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Development of an Online Collaboration Tool for Research and Innovation in the University

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Abstract

For our Universities to match global demands for research and innovation, the absence of viable collaboration platforms that encourage continuous and relevant multi-disciplinary research would have to be addressed to enable collaborative research take place at the convenience of all team members. This research study aims at presenting the academia with a suitable online collaboration platform that promotes collaborative research among students with lecturers serving as online supervisors such that research activities can be shared among all team members anytime and anywhere. The Adaptive Software Development model was employed. A Joint Application Design Requirement Gathering (JAD-R) session was conducted to determine the required functionalities and tools for the user interface design of the web-based platform. Based on the findings of the JAD-R session a database was designed for the platform's information system. The software was constructed using PHP and Javascript programming languages with the Model Viewer Controller (MVC) programming technique on the programming framework called CodeIgniter (CI) to support continuous development and subsequent maintenance of the software. The testing and evaluation procedure employed students from different faculties to register their accounts, add or join research teams and create specific research projects while adhering to the requirements of the system to maintain standard. The online collaboration tool developed was tested with respondents filling questionnaires. Eighty-eight percent (88%) of the respondents were satisfied with the general overview of the application; eighty percent (80%) of the respondents accepted that the application's user interface was user friendly; and sixty-five percent (65%) accepted that the functionality of the application was satisfactory. This research study helped to demonstrate how research and innovation in the University can be supported and promoted using collaboration platforms while bringing to light other areas for further research.

Keywords:Collaborative Platform, Computer-Supported Collaborative Work (CSCW), Information Systems, Research and Development, and Innovation

1 Introduction

The role of the University in Africa's sustainable social, political and economic development is non-contestable. The knowledge produced by the academia and the skills possessed by its graduates have always been an essential force in promoting economic progress and social welfare around the world. Research evidence indicates that sustainable development of a country in today's world depends largely on its ability to generate, adopt and apply knowledge (Mulu, 2017). Additionally, the academia, through its basic mission of generating and disseminating knowledge from teaching and research, is expected to play that fundamental role of accelerating the scientific and relevant technological innovations that would enhance the economic vitality and competitiveness of a nation (Geiger, 2006). Hence, the countries and cities, which tap into an expanded system of higher education through higher levels of investment in research and innovation activities, possess higher potentials to grow faster in a globalized knowledge-based economy (Varghese, 2013).

However, due to certain challenges, the relationship between the academia and field practitioners has produced very little (Varghese & Peral, 2014). One major challenge facing the higher education sector is its limited capacity for research and innovation, which results in a lack of strength in driving socio-economic transformation. Here are a number of factors causing this challenge:

1. Universities focus on education and basic research in science and business rather than knowledge and technology transfer beyond the academia (Tödtling, 2006).
2. There are no interactive integrating platforms in our Universities for research and innovation.
3. There is very little collaboration among researchers in Universities and the absence of an organized management system that supports research and innovation procedures poses a significant bottleneck.

Iren Greif of Massachusetts Institute of Technology (MIT) and Paul Cashman of Digital Equipment Corporation, in 1984, organized a workshop that had far-reaching effects. In this workshop, twenty people across different fields who shared the same interest in how people work explored the role of technology in the work environment with focus on collaborative work. The name Computer-Supported Cooperative Work (CSCW) was adopted to address the concept. Thousands of researchers have continued to respond to this first meeting and to build on the CSCW initiative since then due to the increasing need for tools to drive collaborative work effectively (Grudin & Poltrock, 1997).

Today, the web-based computer-supported cooperative work (CSCW) tool comes in as a very effective and efficient tool in dealing with the challenges mentioned above as it will boost collaboration and interaction among students and lecturers of the University as far as research and innovation is concerned while boosting the efficiency level of research and innovation activities. Managing collaborative research is a multifaceted operation that can become quite cumbersome depending on the challenges the working domain presents. The development of a CSCW tool to carry out this operation must consider defining the tasks, clarifying and also encoding the social processes involved. This tool is expected to meet the needs of facilitating teamwork through promoting communication, consolidating project introduction and making it available (Cheng, 2003). Such a project, if conducted within the academia, would enhance collaborative research that will lead to more innovation from the University. Collaborative research, in this context, means any research in which a group of two or more researchers work together toward a common goal, and in which all of the researchers make an important substantive contribution to the project through the development of global, collaborative multi-disciplinary research communities that depend on the construction of more impactful computational, data and communication infrastructures.

