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# INTEGRATION OF HIGH-TECH COMMUNICATION PRACTICES IN TEACHING OF BIOLOGY IN INDONESIAN HIGHER EDUCATION INSTITUTIONS

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## ABSTRACT

The integration of Information and Communication Technology (ICT) in education introduced high-tech practices in teaching and learning in universities useful for both teachers and learners. The main objective of this study was to investigate the extent to which such high tech communication strategies and practices have been embedded in the teaching and learning of biology in Indonesian higher education institutions (HEIs). The high tech communication practices included the use of tablets/laptops and taking assistance of such human behavioral and communication practices which stimulated both teachers and students to optimize teaching and learning processes. This study emphasized the fact that Biology being central to the scientific learning is required in the study of advanced domains like medicine, genetics, zoology, etc. Hence, for the successful dissemination of the knowledge of biology through teaching, the instructors need to have access to and familiarize with the pedagogical principles and management strategies used in classroom instruction. This study attempted to understand how the high-tech communication practices should be integrated in the teaching of biology in Indonesian higher education institutions. No doubt, 'communication biology' has the potential to evolve into a scientific study in the field of communication science and educational practices. The need is to build a framework of a new paradigm of communication biology which is expected to contribute to the development of the education system in the Indonesian HEIs. This study will potentially draw attention of the academicians and policy makers towards integration of such advanced communication practices in teaching of biology in the Indonesian HEIs.

**Contribution/Originality:** This study contributes to finding how high-tech communication practices integrate with the teaching of biology to design the framework of a new paradigm of 'communication biology.' It states how this new term, 'communication biology,' can potentially evolve into a scientific study in the field of communication science and educational practices.

## 1. INTRODUCTION

The domain of education has grown tremendously with the help of information and communication technology (ICT). Darmawan, Ruyadi, Abdu, and Hufad (2017) observe that the communication process under which learning and knowledge is gained requires analyzing and understanding the information being passed across in educational institutions. Communication has in fact become synonymous to education in the teaching and learning process which is also necessary, due to the transitional state of education (Luther, 2000). Besides, the growing scientific and high-tech culture in a pluralistic society has also increased the need to develop formal communication patterns for comprehending the factual knowledge around them which students need to learn, construct a conceptual framework

and develop hypotheses, particularly to understand scientific concepts (Joseph, 2010). In schools and colleges, academicians, policy makers and instructors emphasize on such scientific communication through science education particularly in early stages of education such as primary and secondary levels (Baram-Tsabari & Osborne, 2015). The young audiences at these levels need perpetual inputs that can help them to choose their careers as scientists, researchers or science practitioners in science industries.

Such formal scientific communication is carried out through seminars, workshops, extra-curricular experiments in addition to a scientific pedagogy and a state-of-the-art curriculum. The scientists disseminate scientific communication in the macro or external environment while schools and teachers represent the micro or internal platforms to impart the scientific understanding of the subjects under study. Such scientific communication is based on pedagogical practices embedded in the teaching and learning of science subjects. The advantage of pursuing science communication through educational institutions is to decipher the controversial scientific concepts that often become increasingly difficult to agree upon. A well framed science curriculum and appropriate pedagogy helps young minds to develop the empirical and scientific approach to problem solving and comprehending complex issues.

The use of high-tech communication practices to study biological sciences is not an exception. The communication patterns to teach biology need to undergo a proactive process. Biologists should globally adopt high tech methods to teach biology making this subject the core of informational science. For instance, a student of biology needs to understand the embedded genetic codes in molecules, the structure and function of proteins, the regulations and gene sequences, DNA microarrays and like. This requires a communication network which should have computer models, IT tools such as microscopes and databases, gene and protein data banks and like. These communication devices should help learners in understanding complex ideas and concepts. In university education, there is a need to adopt data analysis methods and latest software to assist in interpretation of data. Students of HEIs need to work on devices equipped with imaging technology and computer vision intelligence. They should be taught with modeling and simulation methods to understand complex biological systems comprising cells, tissues and organisms.

Looking at such needs and prerequisites, many educationists have attempted to coin a new paradigm based on communication practices in the field of teaching and learning biology. Darmawan (2012) for instance, proposed the idea of communication biology while Boren and Veksler (2011) improvised the concept of a commune paradigm in biology; Joseph (2010) emphasized on devising new teaching methods and Prozesky (2000) stated that the most vital component of communication in teaching are the new biological techniques. Experts have therefore emphasized upon the need to acquire scientific techniques in order to understand the communication practices in the field of biology. The adoption of these high-tech communication practices would pave the way to understand and implement concepts like 'communication biology' or 'commune paradigm.'

