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cs4fn: A Flexible Model for Computer Science Outreach

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ABSTRACT
There are a variety of initiatives to attract secondary school students to computer science. cs4fn is one such project. It combines a magazine, website and live shows, telling stories about computer science in spirited and creative ways. Here we focus on the use of the magazine and, using sociolinguistic discourse analysis, we analyze comments from students and teachers to understand why they have requested (free) subscriptions to the magazine and how they plan to use it. Our analysis shows that both students and teachers are attracted to the flexibility that cs4fn provides, and use it in a variety of learning contexts. We find that the flexibility of the magazine makes it a valuable tool to engage students and teachers and that they use it to further enthuse others (i.e., other students and teachers). We suggest that cs4fn magazine is a powerful form of outreach and that this approach can be widely disseminated within computer science and other academic disciplines, raising the profile of computer science among students.

cs4fn is based at a UK university (Queen Mary, University of London); however, its combination of a free magazine, website, and a series of talks and lectures are used by other universities in the UK and abroad to support their own outreach. The magazine, which is the focus of this paper, is sent to individual subscribers and classrooms in more than 80 countries. Our early evaluation data suggests that the cs4fn project is meeting its aims of sparking interest in computer science [4]. Data from the website shows that the average number of pages viewed per visit is increasing [4]. An evaluation of the talks and lectures, found that this style of kinesthetic teaching approaches provide learning and engagement activities that are successful for a range of age groups and levels of achievement [5, 6].

In this paper we explore how students and teachers use cs4fn magazine and discuss how the magazine is considered useful by a range of teachers and students, including those in subjects other than computing-related courses. A key finding is that, by basing the material and stories on exciting research topics with the aim of enthusing our audience, we encourage flexible use of the materials. This allows us to meet our aims, whilst allowing our users to address their own needs and interests. In addition, while the magazine is not directly tied to the K-12 curriculum of any jurisdiction, it lends itself to use by teachers in fulfilling curriculum objectives.

2. CONTEXT AND RELATED WORK
There are many approaches to computer science engagement that emphasize raising interest in the subject. One way to do this is to run workshops or events either in university computing departments or at schools. For example, Doerschuk et al. describe programming workshops in which students have ‘cool’ tasks such as building robots [8]. Other projects allow others to recreate their workshops, such as CS Unplugged who make their materials available in several languages such as Mandarin as well as English [1]. Wahla et al. adopt another approach to enthusing students in computing, using technology-assisted scavenger hunts to introduce school children to sensory networks [11].

An alternative to workshops can be the development of curriculum material that teachers can use to increase students’ engagement whilst also fulfilling teaching requirements. For example, the Computing at Schools group (UK) and the US-based...
Computer Science Teachers Association aim to improve the curriculum while supporting teachers’ professional development. There are also organizations that offer workshops that are directly tied to the curriculum. Two examples of programs that use workshops based on kinesthetic activities to provide curriculum support are Google’s CS4HS program, which supports US computer science teachers through workshops [3], and the CS Inside project based in Scotland [7].

There are also a variety of approaches taken to enthusing students about computer science in order to improve recruitment at the university level. One commonality amongst large-scale campaigns is that many bolster motivation for taking the subject while also providing some support to teachers (e.g., CS Unplugged, Computing at Schools, and CS Inside). Workshops, away-days and teaching support provide excellent opportunities to participating students and schools. The cs4fn project proposes that it is also possible to increase motivation and support teachers through ‘take away resources’ such as magazines. The cs4fn approach makes the magazine a flexible resource that can support teachers and students to match their individual needs. The magazine format scales to audiences much larger than typical workshops (i.e., there are thousands of subscribers), which is an advantage. By sending out magazines to subscribers twice a year we have the opportunity to repeatedly re-ignite the interest of our readers.

