# Emerging Technology Curriculum on the Focus of Cloud Computing

HSIEH-HUA YANG, LUNG-HSING KUO, WEN-CHEN HU, HUNG-JEN YANG

***Abstract*—**The purpose of this study was to design a curriculum for learning emerging technology on the focus of cloud computing at the high-school level. Based upon theories of technology education, the emerging technology content was selected and organized. The technology universal theory was applied in content selecting and the technological method model was applied to design learning activity. Based upon professional committee panel review, the content was verified. There are two chapters and nine sessions in the integrating learning materials. The procedure of developing and evaluating emerging technology curriculum were concluded based upon both theoretical and field evidences.

***Keywords*—**Cloud Computing, High-School Technology Education, Emerging Technology, High-Scope Project

## I. Introduction

TECHNOLOGY education is a subject area of common education and provides learner the opportunity of understanding technology. New technology grows everyday and the information and knowledge of technology expands, too. Systems of technology in some areas are even exploded, such as energy & power technology and information & communication technology [1-4].

In science education, how to integrating emerging technology into formal education becomes a concern. Education reform acts in Taiwan pointed out this trend and raised a “High Scope Curriculum Development” project to foster teachers to design teaching material and learning activities of emerging technology[5, 6].

Technology education is a important course to host learners with the opportunity of adopting technology to gain innovation. Based upon the recognition of problem solving, technology resource and technology process, learning experience could provide a profound foundation of preparing behavior in using technology

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## II. Technology of Cloud Computing

Technology is a body of knowledge and the systematic application of resources to produce outcomes in response to human needs and wants. Technology education is a subject of studying technology in which learners could learn about the context, process, and knowledge related to technology[7].

Technology is an integral part of our social structure. This structure can be defined in part by its use of technology which transforms the environment, ideologies, and its sociological elements. It is this interaction, that is, the dependence of humans on technical means for survival that warrants the study of technology by all people.

Survival of the human species has continuously relied on means to adapt to the natural environment. Humans, constrained by their biological inheritance, have been forced to utilize support mechanisms for their sheer survival. By creating technical means for this survival, hun1ans were able to adapt both physically and socially. The acquisition of these technical means has been cumulative over the years with each new element adding to the existing inventory of knowledge. Archaeological evidence reveals the use of technical means in the past and it is obvious that our reliance on our technology has not diminished today. As a result, the nature of humans is expressed in cultural contrivances, both tangible (e.g., tools, machines) and intangible (e.g., ways of thinking).

One of the major contributors to the W1iqueness of our culture over the last quarter century is the scope and pace of technological change. Since we do not inherit culture through genetic transformation, we must rely on our exposure to information.

In this way, culture is learned. Understanding and coping with technology was relatively easy decades ago. However, today, making sense of culture on a global basis is a difficult task due to the avalanche of inventions and innovations.

A society is a group of people working as a cohesive unit bound together by its culture. Within society is the human endeavor called technology. Therefore, it is the human who conceives what should be developed, and it is the hun1an who should control its destiny. One significant challenge is to ensure that technical means are used appropriately for the welfare of all peoples without dan1aging the natural environment. It is imperative, therefore, that information be available for all people information that is accurate and usable. The primary vehicle for this dissemination is the educational enterprise. Just as society advances technologically, so must its educational system, thus enabling individuals to make a commitment to generating a society and environment that are human and controlled for the betterment of humankind.

The massive growth of technology and technology transfer has introduced us to the realities of an interdependent world. Global culture has moved within the past decade from self-sufficient economies to an integrated system of global production.

The use of technology is a global phenomenon with no country immune to the need for extending the potential of the human being. Willie not all countries have developed equally in a technological sense, it is clear that today new technologies will develop ·where human resources and commitment exist. No longer is the greatest asset capital or natural resources, but rather the ability to use information. Information is one of the most useful resources in developing and managing technological systems.

Countries that have access to and can manage technical information have a definite competitive edge in the worldwide marketplace. As a result, the demand for more innovations and inventions related to technology will continue to increase on a global scale.

Technological advancement, however, increases the demand for finite natural resources, compounding the problems of our planet. New transformations, prompted by technological growth, will come in shorter periods of time and will be more potent than ever before, while providing both social dissonance and opportunity.

The human race cannot look only to history to guide it through future unprecedented problems and opportunities. We must look to technology for more answers. Technology is a product of human effort; therefore, it must be carefully designed and utilized so that all cultures may benefit. This must be done with a global view, in order to maintain a balance of the systems which sustain the human race. Hence, technological literacy should be a mandate in all cultures.