For this purpose, there is a need to first design a framework to understand how communication sciences or related intelligence practices can act as stimulus to students' understanding of the biology content in their curriculum. Figure 1 is a framework of the paradigm of Communication sciences in relationship with education practices. It shows the linkages between education and communication until the learning outcomes are accomplished:

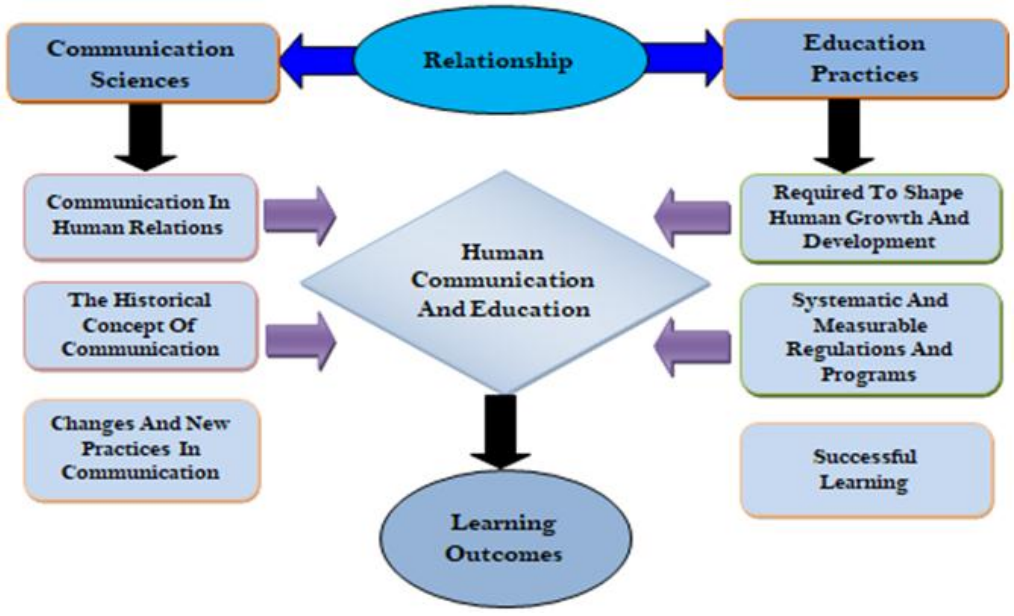


**Figure-1.** Basic education communication framework.

**Source:** Observations of the researcher.

Such a framework influences the human growth and development while there is also a simultaneous progress in communication practices in human relations. Fadhil (2014) state that communication strategy is a method of managing the communication process from planning, implementation to evaluation and also it aims at making messages easily understood in human context. Uchjana (1981) also explained this as a planning (communication planning) and managing (communications management) for achieving common goals. The framework in Figure 1 reiterates how to develop a communication strategy so that tactical operations (learning outcomes) can be accomplished by making use of systematic and measurable use of learning programs in terms of human relations. In the context of education at the micro level, communication science emphasizes upon the approach of "Human Communication" or "Human Relation" showing a clear model of a teacher (communicator) as a messenger and the student (Communicant) as the recipient of message.

Effective communication originates from a free environment of learning where teachers are responsible during class sessions (Abdu, 2019). The tutors encourage efficient growth and development of knowledge inside and outside of school by effectively communicating the importance of self-directed learning (Wegner, Minnaert, & Strehlke, 2013). In this perspective, communication biology as a new paradigm in education practice is considered one of the modern adopted learning and teaching techniques. This study attempts to identify appropriate communication strategies that are adaptive for audiences at various educational disciplines, including the field of biology. These audiences constitute learners and teachers who consistently produce a network of education practices that are clear and measurable. The importance of understanding communication patterns in teaching supports students' achievement in learning.

Furthermore, this study also explores the use of modern communication means in teaching biology, which includes the use of ICT and other high tech communication practices. These practices make students mentally active and help them quickly acquire knowledge and skills by using the information obtained in daily life situations (Joseph, 2010). This study puts into consideration the need to understand the facts and their application in real-life situation. Meanwhile, the focus is more on high tech communication practices and their application in the teaching of biology in Indonesia.

## 2. PROBLEM STATEMENT

In communication science, the ICT integration and the use of scientific practices to acquire abilities and competencies are capable of changing the educational sector (Khan, Khan, Zia-Ul-Islam, & Khan, 2017). These practices are applied and embedded in various forms in almost every field of specialization, including the biology field. However, despite significant accomplishments in terms of knowledge acquisition with the help of ICT implementation, the higher education system has witnessed a great decline in students' ability to communicate in biological sciences (Boren & Veksler, 2011; Darmawan, 2012, 2012b; Joseph, 2010). Such communication deficits become more prominent when these graduates enter the professional fields.

The Boyer Commission Report (Katkin, 2003) stressed upon the need to understand and review how people communicate during their academic discussions particularly from the perspective of teaching various disciplines. This concurs with the belief that biologists should search for better methods of helping students understand the biological concepts (Joseph, 2010) for which innovative teaching is required. New and novel methods can provide better opportunities of knowledge acquisition in biology subject (Boren & Veksler, 2011) besides, it also gives teachers an authority of their subject (Luther, 2000).

From the Indonesian perspective, the issue of communication practices in higher education is being dealt with for last few decades in several studies (DeVito, 1989; Hubley, 1993; Uchjana, 1981). These studies have reviewed communication practices in curricular and pedagogical terms; but to the best of researchers' knowledge, no study has investigated the impact of the ICT implementation or of the high tech communication practices in the teaching and learning of biological sciences in Indonesian higher education institutions (HEIs). A need was therefore felt to design a communication framework that could explain the relationship of cognitive, behavioral, psychological and epistemological aspects of communication with the IT enabled tools and high tech pedagogical practices adopted in Indonesian HEIs to teach the subject of biology. The study shall also throw light on the impact on students' learning outcomes, their perception and understanding of the biological content in the curriculum. This objective concurs with a recent study which reiterates that when people learn new concepts through high tech pedagogical practices, it impacts their communication skills (Baharuddin & Dalle, 2019).

