Creating a Virtual Learning Community with HUB Architecture: CLEERhub as a Case Study of User Adoption

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Abstract: The research aim of this article is to investigate the adoption patterns of HUB platforms that create and support virtual learning communities (VLC). The adoption patterns of one particular HUB called the *Collaboratory for Engineering Education Research* or CLEERhub, is presented as an example of how HUBs may be used as VLCs. After explaining the affordances of the HUB architecture, the article uses two approaches to discuss the adoption of CLEERhub by users. First, the authors link the five stages of Rogers' Diffusion of Innovation model with various CLEERhub user metrics. The resultant mapping suggests that CLEERhub users are primarily in early stages of adoption. This is not an unexpected finding given that CLEERhub has been recently created. The second approach to studying adoption investigates the experience of a group of college students who used CLEERhub to aid them in completing a group assignment. A CLEERhub Usage Survey was developed and implemented during the last part of the semester to collect information about students' experience with CLEERhub. Student reactions to CLEERhub were generally positive. After the two approaches are presented, the paper connects the approaches by speculating on how student experience (adoption approach 2) might be mapped to the five stages of Rogers' model (adoption approach 1). The paper ends with considerations and suggestions for best practices.

Keywords: CLEERhub; Diffusion of Innovation; Virtual Learning Communities

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1. Introduction

Access to Web 2.0 tools has significantly changed our ways of learning and teaching. Affordances of features such as social media sites, web blogs, podcasting, wikis, and social bookmarking have created new opportunities for interaction where students are no longer passive knowledge receivers, but can actively participate in knowledge co-construction with their peers, teachers and experts in the field.

Dede (2004) highlights the importance of making emerging educational technologies available in schools and colleges "to match the increasingly "neomillennial" learning styles of their students" (p. 7) which he identifies as:

- "Fluency in multiple media and in simulation-based virtual settings;
- Communal learning involving diverse, tacit, situated experience, with knowledge distributed across a community and a context as well as within an individual;
- A balance among experiential learning, guided mentoring, and collective reflection;
- Expression through non-linear webs of representations; and
- Co-design of learning experiences personalized to individual needs and preferences." (Dede, 2004, p. 7)

Greenhow et al. (2009) and Baird & Fisher (2005) found that emerging social networking media can support Neomillennial "always-on" user learning styles by fostering engagement, motivation and supporting the formation of learning communities. Their research has shown that today's students are expecting interactive and engaging course materials as part of their learning process and educators need to focus their attention on how to design courses with meaningful integration of online social media tools that would support different student learning styles and narrow the "digital disconnect" between learners and educators (Levin et al., 2002).

To support better pedagogies of engagement and provide today's "digital natives" with more opportunities for interactive and participatory environments, Web 2.0 technologies have the capacity to enhance student learning through authentic, real-world scholarship by enabling students to be active participants in the virtual learning communities and have a part to play in the growth of knowledge (Lemke et al., 2009; Jonassen & Duffy, 1992). Fleming (2005) defines virtual learning communities as "emerging constructs that depend on the notion of socially constructed learning to provide a focus for informed discussion and lifelong learning. They make use of increasingly sophisticated technologies to establish, support, and maintain communities" (p. 1055).

This paper focuses on the following research question: How have users adopted the *Collaboratory for Engineering Education Research* (CLEERhub) as a virtual learning environment? User adoption is explored using two methods. First, we employ an approach pioneered by Hacker and Magana (2011) that uses the *Diffusion of Innovation* model (Rogers, 1995) to document HUB adoption. Secondly, we look at adoption through the eyes of student users and present a case study students' experience of CLEERhub use in a college course. We also posit how student experience of HUB use might map to Rogers' model. The paper ends with considerations and best practices for using HUBs as virtual learning environments.

2. HUBs

2.1. HUBs as Platforms for Virtual Learning Communities

Any discussion of HUB adoption must begin with an explanation of the HUBs. So we begin the paper with background information about HUBs.

HUBs are platforms created by HUBzero (McLennan & Kennell, 2010), a group created by Purdue's Hub Technology Group in partnership with the NSF-sponsored Network for Computational Nanotechnology (NCN) to support the first HUB, nanoHUB.org. (See HUBzero.org for more information).

As defined by HUBzero a "HUB is a dynamic web site with many built in open source packages—a Linux system running an Apache web server with LDAP for user logins, PHP web scripting, Joomla content management system, and a MySQL database for storing content and usage statistics." (http://hubzero.org/tour/features) In this context, a HUB is specifically defined as a "web-based collaboration environment." CLEERhub uses the following features to aid in this collaboration.

- **Online Presentations, Workshops, Seminars and Webinars:** CLEERhub features a series of online presentations, workshops, seminars and webinars.
- **Uploading New Resources:** CLEERhub contains a self-service wizard that guides users to upload resources of their own. New resources are advertised under the What's New heading on the home page.
- **Ratings and Citations:** HUBs facilitate community building and quality control by allowing registered users to post comments, use a 5-star rating scale, and add citations related to a particular resource.
- **Content Tagging:** Tags are mechanisms to categorize and search for content. They are defined by the users or HUB administrators and are linked to resources.
- **Wikis and Blogs:** HUBs supports knowledge creation through the use of "topic" pages that use wiki syntax and are created by specified authors. A topic page can be accessed by a specified part of the community, or the entire community. Like a wiki, anyone with access can add to the topic page.
- **User Groups for Private Collaboration:** CLEERhub allows registered users to create groups, manage membership and roles of members, and determine privacy settings.

