The 10th International Scientific Conference
eLearning and software for Education
Bucharest, April 24-25, 2014
10.12753/2066-026X-14-192

A REGIONALIZED COLLABORATIVE COMMUNITY BASED CLOUD COMPUTING AWARENESS EVANGELISM INITIATIVE

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***Abstract**: Knowledge acquisition often is considered as a prerequisite for enhancing human wisdom and to ensure proper amalgamation into the civilized society. This often is achieved through society approved legal frameworks leading to formal education. It is practically impossible for formal education to encompass new knowledge evolutions which usually have dynamic trending. This may be because of advances that the societal ecosystem creates for its survival. It is often proved and empirically observed that knowledge acquisition through an informal knowledge delivery framework results in filling up the fragments that exist in an entity due to knowledge evolution. Such frameworks are also called as "knowledge communities" who are driven by passion to dissipate the acquired knowledge back to the society. The very fact of the success of the open source communities across the world legitimates the above said claim. It is always a challenge to disseminate knowledge for large spectrum of learner communities due to the initial gaps that may exist about a specific concept. This may again be more challenging if it is a technology based topic and/or concept such as cloud computing. The interesting aspect of informal teaching learning process gives an opportunity to propose and experiment novel pedagogical approaches to address these challenges. These approaches can also enable us to generate statistics about the awareness of the entities in the society about a trending topic. This work carried out addresses a cloud evangelism framework to effectively inculcate the trending cloud computing ecosystem into the society. This work also proposes an efficient pedagogical approach to create cloud computing ecosystem awareness among the desirable community at large.*

***Keywords:** Cloud computing; evangelism; collaborative; pedagogy; Open source*

I. INTRODUCTION

Utility or services are systems that cater to a public need such as transport, communication, electricity and water. Today, in this technologically trending world we have come across computing as a utility. Cloud Computing is an emerging infrastructure paradigm that encompasses virtualization and provides infrastructure, platform and software as a service based on the needs of an enterprise [1]. Cloud has revolutionized data storage capabilities and is synonymous with the phrase "pay for what you use" which has resonated with enterprises and community-scale businesses [2]. The compelling need for Cloud Computing Awareness lies in realizing the potential of the Cloud for both large and small businesses in terms of cost-cutting, scalability and maintainability issues [2].

Cloud Computing is touted to be the future of Computer Science and is currently one of the fastest growing trends in all of IT, in both the public and private sectors [3]. Although, the value proposition of cloud infrastructure has proven to be tremendous, a significant number of enterprises fail to utilize this infrastructure largely due to financial constraints and/or lack of acceptable awareness. Therefore there is a need at both an enterprise level as well as community level to evangelize the concept of Cloud Computing, the benefits associated with it and the many possibilities it offers.

This need for "Cloud Computing Awareness" calls for a framework that imbibes this knowledge amongst large communities. Traditionally, these frameworks are part of the formal education process. They arguably however fail to keep up with the pace of the dynamically trending cloud ecosystems [4]. This stands as a reason for the knowledge transfer of cloud computing to be impossible via static formal educational frameworks. The work thus presents a regionalized community-based informal knowledge delivery framework called "iNoah" ("iNoah" means chanting in Hawaiian). The primary motive of "iNoah" is to provide a knowledge framework using the concept of "open source" to enable any person/community with basic computing knowledge and with a purpose for cloud usage to be able to set up and manage cloud efficiently. This delivery model is non-commercial and not-for-profit.

Knowledge being a vast ocean in itself needs a dedicated offering for each of its sub-divisions to drive home the concepts behind it. The Cloud Computing Awareness Evangelism Initiative using the framework of "iNoah" aims to do just that.

The iNoah framework is the backbone of the Cloud-Computing Evangelism Initiative. The model has the following aims:

- To enable a person from any language background to learn about Cloud Computing with no language barriers.
- To enable any person/ community with basic computing knowledge to be able to set up and manage a private cloud to cater to his/ her/ community's requirements.

II. PROPOSED MODEL

"iNoah", an informal knowledge delivery community model consists of 5 stages. Each stage concentrates on a particular section of the awareness model proposed in the work. The Cloud Computing Awareness Quotient (CCAQ) increases gradually as the participant goes through the different stages of the framework. The various stages have been designed and structured keeping the target community in mind, which consists of people who may have little or no knowledge about the concept of "Cloud Computing". The 5 stages are:

1. Cloud Hardware Aware
2. Cloud Infrastructure Aware
3. Cloud Infrastructure Usage Aware
4. Cloud User Application Aware
5. Self-Assessment

At the end of the 5 stages, the person is said to be Cloud Computing Aware.