The aim of this research study is to implement a web-based application in the University that will enhance teamwork and collaboration in carrying out innovation-oriented research projects. To achieve the set aim, the following measures were taken:

1. A joint application design requirement gathering session was conducted to create awareness about the concept of collaborative research and to determine from prospective users (students and lecturers) the required functionalities of the online collaboration platform to be developed;
2. A database for the interactive site's information system was designed; a progress monitoring tool that will support effective project supervision was developed;
3. An online collaborative platform that integrates the monitoring tool with the various interactive facilities was designed and implemented;
4. The system was tested and the result analyzed to demonstrate the extent to which students from different fields of study can collaborate effectively in conducting innovative research studies anywhere and anytime under the supervision of a lecturer of their own choice using a web-based computer-supported cooperative work (CSCW) tool.

The scope of this research study covered the academia with the University of Calabar in Calabar, Nigeria selected as the case study. The study focused on the development methodology, application modeling, database design, development environment and tools required for the implementation of the web-based application. The web-based application was designed to be only accessible via a system browser and not as an installed application.

2. Methods

The Adaptive Software Development (ASD) Model

The development model adapted for this project was the adaptive software development (ASD) model. It was adapted based on the innovative nature of the project and the innovative approach to be used. The ASD model allowed the developer to speculate, collaborate and learn as the software program was designed. It is a suitable model for this project due to the uncertainty of its outcome and the fact that the project required less rigidity in its development. (Highsmith,2000).

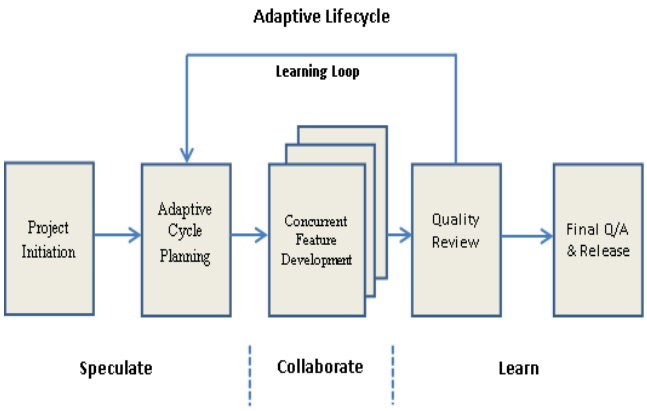

Fig. 1 Adaptive Software Development (ASD) Model (Highsmith, 2002).

Speculate: Initiation and Planning

To speculate in this case means to venture, to make clear the realization that we are unsure, and to deviate from initial plans without fear. It does not mean that planning is unnecessary. Rather, it just means that plans could be flexible due to the level of uncertainty the project brings. With the ASD model, the developer recognizes the uncertain nature of complex problems and is encouraged to explore and experiment, which is exactly what happened in this project.

At the project initiation stage:

- The project's mission and objectives were set.
- Constraints were defined.
- The project plan was established.
- Requirements were identified and outlined; initial size and scope estimates were made and the key project limitations were identified.

Since speed is usually a major consideration in using the ASD model, much of the project initiation data were gathered in a preliminary joint application design (JAD) session where functional requirements were collected with sufficient detail to enable the identification of the features and appropriate architectural model of the system while the information system was developed.

Collaborate: Concurrent Feature Development

At this stage, the software development took place along with collaborative activities such as focus group interactions, informal and formal interactions with various user levels including students, lecturers, academic administrators, entrepreneurs and consumers for which new products will be created. At this stage, collaboration and communication tools were used to facilitate various processes. While collaborating, various technical problems, research and development requirements as well as the need for rapid decision making were taken into consideration.

