STEMEdhub: Supporting STEM Education Initiatives via the HUBzero Platform

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Built as one of 60+ hubs on the HUBzero platform, STEMEdhub was developed in 2011 as a resource for research, education, and collaboration in STEM education. The hub currently supports 82 different groups. In this article, the authors describe two specific groups (SLED and AAU) that are taking advantage of numerous communication and resource tools available through the hub platform. They conclude with advantages and limitations to using hub technology, particularly with STEM educators.

Introduction

Rosie Chavez was feeling stuck. As she started to gather resources for the next STEM unit in her curriculum, she decided to do something different to teach her fifth-grade students about the future of energy. She logged on to STEMEdhub, which she had joined as part of a two-week summer STEM workshop, to see if others had any suggestions. As she hoped, there were a number of resources available through the hub, including publications, simulations, and lesson plans. Still, she wasn't sure which would work best for her students. In reviewing the various resources, she noticed that she could search by topic, discipline, or grade level, and that other users had rated the resources. This enabled her to select those that would most likely fit her students' needs, providing a useful place to start.

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Background

Purdue University's HUBzero is "an open-source software platform for building powerful Websites that support scientific discovery, learning, and collaboration" (Hub Technology Group at Purdue University, 2014). The platform was originally created to support *nanoHUB.org*, an online community of nanoscientists affiliated with the Network for Computational Nanotechnology and supported by the National Science Foundation since 2002 (McLennan & Kennell, 2010). However, HUBzero has now expanded to support many hubs in a variety of disciplines, including science, technology, engineering, and mathematics (STEM) education (*STEMEdhub.org*). At its core, the HUBzero platform is a content management system (CMS), currently built on the Joomla platform, supplemented with numerous custom-built components, modules, and plugins developed by either HUBzero staff or members of individual hub communities.

nanoHUB.org was created as a cyber-infrastructure where researchers, educators, and professionals could collaborate, share resources, and solve nanotechnology problems (Klimeck, McLennan, Brophy, Adams, & Lundstrom, 2008). According to Madhavan, Zentner, and Klimeck (2013), nanoHUB now serves more than 250,000 users, distributed across 172 countries. An important capability of nanoHUB is the ability for users to run Web-based simulations, uploaded to the platform by members of the community. Last year, more than 13,000 users ran nearly 450,000 simulations (Madhavan *et al.*, 2013).

nanoHUB also allows users to access, rate, and comment on a variety of resources provided by members of the community. Resource developers can take advantage of workflow support and a CMS for tool publication (McLennan & Kennell, 2010). Users can interact with other members of the community, for example, by posting questions in a community forum. nanoHUB has also developed the capacity to provide formal education via its infrastructure, and currently contains more than 90 complete courses on nanoscience and nanotechnology. nanoHUB-U, a more recent addition to the platform, enables users to access both self-paced and instructor-led short courses on topics from multiple branches of science or engineering (Madhavan *et al.*, 2013). Thus, nanoHUB

has become a vehicle that uses cloud computing to support the learning and collaboration among members of a broad community of nanoscientists.

Since 2007, HUBzero has expanded to support over 60 hubs in a variety of disciplines, including environmental sciences, pharmacy, engineering, health care, and STEM education (McLennan & Kennell, 2010). While some hubs focus on using simulation and high-performance computing capabilities, others are more interested in using the online collaboration tools or sharing resources with other hub users. For example, cceHUB (Cancer Care Engineering HUB) is a network of cancer researchers who use the hub technology to manage and distribute medical and scientific research databases and then, in turn, run simulations on that data (cceHUB Group at Purdue University, 2014). Another hub, My GEO Hub (*mygeohub.org*), is built around a group of environmental projects focused on the use of geospatial technology (mygeohub group at Purdue University, 2014). An example of a self-supported hub is *knowinnovation.com*, which works with groups of scientists and academics to identify innovative and creative ideas and uses the communication and collaboration tools of HUBzero to support workshops for funding organizations in both the United States and Europe (knowinnovation, 2014). The creators of this hub downloaded the open-source code to create their own site and joined the HUBzero foundation, which was created to promote the use of HUBzero and to address ongoing sustainability of the core HUBzero software (HUBzero Foundation at Purdue University, 2014).