- **User Support Area:** This is the area where users can find Help or fill out a support ticket that is forwarded to a HUB administrator.
- **Usage Metrics:** Each HUB reports a variety of user and resource metrics.
- **News and Events:** Registered users can post events on the HUB calendar. The HUB administrator can post short stories about the accomplishments of the community.
- **Feedback Mechanisms:** Each HUB contains an area where users can take surveys, share news items, or post comments or suggestions.

These features of the HUBzero infrastructure create an interactive, resource-rich environment where a community of practice can access and share information.

2.2. Overview of HUBs

The Network for Computational Nanotechnology (NCN) created the first HUB, nanoHUB.org at Purdue with the goal is to transform nanoscience and nanotechnology through resources for research, education, and collaboration in nanotechnology (NCN, 2006). The HUB platform has become very popular a new entity, HUBzero, was formed to respond to this interest. The Purdue University HUBzero group has created a consortium along with Indiana University, Clemson University, and the University of Wisconsin. Each of these entities provides a hosting service for HUBs. HUBzero is also available as freeware for groups who do not require a hosting service. There are currently twenty-three live HUB sites – including CLEERhub - supporting work on the topics of engineering, healthcare, nanotechnology, computer science, the environment, earth sciences, accessible science, and STEM education with even more sites under development.

2.3. CLEERhub

As a result of our partnership with HUBzero we customized an empty hub and created CLEERhub that uses HUBzero architecture to create a "digital habitat" for engineering education researchers (Streveler, Magana, Smith & Clarke Douglas, 2010). CLEERhub.org is a web-based collaboration environment with a clean interface and selected features that would be most appropriate for the engineering education research community (Streveler et al, 2010). As a member of HUBzero community, CLEERhub is being constantly upgraded to keep it compatible with web 2.0 environments.

CLEERhub was created to fulfill three purposes. CLEERhub provides the target users (engineering education researchers) with: 1) a *knowledge base* with an embedded *feedback mechanism*; 2) a *learning environment*; and, 3) a *collaboration space*. The *knowledge base* is an organized collection of all resources, data, and documentation. It is meant to provide easy access and one window search capability to the engineering education researcher. As a *learning environment* CLEERhub provides an online learning space with access to host of presentations, workshops, seminars, webinars, course materials, tools and instruments, and news and events. The *collaboration space* is comprised of an interactive and collaborative platform in a Web 2.0 environment. A user can create public and private groups to share and upload resources with the other members of group, develop and share interactive simulation tools and instruments. The strength of CLEERhub lies in the effective use of the collaborative space that makes it unique over an ordinary website. The *feedback mechanism* is created for the user to interact with the management and other users through content rating to judge the quality of the resources, post citations that reference the resource in literature, content tagging to allow useful resource searching, taking a poll, asking a question, sharing a success story and reporting an abuse.

In addition to being technically supported by a team of HUBzero professionals, CLEERhub is managed by a community coordinator or "technology steward," (Wenger et al., 2009) who helps the community construct and maintain a suitable digital habitat.

3. Adoption of CLEERhub

Because CLEERhub can be identified as a complex networked technology (Lyytinen & Damsgaard, 2001), multiple levels of analysis are required to investigate how HUB technologies can or will diffuse. First, we use the framework developed by Hacker and Magana (2011) that uses the Rogers' (1995) Diffusion of Innovation model to discuss patterns of HUB usage. These patterns provide a global picture at the macro level. Second, to have a detailed picture of the adoption process, we look at how students in one college classroom used CLEERhub as a local case study. These approaches allowed us to look at the adoption process at both macro and micro levels and provided us with insights on the impact of the technology in a specific learning environment.

3.1. Diffusion of Innovation Model as a Theoretical Framework for Adoption of CLEERhub

Hacker and Magana (2011) proposed a framework, informed by the Diffusion of Innovation model (Rogers, 1995) to measure the impact and effectiveness of the HUB created for the Network for Earthquake Engineering Simulation (NEES) (Hacker et al, 2011). Although research on the Diffusion of Innovation model has focused specifically in the area of information technology adoption, there has not been any consensus of an integrated framework (Lyytinen & Damsgaard, 2001; Fichman, 1992). Furthermore, this research has mostly been focused at the organizational level and it may not be mature enough to be applied to the study of diffusion and adoption of complex networked technologies such as CLEERhub. Therefore, we utilized the Hacker and Magana framework because it builds upon Rogers' rich and complex theory that can be applied to all kinds of innovations and provide a framework that has been validated by large body of empirical results and at the same time is flexible (Fichman, 1992). Because Rogers' model describs the adoption process as one of information gathering and uncertainty reduction (Agarwal, Ahuja, Carter & Gans, 1998), the adoption process can then be inferred from looking at user metrics that suggest patterns of information seeking behaviors performed by users to learn about the expected consequences of using the innovation.