3. MAGAZINE

cs4fn magazine is a professional quality magazine that is produced twice annually. Each issue is 20 pages in length and is printed on high quality, thick, glossy paper. All pages of the magazine contain graphics and vibrant colour alongside a distinctive font. Every issue has a main theme around which the articles are based, a short editorial note about the topic and an assortment of short, one-page, and two-page articles. We often choose themes to coincide with events. For example, the issue (14) in production at the time of writing is on Alan Turing and his work to coincide with the hundredth anniversary of his birth. Similarly, “Faces” (issue 13) matched the content we delivered at our stall at the Royal Society Summer Science Exhibition in summer 2011. This way we were able to give attendees copies of the magazine that matched the content that we displayed at the prestigious London science festival. We also attempt to maintain some variety in the themes: a very technical theme is likely to be followed by an interdisciplinary theme that relates more to the arts or social sciences.

In addition to the two regular issues published each year, we produce a third magazine, which we call an “annual”; a denser magazine that is usually three-times longer than the standard issues. Similar to standard issues, the annual usually has a theme around which we base our articles. The annual collates articles we published in earlier standard cs4fn issues on the topic as well as new articles written especially about the topic. Our most successful annual was 2010’s “The Women are Here” which focused on women’s historical and contemporary contributions to computer science [2]. We have also created other themed booklets, such as two magic books that support our magic of computer science shows [6].

Support for the production and distribution of the magazine currently comes from three main sources, each committed to improving recruitment into computer science. Base costs of printing and distribution are paid by a grant from EPSRC (Engineering and Physical Sciences Research Council) who also pay for staff time. Support from Google covers extra costs of printing and distribution, and our university provides support for additional overseas distribution as well as seed funding for new initiatives.

We do two types of mailing: the first is unsolicited mailings of new issues to teachers in the UK and the second is to those, including teachers, students and the general public, who have completed the webform to become subscribers to the free magazine. With regard to the unsolicited mailing, we send copies of the magazine to computing and ICT teachers in the UK based from a database of secondary schools in the UK that we developed. In addition to these teachers we also send copies of the magazine to teachers of other subjects that are relevant to a particular issue’s interdisciplinary focus. For example, we sent “Animation” (issue 11) to arts teachers as well as computing/ICT teachers.

4. METHODOLOGY

Our aim in the study discussed here was to gain insight about teachers’ and students’ use of the magazine as represented in the (optional) comments that they left in the online request form when they subscribed. The cs4fn team is multidisciplinary and one member is also a sociolinguist. Drawing from her skill set, we embarked on a qualitative sociolinguistic discourse analysis of the comments, and that is the data we present and discuss here. Discourse analysis is a branch of sociolinguistics that emphasizes the importance of “language use above and beyond the sentence” [10]. Of importance to discourse analysts is not merely what is said, but the context in which it occurs, including its meaning and effect [9]. Many discourse analysts adopt a somewhat functional approach to language, as we do here, which means that our analysis emphasizes the use of language rather than its form [10]. For instance, we are concerned with social aspects such as examining the diversity of speakers – including teachers and students, as well as regional differences – rather than purely linguistic issues such as the syntax of comments.

Discourse analysts typically use ‘naturally occurring’ conversations rather than scripted or invented examples. Our study uses naturally occurring comments that individuals left when requesting copies/subscriptions of cs4fn magazine. Almost all requests for copies of the magazine come via an online form on the cs4fn website. The form has textboxes for individuals to leave their name, address, status (e.g., profession), position (e.g., job title), the number of copies they request, and an additional optional text box for them to provide a comment. We ask on the form that people who request multiple copies use the space to inform us of how they will use/distribute the additional copies.

When individuals submit these online webforms they go to a cs4fn email address, which has three recipients (all are members of the cs4fn team). We received an average of 18 new requests per week (01 January 2008 – 01 March 2010). The numbers of requests vary from month to month, with an overall increase over time. Spikes in the number of requests can be noted soon after we post copies of new issues to schools twice annually, and when school is in session.

We uploaded all of the data collected during this 26-month period into a qualitative data software package (Atlas.ti); the total number of requests over this time period was 2055 and included five issues of the magazine. The issues in chronological order are: “Images”, “Space”, “The Environment”, “Mobile”, and “Animation”. Over this period the number of copies of the magazine we printed (and distributed) doubled from 11,000
copies of “Images” (issue 7) to 22,000 for “Mobile” (issue 10). Although the webform asks individuals to provide their name and address for mailing purposes, we did not upload that information when producing a data file. We included only: status, position, country, date and comment fields. We did not link the mailing list and the hermeneutic unit used to analyze the data.