## 3. LITERATURE REVIEW

There is no dearth of studies on communication practices and biological sciences, a few of which are scientific analyses, interpretations, philosophical studies, and commentaries on psychological and behavioral communication (Boren & Veksler, 2011; Darmawan, 2009, 2012, 2012b; Mercer-Mapstone & Kuchel, 2017). These studies have also expostulated theories of learning, defining the linkages between communication practices and biological sciences. There are also communication studies focusing on guidance, learning and teaching of various disciplines including biological sciences (DeVito, 1989) ontology and epistemology (Abdu, 2019) Medicine, and Neurology (Baharuddin., Hamid, Mutalib, & Dalle, 2018) and Psychology (Popescu, 2012). All these studies support ICT-based stimulus to teaching and learning in higher education, irrespective of the discipline. This is also evidence of the collaborative role of communication in the development of various domains of education and its ability to understand new

paradigms in those fields and embracing ideas from various areas of specialization and fields of knowledge (Saunders & Mill, 1999).

Figure 2 below illustrates the interrelationship between communication and education, building individual perception, beliefs, attitudes, critical thinking and collaborating with biological communication.

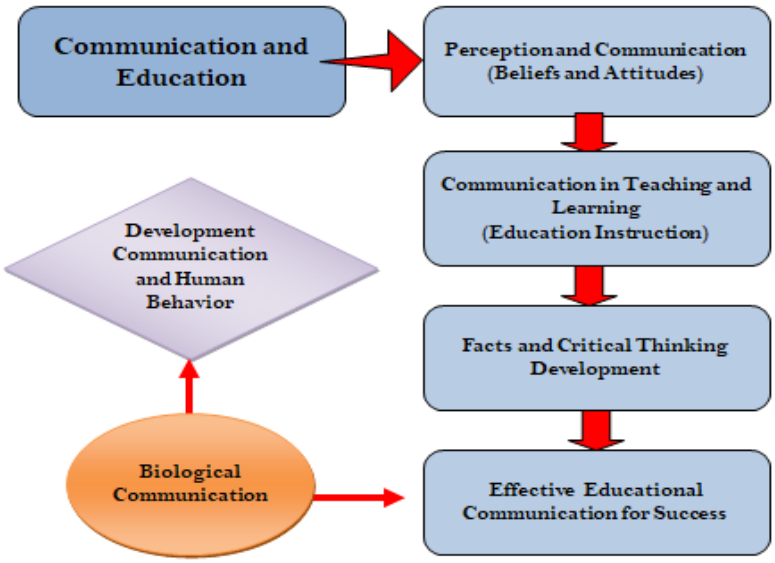


**Figure-2** Communication and education collaborating with biological communication
**Source:** Observations of the researcher.

The communication practices have expanded due to their popularity in academics and propagation of theories by scientists and experts of different subjects (Quebral, 2006). Popescu (2012) and Prozesky (2000) however assert that communication practices are already deeply rooted in various disciplines integrating with ICT practices, with the subject of biology as no exception.

The impact of ICT on biology and bioscience research can be observed in many different ways, namely for coding and computing of genetic information in DNA (De Jong, 2002), learning about genetic sequences and codes; categorizing genes and proteins; and deciphering the function and structure of these genes and proteins (Lander, Langridge, & Saccocio, 1991).

The ample use of information science in Biology has given birth to several new interdisciplinary subfields such as "bioinformatics," "computational biology," "genomics," "metablomics," "pharmacogenomics," and so on. All these subfields employ high tech communication practices in their application. For instance, if a vast amount of data in biological project on human genes and genome sequencing needs to be analyzed for their patterns, we need bioinformatics and computational biology for data management (Kaminski, 2000). Similarly theoretical and experimental studies in biology make use of advanced communication practices such as mathematical modeling and computational simulation techniques.

The subfields ending in the suffix "omics" also make use of communication practices – which include genomics, a study of DNA sequencing of organisms; transcriptomics, a study of RNA transcripts produced genomes; proteomics which helps in determining proteins in an organism; metabolomics, to study metabolites in an organism, cell, or tissue; lipidomics, to study the structure and function of lipids in a cell or organism; pharmacogenomics, to study how genetics affects individuals responses to drugs; and so on. All these subfields also represent collaboration with communication practices as they combine high tech quantitative, experimental, and computational approaches to understand the complex biological systems and processes.

Darmawan (2009) and Darmawan (2012) cite interesting analogies of communication practices between Biology and electromagnetic waves of the brain nerves, whose velocity and amplitude can be computed with such high tech computational linguistics patterns. The brain nerves are involved in activities such as seeing, understanding, listening, feeling, and reacting, to a stimulus. This is concurred by Teplan (2002) who also conducted a study to investigate how ICT computes data from electromagnetic wave currents from the EEG in order to explain the electrical activity in the brain, thus justifying the use of the communication practices in biology. The EEG measurements are recorded as communication messages transcribed as audio-visual animations.

