Educational Communications and Technology:
Issues and Innovations

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Educational Technology to Improve Quality and Access on a Global Scale

Papers from the Educational Technology World Conference (ETWC 2016)

AECT ASSOCIATION FOR EDUCATIONAL COMMUNICATIONS & TECHNOLOGY

Springer

Chapter 13
Instructional Design for the Computer Network Subject: A Balinese Culture-Based Learning Using Subak

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Abstract Indonesian culture is very diverse and many of its indigenous concepts and values can potentially be applied in modern education and daily life. Subak is a Balinese irrigation system, which is known widely in the world. The Subak system with its unique resources management is similar to the concept of a computer network system. The Subak concept can be applied to an innovative learning model to improve students' understanding and mastery of certain concepts. This is a needs analysis study to produce an instructional design manual based on Subak concepts, for the subject of computer networking. The subjects for this study were students majoring in Informatics Engineering Education while taking a course in computer networks. The data were collected through the use of questionnaires, observation, and interviews and analyzed through a descriptive qualitative method. The instructional design manual being developed consists of 11 chapters with 23 specific instructional objectives where each chapter illustrates two important points. However, there are still three chapters having material which is still difficult to be analogically linked to Subak concepts, such as Internet Protocol, internetworking, and directory of naming. The computer network concepts are associated with the analogy of a Subak network system. The aspect that does not seem to be covered with the analogy is the commercialization of computer networks/Internet and the involvement of large corporations.

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K.A. Persichitte et al. (eds.), *Educational Technology to Improve Quality and Access on a Global Scale*, Educational Communications and Technology: Issues and Innovations, https://doi.org/10.1007/978-3-319-66227-5_13

1 Introduction

In the era of globalization and the ASEAN Economic Community (AEC), mastering science and technology is very important to keep competitive. Human resources in Indonesia have the challenge of being reliable, qualified, and able to master science and technology but Indonesians also have typical national characteristics based on indigenous culture. Gardner (2007) claimed that future challenges require five characteristics: a disciplined, synthesized, creative, ethical, and respectful mind. Miarso & Hadi (2007) and Tilaar (2012) stated that globalization should be encountered by fostering creativity and entrepreneurship through transformative critical pedagogy in national education.

Educators have to prepare students with good technological skills, critical thinking, creativity, and the ability to adapt to changes and developments. Accordingly, there is a need to reorient education in these changing times so as to facilitate pedagogical transformation and to raise self-awareness.

ICT knowledge, particularly in relationship to current computer material networks, tends to have weaknesses such as: (a) the learning concepts are not connected to real life; (b) students complain that it is too difficult to learn the materials; (c) the material does not encourage students to think creatively and critically; and (d) the materials do not support concrete understanding of concepts and lack relevance to existing cultural values. This is confirmed by Suastra (2008) who argued that nowadays education tends to be a means of social stratification and the education system simply attempts to transfer knowledge to students, which is unrealistic He adds *dead knowledge* is achieved through rote learning (text books).

Attempts have been made to improve student learning outcomes, by (a) applying the cooperative learning model, (b) holding workshops, and (c) reproducing tasks. Although these efforts achieved some success, the results were not optimal because students had difficulties understanding concepts and problem analysis. Learning outcomes do not only depend on the experience in the classroom, but also depend on culture and the environment.

2 Literature Review

Cultural values can be included in the instructional design and learning process. Morrison, Ross, and Kemp (2007) argued that cultural and social differences, as well as other differences, should be recognized and addressed in an instructional design because they can affect student performance and the ability to take responsibility for individual work or to engage in creative and collaborative activities. Paul and David (Ardana, 2008) argued that several approaches might be taken to investigate individual differences that are a result of cultural diversity. Philosophically and practically, in daily life, environmental circumstances strongly influence students in developing their knowledge. One environmental influence on the learning process is

a cultural aspect because the learning process should not be separate from the learners' culture and environment.

According to Subagia and Wiratma (2006), life values adopted by the community have an effect on the educational process. They state that there is potential for local wisdom to be relevant to modern instructional and educational theory. Local wisdom can potentially play a part at the level of the (1) learning concept, (2) learning discipline concept, (3) teachers as leaners concept, (4) how to teach concept, and (5) how to learn concept. Based on these findings, Subagia and Wiratma (2006) suggested that local wisdom should be taken into account in developing the concepts of a culturally based education. This opinion is emphasized by Kesiman and Agustini (2012) who claimed that by studying and analyzing Indonesian culture, one may find many concepts of local wisdom that have been practiced in daily life that can be beneficial for the study of information technology. Ardana (2008) indicated that a local wisdom-oriented learning model can be effectively used to improve learning quality, learner participation, student achievement, and student responses in the learning activity.