STEMEdhub

STEMEdhub was developed in 2011 as a resource for research, education, and collaboration in STEM education. It supports multiple projects through a hub feature called "groups," which allows individual interest groups within a hub to host their own Web pages, communication tools, and resources. Most of the content on STEMEdhub resides within its groups, although anyone can register on the hub and publish their own resources. STEMEdhub currently has 53 regular hub groups and 29 super groups. A super group is a group that has a custom template design that allows for a unique look. As an example of a group, we describe SLED, a five-year NSF-supported Math Science Partnership (MSP) project between Purdue University and collaborating school districts in Indiana, which began in 2010.

SLED Group

The goal of the Science Learning through Engineering Design (SLED) project is to "improve science learning in grades 3–6 through the integration of an engineering design-based approach to science learning in the targeted grades" (SLED project, 2014). The project involves three interrelated components: (a) adapting or creating engineering design-based curricular materials, (b) providing professional development to prepare in-service and pre-service teachers to teach science through design, and (c) assessing outcomes with respect to teachers' practices and students' learning in the project.

The SLED project is grounded, in part, in ideas about situated learning (Lave & Wenger, 1991) in which individuals develop their expertise by becoming part of a community of practice. The project team hoped that teachers would become members of an engineering design community of practice through teacher professional development, interactions with STEM disciplinary faculty members, and interactions with other teachers. When the project was conceptualized, the development of a cyber-infrastructure was envisioned as a key means to promote community building.

Because of the availability of the HUBzero platform, and its capabilities, as demonstrated by nanoHUB, this platform was chosen to support the SLED project. Initially, the SLED project intended to develop its own hub, but sustainability was a concern. How could the hub be maintained after the NSF funding ended? The SLED project leadership discussed this issue with Purdue's Discovery Learning Research Center, which was launching STEMEdhub, and made the decision to join STEMEdhub. The funding allocated for SLED's hub was used to enhance the capabilities of STEMEdhub, with the understanding that STEMEdhub would provide long-term support for SLED resources. In the process, STEMEdhub became a model of a hub that supports multiple projects through the groups feature.

Figure 1 provides a screen shot of one page in the SLED group on STEMEdhub. As shown in the figure, the top menu connects users to information and resources for all of STEMEdhub, while the left-hand menu is specific to the SLED group (*https://stemedhub.org/groups/sled*). Thus, participants in the SLED project have a site where they can find project-specific information while still having access to the broader resources of STEMEdhub.

The SLED group site serves as the central information site and resource repository for the project. Individual resources, such as engineering design curricular units, are uploaded by members of the project community and then tagged with key terms to allow users to search for relevant resources. In addition, resources can be rated by users using a five-star scale that also allows comments. When accessing a given resource, users can view a description of the resource, as well as the ratings and any supporting documents, and then download the resource with the click of a button. The Design Resources page, shown in ***Figure 1***, provides ready access to all of the SLED materials through hyperlinks. The primary use of the SLED site by participating teachers has been to locate and download available resources.

The ability of groups to have multiple Web pages allows the SLED project to provide information in a conveniently accessible form. In addition to the Design Resources page,