Almost on similar lines, there are studies of communication practices based on the psychological stimulus from within or outside the individual and interpersonal communication (Darmawan, 2009, 2012; Pfeiffer, 1998; Pope, 1984). These studies correlate biological communication behavior with socio-psychological functioning of individuals as reflected in their interpersonal and intra-personal communication. This is however different from the simple communication process of sending and receiving messages between two persons followed by a feedback. Such a communication is based on the biological foundation laid down in a study by McCroskey, Simpson, and Richmond (1982) who stated that effective communication is achieved by aiming for accuracy between

communicators and communicants in every condition and that the similarities between individuals influence social effectiveness or efficacy. Tanner, Chatman, and Allen (2003) have opined on the novel approaches required for biology teaching and learning across HEIs and emphasized upon nurturing scientist-teacher partnerships to carry out curricular studies. This is also consistent with Mercer-Mapstone and Kuchel (2017) who stress upon acquiring core skills for effective science communication prior to addressing curricular issues.

This also illustrates the complexity of behavior in communication, when the study of biology communication becomes the subject of scientific research, particularly in the context of social biology where an individual communicator conveys the message through a stimulus and changes the behavior of others as a communicant. Such a phenomenon explains that biological communication is capable of interacting with the environment in which body organs and speech nerves play an intermediary role (Applbaum & Karl, 1974). This is also justified in a study on the philosophical school of pragmatism (Darmawan, 2009) where evidence reveals linkages of communication practices with the anatomical sciences of the body in conducting and experiencing interaction process.

In another example, McQuail and Windahl (1981) and Ruben (1984) build a psycho-behavioral communication framework in which verbal symbols are used to interpret biological functions of mouth, hand, eye, etc. during the communication process. The message is delivered through verbal symbols acting as a stimulus. This provides the view that the ability to communicate through verbal resources is not enough; it requires a biological capability to process and place the verbal message until it becomes a stimulus and is accepted and understood by the communicants, especially when presented in the form of symbols (Roger, 1983).

In the same vein, biological communication is represented in individual cognitive processes which determine the understanding of message received or conveyed (Chauchard, 1983; Frick, Bich, & Moreno, 2019; Scott-Phillips, 2008). Matlin (1994) stated that cognition or mental activity involves the acquisition, storage, retrieval, and use of learners' experience which help them to recall with accuracy. Such an accuracy is measured because learners are able to control their brain nerves that act as assessment tools to observe the biological process of communication (Deddy, 2013). Eventually, cognitive psychology emphasizes that obtaining answers to any proposed stimulus is based on the submission and proof of a balanced hypothesis. It means that whatever is said (verbal) is the function of cognition (mental), and that it starts from the activity of receiving, processing, storing, and reusing information (Chauchard, 1983; Dainty, Moore, & Murray, 2006; Straubhaar & Robert, 2000).

There is also a biological control of human attitudes, moods, feelings and emotions such as happiness, sadness, hunger, sickness, or health (Baharuddin. et al., 2018; Darmawan, 2009; McQuail & Windahl, 1981). These phenomena are well supported by biological theories that address psychological and human behavioral aspects and their relationship with controlled and unconscious communication systems. These communication systems act as functional networks representing social cognition (organisms) in a balanced environment. Social biology thus directs the process of interaction and transformation of conscious and subconscious messages to the tissues in the human body in various stages (Baharuddin & Dalle, 2019). The first stage is the level of sense organism, the second stage is the degree of equalization, the third stage is the level of construct memorial, the fourth stage is the degree of organism emotional-interaction, and the fifth stage is the level of social emotional-interaction. The study of Mønster, Håkonsson, Eskildsen, and Wallot (2016) is based on these interactional levels and examines physiological and morphological aspects of individuals interacting inside or outside a group.

From the ensuing review of literature, it is evident that high-tech communication practices in the teaching of biology shall not only use biological or anatomical patterns but shall also entail behavioral, psychological, computational, mathematical and ontological modeling. These inter-disciplinary communication practices influence the learners in HEIs and help in shaping their individual behavior while interacting with one another as well as with the environment (Joseph, 2010). This also explains how these communication practices contribute to teacher – student relationship inside and outside classroom as their emotional behavior affects their individual interactions.

## 4. RESEARCH METHODOLOGY

The study adopted descriptive survey design involving collection of data from a sample of 60 biology teachers teaching at three levels: high school, pre-university and university from six educational institutions located in Kalimantan and Medan regions of Indonesia. The purposive sampling method was used for selection of sample with non-probability parameters. The selection criteria of teachers included: teaching the biology subject at one of the levels; having at least B.Ed. or post-graduation with biology major and five years of teaching experience. No specific high tech communication practices were specified such as computer applications or use of online teaching methods since the empirical inquiry was based on this information. A questionnaire with 30 closed-ended and open-ended items was distributed to all teacher respondents which mainly dealt with attitude towards implementation of high tech communication practices in biology teaching, effectiveness of these practices and challenges faced in their adoption and implementation.

