Protocol**

It is with great delight that I warmly welcome you all, on behalf of the staff and students of the school of science and technology education (SSTE), Federal university of technology, Minna, to the 8<sup>th</sup> international conference of the school. I am glad that you all found time to be part of this ceremony to usher in another moment of robust deliberations on issues bothering on the progress of our immediate society in Nigeria and elsewhere in Africa and beyond.

I extend my warm welcome to our distinguished Keynote Speaker, Professor Joseph De-Beer of North West University, South Africa and our lead paper presenters, Professor Aloysius Uzoagulu of Enugu State University of Science and Technology, Dr. Islam Alhaji Abdou of Science, STEM and Bioethics Education, Egypt, and Professor Binyao Zheng of Kennesaw State University, USA. These carefully sourced and selected scholars are true representatives of 21<sup>st</sup> century resource persons in science and technology education. They are chosen because of their passion and dedication to the development of the individual through science and technology education and of the society at large. I appreciate all participants who are connected to us from different parts of the world and we believe that together, we shall make the conference a success.

STEM and TVET are two very significant areas in science and technology education which deal directly with human capacity development for the advancement of the larger society. These are areas that have what it takes to build up or destroy the future of an individual or a society.

But, education is all about the development of the individual to the benefit of the society. Science and Technology Education is a factor to the technological growth and stability of every economy irrespective of its size or status. It is, therefore, of great importance to expose our generations to what it takes to grow and develop in this 21<sup>st</sup> century. Thus, this international conference is organised to bring together world experts to deliberate on emerging trends in STEM and TVET in the 21<sup>st</sup> century world of technology which are considered driving factors of economic growth and development.

The sub-themes of this conference were carefully extracted from the main theme *Emerging Trends in STEM and TVET in the 21<sup>st</sup> Century* to cover the major areas of impact of science and technology education globally including Covid-19 pandemic. The conference has great interest in capacity building and innovation as modern trends emerge in STEM and TVET.

This conference also covers current and fundamental issues relating to research and innovations in education which seeks to unravel the currency of the trends in science and technology to align education seekers to the realities of the time. This conference is, therefore, an avenue to bring together academic researchers and teachers of no mean reputation to deliberate on the new trends and the future of science and technology, globally. Global knowledge and experience in top level research that can engender scientific knowledge will be shared, presented and discussed internationally focusing attention on recent outstanding academic breakthroughs in science and technology education.

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The urgent needs of education in the present, are necessary skills designed to move learners to the top of the ladder of scientific breakthrough in education and technology. Hence, the various sub-themes cover such interests from both local and international perspectives to equip both teachers, learners, education providers and policy makers to revolutionise and renew initiatives.

Nigeria is struggling to make in-road into the league of technologically developed Nations, the impact is still far from being felt. The slow motion being experienced in the field of education can be attributed to archaic curriculum being circulated and used in schools. This type of curriculum that has little to show in the current dispensation of technological initiatives in science and technology cannot translate any learner to a scientist. Such obsolete learning can bedevil the good and spirited proposals of scientific development and equally weaken economic viability.

No society can rise beyond the level of her educational system, meaning that, every country is confined to the extent of her educational provisions and aspirations. A disadvantaged curriculum produces a disadvantaged populace in a disadvantaged economy.

Nigeria is still waiting for a curriculum where new things in science and technology will be enshrined, where provisions for laboratory furniture or technology study materials are provided, where students have trending tables and chairs for reading and writing, where teaching materials are provided and where technological development will be ensured.

These challenges are issues that this conference will address and proffer solutions to. With full knowledge of emerging trends in STEM and TVET in the 21<sup>st</sup> Century, lasting solutions are expected to emerge from this conference, where economic security strategies will be unveiled to enable science and technology education run on smooth wheels.

Ladies and gentlemen, you are welcome once again to this conference. I express my heart felt gratitude to the Vice Chancellor of this great and dynamic University and his management team for standing by us in every of our conferences. I am grateful to my colleagues in the School of Science and Technology Education and to our dear students for their support at every stage of the preparation for this conference. To all our participants, I wish you successful sessions and a fruitful outcome.