In the early 1980's, the Jackson's Mill Industrial Arts Curriculum Theory identified a base for curriculum derivation. Many of those concepts have been incorporated into the foundation of this document, especially the perspective on the relationship between the domains of knowledge and the hun1an adaptive systems. Scholars[7] have identified knowledge which enables humans to adapt to their environment. This prospective knowledge gives people an understanding of what was, what is, and what can be. It is provided with a syntactical and conceptual structure into bodies of knowledge known as domains. Four major cultural universals or domains for providing a cognitive base for human adaptation in the natural environment are the (1) sciences, (2) humanities, (3) technologies, and (4) formal knowledge. These four domains are intrinsically linked, with the fourth, formal knowledge, being represented by language, linguistics, mathematics, and logic. Formal knowledge is separate, yet provides form and structure for the other three domains.

Each domain has its unique purpose, knowledge base, and structure. The technologies domain of knowledge contains all recorded knowledge relating to the types of technology. Similarly, the sciences and humanities domains of knowledge contain all recorded knowledge of the sciences and humanities, respectively.

Technology as a human endeavor can be understood by analyzing the three human adaptive systems[7]: (1) technological, (2) sociological, and (3) ideological. Technological human adaptive systems pertain to technical means of manipulating the physical world to meet human needs and wants. Sociological systems are patterns of societal endeavor, characterized by social organization and regulation. Ideological systems are concerned with the values and beliefs of society. The three human adaptive systems, as presented in the ]Jackson's Mill Industrial Arts Curriculum Theory, are interrelated and exist within the human-made and natural environments [8].

The human adaptive systems mutually interact with the domains of knowledge and contribute to each other. As people develop better and approved ways to adapt, the results contribute to the domains of knowledge. The adaptive systems utilize knowledge processes to create new knowledge by calling upon appropriate quantities of technological knowledge usually through a systematic process.

Any new knowledge produced as a result of this interaction becomes part of the body of knowledge of technology. As previously noted, technology exists as a domain of knowledge which gives people an understanding of what it was, is, and can be. The application of technology in a human adaptive system involves people applying technological knowledge and other resources in a social/ cultural context through technical processes and systems to produce outcomes in response to human wants and needs. Technology, as a human adaptive system, interacts with the other two human adaptive systems: ideology and sociology. As a result, technological outcomes have an impact on people, society, culture, and the environment which must be assessed and w1derstood. Hence, the other adaptive systems are affected by, and are used to evaluate, technology.

Also, the improved ways to create, implement, assess, and manage technology contribute to the domains of knowledge.

Technology has an effect on people's values, which must be considered in the assessment and shaping of technology in a global society. This interaction must be understood and practiced within the human adaptive systems in order to use and control technology effectively.

The individual in today's world faces unprecedented change which requires the ability to continually cope and adjust. The inability to make these adjustments can cause individuals to be out of harmony with the very technology they worked to create and maintain. Technology has the potential to threaten and alter our cultural mores and customs, as well as our views of ourselves.

An understanding of technology can allow individuals to cope with, adjust to, invent, and innovate in this technological world. Literally, ignorance of how technological systems are designed and function leads to inadequacy and a lack of productivity. These traits limit one's ability to function as a consumer, producer, decision-maker, worker and planner.

Survival of the human race and its natural environment relies on individuals who:

- see themselves intrinsically involved in nature,
- do not deny that there are problems created by technology and are willing to consciously add to the solution,
- do not see themselves as a single entity, but rather as part of an interdependent world, and
- realize that there is a pattern of relationships that provides opportunity for individuals in a technological society.

The study of technology over time has resulted in the· identification of universal attributes[7, 9]. They are:

- People create technology.
- Teleology responds to human wants and needs.
- People use technology.
- Technology involves actions to extend human potential.
- The application of technology involves creating, implementing, assessing, and managing.
- Technology is implemented through the interaction of resources and systems.
- Technology exists in a social/ cultural setting.
- Teleology affects and is affected by the environment.
- Technology affects and is affected by people, society, and culture.
- Technology shapes and is shaped by values.

### A. *Universals of Technology*

Technology is human innovation in action. It involves the generation of knowledge and processes to develop systems that solve problems and extend human capabilities. As such, technology has a process, knowledge, and context base that is definable and universal in Fig. 1.

