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# A Tale of Three Sites: Resource and Knowledge Sharing Amongst Computer Science Educators

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## ABSTRACT

Computer science educators, especially those in schools, often work in small departments which allow little support or sharing. This problem can be alleviated via virtual online communities that allow educators to support each other and share knowledge and teaching materials. Virtual communities experience varying levels of success or failure, and it is often not easy to determine the causes for these differences. Factors include social and technical aspects, and it is typically not trivial to attribute community behaviour clearly to one or the other. In this paper we describe the “ColourRoom” software, a web-based platform to support virtual communities of educators. This software has been deployed to three distinct communities – educators using BlueJ, educators using Greenfoot, and UK computer science school teachers (regardless of software) – which affords a rare opportunity to analyse the usage of the same software in different communities, providing insights into both the communities and the design of software to support them.

## Categories and Subject Descriptors

K.3.2 [Computers and Education]: Computer and Information Science Education – *Computer science education*.

## General Terms

Design, Human Factors.

## Keywords

Educator communities, Online communities, Resource repositories, Online discussion.

## 1. INTRODUCTION

The Internet has enabled many new forms of collaboration, due to the ease of long-distance communication and data-sharing. For educators, two types of platforms have traditionally been used to support sharing and collaboration: teaching resource repositories, which allow teachers to share teaching materials and artefacts, and community sites, which support discussion and sharing of knowledge and experiences. This paper describes the “ColourRoom” software which combines these two aspects into a single system.

The success of a repository/community is determined by a number of factors. Some of these are technical, based on functional or interactional design of the software system, and others are social, based on characteristics of the community using the system and its

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members. For those wishing to create a repository and/or community, the software design is the factor over which they have most control. However, it is generally difficult to ascribe failures or successes to individual aspects of the system, and to determine the extent to which an observed outcome of a system deployment is caused by technical and social factors.

The ColourRoom software has been deployed three times in independent installations. Each time, the technical design and implementation is (largely) identical, but the characteristics of the communities differ. This affords the rare opportunity to study a single educator-oriented technical system with different social characteristics and observe some effects of differing communities.

Our contributions are:

- A description of the ColourRoom software's functionality and underlying design philosophy. The colloquially formulated principle “It’s about people, not artefacts” guides much of the design choices and encourages knowledge and resource sharing (Sections 3 and 4).
- An examination of the three different deployments (described below) and an analysis of how the different sites are being used (Sections 5, 6 and 7).
- A discussion of the experiences and lessons learnt during the design, deployments and ongoing administration of these sites (Section 8).

## 2. THREE DEPLOYMENTS

The ColourRoom software has been deployed three times to three different communities. The software underwent some continuing development between deployments, but the core of the system has remained largely unchanged since the initial launch. The activity levels of the sites, relative to their opening, are shown in Figure 1.

### 2.1 Greenroom

The first deployment of the ColourRoom software was for users of the Greenfoot educational programming environment. The site was intended specifically for educators using Greenfoot to share resources and have discussions about teaching with Greenfoot. This deployment is known as the *Greenroom* (<http://greenroom.greenfoot.org/>) and was opened in March 2010.

Prior to the opening of the Greenroom, there was an existing Google Group (a mailing list/forum) with 170 members. Members of the Google Group were informed of the site's opening and encouraged to create an account. About 90 of the existing members transferred to the new site. Rapid growth of membership meant the Greenroom surpassed previous membership numbers within its first month of opening. Membership of the Greenroom is dominated by school teachers (73.0%), followed by educators from universities and other Higher Education (HE) institutions (20.8%) and people in various other roles (6.2%). At the time of writing (April 2013), the Greenroom has 2,169 members.