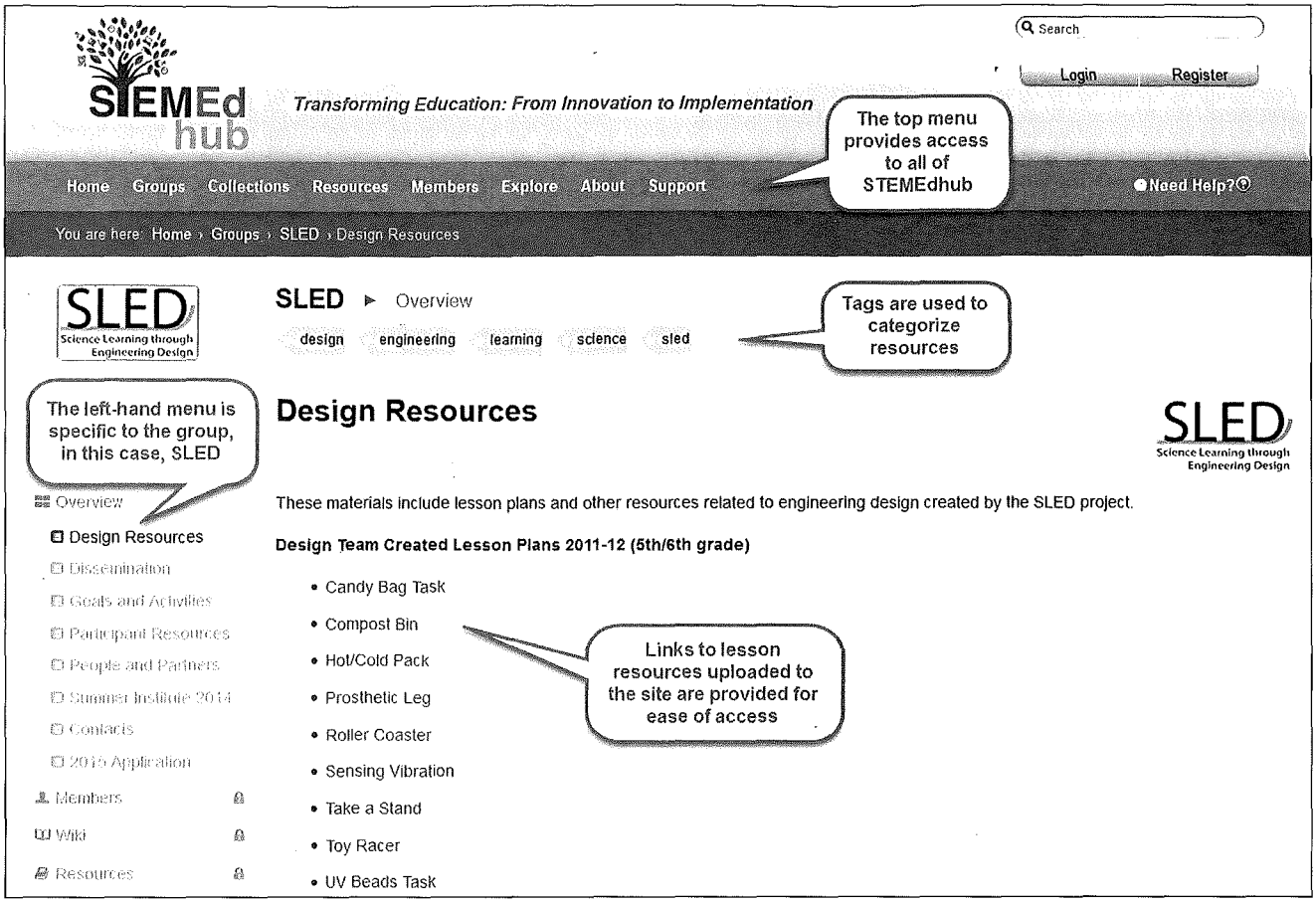

Figure 1. A screen from the SLED group in STEMEdhub.

other SLED group pages include: Dissemination (links to project-related publications, presentations, and media), Goals and Activities (project goals and activities), Participant Resources (ancillary resources for participants), People and Partners (information about participants), Summer Institute (information for summer institute participants), Contacts (contact information for project staff), and 2015 Application (application information for prospective 2015 participants). In addition to the group-specific pages, which were created by the SLED project team, every group provides access to additional resources, including member information, a wiki, a blog, discussion forums, a calendar, announcements, and collections (which resemble Pinterest boards). These allow groups to build a community among their members.