The aim of this questionnaire was thus to explore the attitude, effectiveness and challenges faced in the application of communication practices in teaching of the biology subject at various levels of education in Indonesian educational institutions. SPSS ver 25 was used to analyze the quantitative data and draw conclusions and generalizations. Table 1 illustrates the demographic details of the sample under study. Out of the total 60 participants for this study, 45(75%) were males and 15(25%) were females. A total of 44 teachers, both male and female, (73%) were under the age of 30 years, while11 were between 31 and 45 years (18%) and rest were above 45 years. This is the evidence that a majority of teachers in biology or related specializations in the sample of the study

were young and therefore had a natural inclination for smart and high tech communication practices in their teaching.

**Table-1.** Demographic details of the sample.

| N=60 | Description | f | Percentage |
|---|---|---|---|
| Gender | Male | 45 | 75% |
| | Female | 15 | 25% |
| Age | >30 years | 44 | 73% |
| | <31 to 45 years | 11 | 18% |
| | Above 45 years | 5 | 9% |
| Qualification | B.Ed. | 39 | 65% |
| | Master | 18 | 30% |
| | PhD | 3 | 5% |
| Teaching subjects | Biology (Core + Specialization) | 49 | 82% |
| | Biology (subsidiary) | 11 | 18% |
| Teaching levels | High school | 36 | 60% |
| | Pre university | 12 | 20% |
| | University | 12 | 20% |

**Source:** Results from the findings of this research.

The data also revealed that 39 teachers (65%) had B. Ed qualification, (30%) or 18 had master's degree and only 3 teachers (5%) had PhD qualification. A total of 49 teachers (82%) had specialized in core biology and the rest 11 teachers (18%) had Biology as their minor subject. A total of 36 teachers (60%) taught in high school, while 12 (20%) each taught in pre university and university levels.

## 5. RESULTS AND FINDINGS

Apparently the previous literature explains how communication practices in biology have taken inter-disciplinary approaches and attempted to enlighten the teaching of biology through employing such practices. The macro analysis of the educational process in Indonesia however reveals a different perspective, assumedly based on "communication biology" principles. Figure 3 illustrates the comparison of education and communication concept of communication practices in biology in Indonesia:

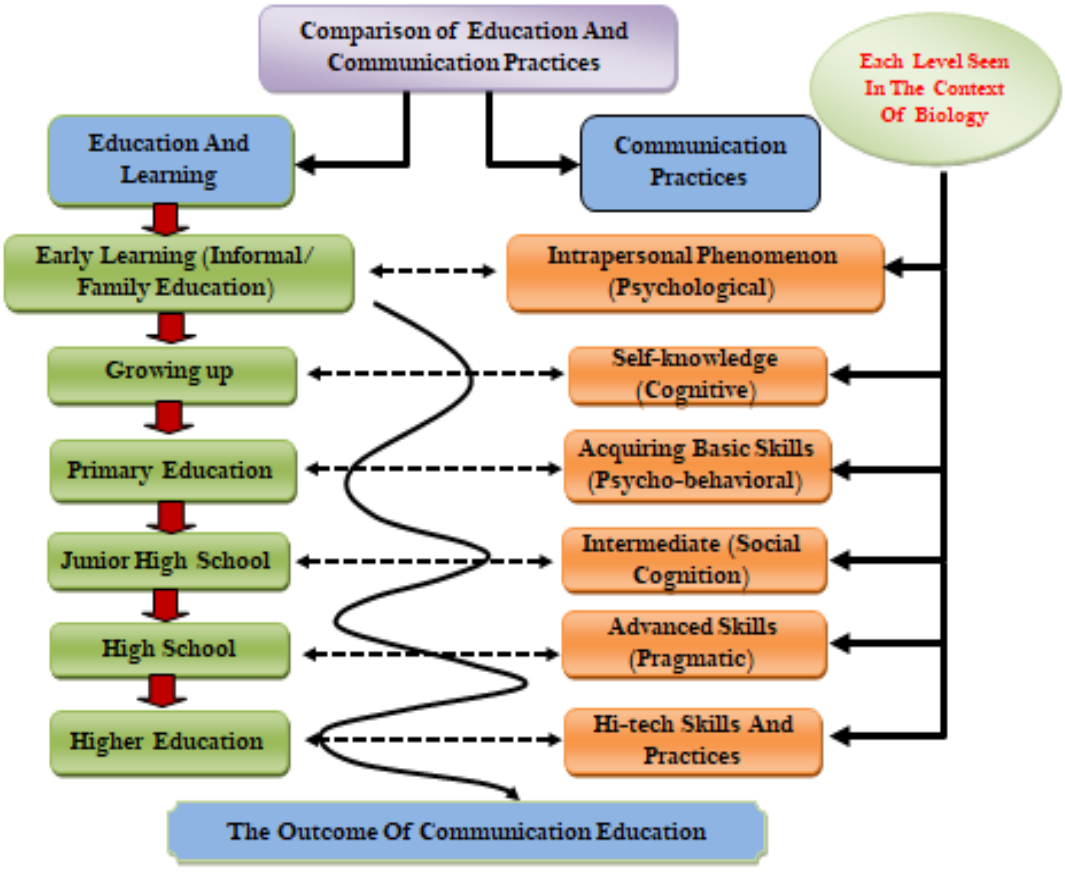


**Figure-3.** Analysis of the Education Praxis in Indonesia.

**Source:** Based on (Darmawan, 2009, 2012, 2012b).

This figure summarizes the educational praxis in Indonesia from early learning stages (informal family education) to higher education levels. It distinctly portrays how the communication practices evolve with each stage of learning. For instance, the communication practices at very early stages of childhood when a child acquires its first learning lessons in intra-personal emotions and feelings, gets evolved into the child's communication practices. The process continues with each level of learning and the communication practices evolve noticeably at each learning level until the higher education level. These communication practices include the use of computers and Internet, Radio, Television, mobile digital cameras and software. This framework is seen integrating communication practices with the field of education, suggesting that both models are inter-related, concurrent and related to human behavior (Quebral, 2006). This framework is also the evidence of the practices employed in teaching of biology education and for the fast implementation of educational policies, particularly the implementation of the 2013 curriculum, and the establishment of the National Exam by the Ministry of Education and Culture.