Thank you very much for your attention.

**A WELCOME ADDRESS PRESENTED BY THE VICE CHANCELLOR, PROFESSOR ABDULLAHI BALA, AT THE OPENING CEREMONY OF THE 8<sup>TH</sup> INTERNATIONAL CONFERENCE OF THE SCHOOL OF SCIENCE AND TECHNOLOGY EDUCATION, FEDERAL UNIVERSITY OF TECHNOLOGY, MINNA, ON 6<sup>TH</sup> OCTOBER, 2021**

**PROTOCOL**

It is my pleasure to welcome every participant, on behalf of the Governing Council, Management, Staff and Students of Federal University of Technology, Minna, to the 8<sup>th</sup> edition of the annual International Conference of the School of Science and Technology Education (SSTE) of our distinguished University. I specially welcome the Keynote Speaker, Professor Josef De-Beer and the eminent lead paper presenters, Professor Aloysius Uzoagulu of Nigeria, Dr. Islam Alhaji Abdou of Egypt and Professor Binyao Zheng of United States of America.

This 8<sup>th</sup> SSTE International Conference is a unique one being the first to go virtual, a signal of greater things ahead. The conference theme “**Emerging Trends in STEM and TVET in the 21<sup>st</sup> Century**” offers another opportunity to education Technology experts to explore global emerging trends in the education industry which is regularly shaped and reshaped by Technology. It provides a platform for scholars in academia to explore greater opportunities through well researched and exhaustively articulated and documented research efforts to unveil various pedagogical challenges frustrating effective teaching and learning in today’s world of science and technology. It is also an avenue for both local and international academic and research communities to share their breakthroughs in teaching and learning research as well as explore opportunities for further developments in science and technology education, not only in Nigeria but also in the world at large.

The conference presentations will provide direction to further incorporate and integrate greater and healthier methodologies into teaching and learning in STEM and TVET to reflect the 21<sup>st</sup> century skills and learning.

It is becoming evident now that the state of education in Nigeria, Africa and the world is facing pedagogical challenges that need innovative interventions to address. The current quality of education, especially in Science and Technology, has not taken Nigeria far and has no promise of doing so. This Conference is, therefore, designed to unmask and rearrange the methodological shortcomings hindering effective teaching and learning by affording brainstorming opportunities to local and international participants on the emerging global trends in Science and Technology education. The redemptive conference sub-themes have been built to address these challenges in various areas of developmental endeavour. What Nigeria needs now is the restoration of the glory of education through emerging trends in the 21<sup>st</sup> century classroom practices. This will mark the beginning of new things in STEM and TVET in a country zealously seeking for technological solutions to her numerous domestic problems.

The beginning of new things in STEM and TVET will be driven by the identification of the relevant skills needed to acquire the much desired technological innovation to upgrade learning abilities and competencies of students. Pedagogy explores the processes by which society deliberately transmits its accumulated knowledge, skills and values from one generation to another. The major methodological concern in the mind of education stakeholders is how to educate students in various institutions of learning to meet their corporate and individual needs. The ability to overcome this methodological concern will be based on willingness to overcome the teething concerns by meeting the educational goals set by the student and the teacher, and also the strategies put in place to achieve those goals. Also, such factors as the educator’s own philosophical beliefs, the curriculum provision and the availability or no availability of technological devices can affect the ability to overcome those learning concerns.

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The emerging trends in STEM and TVET in the 21<sup>st</sup> Century is robust technology application which drives humanity to major discoveries unlike in the old analogue world, ruled by ancient pedagogies. The world is moving on the fast lane and no learner will be left behind. I, therefore, challenge this conference to offer to our society the best and nothing but the best trends emerging now in Science and Technology education through 21<sup>st</sup> century pedagogies. The teachers of our children need to be placed in a position to produce world renown scientists and technology experts who can in turn pass the competencies to the future generations of scientific achievers. The Universities and other education providers should be willing and able to adopt emerging innovative trends and key into the accruing benefits for the survival and advancement in knowledge to the benefit of society. All hands must be on deck to ensure that our future generations align with the realities of the 21<sup>st</sup> century by ensuring genuine technological immersion.