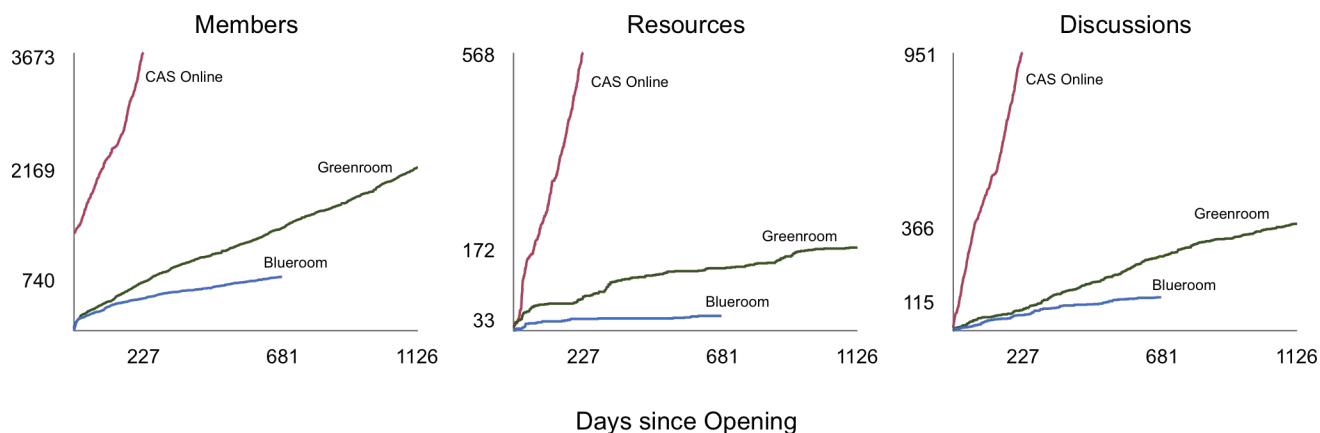


Figure 1: Growth over time of the number of members, resources and discussions for the three deployments.

## 2.2 Blueroom

Following the opening of the Greenroom, the same website software was deployed to support another educational programming environment, BlueJ. Visual alterations (such as the name, logo, and colour scheme) were applied, but the functionality stayed the same. Similar to the Greenroom, the site was intended specifically for educators using the BlueJ environment to share resources and have discussions. This deployment was correspondingly named the *Blueroom* (<http://blueroom.bluej.org/>) and was opened in May 2011.

The opening of the site was advertised to some existing BlueJ-related low-traffic mailing lists, but no existing community of BlueJ educators transferred into the Blueroom. Reflecting the different target user group of BlueJ (compared to Greenfoot), membership consists of a larger share of university and HE lecturers (55.1%), followed by school teachers (40.8%) and others (4.1%). Membership currently consists of 740 accounts.

## 2.3 CAS Online

*Computing At School* (CAS) is a UK organisation that promotes computer science in UK schools [4]. CAS were operating via a Google Group but wanted a site that would support resource sharing and improved discussion among its members. The requirements were similar to the previous deployments, so the ColourRoom software was again used with appropriate visual alterations to act as the CAS community site, *CAS Online* (<http://community.computingatschool.org.uk/>), launched in August 2012. In contrast to the Greenroom and Blueroom, CAS Online is not intended to support users of a specific software system, but rather is broadly targeted at supporting teachers delivering computer science to students aged 5-18 in the UK – which thus may include special attention to UK qualifications and curriculums for that age group.

Since a large membership existed prior to opening the site, the transition was semi-automated, with accounts created for all existing CAS members which then had to be manually activated by the individuals. A few members were displeased with this, but ultimately 1311 of 2526 Google Group members joined the site via this mechanism. Un-activated accounts were deleted after a few months' grace period.

CAS Online has a few minor additions to the site design to cater for the higher membership numbers and diversity of interest. These include use of multiple forums and the ability for members

to specify their professional roles, such as “Secondary School Teacher (16-18)”, “IT Professional” or “Higher Education”. At the time of writing, CAS Online has 3,673 members.

## 3. DESIGN GOALS AND PHILOSOPHY

A leading design goal in the development of the ColourRoom software was to encourage participation, especially to encourage continuing and regular engagement. Prior experiences and literature show that resource repositories often fail because they do not manage to attract sufficient sustained activity or contributions [8]. OntoShare, for example, observed that users “were happy to receive e-mails and read documents but did not add items to the system” [7]. Similarly, Chiu et al. [6] state, “clearly, the biggest challenge in fostering a virtual community is the supply of knowledge”.

The design of many resource sharing systems is centred around interactions between the user and the system. Citidel provides a typical example (<http://www.citidel.org>), offering functionality to upload, search and browse resources. Many systems of this type struggle to maintain user engagement over time – we believe this is because the interaction between a user and the system is only half of the full interaction: between people.

For the ColourRoom, we decided to centre the design around interactions between people, rather than interactions with artefacts. Lessons learned from social networking sites, such as Facebook and Twitter, which often manage to engage users over extended periods of time, were incorporated and influenced functionality and presentation. “*It’s about people, not artefacts*” became the leading guideline during the site design. The mental model incorporated was that of a staff common room (peers meeting and chatting) rather than that of a library (people coming to find a resource).

The decision to concentrate on people (and through this: on community) addresses some of the challenges in creating and understanding the motivations to participate [2]. It also fundamentally influences the site design and presentation; visible manifestations of this include:

- Use of real identities of real people. Users must log in to use the site, provide their real names and – ideally – a picture and geographical location of their workplace.
- Users build up a reputation: Past activities are presented, and contributions acknowledged.