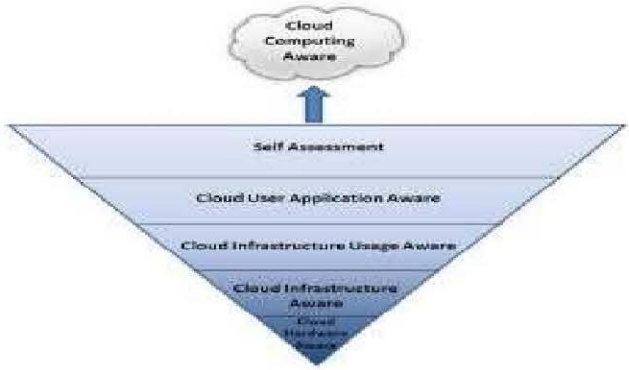


Figure 1. 5 stages of "iNoah" framework(iNoah roadmap)

2.1. Cloud Hardware Aware

Before trying to understand the intricacies of Cloud-Computing and its ecosystem, a basic understanding of the hardware required and physical architecture adopted in the framework is necessary. This stage solely focuses on the hardware requirements and the physical architecture of the cloud ecosystem. At the end of this stage, Cloud Hardware Awareness is achieved and the participant can now begin understanding the technical aspects of cloud ecosystem.

2.2. Cloud Infrastructure Aware

A clear understanding of how the cloud works in the back-end along with details regarding how to set up the cloud with respect to the physical architecture explained in the previous stage is useful before the participant actually learns about how to work on/ with the cloud. This stage focuses on the conceptual architecture of the cloud ecosystem and the procedure of setting up the cloud. At the end of this stage, cloud infrastructure awareness is achieved and the participant would be capable of setting up his/ her own cloud.

2.3. Cloud Infrastructure Usage Aware

Once the participant is capable of setting up his/ her own cloud, knowledge regarding the management and usage of cloud resources becomes necessary. This stage focuses on creating awareness about the different features of the cloud setup. During this stage the participant understands the various features of the cloud setup from the point of view of a cloud administrator. At the end of this stage, cloud infrastructure usage awareness is achieved and the participant would be able to manage his/ her own cloud.

2.4. Cloud User Application Aware

After the participant learns the procedure to set up and manage the cloud ecosystem, he/she then learns how to host applications on cloud. This stage focuses on creating awareness regarding the various applications that can be set up easily on a cloud and also how the participant can create his/her own applications on the cloud. At the end of this stage, cloud user application awareness is achieved and the participant is able to create and run applications on the cloud.

2.5. Self-Assessment

To assess his/her Cloud Computing Awareness, the participant is made to carry out 5 experiments. These experiments were created with the intention of enabling the participant to apply the knowledge gained during the afore-mentioned stages and assess his/her learning and concepts.

The participant goes through the five stages of the framework of "iNoah" by attending a workshop, which is basically an enactment of the stages required in learning the cloud ecosystem. The "iNoah" team has successfully conducted a number of workshops in various colleges offering professional courses. The feedback and self-assessment modules are a testament to the fact that the model aids the learning process. At the end of the workshop, the participant leaves with the basic understanding of Cloud ecosystem and he/she is capable of setting-up and managing a cloud ecosystem.

III. IMPLEMENTATION OVERVIEW

The execution of the proposed framework has been implemented keeping in mind the target community. The model draws inspiration from the success of Open Source Communities and their contribution. The implementation of the framework is based upon an existing Open Source software – OpenStack® [5].

3.1. OpenStack®

OpenStack® is an Open Source project, which aims to provide a "ubiquitous open source cloud-computing platform for public and private clouds". The proposed framework aims to make the community cloud-aware using OpenStack® Grizzly version as the medium. The implementation architecture is logically divided to spread across 3 physical computers (nodes) to aid the participants in understanding each node and all the services of OpenStack® in that node. This enables the participant

to get the complete picture of a Cloud ecosystem while also focusing on the granular aspects of the infrastructure requirements in the chosen architecture.