At this juncture, let me congratulate the Dean of the School of Science and Technology Education, Professor Amosa Isiaka Gambari on his doggedness to see that this conference becomes a reality. I sincerely appreciate the efforts of the Conference Organising Committee and the entire staff of the School for their relentless efforts towards the success of this conference. Please, accept my best wishes.

Ladies and gentlemen, I welcome you once again to this International Conference, have a very fruitful and rewarding occasion. Enjoy your day.

Thank you for your attention.

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**Application of Learning Styles in Technical Education: Meta-Learning Perception**

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**Abstract**

*The idea of meta-learning describes the state of 'being aware of and taking control of one's own learning' while learning styles address the ways students perceive and process new information. This paper explores the perception in which meta-learning involving students' learning styles. An evolved conception is proposed in which meta-learning is a sub-concept within metacognition and self-regulation. It is professed as a kind of creativity that is best displayed by proactive self-regulators for whom deliberate self-regulated learning is a way of life. This perception of meta-learning is dependable with the 'awareness' and 'taking control of' elements of Biggs' original definition. The application of learning styles in conjunction with meta-learning concept is to help students of technical education to connect thinking about their own learning styles in order to achieve smooth learning processes.*

**Keywords:** Technical Education, Learning Styles and Meta-Learning

**Introduction**

Knowledge acquisition is realized through education and learning. Learning plays an important role in man's social progress, yet learning process is a complicated and multidimensional process. Psychologists and those involved in education have developed various methods of learning and teaching with regards to their own intellectual systems and proportional to the educational changes. It is expected that classroom learning be transferred into solving problems in real life situation. The inability of students to engage actively in the learning process (especially learning that require minds and hands like that of technical education) tends to dispose the students to constant rote learning and frustration leading to poor academic performance (Eze, Ezenwafor & Obi, 2015).

Technical education is an integral part of education that is meant to produce semi-skilled, skilled and technical manpower necessary to restore, revitalize, energize, operate and sustain national economy and largely reduce unemployment in the word of science and technology (FGN, 2013). The United Nations Educational, Social, and Cultural Organization (UNESCO) and The International Labour Organization (ILO) (2002) recommended that Technical education system should be geared towards lifelong learning that can maximize the creative potentials and skills of the individual through effective learning styles. Active learning style is required to uplift the sensational aspect of students for smooth learning process. This cannot be achieved if appropriate learning styles through meta-learning are not employed during and after instructional strategies for technical education students.

The appropriate learning styles among technical education have generated to meta-learning that helps students to have understanding, aware and control of the learning processes that lead to skill

acquisitions. The term meta-learning is synonyms with thinking about learning styles that individual adopted for learning processes. Through meta-learning, technical trades such as building trades, electrical/electronic trades, automobile trades, woodwork trades, metalwork trades among others trades in technical college can allow students to plan, execute, monitor and evaluate the learning activities by themselves. Thus, meta-learning can enhance technical college students' learning styles in order to assist learners to have a deeper awareness of the content and context in their specialized trades.

Meta-learning is originally described by Maudsley (1979) as "the process by which learners become aware of and increasingly in control of habits of perception, inquiry, learning, and growth that they have internalized". Based on this definition, Eze, Ezenwafor and Molokwu (2015) regard meta-learning as a student-centered (self-regulated) approach to teaching and learning. Meta-learning is then important in understanding the interaction between the mechanism of learning and the concrete contexts in which that mechanism is applicable. The field of meta-learning is focused on the relation between tasks or domains and learning strategies that can be used to improve learning style of learners.