The Hacker and Magana framework maps the five stages of diffusion of innovation that posits how individuals discover, assess, and ultimately decide to adopt an innovation, with different sets of HUB usage metrics. Hacker and Magana's mapping is shown in Table 1.

We use Hacker and Magana (2011) model to examine CLEERhub adoption. As they point out, HUB developers' goal is for users to reach the confirmation stage, for it is at this point that true adoption of an innovation (in this case the HUB) happens.

Table 1. Framework for measuring impact and effectiveness of HUB technologies mapped to the diffusion of innovation process (from Hacker and Magana (2011))

Diffusion of Innovation Stages	Rogers (1995)	Hacker & Magana (2011)
Knowledge	An individual is first exposed to an innovation.	Users learn of the existence of the cyberinfrastructure (CI) and gain some basic knowledge of the functioning of the CI. Users in this stage follow a link, type in a URL, or learn of the existence of a web page portal using a search engine.
Persuasion	A user acts on the knowledge about an innovation and puts the innovation through a series of trials.	Users return to the HUB looking more deeply into the CI to gain knowledge and additional information about the capabilities of the CI.
Decision	A user decides whether to adopt or reject an innovation based on a cost/benefit analysis.	Users put the CI through a series of trials that lead to a decision to adopt or reject the technology. Users in this stage have registered on the HUB and access it periodically (e.g., on a monthly basis).
Implementation	A user puts the innovation to work and continues to assess the costs and benefits of the technology.	Users in this stage have put the HUB through assessment trials, registered for an account, and are ready to integrate the HUB to work for their research.
Confirmation	A user ultimately adopts or rejects a technological innovation.	Users make a long-term commitment to use the CI and to make it an integral part of their work. Users in this stage have produced publications as a result of their work through the HUB. Users also contribute with data, documents, tools, and learning modules.

We used Google Analytics and the CLEERhub cyberinfrastructure to collect data about CLEERhub usage. These data sources provide different kinds of data: Google Analytics provide data such as the location of users and how long they spend on different pages, while CLEERhub itself collects information about the visits of registered users.

Knowledge Stage. Hacker and Magana used the term “window shopping” to describe users in the knowledge stage. Users are curious about what various CI platforms offer and “shop around” to see what is available. We used the number of *New* and *Returning Visitors* over time as a measure of users in the knowledge stage. *New Visitors* are coming to CLEERhub for the first time (window shopping) and *Returning Visitors* have been to CLEERhub previously.

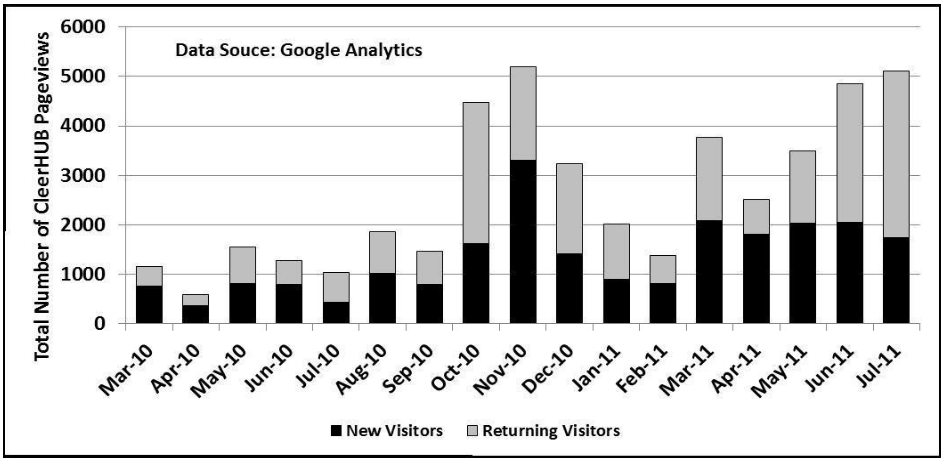

Figure 1. New and returning visitors to CLEERhub

Figure 1 shows a stacked area graph containing a monthly summary of the number of pageviews of *New* and *Returning Visitors*. During the first year after the launch of the CLEERhub (March 2010-February 2011), the number of pageviews by *New Visitors* remained under 1000 pageviews per month, except for a spike in the activity during October-December 2010 when the pageviews crossed 3000 pageviews per month (Nov 2010). Thereafter there has been a steady activity averaging approximately 2000 pageviews per month. There were a total of 44,977 pageviews of which almost 50% were from the *New Visitors*.