The Indonesian teachers of biology are required to integrate appropriate ICT techniques and advanced communication practices at each level to complete the teaching and learning process. The survey findings revealed the knowledge and competence levels of the biology teachers, accessibly, effectiveness and challenges faced in the teaching of the biology subjects. The objective was to examine how far the access of ICT applications and their integration contribute to the teaching effectiveness of biology teachers. Table 2 exhibits the access and application of ICT tools and communication practices in the sample of the study.

**Table-2.** Access and Application of ICT tools and Communication practices.

| Type (N=60) | f | Percentage |
|---|---|---|
| Training in computer application | 18 | 30% |
| Use of Laptops / Tablets | 48 | 80% |
| Access to Biology databases and graphic tools | 24 | 40% |
| Use of software and processors | 36 | 60% |
| Use of multimedia in classrooms | 24 | 40% |

**Source:** Results from the findings of this research.

According to the data, only 18 teachers (30%) reported that they had received training in computer application which suggests that the rest had not received any formal training in the use and application of computers. A majority of teachers, 48 (80%) though expressed their ability to use Laptops / Tablets, which seemed to be more for personal use rather than teaching and classroom purposes because only 24 teachers (40%) reported that they had access to biology databases and graphic tools or they used multimedia in classrooms. A total of 36 teachers (60%) however had access to software and processors.

In order to determine the use of ICT application and high tech communication practices in teaching and pedagogical activities in the biology subject, the respondents were asked to share the frequency of the use of these practices. On a four point Likert scale, the respondents reported the extent of their usage as Always, Sometimes, Seldom and Never. Table 3 presents these findings:

**Table-3.** Usage of ICT practices in teaching of biology.

| N=60 | Always | Sometimes | Seldom | Never |
|---|---|---|---|---|
| Classroom presentations | 30 (50%) | 15(25%) | 6(10%) | 9(15%) |
| Handouts | 27 (45%) | 15(25%) | 6(10%) | 12(20%) |
| Online teaching aids | 12 (20%) | 12(20%) | 6(10%) | 30(50%) |
| Communication with students | 6 (10%) | 9(15%) | 30(50%) | 15(25%) |
| Assessment | 6 (10%) | 6(10%) | 30(50%) | 18(30%) |

**Source:** Results from the findings of this research.

The most commonly used application was the classroom presentations and handouts when 75% and 70 % respectively reported that they always or most of the times used these practices. This was followed by the use of online teaching (40%) and a very low usage was reported in online communication with students and in assessment through ICT or computer application at 25 % and 20% respectively.

The study performed the inferential analysis to examine the tools, application and high tech practices used in teaching of biology subject and challenges faced by teachers in their teaching. A correlation analysis was done to find out whether there was a linkage between the given variable, viz tools and applications and the high tech practices with the teaching of biology subject. It was followed by a similar analysis of the challenges faced in the use and application of these tools and high tech communication practices. Table 4 and Table 5 illustrate the results of the analysis.

**Table-4.** Correlation of the effectiveness of tools application and high tech practices.

| Variables | Pearson Coefficient | Significance |
|---|---|---|
| **Tools and application** | | |
| Use of Laptops / Tablets | .763** | .000 |
| Access to Biology databases and graphic tools | .744** | .000 |
| Use of software and processors | .748** | .000 |
| Use of multimedia in classrooms | .677** | .000 |
| Training in computer application | .769** | .000 |
| **High tech practices** | | |
| Classroom presentations | .733** | .000 |
| Handouts | .773** | .000 |
| Online teaching aids | .687** | .000 |
| Communication with students | .725** | .000 |
| Assessment | .718** | .000 |

**Note:** **. Correlation is significant at the 0.01 level (2-tailed).
**Source:** Results from the findings of this research

As shown in the above table the value of significance for all the variables is less than the significance level of the study i.e. 0.000<0.05. Thus, there is a possibility of having a significant linkage between the given variables viz., tools and applications and the high tech practices with the teaching of biology subject. Further, the Pearson Coefficient value of each variable is greater than the coefficient value required for having at least moderate linkage between variables. This suggests that there is a significant linkage between whether there was a linkage between the given variable, viz tools and applications and the high tech practices with the teaching of biology subject. Table 5 shows the results of the analysis of the challenges that were cited by respondents to the open-ended questions in the questionnaire.