Maudsley's conceptual on meta-learning synthesized under headings and assumptions, structures, change process and facilitation. He enunciated five principles that facilitate meta-learning in which students (technical education students) must;

- a. Have a theory, however primitive
  - b. Work in a safe and supportive social and physical environment
  - c. Discover their rules and assumptions
  - d. Reconnect with reality (information from the environment) and e. recognize themselves by changing their rules and assumptions.
- The design was later adopted by Biggs (1985) to describe the position of being aware of and taking control of one's own learning. According to Biggs, the concept is framed around the idea of being aware of and taking control of one's own learning. Implicit in this conception is that technical education students need to have knowledge of how they learn, have the motivation to be proactive in managing themselves and the capacity to regulate their learning styles.

### **Technical Education**

Technical education is expected to create manpower that will assist to uplift Science and Technology to the next level to solve human problem. A level of understanding of learning that can be possessed to solve human problem requires technical students to know how to learn, can learn and develop their learning styles to achieve smooth learning process. Technical education is an aspect of education that exposes the learner to acquisition of demonstrable skills that could be transformed into economic benefits (Akerele, 2007). However, UNESCO and ILO 2002 sees technical education as a comprehensive term which encompasses the study of technologies and related sciences, and the acquisition of practical skills, attitudes, understanding and knowledge related to occupations in various sectors of economic and social life.

According to Man (2005) technical education is the systematic and orderly transmission of knowledge, skills and values to develop a workforce that is able to enhance productivity and sustain competitiveness in the global economy. The Federal Republic of Nigeria (FRN, 2004) affirmed the goals of vocational technical education as to;

1. Provide trained manpower in the applied sciences, technology and business particularly at craft and advanced craft levels.
2. Provide the technical knowledge and vocational skills necessary for agricultural, commercial and economic development.
3. Give training and impart necessary skills to individuals who shall be self-reliant economically. These can only be achieved if students of technical education are engaged with right learning styles that involve meta-learning skills.

### **Learning Styles in Technical Education**

Just as teachers develop preferences for particular methods, students develop preferences for particular way of learning which is called learning styles. Teachers and students, probably have preferred ways of perceiving and processing new information. These preferred ways can be called learning styles. Educators cannot dismiss the fact that individuals have preferred ways of learning throughout different stages of learning.

Learning styles address the ways students perceive and process information. Perceiving relates to the way students notice the learning and the way the reality of learning is. Processing relates to the way students internalize an experience and make it their own. Some students prefer to perceive the learning through *concrete experience*. These students of technical education perceive by sensing and feeling, and prefer to use intuition to solve the problems of a given task showed. They function well in unstructured situations. Other students prefer *abstract conceptualization*. They like to think things through, analyze and intellectualize. They function well in structured situations. Some students prefer to process new information by *active experimentation*. They like to roll up their sleeve and immerse themselves in the task. They look for practical ways of applying what they learn. They embrace risk-taking and are results oriented. Other students process through *reflective observation*. They like to watch and ponder the situation. They likely see tasks from several points of view. These students value patience and judgment. Concrete experience, abstract conceptualization, active experimentation and reflective observation are four general learning styles.

### **Theories of Learning Styles and Categories of Learning Styles**

There are numerous theories of learning styles and categories of learning styles associated with the theories. Rita Dunn and Kenneth Dunn's learning styles inventory focuses on the environmental, emotional, sociological, physiological and psychological aspects of learning in which all students must find themselves in one or two aspects. Howard Gardner's theory of Multiple Intelligences derives nine learning styles from his nine intelligences. Their learning styles are derived from combinations of these aspects.

**Global or Feeling:** prefer to have big pictures of tasks presented first. Learn most effectively when a meaningful context is provided.

**Analytic or Thinking:** prefer to have small steps build to whole. Learn most effectively when pieces are provided first.

**Verbal:** rely on words and labels. Prefer to have definitions over images.

**Imaginal or Intuitive:** prefer to have images (concrete or abstract), metaphors, symbols and diagrams. Difficult concepts are best explained through images.

**Concrete or Sensing:** prefer concrete examples, followed by concepts or principles.

**Abstract or Intuitive:** prefer concepts of principles prior to concrete examples.

**Haptic, Trial and Feedback or Judging:** prefer doing tasks and hands-on applications followed by feedback. Prefer to make errors and build on trials and errors.