- The front page does not show a form to browse the resources, but rather a stream of activity of people.

In every aspect, the site design tries to say: “You are not alone here. You are among peers and friends.”

An important goal was to place hurdles to engagement as low as possible to allow as many people as possible to become active, and to have positive experiences. To this end we incorporated various mechanisms for small scale peripheral participation as an entry to engagement for a larger number of members. These include the ability to make small simple edits (e.g. to correct a spelling error), the ability to ‘Like’ a resource, or the ability to leave a short comment. In systems where the only possible contribution activity is to upload a resource (a heavy-weight contribution), engagement is significantly harder.

Another aspect reinforcing this message is a very simple, almost simplistic, site design. Where some other community sites (e.g. the US CS10K community, <http://cs10kcommunity.org/>) employ a very sophisticated graphical design with professional effects and presentation, the ColourRoom interface looks simple, and somewhat “home made”. The intention is to create a feeling of “This is us; this is ours” as opposed to an “us versus them” divide. The more professional a site looks, the more an assumption is created that there exists somewhere behind it a (large? powerful? influential?) organisation that is in control. We fear that this may discourage participation by creating a larger perceived divide between those perceived to be in positions of power and individual users. Simplicity can remove hurdles to participation.

## 4. SITE FEATURES

The ColourRoom website software has two major components – discussion forums and resources – along with various other small mechanisms designed to encourage or support participation. We describe the general features here, noting where appropriate the differences between the three deployments.

### 4.1 Identity

Members sign up with real names and provide information about their workplace. They are encouraged to provide a picture of themselves which is displayed next to their contributions in forum discussions to humanise conversations. A map is provided showing geographical locations of members, again emphasising the connection to real people. On CAS Online, members are also asked to specify their professional roles. Over time, members receive badges (which are displayed with each of their discussion posts or comments) identifying their standing in the community: length of membership and various aspects of active contributions.

### 4.2 Discussions

The discussion forum has simple, flat (non-threaded) discussions. The Greenroom and Blueroom have one discussion forum that contains all the discussions, while CAS Online has several different forums. Participants in discussions are identified next to their post with their name, picture, roles and badges.

### 4.3 Resources

In technical terms, a resource in the ColourRoom is a rich-text webpage with an associated thumbnail image and zero or more files attached. Any user may create a resource, and thereafter any user on the site may edit it (by changing the webpage content, the image, or adding/removing/altering the attached files). Resources have a comment trail attached to it where users can leave their feedback or ask questions. They may be added to resource sets for

grouping, and contain “see also” links to related resources. Finally, resource pages include a version history where past edits can be examined and, if necessary, prior versions can be restored.

### 4.4 Wiki model

Access to resources is governed by a wiki-like model: every user has equal editing rights; everyone can edit any resource. This serves several purposes: First, it presents a solution to the question of curation: How do you ensure quality of content? One method is to have a gatekeeper to filter contributions. We considered this too centralised and restrictive. The wiki model has at least the theoretical chance that weak contributions are quickly identified and improved. The second reason is that a wiki model may remove one anecdotally-reported barrier to resource-sharing: the fear of uploading a resource that is not perfect. A wiki allows a user to upload their resource, and others to improve it – ideally, encouraging community development of resources, which is a more scalable model for resource development.

### 4.5 Peripheral participation

Various mechanisms support peripheral (small scale, low overhead) participation. These include commenting on a resource (which often just consists of a “*Great resource – thank you.*” note), or clicking a resource’s “Like” button. In each of these cases, the identity of the contributor is displayed. When users download a resource, they get prompted one month later to leave a comment, to encourage this activity. The wiki model of access also allows small scale edits. For example, we observe regular activity of some people fixing spelling or formatting mistakes.

### 4.6 Email Notifications

The ColourRoom has an email system of notifications. Users choose an email frequency (ranging from hourly to weekly), and which changes to be notified about: forum posts and/or resource creation and/or resource edits. These notifications contain the name of a new resource or title of a discussion, but not the full content – users must visit the site to see the content itself. This decision was taken to encourage users to visit the site (although some users dislike it), which increases the likelihood that they will browse other areas and engage further with the community.

### 4.7 Walled Garden

All three sites are walled gardens: the content is only available to members when logged in. There are two primary reasons for this. First, being in a closed community of peers significantly changes the tone of discussion. Members tend to be more respectful, and more open. For example, we see regular instances of new teachers asking for help, stating that they have to teach a new subject shortly, but don’t know how to do it. These types of admission are impossible to make if pupils were listening in to the conversation. We believe that the use of real identities, rather than pseudonyms, leads to more polite and thoughtful interactions. (Kilner and Hoadley [11] found real names made no difference, but Booth [3] found that a closed site encouraged trust.)