Learn: Quality Review

Due to the uncertain nature of the outcome of this project, there was a need to learn from mistakes made. To reduce the amount of rework, we endeavoured to find small problems before they became large ones. Our quality review took place under these categories after each developmental iteration:

- Result quality from the users' perspective – engagement of a user focus group
- Result quality from a technical perspective – technical architecture review
- The operations of team members – the people and process review

System Requirements

A preliminary joint application design requirement (JAD-R) gathering session was held with senior lecturers of the Computer Science department (potential users) to figure out how the necessary measures to consider in capturing the needs and expectations of the main users of the CSCW tool being created. A questionnaire was designed for the focus group and administered at the venue of the meeting.

Based on the feedback received from the preliminary JAD-R gathering session, interviews were conducted with different potential users using questionnaires and note taking. This included lecturers and students. This helped in finding out the actual needs, expectations and preferences of potential users of the web-based application as well as the features to include in the design of this application. In addition, research was conducted to figure out features that are quite essential in the design of a CSCW tool.

The Features

1. Communication
   - Chats (tags)
   - Group chats, personal messaging
2. Sharing Information
   - File sharing
   - File formats: JPEG, Microsoft office file formats, .pdf
   - Likes and comments
3. Documentation
   - Selected files are put together.
4. Continuous Project Assessment:
   - List of Project Milestones
   - Assessment Score

This groupware was designed to ensure that academic progress is made through collaborative research in the University in the following ways:

1. More information is provided for a research project than would be the case for a single person's research work.
2. Creativity is stimulated during problem solving and brainstorming sessions.
3. Learning, comprehension and retention of knowledge acquired is fostered.
4. There is more commitment to the project outcome and the solutions arrived at due to the greater satisfaction derived.
5. A better understanding about each other is engendered among students due to collaboration at different levels.
6. Students increase their interpersonal skills and become much more sought after in the job market (Graduate Outlook Survey, 2010)

User Roles

There are three user categories considered for this research study. They are the administrator, the researcher (student) and the supervisor (lecturer)

The Administrator

The administrator has the role as the manager of the online CSCW application for collaboration research. The administrator will need to log in first into the application to perform required functions on the backend of the groupware. The activities of the administrator include the following:

- View, contact and delete users
- Add and edit user roles
- View, contact and delete teams
- View and delete submitted materials

The usage scenario includes:

1. Administrator opens web browser and writes the website address for the application.
2. Administrator logs in to the application with email and password.
3. Administrator proceeds to system management activities, which include add, view, contact, delete, review and scoring.
4. Administrator selects item in menu such as:
   a) Manage users
   b) Manage user roles
   c) Manage teams
   d) Manage contribution/submissions/discussions
5. Administrator carries out system management activities
6. Issues token of permission for incoming supervisor
7. Administrator logs out

The Researcher (Student or lecturer)

The researcher, who is a student or lecturer of a University, has the role of the customer and is the main beneficiary of the CSCW web-based application. With the application, the researcher is able to communicate and collaborate with preferred team members while carrying out research projects that will lead to innovation. The activities of the researcher include the following:

- View and set up project team(s)
- Invite team members
- Create, edit and delete personal user accounts
- Add, edit and delete submissions
- Comment and like submissions
- Send instant messages (chats)
- Create, edit and delete research project plans
- Select and invite supervisors
- Interact with supervisors

The usage scenario includes the following:

1. Researcher opens the web-based application by opening the website on a web browser.
2. Researcher signs up with required data and selects password.
3. Researcher logs in with email and password.
4. Researcher proceeds to the research panel where user carries out intended activities.
5. Researcher selects menu item such as:
   - Project
   - Submission
   - Project Status
   - Documentation
6. Researcher carries out user activities
7. Researcher logs out

The Supervisor (Lecturer)

The supervisor, who is a lecturer of a university, has a very important role of supervising the research work carried out by the team and ensures that the research submissions and processes are credible and meet required standards. The goal for the supervisor is to ensure that the research output meets institutional, local and global standards while possessing potentials for innovation. The activities of the supervisor include:

- Create, edit and delete personal user account
- View and review submissions
- Comment on submissions
- Review and score collaborative performance of each group
- Sign in and sign out

The usage scenario includes:

1. Supervisor opens the web-based application by opening the website on a web browser.
2. Supervisor signs up with required data provides token of permission for authentication and selects username and password for the account created.
3. Supervisor logs in with username and password
4. Supervisor proceeds to the research panel where user can implement designated activities captured above.
5. Supervisor selects menu item such as:
    - User account
    - Project submission
    - Team
    - Project plan
6. Supervisor carries out activities as captured above.
7. Supervisor logs out.