**Reflective or Perceptive:** prefer to think through and reflect on tasks prior to trials. More dependent on time to respond than on external feedback.

**Relational:** prefer to link new material to what is already known, or unfamiliar tasks to familiar tasks. These students need time to discuss what is being learned prior to executing the tasks.

Generally, the following nine learning styles, in pairs, are considered to be the most common. Of course, most of students' function by accommodating combinations of a range of learning styles. The most common test of learning style is the 126 items Myers-Briggs Type Indicator (MBTI), Form G. The MBTI provides data on four sets of preferences. These preferences result in 16 learning styles, resulting from combinations of Introversion versus Extraversion, Thinking versus Feeling, Sensing versus Intuition and Judging versus Perceptive.

**Thinking** students value fairness. They place great weight on objective criteria in decision making and judge situations on logic and reason. Data on *Star Trek* had an extreme preference for thinking.

**Feeling** students value harmony. They focus on emotions and needs as they make decisions or arrive at judgments. They tend to be good at conversation, persuasion and facilitating differences among group members. The character played by Whoopi Goldberg on *Star Trek* demonstrated an extreme preference for feeling. Some students choose to rely on their five senses and prefer taking in information through a "sixth" sense. **Sensing** students are detail oriented and want facts and explanations. **Intuitive** students, on the other hand, seek out patterns and relationships among pieces of information. They trust hunches and their intuition and look for the "big picture." Some of students prefer to postpone action and seek more information. **Judging** students are decisive, plan out their decision and are self-regimented. They focus on completing the task, only want to know the essentials, and speak or act quickly, often too quickly. Deadlines and clearly defined roles are extremely important. They prefer to "just do it!" **Perceptive** students are curious, flexible and relatively spontaneous. They start many tasks, have to know the details about each task and often find it hard to complete a task.

Another learning style theory is that of Bernice McCarthy's learning style theory which is based on right brain, left-brain neurological science. Bernice McCarthy expanded on Kolb's learning cycle, and defined her four general learning styles as Imaginative, Analytic, Commonsense and Dynamic in which technical education students can find themselves: "*imaginative learners prefer to experience and reflect, analytic learners prefer to conceptualize and reflect, commonsense learners prefer to experiment and conceptualize and dynamic learners prefer to experiment and experience*".

McCarthy stresses that students should accommodate all four of these learners in our activities or lessons.

Most learning styles, including McCarthy's, are based of perceptual modality preferences. Perceptual modality refers to the way we perceive or take in the world. The notion of sense modalities is based on the Perceptual Learning Styles theory of French, Gilley and Cherry. Perceptual learning styles refer to the means by which learners extract information from their surroundings through the senses. Each individual has a preferred sense for accessing knowledge—they use different "pathways" specific to them. Initially, knowledge is stored in short-term memory. Repeated exposure, experience and application promote retention in long-term memory.

Perceptual Learning Styles refer to the pathways we use to access and reinforce knowledge. According to this theory, there are seven pathways or learning styles at work in the average classroom: These seven pathways or learning styles can be adopted and adapted for students of technical education:

1. **Print:** refers to seeing printed or written words.
2. **Aural:** refers to listening.
3. **Interactive:** refers to verbalization.
4. **Visual:** refers to seeing visual depictions such as pictures, graphs.
5. **Haptic:** refers to the sense of touch or grasp.
6. **Kinesthetic:** refers to whole body movement.
7. **Olfactory:** refers to sense of smell and taste.

For example, dynamic and common sense learners tend to be haptic, kinesthetic or enactive. They prefer to learn by physical contact and the "mind's hand." Imaginative learners tend to be visual or iconic. They prefer to learn by figural and spatial thinking or the "mind's eye." Analytic learners tend to be auditory or symbolic. They learn through verbal thinking or the "mind's ear."

