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The utilization of information and communication technology (ICT) on learning in the 21st century

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Abstract
Rapid development in technology affects education greatly. Thus teachers are required to have some skills that must be mastered, so that education can prepare students to master these skills in order to become a successful person in life. The essential skills of the 21st century should include skills for living in the world, the ability to access and analyze information, the ability to take advantage of new media and technologies in their learning, combining technology with pedagogy. This study reviews and evaluates the results of empirical research on Information and Communication Technology (ICT), the importance of Information and Communication Technology (ICT) in terms of research results, and how to utilize Information and Communication Technology (ICT) in learning. This study used a literature approach critically to primary scientific reports as a source of data. The results showed that ICT is a technology that stores, produces, and processes and disseminates information. ICT is used to describe interesting and innovative ways to provide lifelong learning with global access to information, learning and support. ICT gives influence to motivation, interest, learning activity, learning result and learning achievement. On the other hand learning using ICT is also more effective and efficient. It can be learned anytime and anywhere and makes learning more attractive. ICT can be applied innovatively at all stages of teaching and learning activities as of making lesson plans, preparing materials, presenting materials, implementing lessons, and evaluating. The implementation of ICT in learning can be grouped into two categories namely: a) ICT as supporting tools and b) ICT as a teaching-learning model (learning with ICT).

Keywords: ICT, learning, 21st century

1. Introduction
Life in the 21st century demands a variety of skills that must be mastered by a person, so that education is expected to prepare students to master these skills to become a successful person in life (Zubaidah, 2016) [42]. Furthermore Supiandi et al (2016) [42] stated that 21st century skills are a set of abilities that must be possessed by students and teachers to successfully live in the 21st century. Griffin et al (2012) [15] stated that quality of human beings in the 21st century are people who have life skills, one of them is skill for living in the world which is a skill based on information literacy, new information technology and communication skills, and the ability to learn and work through digital social networks. Wagner (2010) [52] and Change Leadership Group of Harvard University identify the survival competencies and skills needed by students and teachers in dealing with life in the 21st century, one of which, is the ability to access and analyze information. Barry (2012) [3] stated that the skills needed by teachers and students in the 21st century are the ability to access, analyze, and synthesize information. Hamied (2008) stated that a person living in the 21st century is required to demonstrate a range of functional and critical thinking skills that are close with information, media and technology.
Skills required in the information age are not only reading, writing, and numeracy skills, but also communication skills, high-order thinking, metacognition and mastery of science and technology (Corebima, 2007) [7]. Tilaar (2002) [48] stated that the skills needed in the information age are high-order, creative, productive, and competitive thinking skills. Trilling & Hood (1999) [50] stated the skills needed in the information age are critical thinking skills, hard work, creative, cooperative, intercultural understanding, communication, computer operation, and metacognition.
Tomoredjo (2009) [49] stated that to be professional teacher in accordance with the demands of the global and digital era, teachers should have several criteria as follows: 1) became adept at core competency, 2) know and understand the curriculum along with its application and development, 3) master the pedagogic theoretically and practically along with its development, 4) be familiar with doing research and writing, 5) master the international language, 6) able to apply information and communication technology (ICT) based on learning. Furthermore Zubaidah (2016) [42] stated that a teacher must prepare students to have 21st century skills by mastering various fields, becoming adept at pedagogy, understanding psychology of learning, following curriculum policy development and able to utilize new media and technology in learning.
According to the American Association of Teachers of Education (AACTE), it is stated that 21st century teachers should be able to: 1) successfully combine technology with pedagogy and learning materials and develop creativity using technology that is appropriate for the required learning needs 2) combine the curriculum with demands of the 21st century,

3) offset the learning strategies and problem-based learning methods and projects, 4) mastery of various assessment models or assessments, 5) act as mentors, 6) improve their professionalism as teachers.

Mastery of information and communication technology (ICT) is a very important thing in the age of globalization. The use of computers to access, process, and present information, both individually and in groups, intra-network (intranet) and international network (internet) is a primary need in the digital era. Along with the rapid development of science and technology in the field of information and communication technology (ICT), it increasingly facilitate students in exploring various disciplines of interest, and also facilitate teachers in conveying their subject because of the availability of sophisticated facilities.