Character development is very important and can positively affect people, good manners, positive behavior, and national spirit. Indonesian people characteristically tend to value all, aiming to have a superior and noble civilization. It is time to rebuild awareness of the importance of positive character development for the Indonesian people through quality education based on local wisdom.

Thus, it seems necessary for a transformation of ICT education, from learning by rote to learning through higher-level thinking, from studying superficially to studying in depth, from the transfer of knowledge to the development of knowledge, skills, and positive character traits to improve the nation. It is therefore the responsibility of all ICT education experts to develop an ICT curriculum and testing system which is focused on this new orientation, as well as knowledge disseminating on ICT learning methods, and to develop techniques that are effective and meaningful. All these efforts, however, would be less than effective without considering innovative learning in class.

Developing an instructional design that is focused on developing students' creative thinking and national character based on local wisdom may provide a valuable contribution to support human resource development and improve the quality of learning, especially ICT through innovative learning. There will be a balance and harmony between the knowledge of the technology itself with the development of scientific attitudes, as well as national character-based values of local wisdom and growth in the community. Accordingly, ICT education will be beneficial to the students themselves, the wider community, and the Indonesian nation.

Based on the above rationale, this study aims to: (1) identify and analyze the instructional qualities of the local wisdom using the concept of Subak in managing water resources; Subak's basic concepts are similar to the concepts of managing a computer network system; and (2) define the learning goals that are tailored to the syllabus for the networking course. Through the identification and analysis of the similarity between the two concepts, instructors can assist students in learning concepts in a more concrete way by using this analogy.

In the Indonesian island of Bali, rice farmers form cooperative associations called "Subak" (which is also used to refer to the irrigation system used by Subak associations), averaging 100 farmers working on less than 50 hectares of irrigated rice fields (Falvo, 2000). Subak is a socio-religious organization responsible for irrigation management and religious activities within a defined geographical area. Every Subak has rules that have developed over a long period of time. The rules have been codified into a set of laws called *awig-awig*. These laws regulate the rights and duties among the members of the Subak. Such rights and duties include public obligations, regulations concerning land and water use, legal transactions for land transfer, and collective religious ceremonies (Lorenzen, 2006).

As an irrigation system, Subak owns and manages a network of irrigation from the same water source. Like a computer, Subak is mostly supported by three main components: the *hardware* (facilities and irrigation infrastructure), the *software* (the processes undertaken from planting the seed to harvest, along with a series of religious ceremonies performed), and the *users* (the members of Subak). The three main computer parts, such as the input devices, the processing devices, and the output devices are also contained in the concept of the system of Subak. Subak as a physical unit has a subsystem of artifacts that also serve as input, process, and output devices. Control of access to resources is also done within a Subak system. The basic services of a network operating system can be found commonly in each Subak, such as: Activity Management, Resource Management, Input and Output Management, Protection System, and Distributing System.

Subak members do not have direct access to the resources of Subak. The Subak rules provide a mechanism to access resources on behalf of Subak members. In this case, Subak acts as a resource allocator, for allocating resources to some of its members or to regulate jobs that are running simultaneously. The *Pekaseh* or the head of Subak is responsible for managing the distribution of water fairly and equitably for all Subak members. For a larger Subak (usually called *Subak Gede*), the *Sedahan* is responsible for synchronization when there is a conflict over water usage among Subak members. The flow of water from the dam is governed by the gate controller, in accordance with the agreements made by all members. Interruption is an important part of computer architecture. This mechanism is also applied in the process of water distribution in the Subak system.

From the period of the growing season to the harvest season, the water distribution process is conducted in accordance with earlier agreements of all Subak members. In actual practice, however, some members may complain to Subak about problems in the distribution of water. Like a networking operating system, the Subak system is also responsible for activities related to collective management of resources such as keeping track of and distributing water, selecting cropping activities and religious ceremonies, and also arranging the process of the borrowing/transfer of land and water among Subak members.

Two or more Subak organizations may cooperate to form a larger Subak. In this distributed system of several Subaks lie concepts of local wisdom as a quite complex operating system. A number of ceremonies are for instance conducted in the planting period or to anticipate extraordinary events such as pest attacks. In a

distributed system, Subak attempts to maintain the coherence and consistency of water flow that may become more complex. A rice field area may receive water input from several sources originating from different regions of Subak. The *Sedahan* of each Subak region are involved in the process of negotiations and compromising over water distribution. In addition to the need to calculate the debit of water received from the Subak's own irrigation channels, the quantity of water received from other surrounding Subaks must also be taken into account.