3.2. Additional Features

In order to ensure that the framework achieves its aims, a number of other features were introduced which would act as a catalyst to the entire evangelism initiative. The features introduced/developed are:

- OpenStack® *ISO images*: Each of the 3 nodes in the architecture has an ISO image created for it. Each ISO image has a customized Ubuntu 12.04 LTS operating system along with the packages pre-downloaded to configure the OpenStack® services, which belong to each physical machine. The services that belong to each physical machine depend on the logical division of the OpenStack® implementation architecture. This enables the installation of OpenStack® services for hosting the cloud ecosystem to be a completely *offline procedure*.
- *Configuration & Setup Tool* (referred to as CST in this work): The process of configuration and setting up of the cloud ecosystem is automated. The CST takes the necessary configuration details from the user and sets up the cloud ecosystem within minutes. The front-end of the CST is developed using Java, and the back-end, which makes the system configurations as per the user's specification, is done via bash scripts. The CST enables us to configure the cloud environment within minutes.
- Regionalizing the interactive aspects of the model:
  - *CST* is a multi-lingual tool, wherein the user has an option to select the language he/she is comfortable with. Different configuration interfaces have been developed for different languages.
  - OpenStack® *Dashboard* is the interface which enables a user to launch instances and manage his/ her cloud. It is made multi-lingual wherein the user has an option to select the language he/ she is comfortable with.
- *OpenStack® Dashboard Guide*: This application is Java based. The guide helps the user to walk through the steps required for using and managing his cloud instances.
- *Interactive videos and presentation*: Interactive videos and presentations are used to introduce the concepts of Cloud Computing.

The architecture employed in the evangelism initiative along with the features included to simplify the process of setting up the cloud ecosystem is depicted (Figure 2)

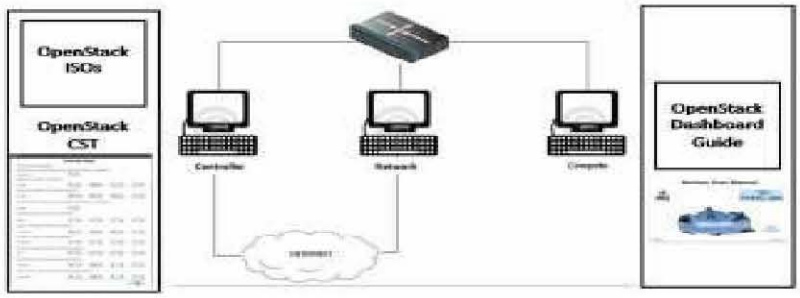


Figure 2. Features included by the iNoah team to simplify the process of setting up the cloud-ecosystem along with the architecture employed

IV. WORKSHOP CONDUCTION

In order to validate the framework proposed in the work, workshops were conducted. They were divided into 3 sessions:

- Introduction
- Installation
- Hands-On

The "pre-iNoah" and "post-iNoah" surveys act as an assessment of the effectiveness of the framework as well as the learning curve achieved by each participant going through the workshop.

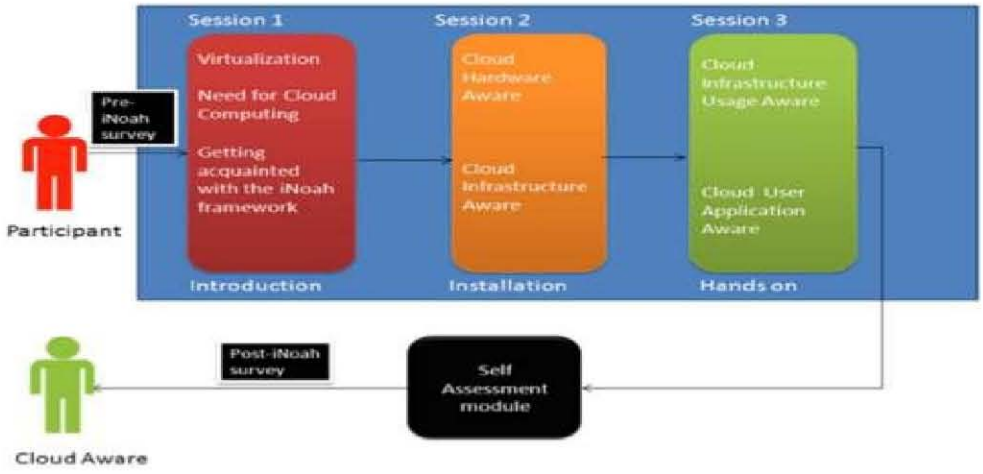


Figure 3. Different sessions of the workshop encapsulating stages of the workshop

4.1. Introduction – First session

The workshop begins with a brief introduction to the concept of Virtualization and Cloud Computing. It also emphasizes the compelling need for Cloud Computing awareness. This is followed by an introduction to iNoah and its various features.

4.2. Pre-iNoah Survey

The first session is followed by a pre-iNoah survey. This collects information about the students' knowledge in form of a questionnaire, with each answer being on a scale from 1 to 10 indicating the individual's knowledge level about the concept in question. The questions include:

- Concepts of Cloud Computing
- Terms related to the domain
- Concepts related to networking

4.3. Installation – Second Session

The second session involves the explanation of the physical architecture and the proposed methodology for the installation. During the installation of a node, functionalities of that node in the physical architecture are discussed.