The Modeling Process

In the CSCW tool designed for this study, models were created for the administrator, researchers (students), supervisors (teachers), teams and submissions with adherence to the process of research projects in the university. In this development process, the use-case diagram and activity diagram were used.

Use-Case Diagram

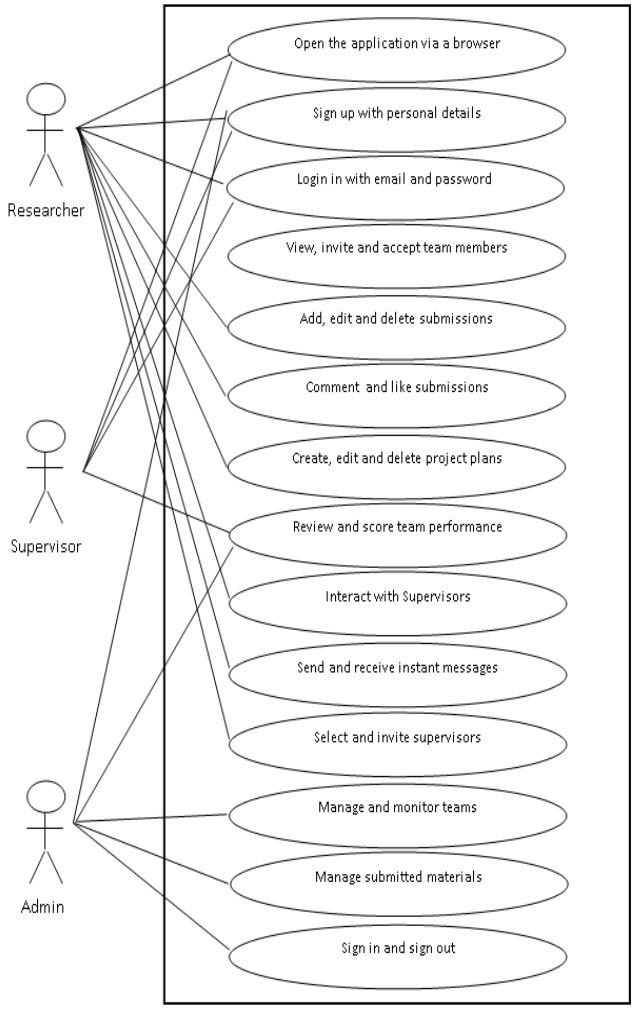

Fig. 2 Use-Case Diagram

Activity Diagram

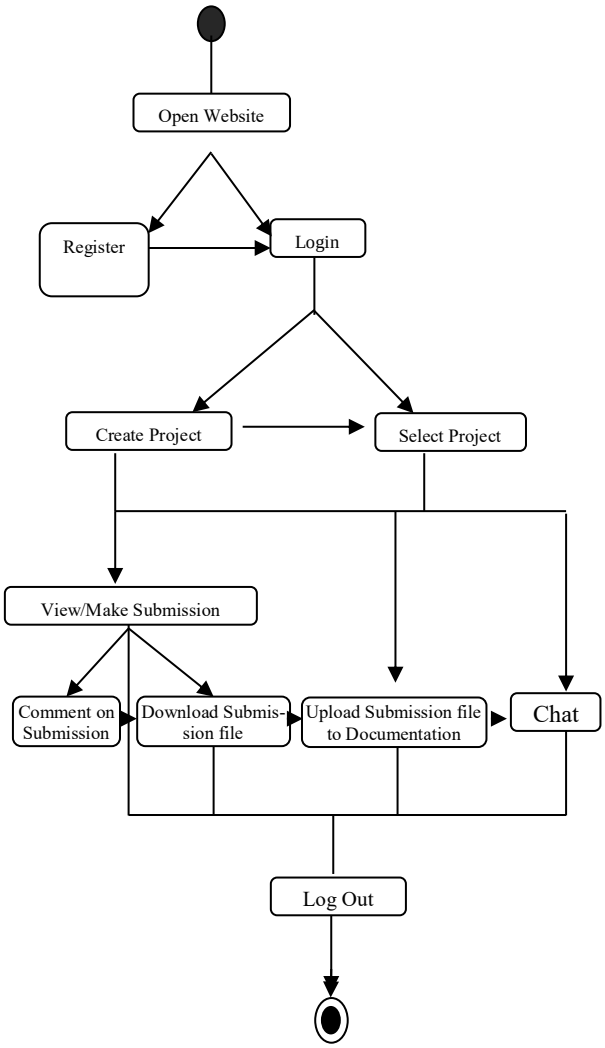

Fig. 3 Activity Diagram for the User Scenario of the Researcher (Student)

Application Design

The design technique adopted for this project is prototyping - an iterative process in software design that emphasizes rapid development, evaluative use, feedback and modification for continuous learning until a concretized system is developed and presented to real users. Prototype-based programming, a form of object-oriented programming, was adopted in this research work with a process of reusing existing objects that served as prototypes whereby they can be cloned and extended in various modules of the application.

The Programming Technique

For the development of the web-based CSCW application, the Model View Controller (MVC) programming technique was implemented. As the name implies, the technique has three parts: Model, View and Controller. The purpose of using this pattern or technique is to keep a clear division between concerns. This made the application easier to maintain and extend over its lifetime, no matter how large it becomes. The PHP programming framework called Code Igniter (CI) was used to implement the MVC programming technique.

3 System Testing and Results

The web-based application went through two major stages of testing to determine to what extent the objectives of the research project have been achieved: Alpha Test and Beta Test.

Alpha Test

A preliminary software field test, also known as an alpha test, was conducted in order to refine the application by finding and fixing bugs as well as to ensure that the complete functionality of the web based application can be presented and tested further; making way for the beta testing. This test was carried out intermittently after all major iterations had been carried out by running the software to see if the outputs of the application met documented requirements and potential user preferences.

Beta Test