The Subak system also provides irrigation facilities and infrastructures within its region. The services provided by Subak in an irrigation system are outlined below. The first service is the planting program (program execution). The Subak should be able to implement the entire planting program that has been planned, including conducting a whole series of religious ceremonies. The second is the setting and maintenance of irrigation facilities and infrastructure (I/O operations). The Subak must organize everything involved in the usage of facilities and irrigation infrastructure. Farmers themselves cannot manipulate the use of irrigation facilities, without any agreement between all Subak members, in accordance with the rules stipulated in the *awig-awig* of the Subak. The third service of the Subak is as a medium of communication among its members. The Subak serves as a bridge of communication among its members for all activities that will be run by Subak members. The fourth one is anticipating conflict and searching for solutions (error detection). The Subak should be able to provide solutions for conflicts arising within its territory. The fifth service is allocating the irrigation of water resources (resource allocation). The last one, the sixth service, is to protect the distribution process and the use of irrigation water resources (a protection system).

Similar to an operating system, the Subak's main objectives are to provide comfort for all members in the use of limited resources. Common to all includes the efficient use and utilization of Subak resources. Evolving systems and organizing of the Subak should be built to enable and to facilitate the development, testing, and filing of the new systems. These objectives are obvious from the characteristics of *awig-awig* of Subak, which is highly flexible; sometimes non-formal agreements among Subak members are needed.

Subak provides services for the proper use of all resources in the operation of an irrigation system. Subak is not only a religious and socially based cultural heritage, but it is also a deep and complex, living system for sharing limited resources, much like a modern computer (Kesiman, 2011).

3 Study Design

This chapter details the results of a two-year research and development study, based on an adoption of the instructional development model referred to as MPI (Suparman, 2012). The MPI contains these important stages: identification, development, evaluation, and revision. This study is focused on the identification stage, which has two main objectives: (1) to assess and analyze the instructional needs in the form of

descriptive research, and (2) to define and establish the conditions and requirements of the empirical development of instructional design of computer networks based on local wisdom, namely the Subak concept of Bali.

The subjects were students majoring in informatics education, who take courses in computer networks. The data were collected through questionnaires, observation, and interviews. The data were analyzed using qualitative descriptive analysis.

The identification and analysis stages were completed through examining the sources of relevant literature, such as relevant aspects and indicators. The identification and analysis were then included in the questionnaire, which was distributed to students. The questionnaire gathered information relating to preferred instructional design. The needs analysis stage of the learning concept was done through a literature review on the concept of Subak, which is analogically linked to the concept of a computer network. This has been adapted in the syllabus and made explicit and clear to students.

3.1 Discussion

The needs analysis of instructional design identifies eleven clusters of computer network concepts which are analogically linked to concepts of Subak system. Those eleven clusters (which could be treated as chapters in an instructional sequence) consist of 23 specific instructional objectives. Some other results of the analysis are:

1. The time-sharing system in the computer network concepts is similar to the concepts of water resources sharing. For example, the specific objectives of emotional and physical well-being (*moksartham jagadhita*) are applied in the Subak system. While networks do not have emotions, the notion of balancing tasks and being equitable with time demands does apply.
2. The broadcasting network with its transmission technology is similar to the Subak irrigation system. The rice fields' distribution scope that enters into the territory of a particular Subak is determined by factors of geographical location of the rice fields. Subak is an indigenous concept of Balinese, who are socio-agrarian, economical, and dynamic in regulating the use of irrigation for paddy fields. Subak members are farmers, including tenant farmers. They utilize the irrigation network, which could include one or more rural areas. Thus, membership-based Subak irrigation (canal based) is not limited to the area of the village (village based). For a small water control system, the area to be managed is not too extensive. It is probably only about 10 % of total area. However, when a Subak involves a larger area (rice fields), which is usually a combination of several small water control systems, the geographical area can be as much as one region or district. Bandwidth issues in a computer network exhibit similar characteristics.
3. The concept of wide area network exists in a larger Subak network, known as *Subak Gede*. The *Subak Gede* consists of several dams and water control systems that use irrigation infrastructure collaboratively. At the *Subak Gede,* communication

must be established between the heads of all the Subaks. The process of water distribution and utilization of irrigation channels will become increasingly complex. Conflicts, which may arise, will also be more complex, because they may involve members of Subak from different regions. Similarities in computer networks include coordination of shared resources among multiple users and user communities.

4. Looking at the function of an irrigation or water control system as a network of irrigation facilities, needed to organize and distribute irrigation water from the source to the rice fields of individual farmers has similarity with how one may view a computer network. The irrigation facilities consist of irrigation channels, along with irrigation and buildings, *awig-awig* (rules/protocols for the management of Subak) and Subak meetings (the interaction and communication between Subak members), which together form an integrated system of irrigation networks. Alternative channels and protocols similar to those in a Subak can be found in a computer network.
5. The structure and functions of the layers in the OSI (Open System Interconnection) are similar to the concept of Subak. Although it is better known as the setting of irrigation systems, the water control system is also a complex organization. Therefore, we need a protocol structure of the network model that can simplify highly complex tasks into smaller units (layers). The Subak system recognizes the existence of four layers that have their respective functions and form one unit. This is somewhat analogous to the notion of protocols and priorities in a computer network.