The second reason is that resources often include answers to worksheets or assignments, which educators would not want students to access. Therefore the content being available only to members ensures that assessments remain viable.

To sign up for the site, applicants must show evidence of their identity. Typically this involves using an official email address from their institution, coupled with a staff webpage confirming their role. This information is checked by an administrator of the site. This has been fairly manageable for the Greenroom and

Blueroom which see an average of 1-2 new applicants per day, but CAS Online currently sees an average of over 15 applicants each day, and thus more volunteers administrators had to be recruited.

## 4.8 Other Features

The website has several additional features that are not relevant to this paper. For CAS Online, an event advertising mechanism is available to announce upcoming events. There is a public news feed, updatable by administrators, and a search functionality which allows users to search resources, discussions and members.

## 5. METHOD

In order to examine how members are interacting with the three sites we pose a set of specific questions.

### 5.1 Artefact Sharing

The amount of sharing can be quantified by looking at the consumption of resources. Resources are effectively an HTML webpage with zero or more attached files. Some resources do not have any files: these resources typically contain links to external resources. We do not track clicks on these links, so we cannot easily quantify the amount of use that these resources attain. Instead, we analyse only resources that have files attached, as we do have data available of the number of downloads.

Using the absolute number of file downloads to measure consumption across sites is misleading for several reasons: the sites differ in time since launch and the numbers of users, resources, and files per resource. To design a measure, we make the assumption that the amount of downloads is determined by demand (i.e. the number of users), not the supply of resources.

We therefore examine downloads per user as a normalised measure of sharing. However, to account for time since launch, we measure downloads per user-months (the total of the months of membership for all site users) instead of purely per number of users. To account for the varying number of files per resource, we count only the downloads for the most-downloaded file in a resource (known as the *max-download* for a resource). Thus our measure of sharing is total max-downloads per user-months.

### 5.2 Discussion Types

The discussions function can be used for a variety of different purposes: pedagogical help, programming knowledge questions, announcements, technical support, programming technique questions, political discussion, and so on. To produce categories, we manually examined 120 discussions (40 from each site) chosen at random, and classified them based on the intent of the initial post in the discussion. Based on these categories, we classified 300 discussions (100 from each site), chosen at random.

### 5.3 Demographics

The Greenroom and Blueroom capture no specific demographic information, but simply have a free-text entry for an autobiographical profile and a field to specify the associated institution. We separated demographics into three groups by the type of institution the members work at: School, Higher Education, and Other. Demographics were investigated by manually checking their institution and assigning members to one of these groups. 400 randomly chosen members of each site were checked for this analysis. A small number of affiliations could not be decided and were excluded from the analysis.

On the CAS Online site members are prompted to indicate which of several roles they occupy: teacher (by age group), industry, higher education, and so on. For CAS Online, we examined what

proportion of members occupy which roles, and also examined resource and discussion participation by role.

### 5.4 Site Access

As well as active participation, there are a number of users who access the site regularly but do not participate. We determined the total number of users accessing the site by looking at the number of users who logged in during a given period: the first three months of 2013. This figure is useful to compare against the amount of resource and discussion activity: we can calculate how many of the users who visited the site actively participated.

### 5.5 Discussion Participation

One measure of participation is the use of the discussion feature. The absolute number of discussion posts can be distorted by the number of users (and by over-active users), so we examined the proportion of users who participated in the discussions in the first three months of 2013. We also measured – for users who have ever made a discussion post – the average (median) length of time from joining the site to making a first discussion post.

### 5.6 Resource Editing

The site's wiki model for resources allows users to edit their own resources, and those created by others. We are interested in the amount and type of edits made after a resource's creation, and who made them. To assess the types of edits, we first examined 15 randomly chosen resources with post-creation edits (5 from each site) to form classifications of the type of edit that was performed. We then applied these classifications to 60 randomly chosen resources with post-creation edits (20 from each site), to see what edits were made (and noted whether these were performed by the original resource creator, or a different creator). We also looked at summary statistics for all edits across the sites, to see what proportion of edits were performed by the original creator, and the number of resources that had received any edits.

### 5.7 Resource Feedback

One goal of the site design is to encourage feedback on resources by allowing comments, automated prompts for feedback, and the "like" mechanism. Comments on resources occupy different roles: suggestions for improvement, thanks, criticism, and so on. To produce a classification for types of comment, we examined the comments on 15 randomly chosen resources that had comments (5 from each site), and formed a classification. We then applied this classification to 60 randomly chosen resources with comments (20 from each site) to see what kinds of feedback were being offered.