A secondary user acceptance test called beta test, was conducted to demonstrate the functionality of each module as well as show how the responsibilities of the target users can be accomplished. The purpose of the testing procedure was to gather feedback through a system evaluation questionnaire distributed to the participants with focus on the system's usability and fitness for purpose. Prior to conducting the test, a brief explanation of research objectives and descriptions of system modules with the roles and responsibilities played by each type of user was done. Consequently, a system demonstration was conducted to show the functions and features of the system. The participants were then presented with a system evaluation questionnaire (indicated in the appendix) to express their feedbacks towards the developed prototype. Subsequently, results from the user acceptance test were used to substantiate the research in terms of boosting the academia's capacity for and commitment to research and innovation.

System Evaluation Questionnaire Format

The questionnaire format used was the Yes-Uncertain-No format. The questionnaire was divided into the four sections namely Functionality, User Interface, Usability and General Overview.

Functionality: The respondent is asked three Yes-Uncertain-No questions based on a three-point scale. This helped to determine if the functions of the application met the user's expectations.

User Interface: The respondent is asked three Yes-Uncertain-No questions as well to find out if the user interface effectively conveyed the user's intentions while encouraging effective communication and avoiding ambiguity.

Usability: The respondent is also asked three Yes-Uncertain-No questions. This time the goal is to determine if the application is user friendly; if the user enjoyed using the application, if it was easy to use and if he is likely to keep coming back to use it.

General Overview: The respondent is asked just one Yes-Uncertain-No question to determine if his overall impression about the system is good or not.

Participants of the System Evaluation Test

All participants were presented with the same questionnaires to give their individual opinions based on to their experiences with the web based CSCW tool to boost collaborative research in the university.

3.1 Test Data Analysis

An analysis on the results obtained from the online CSCW tool evaluation was carried out to determine the feedbacks from users about the ef-

fectiveness and usability of the system. The system evaluation questionnaire designed with the Yes-Uncertain-No (Y-U-N) format is divided into four sections namely Functionality, User Interface, Usability, and General Overview respectively. The first three sections are made up of three questions each while the last section (General Overview) is made up of just one question, making the total number of questions ten in all. Since this portion of the study focuses on the experience of the user and system administration modules, only the results based on these sections in the overall evaluation of online CSCW tool will be discussed.