3.2 Limitations of These Studies

The Subak irrigation system is one example of the culture of Bali, which has only been studied as a socio-cultural organization. Other researchers have studied it in terms of its economic value (Kesiman & Agustini, 2012). Instructional design and development seeks to provide alternative sources and resources in support of learning so that students can build new knowledge from their own experiences. The ability of students to construct knowledge is in line with the opinion of Saekhan (2008) and many others who argue that learning is a process of building knowledge through real experience in the field.

3.3 Content Limitations

There are eleven aspects of computer networks that have been identified and analyzed in the existing syllabus. Among these are three topics that the researcher could not analogically link to the concept of Subak. These are: (1) Internet Protocol; (2) internetworking; and (3) directory of naming. There is no suggestion that such

an analogical approach based on Subak will work outside Bali or outside Indonesia. It might be interesting to find other analogies embedded in local culture that might inform how one thinks and learns about information and communications technologies.

3.4 Demographic Limitations

Indonesian culture is diverse and has developed from a variety of local wisdom to regulate the life of local communities. Every region in Indonesia has a unique culture and local wisdom respectively. If someone comes from a certain area and then settles in other areas, they need to adjust to the local environment. There is a saying that "when in Rome, do as the Romans do." When in Bali, stay in tune with Subak.

A limitation in this research for developing instructional design is that it is specifically appropriate for students who were born, grew up, and lived in Bali. They already know and understand the concept of Subak, so they can easily learn from the material provided. For students, who come from outside of Bali, however, they have to first understand the concept and terminology of the Subak system before applying it to computer network systems.

4 Conclusion and Future Study

In examining the syllabus and lecture material used for computer network systems, eleven chapters with twenty-three specific instructional objectives can use the concept of Subak as an analogy. Three chapters were not analogous: Internet protocol, internetworking, and naming in a directory. Researchers and teachers should continue to explore the nation's local wisdom, as there are still many untapped resources, which could be optimized and used as a reference in the development of education in schools, based on a national character using elements of Indonesian culture.

Acknowledgments The authors thank Prof. Dr. Atwi Suparman for his support and sharing his experience. This has helped us to improve our knowledge. Also thanks to our Institution, Universitas Pendidikan Ganesha, for the permission to conduct this research.

References

Ardana, I. M. (2008). Meningkatkan kualitas pembelajaran melalui pengembangan model berorientasi local genius. In *Proseeding Konvensi Nasional Pendidikan Indonesia VI* (pp. 1135–1137). Denpasar.

Falvo, D. J. (2000). On modeling Balinese water temple network as complex adaptive systems. *Human Ecology, 28*(4), 641–649.

Gardner, H. (2007). *Five minds for the future*. Boston, MA: Harvard Business Review Press.
Kesiman, M. W. A. (2011). Improving student's motivation and achievement by implementing a local cultural based learning. In Z. Sakhiya, I. M. Arsana, & M. Ramadewi (Eds.), *Education counts!* (pp. 169–193). Melbourne, VIC: PPIA.
Kesiman, M. W. A., & Agustini, K. (2012). The implementation of hypertext-based learning media for local cultural based learning. *Journal of Information Technology Education: Innovations in Practice, 11*, 377–385.
Lorenzen, S. (2006). "I am just borrowing water, but I will return it in an hour". The interdependance of informal and formal institutions in Balinese irrigation management. *11th Biennial Conference of the International Assocation For The Study Of The Commons*, Ubud.
Miarso, Y., & Hadi, Y. (2007). *Menyemai benih teknologi pendidikan*. Jakarta: Kencana Prenada Media Group.
Morrison, G. R., Ross, S. M., & Kemp, J. E. (2007). *Designing effective instruction*. New York, NY: John Wiley & Sons.
Saekhan, M. (2008). *Pembelajaran kontekstual*. Semarang: RaSAIL Media Group.
Suastra, I. W. (2008). Pedidikan sains berbasis budaya lokal sebagai upaya meningkatkan mutu pendidikan sains pada masyarakat asli. In *Konvensi Nasional Pendidikan Indonesia VI*. Denpasar. Retrieved from http://pasca.undiksha.ac.id/images/img_item/586.docx.
Subagia, I. W., & Wiratma, G. L. (2006). Potensi-potensi kearifan lokal masyarakat Bali dalam bidang pendidikan. *Jurnal Pendidikan Dan Pengajaran, XXXIV*(*3*), 552–564.
Suparman, M. A. (2012). *Desain instruksional modern*. Jakarta: Erlangga.
Tilaar, H. A. R. (2012). *Pengembangan kreativitas dan enterpreneurship dalam pendidikan nasional*. Jakarta: Kompas.

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