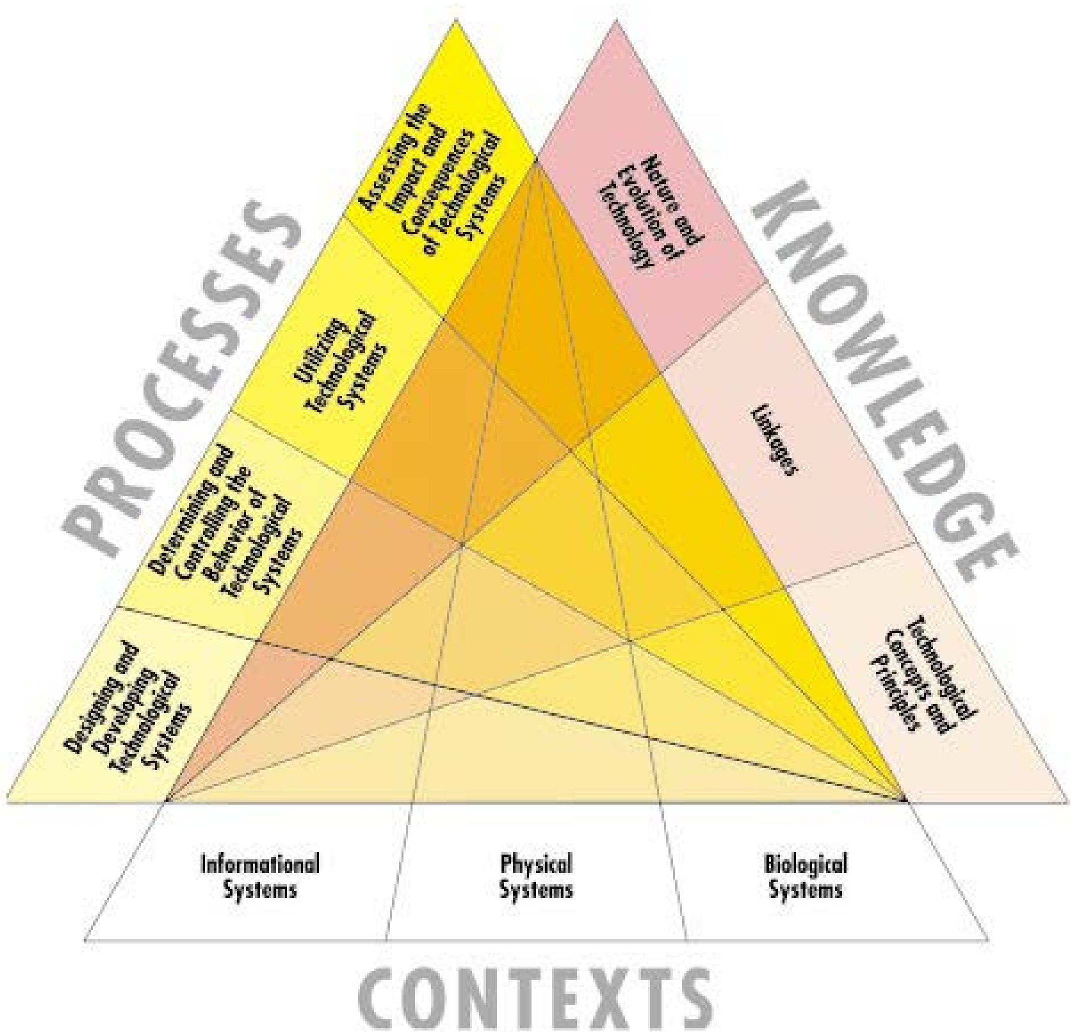


Fig. 1 A Structure for the study of Technology-Universals

The processes are those actions that people undertake to create, invent, design, transform, produce, control, maintain, and use products or systems. The processes include the human activities of designing and developing technological systems; determining and controlling the behavior of technological systems; utilizing technological systems; and assessing the impacts and consequences of technological systems.

Technological knowledge includes the nature and evolution of technology; linkages based on impacts, consequences, resources, and other fields; and technological concepts and principles. This includes much of the knowledge of how the technological processes are developed, applied, and used. The context of technology involves the many practical reasons why it is developed, applied, and studied. People develop technological processes and knowledge for a reason—they want to develop and use systems that solve problems and extend their capabilities. The systems that are developed can easily be categorized as informational systems, physical systems, and biological systems.

The processes, knowledge, and context are all equally critical to the existence and advance of technology. One cannot exist without the others, for they are mutually dependent. With technological knowledge people engage in the processes, yet it is through the processes that technological knowledge is developed. All technological activity is for a reason, or done within a context.

Processes, knowledge, and context, then, are the universals of technology, and must be the foundation of the structure for the study of technology.