Our qualitative discourse analysis approach meant that we coded the comments to note narratives in each comment. To this point, each comment could include multiple ‘discourses’, including a range of functions. Our coding process was iterative and we coded the data until we were satisfied that we had extracted meaning from each comment. While discourse analysis is a qualitative method, we also examined the demographic data pertaining to the numbers of requests from students and teachers.

4.1 Coding Scheme
We allowed the codes to emerge from the data, and did not assume that we knew what the speakers wished to convey in their statements. However, we also had specific research questions to guide our process. These included: how do users frame their requests and use of the magazine, and what if any patterns emerge in the responses in relation to the status or position magazine. In other words, we were interested in how users saw the magazine, their interest in the magazine or the interest of those who they wished to share it with, and if these points differed between the comments left by teachers and students.

4.1.1 Coding Status
In addition to the codes concerning the substantive matter of their comments, we also coded the status they provided in order to offer demographic data of the proportion of requests that came from students and teachers (as well as different types of teachers). Initially we coded only those statuses that were related to formal education contexts: students, teachers, librarians, and academicians. During this process we realized that “teacher” was too generic a classification and that individuals were often more descriptive than that in describing what subjects they taught. Many identified themselves specifically as “Computing” or “Information and Communication Technology” teachers, a small number classified themselves as “Home School” teachers. Therefore we recoded these teachers as “computing/ICT teachers”, “home teachers” and “other teachers”. The “other teachers” category includes those who answered with “teacher” as well as those who listed that they taught the following subjects: arts, careers/work experience, English as an additional language, multimedia, maths, physics, and science. We also included primary school teachers who teach subjects across the curriculum in this category.

Some individuals left the status textbox empty when requesting their subscription to cs4fn magazine. However, there were instances when an individual left this empty but in their comment referred to themselves as a student or teacher. There were also cases of respondents writing “teacher” in the status space but who expanded upon their status in their comment; for example, one teacher states “for use with my year 9 computing students” and another “for use in my home school”. Using a sociolinguistic discourse analysis perspective meant that we were able to classify those teachers as computing/ICT teachers and home teachers, respectively.

Of the 2055 requests for subscriptions to the magazine that we received during the time period, 1303 (63.41%) listed their status as a student or teacher. Our analysis focuses on these 1303 requests. Of those 846 (64.93%) were students and 457 (35.07%) were teachers (including computing/ICT teachers, home school teachers and other teachers).

While it may be intuitive that cs4fn magazine requests from teachers would be from computing/ICT teachers primarily, this is not the case in our data. Including requests from teachers who did not leave comments, we received 229 requests from computing/ICT teachers and 228 requests from other teachers (including the subset of seven home school teachers). It is possible that some ‘other teachers’ do teach computing/ICT but since they did not supply us with any information indicating this we include them in the category of ‘other teachers’.

4.1.2 Coding Comments
The comments we received covered a wide range of topics and because we approached the comments as ‘discourses’, we found a large number of codes (n=20), which we organized thematically. While each request could contain only one comment, some comments were coded more than once because the speakers made multiple points relevant to our analysis. In total we coded 1585 points within the 805 comments that people requesting the magazine supplied. However, not all 805 comments were from teachers or students: 546 were from those who listed their status as teachers (n=167) or students (n=379). A discussion of the 546 comments from students and teachers follows.

5. DISCUSSION
Although the comments students and teachers left when requesting magazine subscriptions cover a range of topics such that 20 codes emerged from the data, in this paper we concentrate specifically on those comments that fall under the remit of the use and impact of the magazine (approximately 1127 of 1587 codes, or 71%) in education and learning. The importance of flexibility intersects comments related to both use and impact of the magazine. New subscribers to the magazine, who may have received hard copies sent unsolicited to their schools or downloaded soft copies of the magazine, find that cs4fn magazine can be used for a range of purposes – including curriculum activities, which aid in communicating enthusiasm for computer science. In addition, diverse student and teacher audiences find the magazine useful to their needs.