**Table-5.** Correlation of the challenges faced in the use and application of ICT tools and high tech communication practices.

| Variables | Pearson Coefficient | Significance |
|---|---|---|
| Lack of personal motivation | .823** | .000 |
| Time consuming | .727** | .000 |
| Infrastructural requirement (e.g computers, Internet, Wifi, etc.) | .717** | .000 |
| Lack of confidence in using tools. | .673** | .000 |
| Less teacher-student interaction | .772** | .000 |
| Expensive and unaffordable | .718** | .000 |
| Students demand traditional teaching style | .764** | .000 |

**Note:** **. Correlation is significant at the 0.01 level (2-tailed).
**Source:** Results from the findings of this research.

Table 5 shows that the value of significance for all the variables is less than the significance level of the study i.e. 0.000<0.05.This is not only as a strong indication of a significant linkage between use and application of ICT tools and high tech communication practices and challenges cited by the respondents. Similarly the Pearson Coefficient value of each of these challenges is greater than the coefficient value required for having at least moderate linkage between variables. This is also an indication that that there is significant linkage between use and application of ICT tools and high tech communication practices and these challenges

The 2013 curriculum by the Indonesian Ministry of Education had issued policy guidelines for integration of computers and other ICT techniques for the teaching of biology. The Indonesian education system thus makes use of education and communication practices right from the beginning levels of intra personal to interpersonal and at both micro and macro paradigms. Since the teaching and learning of biology requires the understanding of complex and unfamiliar concepts, students tend to memorize and resort to rote learning, instead of learning about them (Kilic & Salam, 2004). In such a situation, as a relief, hi-tech communication practices prove very useful to teach the subject of biology and therefore teachers resort to the use of computers, animations, models and other visual simulations to explain the most difficult concepts (Wang, 2017).

When Darmawan (2009) used the term communication biology, it encompassed all the scientific behavior and biological interaction of individuals with themselves and environment. Furthermore, it controlled the ability to understand communication messages correctly with the help of this synergy of the internal and external environment. The question however is raised whether the biological truths are consistent with behavioral values both in philosophy and structure. A study conducted by Calvin and Gardner (1978) had explained how to control the understanding of messages through language and speech in relationship with the function of organs. Hence, the messages received from outside by the human body through brain nerves are actually responses to the stimuli through neurons and axon which highlights the synergy once again between the internal and external elements and brings stability. Biologically, this may be termed as a balancing of mental processes (brain) in translating communication messages (Geisert & Mynga, 1995) and other organs based on this stability. In all such cases, the

biological aspects of the communicator are dominant in influencing and controlling others' behavior (communicants'). This suggests that the science of biology is inherent in communication and it involves the whole human body for producing such interaction.

## 6. DISCUSSION

In recent years, many new and innovative communication practices have been evolved to redefine ICT and make it more viable (Darmawan et al., 2017). Such Innovations at educational institutions focus on only one perspective, namely the utilization of ICT in learning. They recommend the use of a computer-based learning model, a kind of an interactive computer program, which was nowhere based on the function of the left and right brain. A more recent tool that has optimized communication biology is the use of hypertext. According to Geisert and Mynga (1995) hypertext is basically used in search engines and for obtaining information. A hypertext is an information package accessed according to the learners' needs and interests. Based on the hypertext, learners adapt to instructions in order to prevent difficulty or fatigue in learning process using the left or right brain. By using hypertext, it is also easier to assimilate information more quickly without the need of writing. It is further elaborated by Geisert and Mynga (1995) that hypertext offers a high degree of adaptability to individual differences.

There are many factors for such a change in the perspective of educationists, one of which is to achieve success of the teaching and learning process at any cost (Abdu, 2019). While viewing it with the scientific approach, it is clear that the teaching and learning goals cannot be achieved through biologically controlled behavior of learners, especially depending upon the balanced empowerment between the left brain and the right brain (Darmawan, 2009). The reason for such an anomaly could be because intrapersonal communication depends upon the nature of the apparent individual behavior (Latif, 2014) which psychologically contributes to the student's learning ability. Hence the process of interaction and transformation of messages from the left to the right part of the brain does not allow learners to acquire knowledge always but only when they receive stimuli in the form of visual, audio, or a precise touch during the learning process.

There are various teaching methodologies integrated within the biological communication practices like the group discussion method, practical's and experiments in labs, use of graphics and projects that act as inputs in teaching-learning of biology (Frick et al., 2019). Other practices such as sampling techniques and specimen collection are used to explore the concepts of biology. The adoption of ICT has introduced new methods of learning and teaching such as visual learning, online learning, and e-learning. These instructional strategies have helped teachers to explain complex topics such as cell structure, functions of organs, tissues, diffusion processes in cells much more easily and learners to learn faster and with more ease and convenience. The new branches of biology like genetics, biotechnology, endocrinology, epidemiology and virology are also best explained using these high tech communication practices

The study of communication practices in teaching of biology in Indonesian HEIs involves a process of discovering the truth of this emerging field of communication science. Darmawan (2009) and Darmawan (2012) took the initiative to understand this novel paradigm and named it "communication biology" by associating teaching and learning activities equivalent to the human ability to think, create and skills optimization The educational praxis, according to the authors, can be understood in the context of the left and right-brain controlled by the ICT or the computation frameworks that define the quality of education. A contrary opinion was revealed by Khan et al. (2017) who observed that knowledge derived with the aid of ICT or high tech communication practices does not always amount to learners' empowerment nor learners continue to depend upon computer mediated communication to improve their knowledge of biology. This applies to both primary and higher education equally (Smeltzer, 1992).