Hub sites are able to support any number of groups. In addition to the main SLED group, which serves as the primary Website and communication vehicle for the project, SLED also created another group, called SLEDteach. Unlike the main SLED group, which is publicly accessible, SLEDteach is private. The SLEDteach group is a place for participating teachers to share reflections about what is occurring in their classrooms as they implement SLED activities. Reflections may contain comments or information that teachers would not want to be made public. Thus, the group feature of STEMEdhub supports both public dissemination of project materials and private sharing of more sensitive content.

AAU Group

The American Association of Universities (AAU) is a nonprofit organization of 62 member universities in the U.S. and Canada. In 2011 they launched a five-year initiative to improve the quality of undergraduate STEM Education. One of five key goals for the program was to develop an effective means for sharing information, and STEMEdhub provided an effective way to do that. AAU wanted to be a part of STEMEdhub, yet have its own unique look and feel. As such, they created the first super group on the site. When the group site was created, the colors and feel of both STEMEdhub and the AAU home site were integrated to create a cohesive look and feel.

The AAU group on STEMEdhub uses many of the tools available to groups. For example, they use the online site to showcase examples of innovative institutional efforts from both project sites and other member sites. Current institutional reform efforts are displayed through a graphical online interface, developed by HUBzero staff. Forums enable participants to sustain dialogues on systemic change across their member campuses. A member list makes it

possible for members to find others with similar interests. There are sliders on multiple pages to visually highlight the many ongoing institutional projects. An embedded Twitter feed makes it easy to see the ongoing Twitter discussion. Lastly, a resource page makes it possible for the groups to share important documents.

Since the HUBzero technology does not allow for groups within groups, 20 AAU institution groups were added as additional super groups with a very similar look and feel to the AAU group. This way one can navigate between them and feel as though they are within the same site.

Benefits and Challenges for Educators

As a platform, STEMEdhub has a number of benefits for educators interested in STEM education, and it has features supportive of technology-mediated communities of practice (Schlager & Fusco, 2003). The platform provides a site where STEM education projects, such as SLED and AAU, can host Web pages to share information with the members of their communities. The platform also enables communities of users to access a database of many types of resources, including print materials, media, data sets, and computer simulations. Individual users can publish resources on the hub for others to access, and resources can be rated by users. Users can locate resources through built-in search tools or by using hyperlinks from Web pages to specific resources, and the platform provides authors with access statistics. In addition, the platform incorporates a number of features that allow users to interact with one another, including discussion forums, blogs, wikis, and the ability for groups to create their own spaces.

From the perspective of the projects that use STEMEdhub, one of the real advantages of the hub is the ability to manage users. Users can be given varying levels of permissions. Content can be restricted to certain users or be open to the public. Users can be made group managers, and regular group members can be given the permission to add new members to the group and manage group pages. In addition, every hub has a back-end interface that only administrators and managers can access, enabling them to take care of issues like resetting passwords, fixing resources, and managing tags and group approvals.

While HUBzero has many benefits, it also has limitations as a platform for working with educators. Although it can be relatively easy to use for technically savvy users, such as nanoscientists, it is less user-friendly for lay users, such as classroom teachers. Elementary school teachers in the SLED project, for example, have had difficulty with aspects of the platform, such as the multi-step resource publication process, the search tools, and occasional browser compatibility issues. The discussion forums, as currently constructed, are not as easy to use as those in popular learning management systems. Improvements continue to be made, but in some cases system upgrades have caused existing features to change, exacerbating user confusion. Finally, although the problem is not specific to this platform, we have observed the difficulty involved in encouraging participating educators to use the platform for real interaction with others. This may relate to well-documented obstacles to teacher professional development, such as a reluctance to reflect on practice and to engage in dialog about the practice of peers (Schlager & Fusco, 2003), or it may simply be, as the SLED participants report, that teachers do not feel they have the time to use the online platform.

STEMEdhub represents a powerful new technological platform to support STEM education projects and STEM educators, comprising a rich set of features that engage communities of practice. As noted earlier, this growing and evolving site is capable of supporting many different STEM education projects and thousands of users. However, further research is needed to ascertain how best to leverage this and similar platforms for the elusive goal of effective online teacher professional development (Dede, Ketelhut, Whitehouse, Breit, & McCloskey, 2009). □

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