Information and communication technology (ICT) covers two aspects, namely information technology and communication technology. Information technology includes all things related to the process, use as a tool, manipulation, and information management. Communication technology covers all things related to the use of tools to process and transfer data from one device to another (Rahim, 2011) [35]. Khairul (2009) [24] stated that Information and communication technology (ICT) is the result of human engineering on the communication process to extend information from the sender to the recipient faster, wider, and longer storage. In the context of learning, ICT covers all matters related to the use of computers as information process, a learning tool and a source of information for teachers or lecturers and students or university students (Setiawan, 2008) [39].

Information and communication technology (ICT) should take a central role to develop education, both formal and informal. Sulistyowati (2018) [41] stated that the main objective of ICT application in education is to apply ICT equipment and tools in learning process as media and methodology. Shreya (2012) [40] stated that the utilization of ICT in innovative learning is in the acquisition of active, collaborative, creative, integrative, and evaluative lesarning. According to Kaware & Sain (2015) [22], the utilization of ICT media in education can support the learning that is a necessity today, not only to improve the effectiveness and quality of learning, but also, importantly, to increase the mastery of ICT both teachers and students as the provision of living in era of technology which is constantly changing and evolving. Munir (2009) [30] stated that the progress of information technology can deliver the virtual world to be real in front of us. In this information age, the sophistication of information and communication technology has enabled the rapid exchange of information without being impeded by the boundaries of space and time (Dryden & Voss, 1999) [10].

The purpose of this paper is to explain conceptually the articles of previous thought and research as well as other relevant sources on Information and Communication Technology (ICT), the importance of Information and Communication Technology (ICT) in terms of research results, and how to utilize Information and Communication Technology (ICT) in learning.

2. Methods

This research is literature review. Syaodih (2009) [45] described that literature review is a series of research related to data library collection method, or an overview of existing research about the topic being studied through various theoretical information (book, encyclopedia, scientific journal, newspaper, magazine, and document). Further Cooper (1998) [6], Taylor (2012) [46] and The UCSC University Library (2012) [47] described that literature review is a study that critically surveys the knowledge, ideas, or findings contained in the field of academic-oriented literature, as well as formulating its theoretical and methodological contributions to a particular topic.

The sources of data in this study are the primary scientific reports contained in the thesis, dissertation, or local, national, and international journals, printed and non-printed, relevant to Information and Communication Technology (ICT). The source selection is based on aspects of the author's credentials and evidence support, objectivity, degree of conviction, the value of the content contained in the literature and the content or substance studied (The UCSC University Library, 2012) [47] relevant to the use of Information and Communication Technology (ICT) in learning.

Data were analyzed using annotated bibliography technique (Pharisa, 2012). The procedure of data analysis as follows: 1) organize the literature relevant to the topic; 2) synthesize the reviewed literature; 3) identify controversial issues; 4) formulate questions for further research (Mongan-Rallis, 2006; Galvan, 2006; Taylor, 2012; The UCSC University Library, 2012) [28, 14, 46, 47].

3. Results & Discussion

3.1 Information and Communication Technology (ICT)

ICT is an abbreviation of the Information and Communication and Technology. ICT is a technology that stores, produces, and processes and disseminates information (Chodzirin, 2016) [5]. Dodi et al (2007) [9] explained that ICT is a term to describe interesting and innovative ways to provide lifelong learning with global access to information, learning and support. ICT includes communication devices or applications such as radio, television, mobile phones, computers and networking of hardware and software, satellite systems and so on and various related services and applications such as video conferencing and distance learning.

According to the State Ministry of Research and Technology (2006) [25] ICT is a field of technology include collecting, gathering (acquisition), processing, storing, disseminating and presenting information. It includes all hardware, software, content, and computer and telecommunications infrastructure.