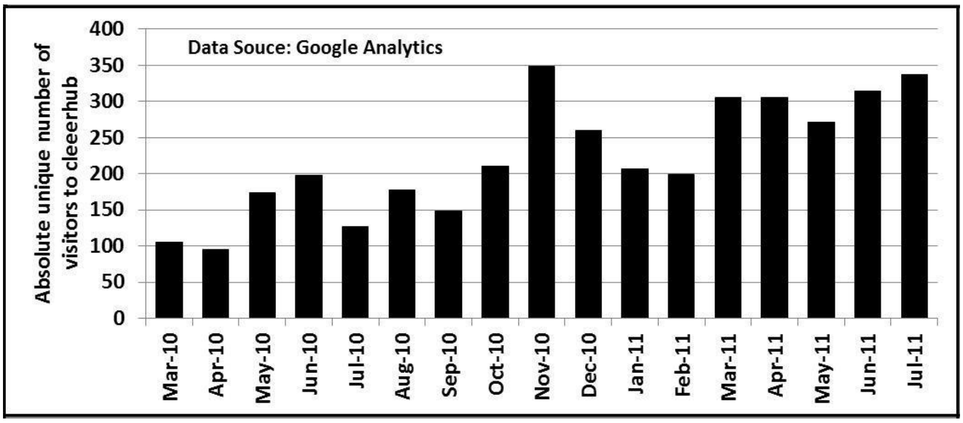

Figure 2. Monthly summary of Absolute Unique Visitors to CLEERhub

Figure 2 shows the number of *Absolute Unique Visitors* to CLEERhub over time. As the figure shows, CLEERhub has seen a steady increase of unique visitors each month, with the exception of a spike in November 2010 that is event-based.

Based on information in Figures 1 and 2, we propose that CLEERhub is passing through an initial phase where the stream of new users viewing pages is event based. As they are attracted to visit pages within the CLEERhub site for the first time, the flow seems to rise to a steady state level for the last five months (Feb-Jul 2011). However, the average number of *Absolute Unique Visitors* to the CLEERhub is increasing over time. This indicates that the visitor traffic to the CLEERhub is increasing, which is another important factor in enlarging the pool of potential users who enter the pipeline leading to use of the CLEERhub CI.

Persuasion Stage. Once a user has explored a site in the knowledge stage, they begin to form an opinion about the site, and this opinion will influence the probability that they will return to use the site again. Hacker and Magana proposed that *Return Visitors* could be used as a metric to measure users in the persuasion stage. Figure 2 shows this metric for CLEERhub. Approximately 50% of the total CLEERhub pageviews (22,229 out of a total of 44,977 pageviews) are from *Return Visitors*, which implies that almost half of the users are revisiting CLEERhub and viewing multiple pages to learn more about the CI.

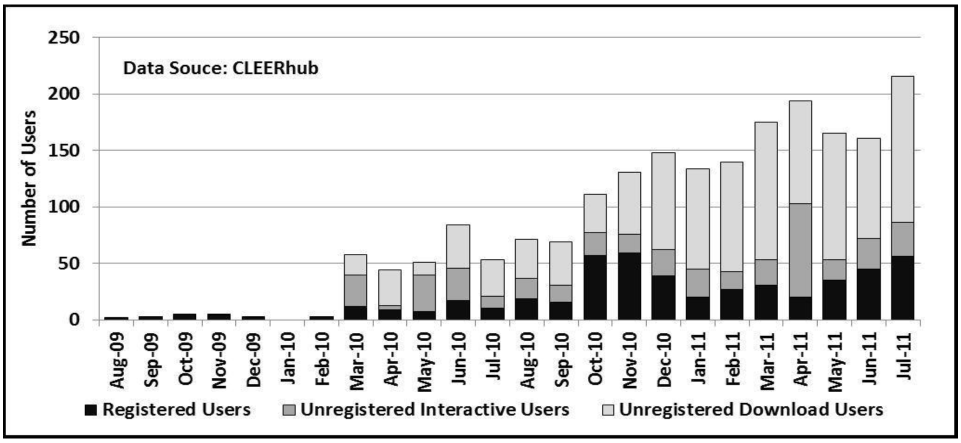

Figure 3. Monthly summary of unregistered users, unregistered download interactive users, and registered users of CLEERhub

Decision Stage. Figure 3 shows a monthly summary of the total number of users in three categories: 1) *Registered Users*, those who have an account and logged in using that account; 2) *Unregistered Interactive Users*, who had an active session without logging in to an account; and, 3) *Unregistered Download Users*, who do not log in but have downloaded a PDF or other resource. Figure 4 shows a monthly summary of the number of users who have registered for a CLEERhub account. Figures 3 and 4 show that the number of users with registered accounts is increasing steadily over time. The number of unregistered download users per month is more than 50% of the total users and remains constant over the last eight months in the measurement period while the number of unregistered users remains small. This steady increase in registered users over time represents those who have demonstrated interest in CLEERhub and have taken the action to register for an account.

Implementation Stage. Users in the implementation stage have assessed the CI, and decided that it has enough potential utility to be worth expending the effort to create an account. One way to understand the user activity is to measure the number of contributions and additions users make to the CLEERhub over time. Figure 5 shows the cumulative number of documents, tools, and learning content contributions to the CLEERhub from February 2010 to July 2011. Figure 6 shows the cumulative number of groups created within the CLEERhub for collaboration by CLEERhub users from March 2010 to August 2011. Figures 5 and 6 show an increasing amount of contributions and usage of the CLEERhub over time. Our analysis of these positive indicators and trends lead us to infer that users are in the process of investigating, exploring, and trying the

CLEERhub CI. This evidence leads us to believe that these users are in the Implementation Stage, and are going through the process of investigating CLEERhub content and testing the CI. The outcome of users' assessment will be to decide to adopt CLEERhub, defer the decision to use CLEERhub, or reject the use of CLEERhub.