## 6. RESULTS

### 6.1 Artefact Sharing

The sharing ratios, as defined in Section 5.1, were 1.57 for CAS Online, 0.51 for the Greenroom and 0.21 for the Blueroom (to 2 d.p.). By this measure, CAS Online sees much more sharing than either of the other two sites. There is no obvious *a priori* reason why this should be the case: in fact, since CAS Online has a lower proportion of educators as members, it would be reasonable to expect it to have the lowest sharing ratio. It is possible that these figures might be slightly confounded by the number of available resources with files, so we provide the counts here – CAS Online: 371, Greenroom: 161, Blueroom: 20.

### 6.2 Discussion Types

The following categories of first posts in discussion threads were identified using the method described above, based on analysing

**Table 1. Categorised discussions on each site (percentages); some columns do not sum to 100 due to rounding (0 d.p.).**

	CAS Online	Greenroom	Blueroom
Sharing	47	17	12
Programming	0	35	15
Teaching	38	19	26
Technical	2	24	48
Coordination	13	5	0

120 threads (40 from each site) – any other posts that did not fit were left unclassified:

**Sharing** – Posts that are intended to make an announcement, or share information (e.g. hyperlinks). These threads generally do not intentionally invite response, but are a way to publicise some information.

**Programming** – Posts that ask a programming question which would not be out of place in a non-educators programming forum (that is, questions which make no specific reference to teaching).

**Teaching** – Posts that ask a question about teaching, or aim to start a discussion on an aspect of teaching.

**Technical** – Posts that ask a technical question, e.g. how to install some software, or how to deal with a firewall problem. This does not include opinions on software for teaching.

**Coordination** – Posts that intend to coordinate members, either organising a meeting, forming a working group, or asking for members' help (more than simply answering a question) in a specific activity.

Of the 100 threads we attempted to classify from each site, we successfully classified 87 on CAS Online, 86 on the Greenroom and 94 on the Blueroom. The percentages (of successfully classified threads, not of the original 100) are shown in Table 1.

### 6.3 Demographics

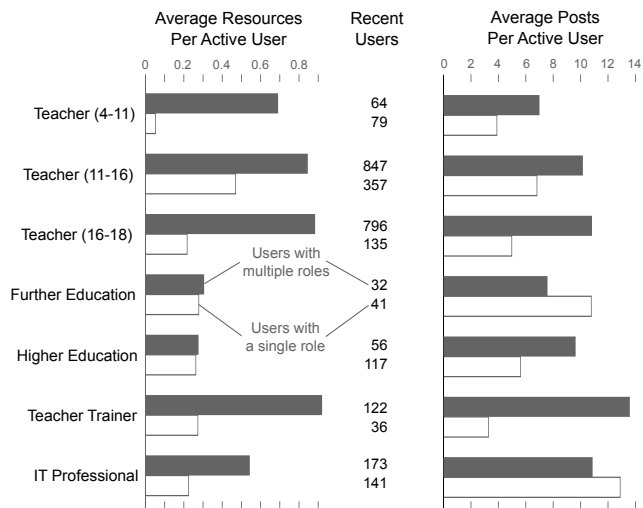
The demographics for CAS Online are depicted in Figure 2. The largest user groups are teachers of 11-16 and 16-18, which have a large intersection – 770 users declare both of these as their role. Interestingly, groups of users who declare multiple roles are (with two exceptions) more active than users who declare a single role.

Those who only teach ages 4-11 contribute the least resources. This is in line with expectation – these teachers are almost certainly generalists who must cover many subjects, and so they will likely lack detailed expertise on computing, which is reflected in their resource contribution. The users who also perform other roles (e.g. teach 11-16) are likely to be specialists who do have the knowledge and confidence to contribute resources.

IT Professionals who have no other role (and thus do not teach) still contribute some resources, although relatively few. However, this group contributes a large amount to the discussions. Although it is positive that they are engaged with CAS, we do have an anecdotal concern that their voice may be slightly drowning out the educators on the site.

Greenroom membership by associated institution consists of Higher Education (20.8%), School (73.0%), and Others (6.2%).

The numbers for the same categories in the Blueroom are: Higher Education (55.1%), School (40.8%) and Others (4.1%).