3.1.1 Results of the Evaluation of the System

Fig. 4 below reveals results obtained from the evaluation of online CSCW tool developed in this study. Table 2 displays the corresponding frequency distribution for the chart in Fig. 4.

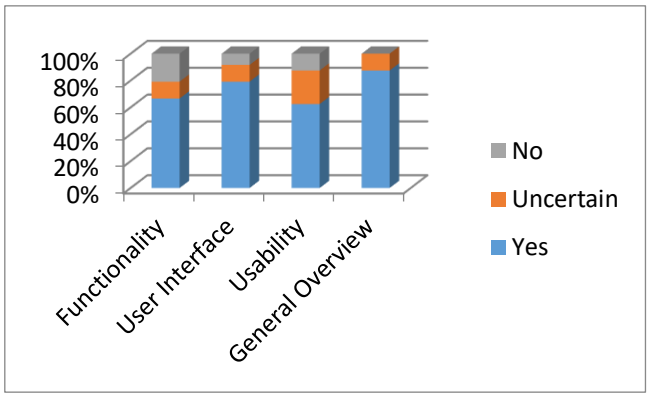

Fig. 4 Results for the Evaluation of the overall performance of the CSCW tool

Table 2 Breakdown of results of the Evaluation of the CSCW tool

Response Type	Q 1	Q 2	Q 3	Q 4	Q 5	Q 6	Q 7	Q 8	Q 9	Q1 0
Y	4	7	5	7	7	6	4	5	6	7
U	1	1	1	1	1	0	3	2	1	1
N	3	0	2	0	0	2	1	1	1	0

Table 3 Frequency distribution of the evaluation results of the overall tool

Reponses	Func-tionality	User Interface	Usability	General Overview
Y	16	20	15	7
U	3	3	6	1
N	5	2	3	0

In the results, most of the respondents agreed that the online CSCW tool delivered its purpose and was usable. However, uncertainty was obvious to some extent in all cases, especially in the case of the usability of the application. This is observed in the three responses in Question 7, two in Question 8 and one in Question 9. From the results obtained from responses to the question under General Overview session, it is obvious that none of the respondents had a negative overall impression about the web application.

3.2 Comments from Participants

After testing the application, respondents made several observations and recommendations that were captured behind the complete questionnaire sheets administered for enhancement purposes. Most comments touched on key features of the application such as the registration and documentation processes, guidelines, and instructions on how to navigate the website as well as the vision of the application. Below are some of the comments made by respondents:

- The team and project creation feature should be improved.
- The documentation feature should be improved.
- The login feature should be hitch free.
- Collaborative research platforms would tackle the drift of student's interest from their academic development into unnecessary social media activities. This would help in boosting students' academic prowess and increase relevant interactions among students.
- Menu or toolbar should contain a 'help' feature that will lead to instructions and guidelines that will enable easier navigation around the website.
- There should be a provision for comments and feedbacks from the public.
- The web application looks too mechanical.
- Graphics is average.
- The vision of the application is impressive.

4 Recommendation and Conclusion

Application of the Tool to the Problem Domain

The resulting web-based CSCW tool, developed in the course of this research work, will address the difficulty our universities face in meeting the research and innovation demands our industries have for research and innovation. With this application in place, students will be encouraged to embark on several multi-disciplinary research projects that will give them the opportunity to interact and brainstorm with their colleagues from other academic fields. This application will also help to deal with the issue of delay in completing group-based research projects due to the challenge of communication, and limited opportunities for face-to-face interactions as team members can make and receive contributions at any time of the day.

4.1 Recommendations

In order to fulfill the purpose of collaborative research for innovation using collaboration tools the following recommendations are given:

1. CSCW tools for collaborative research among students in the university should be very interactive and engaging. The graphic user interface should be compelling.
2. More lecturers should be encouraged to increase their affinity for computer-supported applications.
3. Innovative research should be encouraged and promoted in most Nigerian universities.