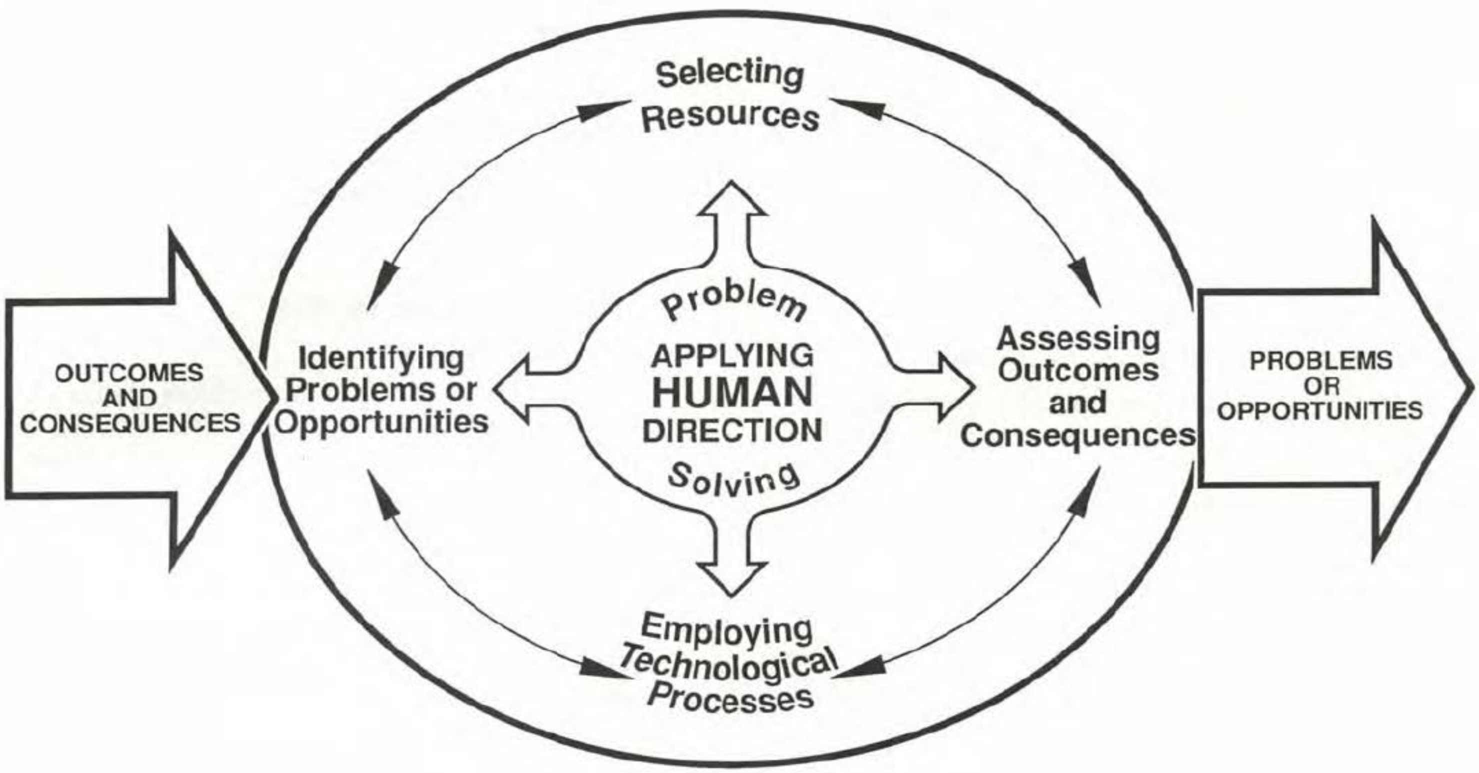


Fig. 2. A Model for Technology Education

### *A. Technological Method Model*

Technology education is a subject area of common education and provides learner the opportunity of understanding technology. New technology grows everyday and the information and knowledge of technology expands, too. Systems of technology in some areas are even exploded, such as energy & power technology and information & communication technology. In science education, how to integrating emerging technology into formal education becomes a concern. Education reform acts in Taiwan pointed out this trend and raised a “High Scope Curriculum Development” project to foster teachers to design teaching material and learning activities of emerging technology.[3, 4]

The key questions concerning any proposed new technology should include the following:

1. What are alternative ways to accomplish the same ends? What trade-offs would be necessary between positive and negative side effects of each?
2. What will the proposed new technology cost to build and operate? How does that compare to the cost of alternatives? What will the social costs be?
3. What risks are associated with the proposed technology? What risks will the technology present to other species of life and to the environment?
4. What people, materials, tools, and knowledge will be needed to build, install, and operate the proposed new technology?
5. What will be done to dispose safely of the new technology's waste materials?

The Technological Method Model provides a fran1ework for teaching technology. That is, it provides the framework for the immersion of students in actual technological practice. & such, in its educational counterpart, the Model for Technology Education (Fig 2 ), students will identify problems or opportunities utilizing the problem solving method, selecting the appropriate resources and employing technological processes to produce outcomes for which they will assess the consequences.

In effect, to teach technology, students must "do" technology which translates into involving students in each element in the Model for Technology Education and in the interactive nature of the Model.

- Applying Human Direction
- Identifying Problems or Opportunities
- Selecting Resources
- Employing Technological Processes
- Assessing Outcomes and Consequences
- Practical Implications for the Study of Technology

### *High-Scope Project*

Emerging technology is always a issue both in science education and technology education. In Taiwan, the National Science Council had copied this issue by establishing several research projects. The high-scope project is one of those projects.