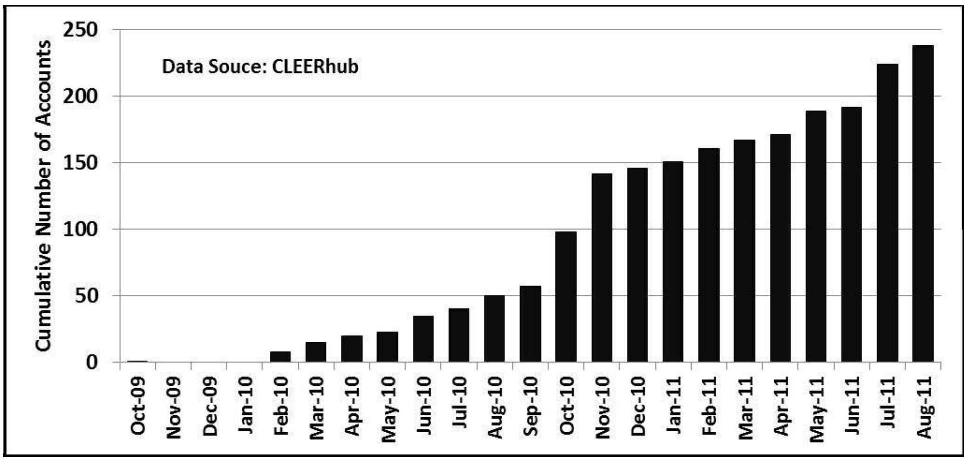

Figure 4. Monthly summary of the total number of registered CLEERhub users

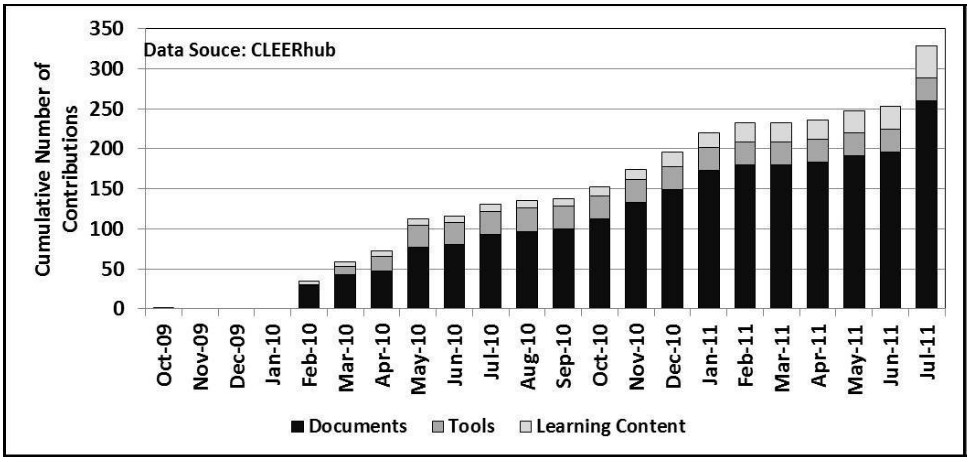

Figure 5. Cumulative number of documents, tools, and learning content contributions to CLEERhub

Confirmation Stage. In the Confirmation Stage, CLEERhub users have finally settled on using the CI as an integral part of their work. Since CLEERhub was created for the engineering education research community, this long-term use should be reflected in the number of publications, technical reports, theses, and other products of research that acknowledge or cite CLEERhub. Because CLEERhub is in an early stage of deployment and is a relatively young platform, we do not have a large body of publications citing CLEERhub that have been produced. It may be too early to discuss this stage for CLEERhub. However, with the progress we are observing in the earlier stages the signs are encouraging.

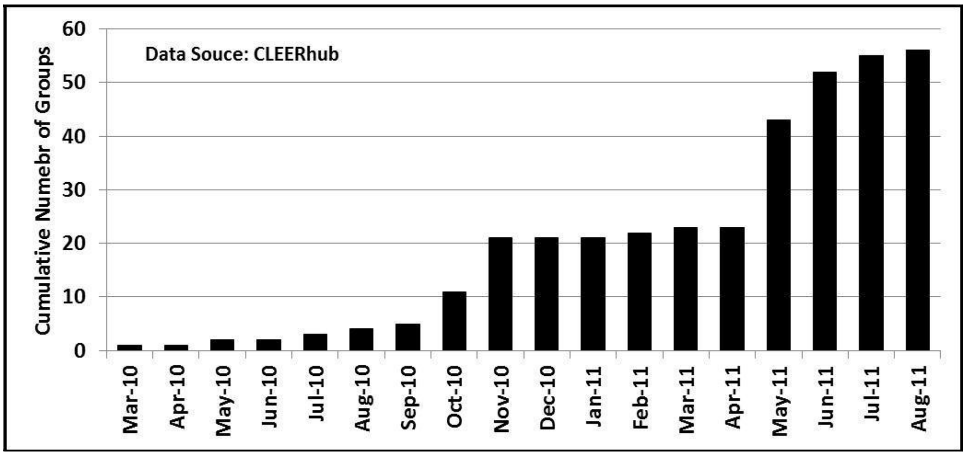

Figure 6. Cumulative number of groups created within CLEERhub

3.2. User Experience of Adoption: A Case Study from CLEERhub

In this sub-section of the paper, we switch gears and move from discussing the general trends seen in overall usage statistics, to focusing on the experience of one group of users.