**Figure 2: CAS Online users and activity broken down by self-declared role. Each role is divided into those who declare that as their sole role, and those who declare multiple roles. The middle column shows the number of those users who accessed the site in the first three months of 2013**

### 6.4 Site Accesses

In the first three months of 2013, 72% of CAS Online's members accessed the site. This statistic has a notable confound: CAS experienced a very high rate of growth in this period (see Figure 1). Of the 3673 CAS Online members, 1227 had *joined* in the first three months of 2013, so they automatically count towards the 2650 who accessed the site. A little arithmetic shows that  $2650 - 1227 = 1423$  of the pre-existing  $3673 - 1227 = 2446$  members have accessed the site: 58%. In the Greenroom, 28% accessed the site in the first three months of 2013; in the Blueroom, the figure was 30%. Thus, it is apparent that CAS Online sees at least double the proportional accesses of the other two sites.

The participation statistics show that not only did CAS Online have more accessing users, but a higher proportion of those were participating. Of the users who accessed CAS Online in the time period, 27% were active (they either made a discussion post or engaged in resource creation, editing, or feedback). However, in the Greenroom the figure was 12%, and in the Blueroom: 5%.

### 6.5 Discussion Participation

In the first three months of 2013, on CAS Online 22% of accessing users wrote a discussion post. In the Greenroom, the figure was 6%, and in the Blueroom the figure was 2%.

Interestingly, the figure for median time from joining to first discussion post was fairly similar across all three sites: 24 days for CAS Online, 33 days for the Greenroom and 27 days for the Blueroom. So although CAS Online is much more active, users do not begin participating any sooner than on the other two sites.

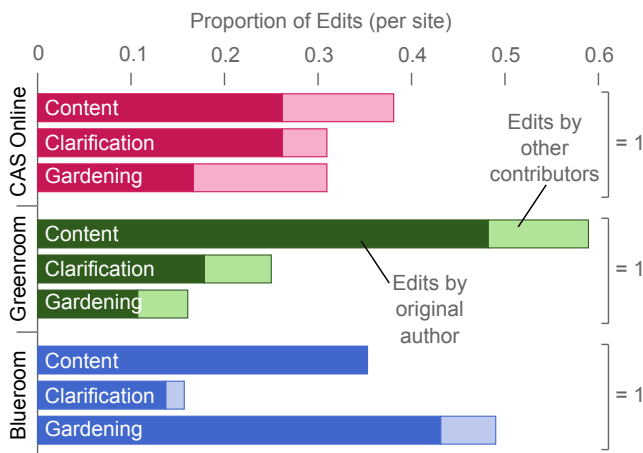
### 6.6 Resource Editing

The analysis of resource types led to the formulation of the following categories:

**Markup** – An edit to fix formatting. The site lacks a preview feature, so markup problems are often noticed after saving. E.g., many edits turn plain-text URLs into hyperlinked URLs.

**Clarification** – An edit that alters a single sentence.





**Figure 3: Resource edits for each site, divided into three categories: Content (large changes), Clarification (small changes) and Gardening (non-content changes)**

**Content** – An edit that adds a paragraph (or more), or adds/changes the files associated with a resource.

**Image** – An edit that adds an image to a resource, or changes the image. (Resources can have a single thumbnail image, displayed when browsing the list of resources.)

In our set of classification-forming edits (our “training set”), each edit fell into only one category. We thus classified the full set of edits by assigning a single, most suitable category to each edit.

One behaviour not classified in our training set but observed during our full set was that some content edits add translated versions of the existing content. This behaviour is primarily seen in the Greenroom, as it has an international audience (but is unlikely to occur on the UK-focused CAS Online site).

The results can be seen in Figure 3. We have combined markup and image modifications into a single “gardening” category that represents small presentational (non-content) changes. Each site is shown with its edits broken down into three categories (content, clarification and gardening), and further split into stacked bars based on who performed the edit: the original creator of the resource, or another member.

The Blueroom has the least amount of edits by a non-creator: only 8%. All of the large content edits are performed by the original creator. We can characterise this as a disseminator model: resources are provided and improved by the original editor, but there is no content collaboration. Members appear reluctant to edit any resources other than their own.

CAS Online has the highest proportion of edits by a non-creator: 31%. Content and non-content edits are both present, showing a larger degree of collaboration between users. Many non-creator edits are gardening edits, which suggests that users are still most comfortable editing each other's resources when the change is a simple non-content change (e.g. turning a URL into a hyperlink).

The Greenroom lies somewhere between these two sites, with 23% non-creator edits. The Greenroom sees markedly less gardening edits, and more content edits. This is perhaps simply because Greenroom resources are more likely to be centred around files rather than web-only resources which invite small or gardening edits (94% of Greenroom resources have files, compared to 65% for CAS Online and 61% for the Blueroom).