In the high-scope project, high schools and university educators are working together to propose group research topic as a multi-year integrating research plan. The goal would concentrated in resolving the question of “how to bring emerging technology into high school formal education”. This study is based on the result of conducting the national high-scope project by the group of National Kaohsiung Normal University and the Fang Liao High School, Pingtung County.

The basic thinking of this integrated project are listed as follows.

1. High school teachers would play core role in coping with emerging technology. Their educational professions are qualified.
2. In-service education is vital to provide high school teachers opportunity to refresh their professions, especially on topics of 1) theory of technology education and curriculum development and 2) contents of emerging technology.
3. Inside evaluation and outside evaluation are important for emerging technology curriculum development.

The steps of conducing this project is illustrated in Fig.3.

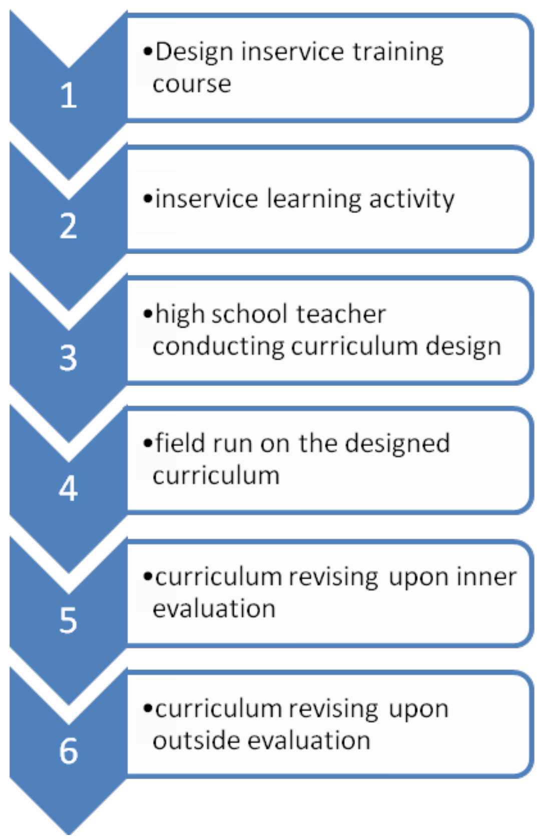


Fig. 3 Steps of project

The emerging technology contents considered in this project would be cloud both computing and green energy and e-learning would play a background content for overall learning. This paper would only report cloud computing, but the overall concept map would be presented in Fig. 4 for the purpose of reference.

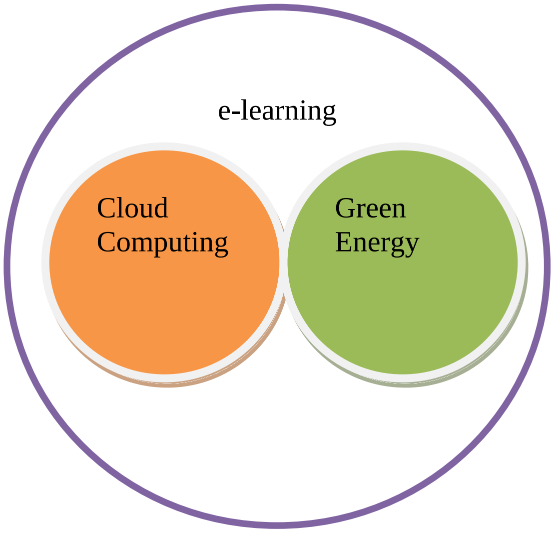


Fig. 4 emerging technology focus

### III. Curriculum Design

The purpose of this study was to design a curriculum for learning emerging technology on the focus of cloud computing at the high-school level.

#### *A. Learning Goals of Cloud Computing*

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Education adopted an approach whereby they skilled their students to gain an understanding of the key principles of virtualization and cloud computing, ensuring that the workforce has the right skill set and competencies to enable the society to support the following transformational objectives with respect to the cloud:

1. Transform the competencies of the IT experience from working in a "traditional" IT environment to working in a next generation service provider.
2. Fit into services of cloud computing as a technology user.
3. Reduce the risk and complexity inherent in a fragmented data strategy.
4. Virtualizes to modern, future-proof platforms.
5. Build an operating model of could computing.

#### *B. Topics of Integrating Cloud Computing*

The high school technology education curriculum were checked for the potential of integrating cloud computing. The best fitted topics are identified in table 2 and 3.

Table 1 Topics of Core Course

| Topics | Major Content | Class in hours |
|---|---|---|
| Technology Development | 1. Innovation of Technology<br>2. Impact of Technology | 4 |
| Technology World | 1. Scope of Technology | 8 |
| Creative Design & Production | ● Principle of Creative Design<br>● Practice of Creative Design<br>● Project of Design & Production | 24 |

Communication technology domain would be the best area for integrating cloud computing for high school students to recognize this emerging technology.