Meta-learning Perceptions

**We all permeate words with different meanings. The conception and propositions of meta-learning is perceived as:** a collection of learning methods that people utilize to help them learn; learning about learning; personal knowledge of learning; metacognition in action; meta-learning embraces more than cognition; it embraces the affective, cognitive mind, body, emotions/feelings; consciousness/awareness of own learning practices and study strategies; awareness of own approaches to learning; imagining possible ways of learning. **Norman (2004) reveals a number of things about the way meta-learning is perceived. For example:**

- The strong connection of meta-learning to metacognition, self-awareness, self-identity as a learner and reflection as a process for achieving this self-awareness as a learner.
- Meta-learning as a product (knowledge), a thought process (a way of thinking to create routes to new learning), an attitude or habit (a way of engaging in learning and life more generally perhaps), a behavioural process (active regulation of behaviours in ways that will enhance learning).
- A way of growing knowledge about learning by imagining and thinking about the future, the present and the past.

According to Davenport and Prusak (2000) meta-learning definition depends on the perception of individuals and its usages. Using conception of Davenport and Prusak generated from participants in email discussion, meta-learning defines as:

- A collection of learning methods that people utilize to help them learn
- Higher levels of learning
- Learning about learning
- Personal knowledge of learning
- Being aware of and taking control of one's own learning
- Changing perceptions of learning
- Knowledge about how other people learn in order to help me learn (selfish or selfless knowledge depending on purpose)
- Metacognition
- Metacognitive skills
- Applied metacognition
- Metacognition in action
- Metalearning embraces more than cognition, it embraces the affective, cognitive, conative and also embodiment... mind, body, emotions/feelings
- Consciousness/awareness of own learning practices and study strategies
- Awareness of own approaches to learning
- Awareness of what works or doesn't work
- The advisory function to self about how to learn in a particular situation
- Learning through reflection, reflective skills, different forms of reflection
- Taking the learning context into account
- Recognizing own motivations for learning
- Knowledge of self as a learner in a context
- A sense of identity in the learning process
- A sense of engagement with learning processes
- Regulating own behaviours in order to learn better/more deeply
- Helping people to be more effective learners
- A route to further metacognition
- The ability to stand back and see the bigger picture for learning
- Capacity to think about processes for learning
- Imagining possible ways of learning
- Imagining the future
- Ability to connect and use different sorts of knowledge creatively

Meta-learning as Metacognition

Flavell (1979) defines metacognition in terms of 'higher order thinking to actively control the cognitive processes engaged in thinking and acquiring knowing' (learning). It involves thinking about thinking and it must therefore include thinking about learning.

*Is the whole concept of meta not that of 'thinking about'? So metacognition is thinking, to good purpose, about how the processes of cognition work, and in particular, about how they can work for users. Meta-learning is thinking about how one's learn, and can learn and develop more effectively.*

Activities such as planning how to approach a given task, monitoring, understanding and learning needs, and evaluating progress towards completion of the task or modifying the task as additional factors emerge, are metacognitive in nature. Wenden (1998) described 'metacognitive knowledge' as the 'facts learners acquire about their own cognitive processes as they are applied and used to gain knowledge and acquire skills in varied situations: People consciously or unconsciously use this knowledge to create metacognitive strategies, strategies about learning rather than learning strategies themselves. These strategies include, for example:

11. Planning—deciding what to do and how to do it (pre-planning) and modifying plans while you are doing it (planning in action).
12. Directed and Selective attention—deciding in advance to work on the general aspects of a task and deciding in advance to concentrate on certain things.
13. Self-monitoring—checking one's performance when engaging in a task.
14. Self-evaluation—appraising one's own performance in relation to self or external criteria or standards.
15. Self-reinforcement—rewarding oneself for success.

According to Flavell (1979), metacognition consists of both metacognitive knowledge and metacognitive experiences of regulation. Metacognitive knowledge refers to acquired knowledge about cognitive processes; knowledge that can then be used to control cognitive processes. Knowledge is considered to be metacognitive (rather than cognitive) if it is actively used in a strategic manner to ensure a goal is met. Flavell distinguishes between knowledge of person variables, task variables and strategy variables. *Knowledge of person variables*: refers to knowledge about how human beings learn and process information, as well as individual knowledge of one's own learning processes. *Knowledge of task variables*: includes knowledge about the nature of particular tasks or more generalized knowledge about types of task as well as the processing demands that will be placed upon the individual. *Knowledge about strategy variables*: include knowledge about both cognitive and metacognitive strategies, as well as conditional (contextual knowledge) about when and where it is appropriate to use such strategies.