In the fall of 2010 we conducted a pilot study to test the feasibility of using the collaborative space in CLEERhub to support team collaboration in an undergraduate course at a private university in the Northeast. Participants were undergraduate students enrolled in an undergraduate semester-long *Climate Change and Energy in the 21st Century* course designed for non-science majors. This course fulfills a science requirement for many of the students. The majority of the students taking this class were pursuing a variety of non-science degrees, such as accounting, marketing, English, and sociology to name a few. Participants' ages ranged from 19 to 22 years old.

The implications of these particular demographics on course design was that the science and math content had to be made accessible to beginners and needed to be explained to students either during class time or as part of supplemental course materials. Another significant issue to consider was the importance of motivating students about the topics of discussion.

The overall goal of this course was to engage students in a scientific dialog about the effects of our current energy production and consumption methods on climate change, and to explore the impact of dependence on foreign oil and fossils on our environment and economy. In the first half of the course, students explored the topics of energy, sustainability, and the role of technology and the engineering design process in the scientific advances. In the second half of the course, students worked collaboratively on projects. Students were asked to design hands-on educational experiments to explore energy-related topics. Six teams worked on topics of their choice, including wind energy, solar energy, potential and kinetic energy, and energy efficiency. The CLEERhub online platform was introduced to students as a way to support their work on group projects.

To collect data about students' experiences with CLEERhub, we designed and implemented a CLEERhub Usage Survey that asked students about their experiences using CLEERhub as an online space for their project work. More specifically, the Survey included questions such as: How frequently did students use CLEERhub? How did they use CLEERhub? What features did they find most or least helpful? This survey was given to students at the end of the semester and took 15-30 minutes to complete. Fifteen of the 22 students enrolled in the course completed CLEERhub Usage Survey.

In the Survey, 27% of the participants indicated that they frequently used CLEERhub for project work, 60% said they used it occasionally, and 13% rarely used it. Students who indicated using CLEERhub rarely explained that "it was easier to send group e-mails" and "CLEERhub was not needed for any other classes." In addition to CLEERhub usage as a collaborative tool for team project work, students frequently relied on e-mail with 67% usage, texting with 67% usage, and 27% used phone frequently. Also 40% occasionally used the phone, 27% used e-mail, and 20% used texting. These results are shown in Figure 7.

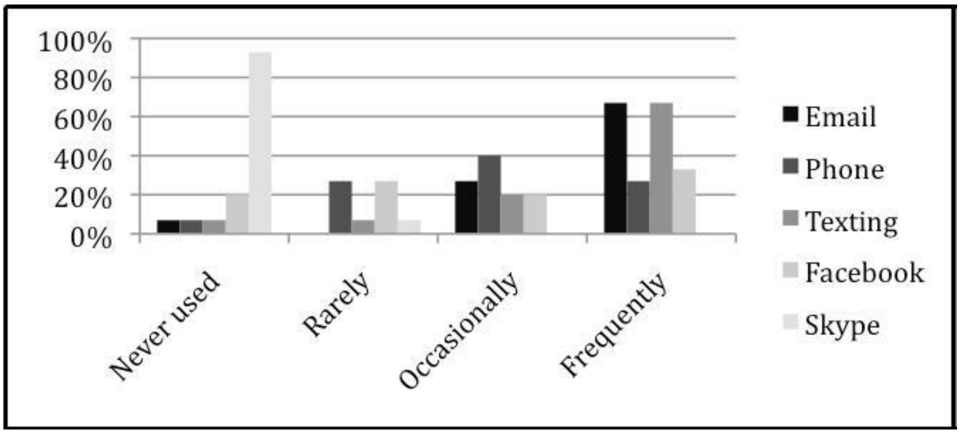

Figure 7. Use of other technologies for class project

Participants were also asked to indicate how they used the CLEERhub workspace. Thirty-three percent indicated they made contributions to the Wiki page frequently and 60% occasionally. Twenty-seven percent said they frequently edited the Wiki page and 60% edited it occasionally. Thirteen percent contributed to the Discussion workspace frequently, 33% occasionally and 27% rarely. For weekly project tasks planning, 27% of students used CLEERhub workspace frequently, 20% used it occasionally. Participants also used CLEERhub for group meetings scheduling, 20% used it frequently and 27% occasionally. Results on CLEERhub workspace usage are shown in Figure 8.

From the results of the CLEERhub Usage Survey, we can see that students use this online workspace mainly for contributing to Wiki pages with 33% making frequent contributions, and 60% occasionally making contributions. Twenty-seven percent of the students frequently edited their wiki pages, and 60% occasionally edited the Wiki. The CLEERhub space was also more actively used for weekly project task planning (27% frequently) and contribution to the Discussion page (33% occasionally).