Table 2 Content of Advanced Course in the topic of communication technology

| Topics | Major Content | Class in hours |
|---|---|---|
| Communication Technology | 1. Electronic Communicatio n<br>2. Information Communicatio n<br>3. Communication Ethics<br>4. Communication Industry<br>5. Project of Design & Production | 36(12+24 project) |

There are core course and advanced course. In table 2, topics of the core course were listed with major content and class hours. The total class hours are 36.

For the advanced course, the topic is communication technology. The class hours are 36. The major content are also listed in the table 3.

*C. Structure*

The following is the proposed structure with both core and advanced course. The core course serves as a foundation for the advanced course. In Fig. 5, the structure was illustrated. In following sections, the proposed content of each course would be described.

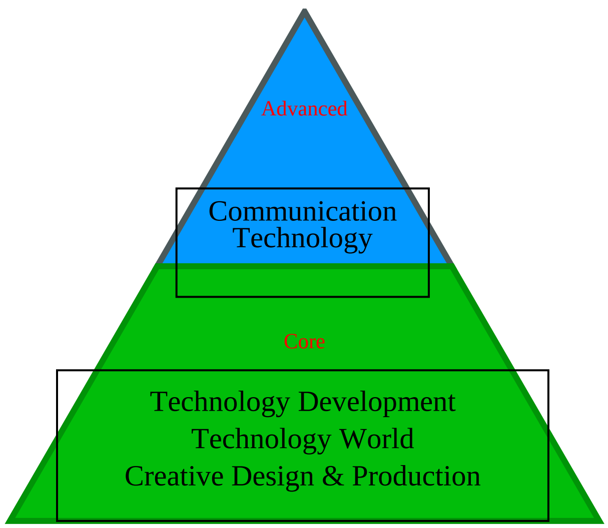


Fig. 5 Curriculum Structure for Emerging Technology of Cloud Computing

*1) Innovation of Cloud Computing*

The learning experience of this topic would focus on the followings:

- The definition, essence, and meanings of cloud computing.
- Contemporary development of cloud computing
- Cloud computing in Taiwan

*2) Impact of Cloud Computing*

The learning experience of this topic would focus on the followings:

- Relations among Cloud Computing, Living, Society, Culture
- Relations among Cloud Computing, Industry, economy development and National Competition Ability
- Cloud Computing and Environment Issues
- Cloud Computing, Ethics, and Law

*3) Scope of Cloud Computing*

The learning experience of this topic would focus on the followings:

- Principles of Cloud Computing
- Application of Cloud Computing

*4) Creative Design Principles*

The learning experience of this topic would focus on the followings:

- Creative Design of Cloud Computing Methods
- Creative Design of Cloud computing Procedures

*5) Creative Design Practice*

The learning experience of this topic would focus on the followings:

- Needs investigation of Cloud Computing
- Concept and design in Cloud Computing
- Operating Cloud Computing

*6) Project of Cloud Computing Practice*

The learning experience of this topic would focus on the following:

- Project based learning on Cloud Computing in real world problem.

*7) Electronic Communication*

This is a part of advanced course. The learning experience on electronic communication would focus on the following items:

- Communication Technology on Cloud Computing
- The electronic foundations and application of Cloud Computing
- The wired, wireless, and communication principles and application of cloud computing

*8) Information Communication*

This is also a part of advanced course. The learning experience on information communication would focus on the following items:

- Cloud computing computer system and application
- Cloud computing for the print media system and application
- Cloud computing for the multi-media system and application

*9) Communication Ethics*

This is also a part of advanced course. The learning experience on communication ethics would focus on the following items:

- Law and ethics of Cloud Computing
- Security issue of Cloud Computing

*10) Communication Industry*

This is also a part of advanced course. The learning experience on communication industry would focus on the following items:

- Contemporary Industry of Cloud Computing
- Impacts of society and life by the Cloud Computing
- Development and trend of Cloud Computing

*D. Definitions and Taxonomy*

For a emerging technology, it is important to establish concrete foundation for people to identify, discuss, and recognize. Following characters should meet:

- A practical customer-experience-based context for discussions on interoperability and standards
- Where existing standards should be related

The following definitions and taxonomy would provide an overview of cloud computing concepts. Based upon use case scenarios, it intends to show overview of cloud computing.

*1) Definitions of Cloud Computing Concepts*

Cloud Computing: Cloud computing is a model for enabling ubiquitous, convenient, on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications, and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction[1].