4.4. Hands-on – Third Session

The hands-on session is an interactive session wherein the participants get the opportunity to experiment on the cloud installed during the workshop. A few experiments are carried out by demonstration while participants carry out a few experiments individually.

At the end of the Hands-on session, the participants assess themselves using the Self-Assessment Module. It comprises of 5 experiments that the participant conducts to understand the various functionalities and application usage of the cloud that has been set up. The experiments include:

- Creating and launching new instances using the OpenStack® Dashboard.
- Logging into the instance using Secured Shell Hosting and Telnet and setting passwords for users
- Logging into the cloud instance via the OpenStack® Dashboard
- Installing Java on the instance and running small java based applications
- Transfer of files from the instance to the physical machines and vice versa using File Transfer Protocol

4.5. Post-iNoah Survey

The third session is followed by a post-iNoah survey. This survey, similar to the pre-iNoah survey, helps us in obtaining a statistic of how much knowledge the students have gained after attending the workshop.

V. RESULTS

The pre-iNoah Survey and the post-iNoah survey results have been tabulated and depicted in the following graphs. The results of the surveys are a testament to the claim that the iNoah framework has enabled knowledge acquisition about a technical concept like cloud computing through a pedagogical/hands-on approach.

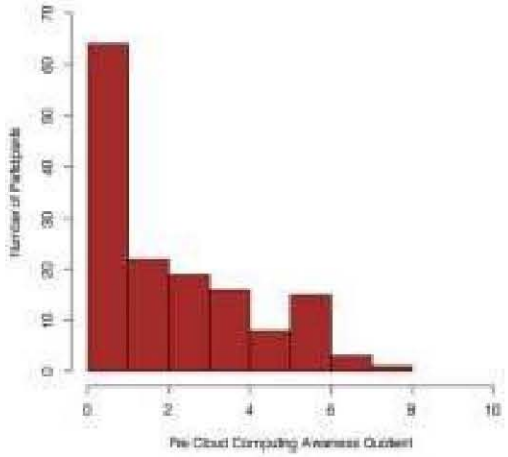
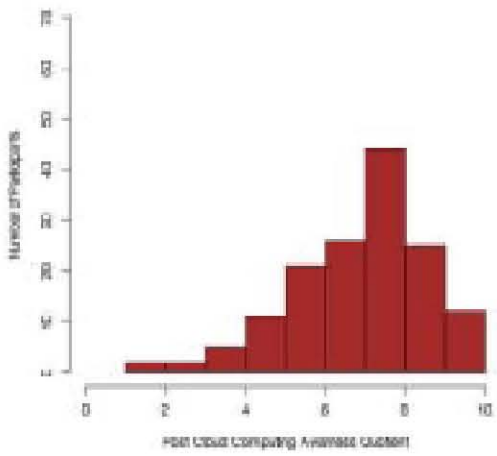


Figure 4



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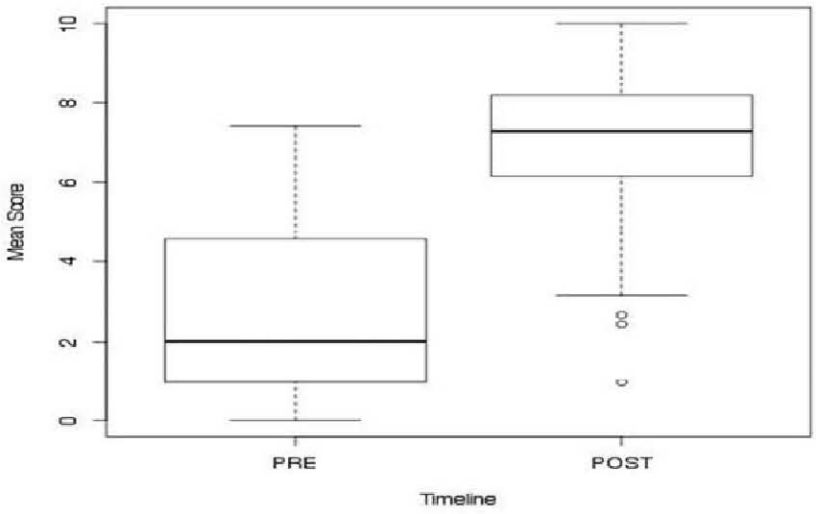