Some of the students' comments about the most useful features of CLEERhub support the importance of co-editing a common document. One of the students said that the most useful feature of using CLEERhub was "being able to have a place where everyone could edit one document without having to constantly e-mail each other updates." Another student said: "I found it very useful how the entire group can log into the same website and edit something that every student can see." Some students said that it was easy to edit their Wiki page in CLEERhub, that the workspace was accessible for all the members of the group and was user friendly, and it was easy to see how many times a person had edited the page.

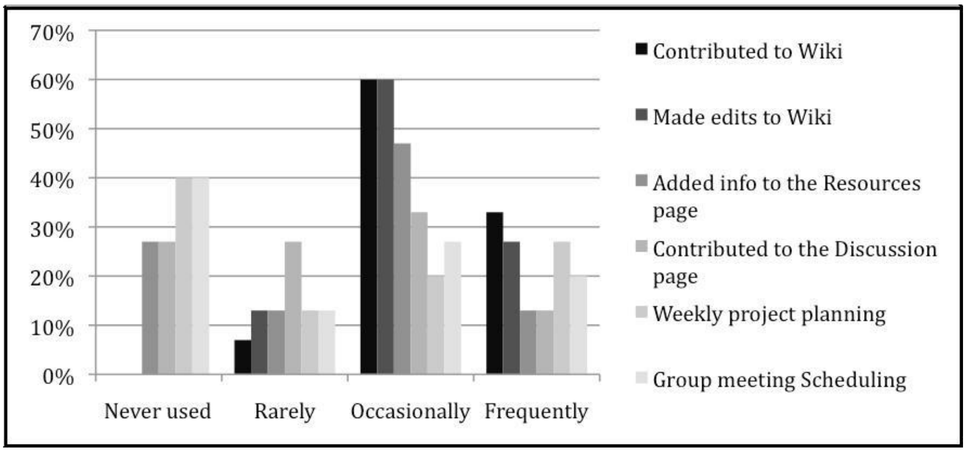

Figure 8. CLEERhub usage distribution results

There were also several comments that highlighted the advantages of the online workspace for collaboration. One of the participants commented on the opportunity to continue group work without meeting in person: "The Wiki page was the most useful since by editing our work we could work sometimes without meeting and contribute to the project by your own way since sometimes we couldn't meet because of the different time schedules we had". Another participant said: "CLEERhub was most useful for being able to share information online without having to get together outside of class time."

Some of the least useful features of CLEERhub students identified were things such as having to update the Wiki page all the time and having a lot of additional options that were confusing. One of the students said: "The Discussion board was not helpful since most of the time we try to discuss in person what we wanted to achieve for the project." Some of the students had difficulties with uploading pictures and video clips saying that: "The format of the Wiki page was hard to use because it was in codes, and not easy to use if you were [sic] not a computer genius. The Wiki page should be set up more like a blog that is easily editable." Overall, many of the students found CLEERhub workspace useful for their project work. Some of the participants said that CLEERhub made sharing information, planning of meetings, and work tasks organization easier. One of the students said that CLEERhub was useful for brainstorming for the project and allowed everyone to contribute.

In conclusion, our results indicate that using CLEERhub online platform can provide an effective approach to support students' collaborative groups projects and foster unique opportunities for students to be active participants and contributors to the online virtual learning community.

3.3. Linking the Two Approaches to Adoption

In an attempt to connect the Diffusion of Innovation approach with the case study, we have added a column to Table 1 that speculates on how the student experience of CLEERhub usage might fit with the Diffusion of Innovation model.

During the knowledge stage, students experience of CLEERhub introduction was based on the instructors' demonstration of the new online platform, helping students create their CLEERhub accounts, and walking them through some of the basic functionalities, such as how to create and co-edit a wiki document, how to post group resources, and to contribute to the group Discussion page. In addition, students were explained how CLEERhub could be helpful in their coursework, and particularly for working collaboratively in groups.

Table 2. Linking Diffusion of Innovation with student experience

Diffusion of Innovation Stages (Rogers, 1995)	Innovation Adoption in Educational Setting	
	Educator/Researcher adoption of HUBs CI per Hacker & Magana (2011)	Student adoption
Knowledge	Users learn of the existence of the CI and gain some basic knowledge of the functioning of the CI. Users in this stage follow a link, type in a URL, or learn of the existence of a web page portal using a search engine.	Instructor introduces students to the CI. Students gain basic knowledge about it, create their accounts and then the instructor walks them through some principal functionalities of the infrastructure.
Persuasion	Users return to the HUB looking more deeply into the CI to gain knowledge about the capabilities of the CI.	Students have an opportunity to explore the CI on their own through the tasks assigned by the instructor.
Decision	Users put the CI through a series of trials that lead to a decision to adopt or reject the technology. Users in this stage have registered in the HUB and access it periodically (e. g., on a monthly basis).	Students discuss in class their initial experiences with the new technology, voice their opinions about its usefulness to the coursework and together with the instructor make a decision to adopt or reject the technology.
Implementation	Users in this stage have put the HUB through assessment trials, registered for an account, and are ready to integrate the HUB to work for their research.	Students continue exploration of the CI outside the scope of the assignments.
Confirmation	Users make a long-term commitment to use the CI and to make it an integral part of their work. Users in this stage have produced publications as a result of their work through the HUB. Users also contribute with data, documents, tools, and learning modules.	Students make a commitment to use the CI and make it an integral part of their coursework. Students' co-write documents, share information and build a virtual learning community outside the scope of the course.