Anderson (2010) [2] stated that ICT covers a lot of technology that allows us to receive information and communicate or exchange information with others, with the tools and functionality to capture, interpreting, storing, and transmitting information as presented in Figure 1.

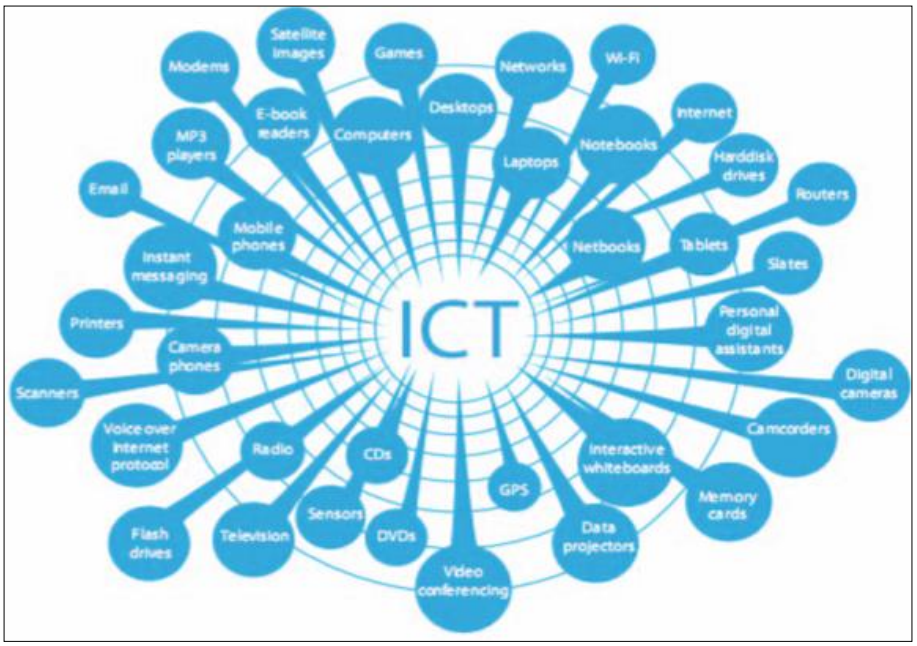

Fig 1: The area of Information and Communication and Technology (ICT)

The rapid development of ICT is not only in the field of technology, but also in its content. On the one hand, experts have developed technology that allows experts to present and deliver their knowledge, but on the other hand experts in various fields have contributed and spread their knowledge through various media such as CD, DVD, internet (website), either individually or collectively (Nisa et al, 2013) [33].

3.2 The Importance of Information and Communication Technology (ICT) based on Research Results

A lot of research has been done related to the use of Information and Communication and Technology (ICT) in learning to improve the quality of the learning process. Here is described the results of research that has been done and its contribution to the students' capability. Reeves (1998) [36] presented the results of a ten year investigation by the Apple Classroom of Tomorrow (ACOT) Project and concluded that pedagogical innovations and positive learning results do eventually emerge from the infusion of media and technology into schools. According to UNESCO (2011b) [51], beyond an impact on achievement in traditional subject areas, a number of ICT studies have established that computers can have a positive effect on student motivations, such as their attitudes toward technology, instruction, or the subject matter.

Fitriyadi (2013) [12] reported that some potential benefits of ICT for education are: 1) being an enabler for lifelong learning, 2) bringing changes in the role of teachers in teaching and student roles in learning, 3) providing open access to materials and interactive information through the network; 4) eliminating time and space constraints in the learning environment; 5) supporting the organization and management of learning and education; 6) opening opportunities to collaborate between teachers and among students. Surjono (2013) [43] reported that with good and innovative design, ICT can offer interesting science learning materials which are not boring, easy to understand, and can be learned anytime and anywhere.

Suryadi (2007) [44] reported that by integrating technology in the learning process will enable students to learn "from" technology (CBI) and "with" technology (constructivist learning tools). Technology also provides fun, ease, and speed in learning, and engages students in technological sophistication and advance (advanced skills). Chodzirin (2016) [5] stated that the use of technology can help the learning process to become more effective, efficient and fun. Nisa et al (2013) [33] laso stated that the development of ICT-based interactive learning media can improve learning activities.