The findings of the study reveal that most of the teachers serving in the region had received very little training on ICT and had only the personal access to computers and tablets but not in the institution. Further, it was also revealed that teachers also had little or insignificant access to biology databases, graphic tools or software and processors and they made very little use of multimedia or internet based applications in classrooms. It was evident that the lack of access to ICT infrastructure and or non-availability of communication resources, the teachers would fail to integrate high tech communication practices in teaching and learning of Biology. The implication here is that due to low access to high tech application, students' academic performance could be adversely affected.

The most commonly used application was the classroom presentations and handouts which were followed by a little use of online teaching practices and assessment. These examples are of those few motivated teachers who volunteered and used their personal laptop or Mobile data to access and make use of these high tech applications. This indicates that a fair use of computer applications and online teaching methods for classroom teaching is a positive signal of the accessibility and awareness of high-tech communication practices among the teachers of biology subjects in Indonesia. On the other hand, the lack of their application in assessment was related to reason of confidentiality and to prevent cheating or the non-availability of adequate supporting resources and infrastructure like labs etc. This is consistent with the findings of Albion, Tondeur, Forkosh-Baruch, and Peeraer (2015) whose pioneering work revealed the significant role of computer applications and ICT integration in the professional development of teachers. A similar study was carried out by Buabeng-Andoh (2012) and Buabeng-Andoh (2012b) who apprehended that non availability of ICT applications and infrastructure contributed to poor pedagogical practices as the teachers fail to make use of even PowerPoint presentation and projectors

These findings have also revealed that high tech communication tools and practices followed an inductive approach and were student centered. These tools and practices not only helped students to develop an interest in

their syllabus but also motivated them to learn creatively and enhanced their performance and increased their productivity. This is consistent with Guay (2007) who also asserted that teaching and learning in the 21st century should be inductive; in other words, student–directed, based on tests, experiments, inferring, and online browsing in a virtual world of computers and internet communication. The deductive method on the other hand is teacher-directed, by asking questions and triggering the learning process through such practices like recall and comprehension.

Since the inductive method is modern and ICT-enabled, it benefits learners in biology classrooms with high tech communication practices like visualization, computer animations, streaming images, information synchronizing and similar other techniques. As aids to inductive teaching, there are websites, blogs, interactive boards, digital media, learning management systems which are accessible even through smartphones, iPods, iPads and other devices (Kagohara et al., 2013; Kiboss, Ndirangu, & Wekesa, 2004; Mikropoulos, Katsikis, Nikolou, & Tsakalis, 2003). The inductive method of teaching also promotes peer learning and student networking (Nee, 2014) ending up in enhancing learners' academic performance in biology (Senthilkumar & Senthamaraikannan, 2014).

The inductive teaching has also revolutionized the curricular and pedagogical processes by changing the traditional classroom structure into a virtual, smart chat room. There are fewer time constraints now, and greater teamwork and facilitation between teachers and students, and a larger scope for repeat sessions through recording devices. Even a subject as abstract as molecular biology become easier with the use of information and communication practices as learners could now visualize the molecular processes on their screens (Rotbain, Marbach-Ad, & Stavy, 2008).

## 7. CONCLUSION

The term 'Communication Biology' is one of the new coinages in the field of biological sciences. Furthermore, as a novel concept, having fulfilled all learning parameters, it tends to examine solutions to communication problems of both academic and professional nature. The world of education is continuously evolving and developing a novel and interdisciplinary concept like 'communicational biology' by joining two authoritative but different fields. But such innovation needs a more appropriate learning model to gain both acceptance and application among teachers and learners. This study has however attempted to show how Communication Biology, supported by high tech practices, has contributed in several frameworks and attempted to provide solutions to problems in the educational praxis in the Indonesian context.

At the macro praxis level, Communication Biology could make a promising contribution to analyzing and resolving issues of educational development. Furthermore, it could suggest new means to enhance the pedagogical practices and curriculum to meet the present and future needs. This would facilitate the teaching and learning of very complex issues and also prove helpful in suggesting solutions to inter-disciplinary issues. At the micro-level, Communication Biology is expected to assist educators and learners in the learning process to understand and decipher complex messages and using the high tech media to produce an excellent conditioned stimulus for students.

Based on these findings, a few recommendations can be made. Since the use of ICT applications and high tech communication practices have revolutionized modern ways of teaching and learning and are also a determinant of the efficiency of teachers, it is recommended that institutions should focus on providing training to teachers in ICT applications and computer usage. It is also suggested that Indonesian educational institutions shroud equip teachers with computer skills through training and make both hardware and software available in the institution. The study also suggests to draw attention to frameworks that are built upon ICT enabled teaching techniques, and to such inter-disciplinary fields of study that are closely associated with the biology teaching, and that could be effective and more enjoyable for the 21st century generation.

To sum up, this study attempted to understand how the High-tech Communication Practices should be integrated in the teaching of Biology in Indonesian Higher Education institutions. No doubt, 'communication biology' has the potential to evolve into a scientific study in the field of communication science and educational practices. The need is to build a framework of a new paradigm of communication biology which is expected to contribute to the development of the education system in Indonesia HEIs.

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