5.1 Teachers and Students
The anticipated readers of cs4fn magazine consist of secondary school students and teachers, the audience discussed here, and 67.83% (n=546) of all comments received can be attributed to either students or teachers. While it is likely that there are many more requests from students and teachers who did not inform us – either in the status/position textboxes or in the comment that they left in the comment textbox – we focus only on those comments that can be attributed to either students or teachers.

5.1.1 Teachers
One common reason that teachers, particularly computing/ICT teachers, requested copies of the magazine was for class sets and/or classroom/laboratory copies. For example, an ICT teacher in the UK wrote, “I have received a few copies of your magazine over the past months and find it incredibly informative, interesting and useful, and would like to provide access to your magazine for our students in our ICT suites.” Providing copies of the magazine in computing labs means that any students interested in the subject may find the magazine and in turn become further sparked. It also allows students to be agents – the resource is there for them to pick up, should they wish. An alternative to this approach is to give copies to all students in a class. One computing/ICT teacher
in the UK explained their request for a class set in the following terms: “I would love to hand out copies to my A-level computing classes as well as having a copy in our school library. We do struggle to get numbers studying the subject and struggle even more to get girls.” One advantage to distributing class sets is that students who may not pick up a copy of the magazine left in a public, shared space such as a classroom or laboratory still have access to the magazine and its content.

5.1.1 Home school teachers
We had not considered the potential for cs4fn to reach home school students. However, a small number of home school teachers (n=7) visited our website and signed up for subscriptions to the magazine, showing the potential interest in computing resources among this community. In addition, it shows that the magazine is having a small but evident impact outside of traditional school environments. The home school teachers in our sample reported that they wanted copies for each of the children in their home schools as well as for themselves in order to teach the content of the magazine.

5.1.2 Students
While teachers often request multiple copies of the magazine as a classroom/laboratory resource or to distribute amongst their classes, students often request a single copy subscription to the magazine. In addition, many students report specific uses for the magazine, which is discussed in the next section “In Use”. When students request multiple copies of the magazine it is often to distribute them to friends.

International (to the UK) students in particular reference their social network in their comments, including in how they came to hear of the cs4fn project. Take, for example, this student from the Philippines who wrote, “A friend of mine who received this magazine in her school referred me to your site and told me good things about this cs4fn magazine. Because of that I would like to have two copies of the magazine. One for me and the other one is for my brother.” This student details how he found out about the magazine through his social network, and additionally requests an extra copy so that he can share cs4fn with a sibling. While students such as this one may not be requesting copies for formal distribution as teachers do, they detail how friendship circles among students further the reach of public engagement projects such as this one.

5.2 Uses
Students and teachers request copies of the magazine for diverse reasons, some of which we described above. While cs4fn does not create content specific to the computing/ICT curriculum, it appears to be a teaching resource among teachers in public/private schools and single/mixed sex schools, as well as amongst home school teachers. Purposes of the magazine given in the webform include: personal benefit, resource for teachers, enthusiastic others, interest and implied interest/benefit. Within these purposes we found variation in the comments indicating that those requesting copies of the magazine see the magazine as serving a function to them and their purposes. This diversity shows that cs4fn is versatile. Within the context of secondary school education, teachers left comments detailing use of the magazine in ways that both suit their teaching styles and can fit the needs of their pupils. For example, some teachers stated that they thought cs4fn would be particularly valuable in their gifted and talented student classes. Because cs4fn is based within a university and we use it in part to interest students in taking computer science at university, it reaffirms the project to have teachers of students who are advanced and likely thought to be on the university-track requesting copies. Yet, other teachers commented that they thought that the magazine would be useful for classes of students classified as ‘at risk’ as well as those who experience behavioural problems. The use of cs4fn in a variety of classrooms and a diverse set of students gives some evidence that public engagement with research can benefit all students, rather than only those students who are seen to be university-bound. Similarly, we have had requests from a small number of teachers working within the prison system who hoped that the magazine would help incarcerated persons to consider careers in computing following their release. While it may seem that in spreading enthusiasm for computer science that it is necessary to develop different tools for different target audiences, the responses that we have show that this is not the case. Rather, it is possible to create a single tool (such as cs4fn magazine) that teachers and students can use in ways that are useful and purposeful for them. It is especially encouraging that, as the comments we analyzed indicate, cs4fn is used to enthuse and inspire students with diverse educational needs. We intend to conduct further research to directly explore the impact of cs4fn on recruitment and with non-university-track groups.