The research conducted by Hidayah et al (2010) [18] showed that the use of ICT-based learning media is able to influence student learning motivation. Lestari (2015) [26] reported that learning using Information and Communication and Technology (ICT) influences students' interest and their learning outcomes. Furthermore, Zulfiati (2014) [57] reported that learning using ICT-based media can improve students' cognitive and affective abilities.

Research on the use of computer technology in learning has resulted in several recommendations, such as: 1) computer as a tool of learning media has advantages in presenting graphics and images as a visualization that can be observed by students in actualizing mathematical concepts and models. It is proved that learning model can improve the quality of learning (Bitter & Hatfield, 1993; Jensen & Williams, 1993; Huang & Waxman, 1996). 2) [4, 21, 19] It is proved that the use of computer in learning mathematics in Japan can improve the effectiveness of learning (Fumiyuki, 2000; Satoru, 2000) [13, 37]. Computer-based learning has several advantages, such as more effective learning time, as the test scores of students who study using computer are higher than students who do not, and students have a positive attitude toward computer-based learning (Schacter, 1999) [38].

3.3 The Utilization of Information and Communication Technology (ICT) in Learning Process

The use of ICT in the learning and learning process is one of the media that teachers can use. The use of ICT in learning becomes very important today along with the rapid growth of science and technology. By using ICT, the teachers will be able to know the development of information in other regions to support the learning material. ICT also enables student to obtain more information related to their tasks at school or as their additional materials.

ICT can be applied innovatively at all stages of teaching and learning activities from making lesson plans, preparing materials, presenting materials, implementing lessons, to evaluating. In biology subjects, ICT enables teachers to create animations or simulations to facilitate students to learn abstract, dynamic and complex concepts. Further, ICT-based learning such as discussion forum, chatting and email can encourage students to interact and cooperate with fellow students, teachers and experts in the relevant field wherever they are (Surjono, 2013) [43].

ICT can be integrated into the learning process as Woodbridge (2004) has done as shown in Figure 2.

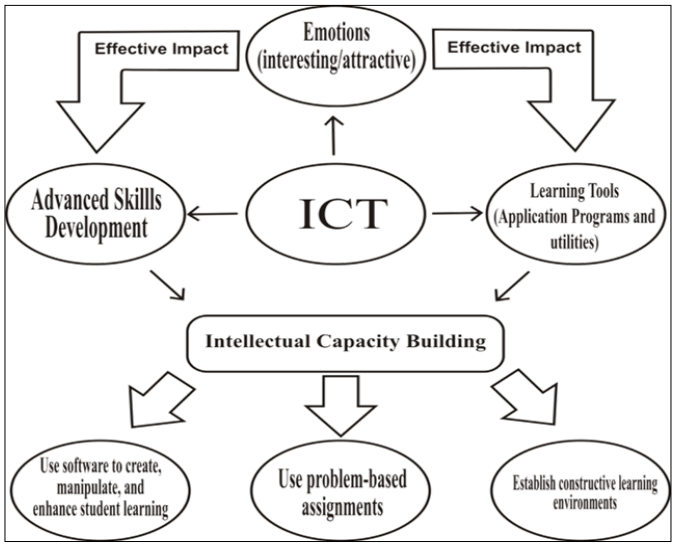

Fig 2: Model of technology integration in learning

Some important notes from the model are as follows: 1) ICTs play a role in three functions: first, create a fun and engaging learning environment; second, equip students' capability to use high technology; third, serve as learning tools with application programs and utilities, not only to facilitate and accelerate the work but also to multiply the variations and techniques of analysis and interpretation. 2) Skills using technology and utilizing programs and utilities are a provision and positive conditioning to increase students' intellectual abilities.