The basic meta cognitive strategies in meta-learning according to (Dirkes, 1985; and Blakey & Spence, 1990) are connecting new information to existing (personal) knowledge, selecting thinking strategies intentionally and planning, monitoring and evaluating thinking processes. The idea of meta-learning sits fairly and squarely within metacognition: that part of metacognition that is devoted to the act of learning in relation to learning styles. There is a merit for students to trace their learning styles through metacognition. To do this, learning styles have to be connected to the process of thinking about learning that allow students to be aware and control their own learning.

### **Meta-learning and Self-regulation**

Biggs' (1985) definition of meta-learning included the idea of 'taking control of one's own learning'. This requires learners to consciously regulate their thinking and behaviours in ways that will achieve desirable outcomes and results for a particular context. It is therefore important to consider the idea of self-regulation. Schunk and Zimmerman (1994, 1997, 1998), Zimmerman (2000) and Zimmerman and Schunk (2004) provide a well-developed scientific construction to explain the links between thinking, actions and the environment (problem situations and learning contexts) within which thinking and action occurs.

Some social cognitive researchers describe self-regulated learning in terms of self-determined processes and associated self-beliefs that initiate, change and sustain learning in specific contexts. These processes and beliefs are linked to three fundamental questions about students' self-regulated approach to learning.

*How questions refer to students' use of metacognitive processes such as planning, organizing, self-instruction, self-monitoring and self-evaluating. Where questions pertain to behavioral processes such as selecting, structuring and creating learning environments that optimize growth. High levels of motivation are necessary to self-regulate when short term goals must be subordinated to long term goals and ultimate gratification must be delayed. In summary, self-regulation refers to metacognitive, behavioral and motivational processes and beliefs used to attain personal learning goals in specific contexts. (Zimmerman, 2000).*

The processes and beliefs that underlie self-regulation are constantly adjusted in response to changes in three sources of control: personal, behavioral and environmental (Zimmerman, 2000). Each of these sources is also changing during learning and each source must be self-monitored and adjusted using feedback mechanisms constructed by the learner. Highly self-regulated people are strategically flexible, environmentally resourceful and perceptive of personal agency. A self-regulated system for learning can be represented as a continuous process that involves *forethought*, *performance* and *self-reflection* operating within a context specific environment that is structured by the learner to provide resources for learning.

*Forethought* involves thinking about the tasks, problems and contexts for learning. The model identifies two subordinate categories—task analysis and self-motivational beliefs.

*Performance* is the doing part of the process. It includes the capacities and attitudes to instruct self and seek help to learn, the self-management of tasks, the creation of processes for learning and the structuring of the environment in order to learn.

*Self-reflection* phase involves both self-judgments and self-reactions to those judgments. The two key self-judgment processes are self-evaluation and attributing causal significance to the results.

Zimmerman and Schunk (2004) draw the distinction between proactive and reactive self-regulators in terms of self-regulatory processes and beliefs. Reactive learners avoid *forethought* and attempt to regulate functioning during and after performance whereas proactive learners engage in *forethought* in order to improve the quality of subsequent phase functioning. It might also distinguish between learners with high levels of self-awareness and intentionality, and those with less well developed. The development of capacity for self-regulated learning have been seen as a process in which the technical educator can play an active and facilitative role to the way of growing knowledge about learning known as meta-learning.

Norton and Walters (2005) explained that meta-learning depends on the learner's conceptions of learning, epistemological beliefs, learning processes and academic skills which are summarized as learning approach that students can adopted and used as their learning styles. Through meta-learning students of technical education can plan, execute, monitor and evaluate the learning

activities to gain smooth learning process that can lead to academic success. Therefore, meta-learning can enhance technical education students to have a deeper awareness of the content and context of the learning process within their learning styles in their specialized trades

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