*2) Delivery Models*

The NIST definition of cloud computing defines three delivery models:

- Software as a Service (SaaS): The consumer uses an application, but does not control the operating system, hardware or network infrastructure on which it's running.
- Platform as a Service (PaaS): The consumer uses a hosting environment for their applications. The consumer controls the applications that run in the environment (and possibly has some control over the hosting environment), but does not control the operating system, hardware or network infrastructure on which they are running. The platform is typically an application framework.
- Infrastructure as a Service (IaaS): The consumer uses "fundamental computing resources" such as processing power, storage, networking components or middleware. The consumer can control the operating system, storage, deployed applications and possibly networking components such as firewalls and load balancers, but not the cloud infrastructure beneath them.

*3) Deployment Models*

The NIST definition defines four deployment models:

- Public Cloud: In simple terms, public cloud services are characterized as being available to clients from a third party service provider via the Internet. The term “public” does not always mean free, even though it can be free or fairly inexpensive to use. A public cloud does not mean that a user’s data is publically visible; public cloud vendors typically provide an access control mechanism for their users. Public clouds provide an elastic, cost effective means to deploy solutions.
- Private Cloud: A private cloud offers many of the benefits of a public cloud computing environment, such as being elastic and service based. The difference between a private cloud and a public cloud is that in a private cloud-based service, data and processes are managed within the organization without the restrictions of network bandwidth, security exposures and legal requirements that using public cloud services might entail. In addition, private cloud services offer the provider and the user greater control of the cloud infrastructure, improving security and resiliency because user access and the networks used are restricted and designated.
- Community Cloud: A community cloud is controlled and used by a group of organizations that have shared interests, such as specific security requirements or a common mission. The members of the community share access to the data and applications in the cloud.
- Hybrid Cloud: A hybrid cloud is a combination of a public and private cloud that interoperates. In this model users typically outsource non-business critical information and processing to the public cloud, while keeping business-critical services and data in their control.

*4) Essential Characteristics*

The NIST definition describes five essential characteristics of cloud computing.

- Rapid Elasticity: Elasticity is defined as the ability to scale resources both up and down as needed. To the consumer, the cloud appears to be infinite, and the consumer can purchase as much or as little computing power as they need. This is one of the essential characteristics of cloud computing in the NIST definition.
- Measured Service: In a measured service, aspects of the cloud service are controlled and monitored by the cloud provider. This is crucial for billing, access control, resource optimization, capacity planning and other tasks.
- On-Demand Self-Service: The on-demand and self-service aspects of cloud computing mean that a consumer can use cloud services as needed without any human interaction with the cloud provider.
- Ubiquitous Network Access: Ubiquitous network access means that the cloud provider’s capabilities are available over the network and can be accessed through standard mechanisms by both thick and thin clients.
- Resource Pooling: Resource pooling allows a cloud provider to serve its consumers via a multi-tenant model. Physical and virtual resources are assigned and reassigned according to consumer demand. There is a sense of location independence in that the customer generally has no control or knowledge over the exact location of the provided resources but may be able to specify location at a higher level of abstraction (e.g., country, state, or datacenter).

*5) Contents of Instructional Material*

There are two chapters and nine sessions in the learning materials after integrating according to the standard of technology education. All titles are listed in Table 3.

Table 3 Catalog of contents

| | |
|---|---|
| Chapter 1 | Development of Technology |
| 1-1 | The essentials and meanings of cloud computing<br>Definition<br>Goal and Importance<br>Pros & Cons of Cloud computing |
| 1-2 | Innovation of Cloud Technology<br>The innovation history of cloud technology |
| 1-3 | Global Developing Situations of Cloud Technology<br>Could computing in major nations<br>Main Stream of Cloud computing provider |
| 1-4 | National Developing Situations of Cloud Technology<br>The Five domains of Could Computing Industry in Taiwan<br>The force-directions of Cloud Computing Industry in Taiwan<br>The future perceptions of Could Technology |
| 1-5 | The Impacts of Cloud Technology<br>Cloud Technology & Everyday Life<br>Cloud Technology & Society-Culture<br>Cloud Technology & Industry-Economic<br>Developing-Nation Competition<br>Cloud Technology & Ethics & Legal Issues |
| 1-6 | Environmental Change & Pollutions caused by Cloud Computing |
| Chapter 2 | Technology World |
| 2-1 | Communication Technology |
| 2-2 | Principles & Applications of Communication Technology |
| 2-3 | Principles & Applications of Cloud Technology<br>Three Service Types of Cloud Computing<br>Four Implementations of Cloud Computing<br>Five Basic Characteristics of Cloud Computing<br>Applications of Cloud Computing |

*E. Evaluations*

For verifying the result of content identified. A content analysis procedure was produced. All selected major contents were evaluated according to the technology principles of the universal model by invited professionals. There existed significant agreement between selected contents and criteria. The evaluators' agreement was 0.87.

The field practice of this curriculum has been conducted for a semester. Other than the formal learning application, two national competitions on emerging technology learning were also implemented based upon this curriculum.