The application of ICT in learning can be classified into two categories: a) ICT as supporting tools and b) ICT as a teaching-learning model (learning with ICT) (Webb, 2002; Lavonen et al, 2006). First, as supporting tools, nowadays a lot of software is available on the market or on the internet that can be used as a tool that allows teachers and students to complete their work efficiently. For example office applications such as word processing, spreadsheets, databases, drawing packages and a simple web-page editor and other applications that can facilitate in preparing and implementing the learning process. Second, as a teaching-learning model (learning with ICT), it involves the use of: a) Computer Assisted Learning (CAL), b) Computer Assisted Inquiry (CAI), and c) E-Learning.

Computer Assisted Learning (CAL) is an instructional method that involves student interaction with a computer program designed to achieve specific educational goals. A complex and abstract subject can be presented through multimedia such as using animation or simulation so that students can easily learn it. The presentation of learning materials that feature the process or motion is implemented through animation. The animated process allows student's intervention through their direct interaction, for example by changing the parameters called simulation. Heinich et al (1982) [17] stated that CAL is a computer system that can deliver learning directly to students and allows them to interact with the available learning programs.

Computer Assisted Inquiry (CAI) is the use of ICT as a medium to gather information and data from multiple sources to support scientific reasoning (McFarlane & Sakellariou, 2002) [27]. *The Association for Education Communications and Technology* (AECT, 1977) [1] defines Computer Assisted Inquiry (CAI) as an instructional strategy whereby the computer is used to provide learning objectives, learning resources, record keeping, progress tracking, and assessment of learner performance.

The CAI program basically has the main characteristics that need to be carefully identified to facilitate student learning, such as: remarkable material, specific instructional objectives, prerequisite test, pre test, content/subject description, tasks, answer explanations, summary, post test, and feedback (Ismaniati, 2001) [20].

CAI program in learning can be done by placing various CAI software programs in a server connected to the internet network, so that it can be accessed by learners either through web-browser or file transfer protocol. To support optimally the utilization of this CAI program in learning process, it is necessary to provide various types of CAI programs that contain various materials related to the implemented curriculum material package (Muhtadi, 2005) [29]. CAI is used as an agent to interact with information sources such as internet or microcomputer based laboratory.

Electronic learning or E-Learning has begun in the 1970s (Waller & Wilson, 2001) [53]. E-learning is an educational activity or course conducted in an electronic learning milieu, using Internet communication technologies for delivery of instruction, curricular materials, and learning activities. The term E-learning is more appropriately refers to developed transformation of learning process, either in school or in college, into a digital content using internet technology (Munir, 2009) [30]. Learning materials can be accessed anytime and anywhere through E-learning. E-learning is an information and communication technology to enable students to learn anytime and anywhere (Dahiya et al, 2016) [8]. The implementation of E-learning requires qualified resources, especially human resources because the implementation of E-Learning requires computer literacy for educators and learners. Computer literacy is a term that is often used to

explain basic knowledge that people need to know how to operate for computer. The concept of computer literacy is not only about the design and development of the computer itself but also about the practical aspects of computer (Murtiyasa, 2006) [32].

The National Science Teachers Association (NSTA) supports and encourages the use of e-learning experiences for science students. NSTA supports e-learning as a promising way to: a) more effectively provide access to images of science teaching such as observation, measurement and scientific research, b) give science educators new information related to science content and its resources, c) give science educators various animations and simulations related to science subjects.

4. Conclusions

Based on the results of this study, it is concluded that: 1) ICT is a technology that stores, produces, and processes and disseminates information. ICT is used to describe interesting and innovative ways to provide lifelong learning with global access to information, learning and support. 2) ICT is very important to contribute the improvement of the quality of the learning process. The results showed that ICT has an influence on motivation, interest, learning activity, learning result and learning achievement. On the other hand ICT is more effective and efficient tool that can be learned anytime and anywhere to produce an attractive learning material. 3) ICT can be applied innovatively at all stages of teaching and learning activities as of making lesson plans, preparing materials, presenting materials, implementing lessons, and evaluating. The implementation of ICT in learning can be grouped into two categories namely: a) ICT as supporting tools and b) ICT as a teaching-learning model (learning with ICT).

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