4. Joint application design requirement-gathering (JAD-R) sessions should be conducted regularly to capture changes in the dynamic academic environment.

4.2 Conclusion

With an increasing global demand for innovation and technology transfer to enable growth and development in all spheres of life, there is a need for the university to play its role of effectively contributing to knowledge and technology transfer beyond the walls of the academia. This research study has successfully demonstrated how a web-based collaborative tool for research will increase the capacity of the university to play its role of driving innovation effectively.

With this research study, university students and lecturers now have a web-based platform for collaborative research that can be assessed anytime and anywhere while promoting flexibility as well as creating an opportunity for multi-disciplinary collaboration.

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References

Aberer, K., Boyarsky, A., Cudre-Mauroux, P., Demartini, G. &Ruchaskiy, O. (2011). The Semantic Web: CSWC 2011. Retrieved from http://iswc2011.semanticweb.org/fileadmin/iswc/Papers/PostersDemos/iswc11pd-submission_72.pdf

Bafoutsou, G. &Mentzas, G. (2002). Review and Functional Classification of Collaborative System. International Journal of Information Management, Vol. 22, No. 4, 2002, pp. 281-305.

Borenstein, N. S. (1992). Computational Mail as Network Infrasture for Computer Supported Cooperative Work. Proceedings of the ACM Conference on CSCW, Toronto, Canada, 1992, pp. 67 -73.

Cheng, N. (2003). Approaches to design collaboration. Automation in Construction Journal, Vol. 12, pp. 715-723.

Cole, M. (2009). Using Wiki Technology to Support Student Engagement: Lessons from the Trenches. Computers and Education, Vol. 52, 2009, pp. 141-146. Oxford: Elsevier.

Fang, M., Rao, J., Su, X. & Li, T. (2009). A Web-Based Collaborative Learning System. Retrieved January 2009, from: www.researchgate.net/publication/242294647_A_Web-Based_Collative_Learning_System

Geiger, R.L. (2006). The Quest for 'Economic Relevance' by US Research Universities. Higher Education Policy, Vol. 19, No. 4, pp. 411-431. https://doi.org/10.1057/palgrave.hep.8300131

Grudius, J. & Poltrock, S. E. (1997). Advances in Computers. M. Zelkowitz, Vol. 45, pp 269-320. Orlando: Academic Press.

Grudius, J. &Poltrock, S. E. (1997). Advances in Computers. M. Zelkowitz, Vol. 45, pp 269-320. Orlando: Academic Press.

Highsmith, J. (2002). Agile Software Development Ecosystems. Published by Addison-Wesley Professional, 1st Edition, April 2002, pp. 448.

Highsmith III, J.A. (2000). Adaptive Software Development: A Collaborative Approach to Managing Complex Systems. Conferencing and Collaborative Computing, Multimedia Systems, Vol. 4, pp. 210 – 225.

Mulu, N .K. (2017). The Links between Academic Research and Economic Development in Ethiopia: The Case of Addis Ababa University. European Journal of STEM Education, Vol 2, No. 2. https://doi.org/10.20897/ejsteme.201705

Stewart, R. A., Smit, D. & Betts, M. (2005). Implementing Web-Based Collaboration Platforms in Construction: Evaluating the Lane Cove Tunnel (LCT) Experience. Proceedings of the International Conference on Construction Engineering and Management, Seoul, Korea, October 2005.

Tödtling, F. (2006). The Role of Universities in Innovation Systems and Regional Economies. An Expert meeting on The Future of Academic Research, Vienna, October 2006.

UNESCO Institute for Statistics/OECD. (2003). Literacy Skills for the World of Tomorrow – Further Results from Programme for International Student Assessment (PISA) 2000. An Executive Summary. Retrieved from www.oecd.org/education /school/2960581.pdf

Varghese, N. V. (2013). Governance Reforms in Higher Education: A Study of Selected Countries in Africa. A Theme Paper for A Policy Forum on Governance Reforms in Higher Education, Kenya, May 2013.

Zalgalsky, A., Feliciano, J., Storey, M. Zhao, Y. & Whang, W. (2015). The Emergence of GitHub as a Collaborative Platform of the Open Classroom, CSCW 2015, Canada, March 2015.