5.2.1 Learning for Enjoyment
One of the uses of the magazine that emerged from the comments left by students is that of their own personal interest or pleasure. While the magazine contains some content that may be linked to their specific studies, many students explain their use of the magazine as personal. For example, a student in the UK wrote, “I am an enthusiastic ICT student and would like to find out lots about computer science. I really enjoy this subject and can’t wait to read the magazine.” Although their expressed aim was to learn, the student here framed their comment as learning for enjoyment rather than as a study aid. Another student from the UK made this point more explicitly: “I found cs4fn.org to be a motivating and inspiring site, and I would like to read more of the information as a hard copy. I am studying Computing for A-level, and am very interested in studying it further. I think that a copy of the magazine would add to my studies substantially, and add a bit of fun.” This same theme of computing/ICT students wanting subscriptions of the magazine for enjoyment is also evident in comments from other students, many of them international; for example, a student from Kenya: “I am a student doing a computer science course and this will help me so much to love my course and explore more” and a student from Indonesia, “I’m a student from Indonesia and very interested in anything about computers, I like to read and learn computer stuff.” While these are only a few examples of the hundreds of comments from students we analyzed, they indicate that students embrace this magazine that focuses on exposing the ‘fun’ of computer science.

Other students commented that they thought the magazine would be helpful for their courses in a general sense. For example, a student from the Philippines wrote, “I just want a large knowledge about my course.” This student hopes that the magazine will serve as some kind of supplementary study aid to the resources in their course. This student hopes to gain general relevant knowledge for their course through the magazine. To this end, cs4fn can be seen as aiding proactive students in their attempts to seek out information geared towards further engaging them with their subject.

5.2.2 Basis for Classroom Activity
Both teachers and students reported using the magazine for specific activities. For example a UK computer science teacher
wrote that the magazine would be useful for stimulating class discussion, “I teach programming and networking to high school students. My max class size is 20, so I will get them into groups of 3 and discuss a topic from the magazine in their group. Then summarise the article, even take a side if there is a side to take. Finally present it to the class.” Another computer science teacher wrote that the magazine would be useful in a reading comprehension section of the course because “your magazine is the only one I have found with articles relevant to today’s students.” The quotes from these teachers represent discourses expressed by many teachers: they want to use the magazine to help them with specific objectives in their courses. In these two examples, they intend to use the magazine to help their computing students to develop essential ‘soft skills’ such as the articulation of points, debate, and reading comprehension.

For teachers of other subjects, the activities they developed also tended towards classroom assignments tied to their teaching needs. For example an art teacher in the UK wrote, “I am new to the school and Y8 [eighth grade] are doing a project on animation. I think your magazine could be very useful for the students to give them ideas and starting points.” Here a teacher of a subject that can intersect computing plans to use the magazine to help them to master their projects. While this may not appear to be directly tied to increasing the profile of computer science, it does mean that students who might not otherwise engage with computing are given the opportunity, and that seed could lead to some students developing a passion for the subject. It is important that all students have a basic understanding of computing. Introducing it through the subjects students are already interested in is one way to accomplish this.

The thematic nature of each issue of cs4fn has meant that teachers can use the magazine for open-ended assignments. In addition, teachers report planning to share the magazine with their students in classroom exercises, giving students the opportunity to find articles in the magazine that interest them. This works as an alternative to a directed assignment through promoting flexibility for individual students. Teachers use cs4fn in the classroom and the analysis of their comments shows that they do so in ways that allows students to discover their own interests in the content and to explore computing perhaps more broadly than they would otherwise be able.