**Table 2. Categorized resource comments (%; 0 d.p.); comments can be in multiple categories.**

	CAS Online	Greenroom	Blueroom
Thanks	58	43	37
Negative	0	0	0
Detail	13	24	13
Editor Question	4	9	5
General Question	1	3	13
Response	7	19	10
Experience	5	13	4
Suggestion	6	3	3

## 6.7 Resource Feedback

When identifying categories for resource comments, many fell into multiple categories, so we chose to allow a post to belong to several categories. The first two distinguish positive and negative comments:

**Thanks** – Comments which compliment the author or content of a resource.

**Negative** – Comments which are negative about the resource.<sup>1</sup>

The next three categories include comments asking questions, and those responding to other comments:

**Editor Question** – Comments which explicitly ask a question of the author or editor of a resource.

**General Question** – Comments which ask a general question (of anyone).

**Response** – Comments which refer to other comments.

Many of the comments are very short (e.g. one clause), and so it is useful to identify the comments that contained content that was more than simply “Great work!” or “Thanks!”, as well as adding two more categories for particular comments of interest:

**Detail** – Comments which are longer than one sentence and have further information.

**Experience** – Comments which mention that the commenter has actually used it for teaching.

**Suggestion** – Comments which suggest how the resource could be improved or augmented.

From CAS Online, 20 resources were picked at random from those with at least one comment, leading to a total of 123 comments being categorised. For the Greenroom, 20 resources were similarly picked, with a total of 117 comments. For the Blueroom, only 12 resources had any comments, so these were all analysed, with a total of 79 comments.

The results are shown in Table 2. There is no major difference in the types of comments made on each site, except that the Greenroom sees some more detail and responses than the other sites.

None of the sampled resource feedback featured any negative comments. We do not investigate in this paper whether resources of low quality simply receive no comments rather than negative comments – forming a reliable metric for quality of resources is beyond the scope of this paper. For information, 41% of CAS

<sup>1</sup> We did not encounter any such comments during classification, but this category is included to clarify this fact.

Online resources have comments (mean average number of comments among those: 6.3), 51% of Greenroom resources (5.7) and 36% of Blueroom resources (6.6).

## 7. DISCUSSION

It is clear from a number of measures that the three sites see differing levels of participation, even accounting for the different numbers of users on each site. CAS Online has nearly double the number of users of the Greenroom, but in the first three months of 2013 it had more than ten times as many users participating in the discussions. In the given three month period, 27% of the members who accessed CAS Online made a contribution (via resources or discussions), compared to 12% in the Greenroom and 5% in the Blueroom. CAS Online thus noticeably outperforms the commonly held rule-of-thumb 10% participation rate [12].

As well as different amounts of discussion, the three sites see markedly different uses of the discussion (see Table 1). CAS Online had no programming questions in our classified sample. This was counter to our expectations: computing is effectively a new subject in the UK, and the biggest challenge that CAS currently faces is training up teachers in computing, with programming being a major part of the subject. Yet very few (if any) of the members are using the discussions to ask programming questions. This could be because they are seeking help elsewhere, or because they are hesitant to ask on the site. Instead, CAS Online saw many announcements and sharing of links and many discussions about teaching, which is surprising since CAS Online has the lowest proportion of educators. In line with expectations the Greenroom and Blueroom had many technical questions. Most of these related to issues with the software specifically, such as installation problems or reporting of bugs.

CAS Online also saw more sharing – it had more downloads per user than the other sites. This runs contrary to expectation, as CAS Online has the smallest proportion of educators of all three sites, and so the least proportion of users who require resources for teaching. Given the level of activity in the discussions, it could have been the case that CAS Online was mainly used for discussions – but the results show that resource sharing is also higher there. In fact, it seems that discussion activity and resource activity have the same ranking across the three sites. This could be considered a sign that the site design encourages holistic participation – throughout the site, or not at all.

The level of activity in the Blueroom is very low, with a smaller community, fewer resources and less discussion. Yet BlueJ, which is at the centre of the site, has 2.5 million unique users each year, compared to Greenfoot's 350,000. Many educators use BlueJ, but few are members of the site. Greenfoot has around one sixth of the users of BlueJ, but three times the number of members in the Greenroom. A possible explanation is the fact that BlueJ pre-dates the Blueroom by many years, so educators who are using it may already be experienced with it, and thus do not need much assistance. Another factor is likely to be the different mix of university lecturers and school teachers: The Blueroom, with a larger share of university instructors, has fewer members and less participation. It may be that university teachers are generally more independent and used to developing their own material, while school teachers have a more pronounced culture or need to use resources developed elsewhere. It is interesting that they also seem to be willing to share more often.

This situation is in stark contrast to the membership of Computing At School, who are undergoing a fast and turbulent transition into teaching computing, and so there are many members who lack

experience and expertise, and who need to get up to speed with computing in a short space of time.