During the persuasion stage, students were assigned the task of creating a Wiki page on CLEERhub. The purpose of this task was to afford students an opportunity to explore the online platform on their own. Students were assigned this task as part of the homework and were told that if they had technical difficulties, they could e-mail some of the work to the instructor. Several of the students had issues with logging to their account that were due to CLEERhub administrative updates and these students had to e-mail their work. In addition, some students were confused by Wiki page functions. The difficulties were primarily due to students' unfamiliarity with the interface and they were quickly resolved in class with the help of the instructor.

As part of the decision stage, students expressed some of their frustrations with using CLEERhub, in particular co-editing a Wiki page, due to formatting issues that are much easier to accomplish in Word document. Some of the students also had problems with navigating the CLEERhub group environment that could be related to the insufficient time spent on exploring the new interface. Although students were not required to use CLEERhub for their group work, they were strongly encouraged to try it and reflect on their experience of using it.

In this particular case, CLEERhub was introduced to students later in the term since the purpose of using CLEERhub was to better support the group collaborative work that occurred at the end of the term. Due to insufficient time for the implementation stage, students moved to the confirmation stage after a short time.

In the implementation stage, students were asked to complete the CLEERhub Usage Survey. Twenty-seven percent of the 15 participants who completed the Survey indicated that they used CLEERhub frequently for their project work, 60% said they used it occasionally, and 13% rarely used it. As mentioned earlier, students who indicated using CLEERhub rarely explained that: "It was easier to send group e-mails," and "CLEERhub was not needed for any other classes." Such comments could indicate students' difficulty in shifting from familiar communication methods to new ones. Very often students want to see an immediate benefit of a new technology in order to readily adopt it. In addition, the comment about the new platform not being used for other classes shows the lack of enthusiasm for investing time to adopt a new technology that do not seem to have more general use.

4. Considerations and Best Practices

Throughout this paper, encouraging data has been reported regarding student and institutional receptiveness to using Web 2.0 technologies such as CLEERhub to integrate with learning objectives. Increased network performance, equipment capacity, and availability have taken the best of what enterprise grade organizations have enjoyed for decades and integrated them into all-in-one solutions that can be developed and used in academic environments at a fraction of the original expense. There are many lessons that can be taken from the successes and failures of implementing similar platforms in enterprise grade organizations as well as early adopters found in educational institutions.

The authors are aware that this technology can behave similarly to groupware that appears in many contemporary organizations, and that this technology could also be seen as a form of e-learning. Although HUB technology will not replace traditional learning that takes place in a classroom, the researchers believe that this technology can provide an added value to an individual's educational experience. In pursuit of the goal of improving the distribution and acquisition of knowledge, it is important to examine and address some problem areas that may be experienced by users.

An abundance of research exists regarding the effectiveness of groupware and e-learning solutions. A common sentiment is that computer based learning is not as immersive as classroom based learning. Part of that sentiment is derived from the failure to use the available technology to its full potential. Early implementations of groupware and e-learning solutions were driven primarily through the delivery of text. This is particularly problematic for human communication. A prominent study by Mehrabian (1971) illustrates that non-verbal cues are vital when decoding communication messages between people. New technologies that seek to impact learning should consider the importance of making available the non-verbal parts of communication - CLEERhub is meeting that challenge by allowing learners to view videos of presenters, participate in interactive, multi-party videoconferencing, and share learning experiences that took place on the HUB with each other in the classroom. The authors are passionate about finding additional ways to use emerging technologies to positively impact learning.

Another challenge that must be addressed is highlighted by Kreijns, Kirschner, and Jochens (2003). They point out a very important consideration that is being neglected in many collaborative learning systems: the need for social interaction. They identify two main pitfalls that designers of collaborative learning environments must address. The first pitfall is the failure to recognize that social interaction is a key part to ensuring a positive learning environment. They also suggest that the social interactions that occur in the classroom play an important role in forming networks that are used outside of the classroom to enhance learning. Therefore, designers of computer based learning environments need to recognize that people need to be able to interact with other members of their group to ensure a positive learning environment.

The second pitfall that Kreijns, et al. (2003) identify is the failure to recognize that merely providing a means to interact does not necessarily mean that members of a group will use those features. Based on their analysis of the literature, Kreijns and colleagues suggested that the group dynamic is severely hindered in text-based learning environments, accompanied with a higher than usual focus on completing tasks instead of getting to know members of their groups better. Kreijns and colleagues highlighted the importance of integrating non-task interaction into a computer based learning experience so that members of the group can get to know each other better. While this may not directly enhance learning, it has a latent effect of creating a positive learning environment, which is very important to ensure that lasting learning occurs.

As CLEERhub and other HUBs continue to grow and develop, it is important to keep these two potential pitfalls in mind. In *Digital Habitats*, Wenger and colleagues (Wenger, White & Smith, 2009) reminded us that we must remember to use technology for the things it does well, and also realize that there are other aspects of community life for which an online environment is not appropriate. Thus we can continue to pursue the appropriate development of virtual learning communities.

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