Figure 6

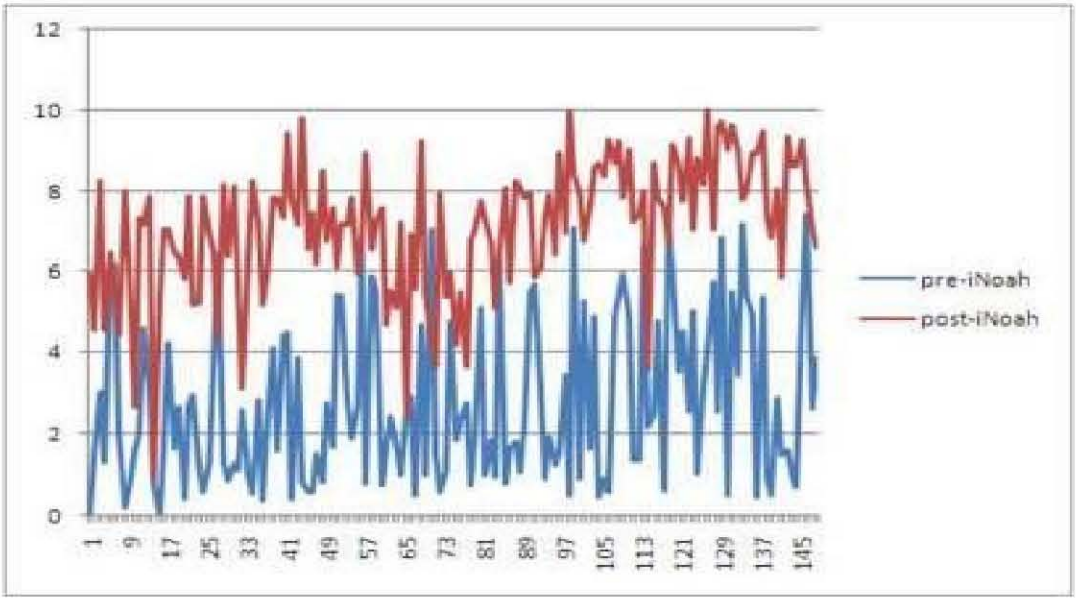

Figure 7

Score: Each question has an answer scale of 0 to 10 which indicates the individual's understanding/ knowledge about the concept in question, with 0 indicating that the individual is incognizant of the concept and 10 indicating that the individual is very knowledgeable about that concept

$$\frac{\sum Score}{QuestionCount} = CCAQ \qquad \text{.....(1)}$$

The bar-graph (Figure 4) depicts the distribution of the various participants with respect to their CCAQ calculated based on their pre-iNoah survey. The second bar-graph (Figure 5) depicts the distribution of the various participants with respect to their CCAQ calculated based on their post-iNoah survey. On comparing the 2 graphs, it can be seen that there is a notable change in the distribution of participants from a lower CCAQ (Figure 4) to a higher CCAQ (Figure 5). This shows that there is an increase in the knowledge of the participants in the domain of Cloud Computing.

The 2 box plots (Figure 6) represent the range and distribution of CCAQs. One of them illustrates the scenario prior to the participants attending the workshop and the other one illustrates the scenario post that. It is clearly seen that there is an increase in the median CCAQ from the first box plot to the second box plot. Also, there is a clear positive shift of the limits (both lower and higher limits) of CCAQ from the first box plot to the second box plot. This shows that there is a considerable increase in the CCAQ after attending the workshop.

This graph (Figure 7) represents the participants' CCAQ versus the number of participants. The plots in blue and red are from the pre-iNoah and post-iNoah surveys respectively. As seen from this graph (Figure 7), the CCAQ shows a marked increase from the pre-iNoah to the post-iNoah survey. This confirms the effectiveness of the framework

CONCLUSIONS

As indicated by the results, the iNoah framework encapsulated in the form of a workshop has appealed to the participated communities and resulted in a significant increase in individual and group learning curves. The iNoah framework strives to make the transition from a Cloud-incognizant person to a Cloud-Computing aware person as natural as possible. The authors hope that the other communities help evangelize Cloud Computing on various platforms in the coming future.

Acknowledgements

The authors would like to thank PES Institute of Technology, Bengaluru, Karnataka, India for their continued support in carrying out this work and in publishing this paper at the conference. The authors thank Prof. D Jawahar, Prof. Ajoy, Dr. K N B Murthy, for their support and encouragement. The authors thank Bhavani B for her active contribution and participation in this effort. The authors thank Dr. Dinakar Sitaram and Mr. Yateendranath for their support. Finally authors thank IEEE, IEEE-CSI, CCBD and Ordell Ugo, A virtual entity concept at PES Institute of Technology, Bengaluru for this collaborative effort.

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