This different culture between the Blueroom and CAS Online is also reflected in the resource-editing behaviour (see Figure 3). Particularly noticeable is that all the sampled Blueroom content edits were performed by the original creator of the resource. This suggests that the Blueroom resources form a disseminator model, where each resource is clearly owned and maintained by the original author. This is different to the pattern on the other two sites – on CAS Online, for instance, around a quarter of content edits were performed by members other than the original author.

The types of comments left for resources are shown in Table 2. The Greenroom has a different profile of comments, with more detailed comments, and more discussions (as indicated by the number of response comments), whereas the other sites tend to have shorter and more independent comments.

## 8. EXPERIENCES

Some observations from our experience of running the sites are worth noting. The launch of each site was preceded by a 1-2 week period where known members of the prospective community were invited to join and seed some content. We believe this helped to ensure a successful launch by not having a totally empty site.

We have received negative comments about some features of the site, particularly the walled garden aspect and the lack of content in the email notifications (which forces users to visit the site to see more). We believe that these features help to build the community in the long-term, even if it comes at a short-term cost to the users. However, it is very difficult to measure this benefit, or to measure how many users have been put off by the requirement to sign up.

We have fought to keep the design simple, both visually and technically. Preventing “feature creep” keeps the visual and conceptual design simple for users and helps to keep the maintenance overhead low. The flexibility of the site features has been shown in the analysis in this paper: different communities have put the site features to different uses in the three deployments.

Similarly, in our design and implementation we rejected any suggestion to add interoperability to other sites or frameworks – nor did we build or use ontologies, a semantic web, metadata schemas or complicated classification schemes for resources. Our opinion was that the conceptual and technical cost of including these would outweigh any benefit that they can convey.

The use of a custom site provides more flexibility than an off-the-shelf technology such as a mailing list. It has allowed us to develop purpose-built functionality to address our requirements.

CAS have a particular group ethic that involves decentralised, member-led grassroots participation [4]. This ethic is at odds with the research that Cambridge and Perez-Lopez [5] summarise as showing that “effective leadership and moderation is key to the success of online communities of practice in supporting [knowledge sharing and professional learning]” – a sentiment supported by Booth [3]. This has been a challenge for moderation – attempting to be effective yet invisible. A better strategy may be to “reinforce leadership roles organically” as Farooq et al. suggest [8].

## 9. RELATED WORK

There has been much work on face-to-face communities of practice (e.g. disciplinary commons [16]) in computer science education, and on online communities of practice [6][1] outside the education profession. Closer to our work, the Office of



Educational Technology provide a review of relevant advice for supporting online communities of practice for educators [13].

Schlager and Fusco [14] discuss eight “guideposts” for developing online communities of practice for educators and argue that the design of the technology should be based on an understanding of the community.

Booth [3] studied online communities of teachers (and provides an extensive literature review) and found that key factors in success were: “a clear purpose; a common identity; purposeful recruitment and promotion; an experienced moderator; a flexible community structure; and guidelines for participation”.

Hur and Brush [10] looked at reasons why teachers participate in online communities and suggested that greater emphasis is required on teacher's emotions and self-esteem. Akbar et al. [1] reported focus group opinions on the importance of community in digital library systems, a sentiment mirrored in the work by Shaffer et al. [15] on the AlgoViz portal.

## 10. CONCLUSIONS

The results show that the ColourRoom software has been successfully used by three different communities. We feel that this is evidence to support the “people, not artefacts” philosophy that we employed in the design of the site.

By deploying the same software to three different communities of computer science educators, we have been able to perform comparisons of behaviour across the three communities. The three sites see varying participation rates, even when user numbers are normalised. CAS Online sees more resource uploads, downloads and discussion posts per user than the Greenroom or Blueroom, and has done even before it had more users than those sites.

The differences are not just quantitative but also qualitative. The discussion facility is used in the Greenroom primarily for programming questions, in the Blueroom for technical questions (e.g. software support) and on CAS Online for announcements and teaching questions. The lack of programming questions on CAS Online is counter to our expectations and may reflect a lack of confidence by educators to ask such questions in the presence of a more mixed demographic that includes professional software developers – who have a disproportionately high contribution level in the discussions.

Resource editing also showed different behaviour between the three sites. The Blueroom had so few edits of other resources that the wiki-like functionality could probably be removed at little cost, but this was not the case for CAS Online and the Greenroom. We believe that the lack of negative feedback contributes to the high level of resource activity.

Our future work will involve continued development and adjustment of the sites. We will experiment to examine what brings the best quantity and quality of participation, and we will continue to try new features to see what produces the best results.

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