The CIPP Model (Context, Input, Process, and Product) can be used for both formative and summative evaluation. Perhaps the most significant characteristic of CIPP is that it makes provision for holistic evaluation. Its elements are systems oriented, structured to accommodate universal evaluation needs. They also notes the rarity of an evaluation model that offers process evaluation, as this one does.

- Context evaluation, to serve planning decisions –"is intended to describe the status or context or setting so as to identify the unmet needs, potential opportunities, problems, or program objectives that will be evaluated".
- Input evaluation, to serve structuring decisions –"the evaluator provides information to help the decision maker select procedures and resources for designing or choosing appropriate methods and materials".
- Process evaluation, to serve implementing decisions – "making sure that the program is going as intended, identifying defects or strengths in the procedures".
- Product evaluation, to serve recycling decisions – "a combination of Alkin's progress and outcome evaluation stages" that serves to judge program attainments.

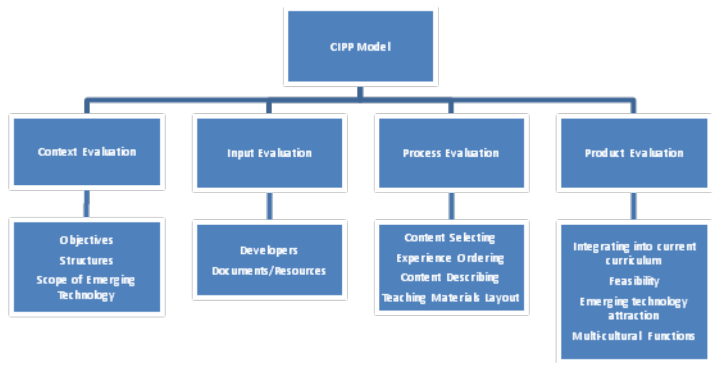


Fig. 6 CIPP Evaluation Model

The CIPP model deals with products or outcomes not only at the conclusion of the program but also at various points during the program. Outcomes are then related to objectives; differences are noted between expected and actual results; and the decision maker decides to continue, terminate, or modify the program

## IV. Discussion & Conclusion

The controversy of facing future with current knowledge is always a challenge to the educators. In technology education, the situation is somewhat even difficult because of technology innovations happen all the time.

In this study, a procedure of curriculum development for technology education based upon emerging technology was presented. In fig. 7, the procedure is illustrated. Since technology is artifact, there always authority institutional control on technological standard. The curriculum development begins with those raw data from authorities. Based upon technology universals theory structure, learning contents were selected and collected for design learning activity or textbook. Based upon the technological method model, learning activity would be organized for students.

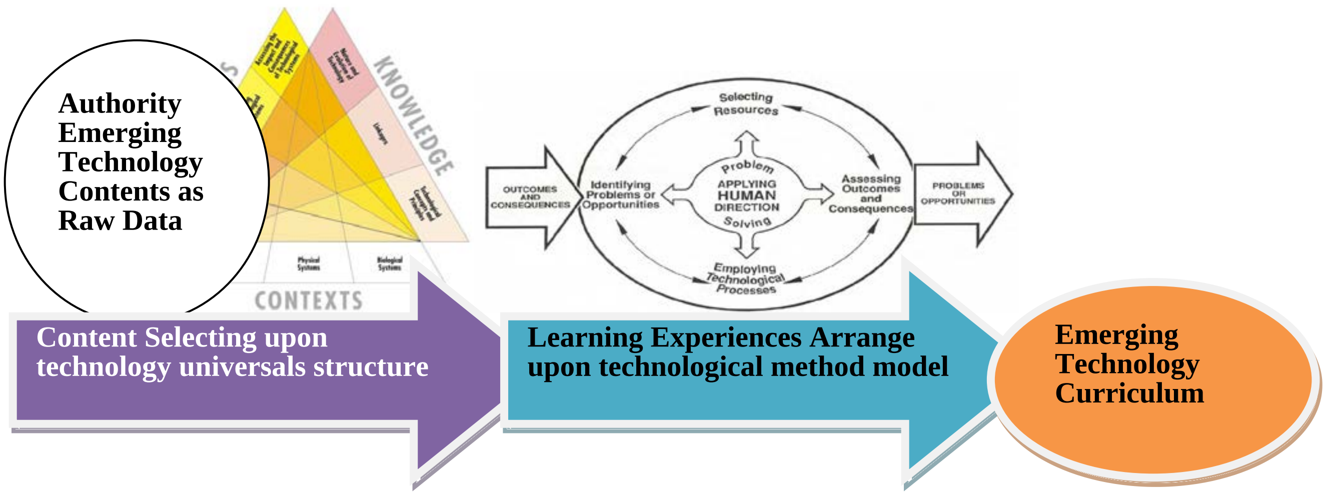


Fig. 7 Procedure of developing emerging technology curriculum

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