5.2.3 Deeper Knowledge for Computing Courses
While some students make general assertions about the usefulness of the magazine in providing knowledge for their courses, other student comments showed that they believed the magazine would help them gain specific types of knowledge and/or skills. Take for example a student from Sri Lanka who wrote, “I’m a computer networking student where I need to read lots of material for my student related assignments and projects and for this reason I believe cs4fn can help me.” Similarly a student from India commented, “I have read the linked articles of this magazine [on the website]. They are very interesting including problem solving and communication. Since I am a computer science student, I find it can help me a lot to understand many things including programming.” Students in the UK also requested subscriptions to help with specific elements of their studies. For example, one student wrote: “I would like a copy please. I am about to undertake my honours year doing computing and my project is going to focus on teaching children about programming. I am interested to see what is being done about the country to encourage children.” All three of the students quoted here offer explanations of how they see the magazine as fitting into their study, and their requests for the magazine are focused on gaining knowledge in specific areas, such as their projects, programming, or networks.

5.2.4 Interdisciplinarity
Many teachers commented on the interdisciplinary approach of cs4fn. In the magazine we stress the connections between computer science and other fields. Because of cs4fn’s attention to other disciplines and the ways in which computer scientists work with artists, biologists, psychologists and others, teachers write to us for copies to share with students of diverse subjects. A teacher in the UK wrote, “I think this will be of great interest to our computing, multimedia and art students.” This teacher is an example of one who wants to expose students in computing and other subjects to computer science topics. Other teachers explicitly state that they want to use the magazine to highlight the interdisciplinary nature of the real world. A teacher requesting copies of the magazine wrote, “additional issues would be an excellent resource for our students taking options in Year 9 who are interested in ICT and would benefit from seeing the links between ICT, science, art, and technology. This could enable them to make informed option choices based around areas of interest, links between subject areas, and would help them to understand their potential job opportunities.” Other teachers remarked on the possibility of using the magazine to create links across teaching curriculums. For example, an art teacher in the UK wrote, “I was happy to receive the pack and want to use animation to create links across the curriculum.” Some of the interdisciplinary elements of the magazine had been envisioned at the start. However, by making connections between computing and other fields in the magazine, especially through themed issues that intersect multiple areas, and by sending single unsolicited copies of themed issues of the magazine to teachers of other subjects we were able to engage more fully with teachers of other subjects. The fact that some of these teachers wrote to us requesting multiple copies would seem to underscore the value of interdisciplinary themes and the potential to enthuse or recruit students who may not be studying computing/ICT at secondary school.

6. Conclusion
In this paper we used a sociolinguistic discourse analysis to analyze comments people reporting to be students or teachers left when completing an online webform to become subscribers to the computer science educational magazine cs4fn. We examined comments made by 546 teachers (n=167) and students (n=379). Specific themes emerged from the data and these categories can be understood as reinforcing flexibility of the resource both in terms of attracting the attention of teachers and students outside of computer science and in how students and teachers use the magazine.

cs4fn magazine provides highly malleable computer science content that serves multiple educational audiences and most subscribers to the free magazine define themselves as students or teachers. This audience includes computing/ICT teachers; teachers of other subjects: arts, careers, English as an additional language, multimedia, maths, physics, and science; home school teachers; and students themselves. That a notable proportion of the number of teachers’ requests for subscriptions were from teachers of subjects other than ICT/computing shows that the magazine can be seen as a tool for promoting computer science both in and outside of computing/ICT classrooms. The ultimate student audience, reached directly via their own requests and indirectly through teacher requests, is diverse in age and
nationality and includes students across the spectrum, including gifted and talented students, standard classes, as well as students who are ‘at risk’ and those who are currently incarcerated.

Subscribers use the magazine in equally diverse ways to meet their own individual aims, ranging from personal interest to variety of self-directed and formal educational uses. When teachers request multiple copies, they report that they will: 1) give the magazine to other teachers in their department; 2) leave copies in their laboratories/classrooms or libraries for students to pick up on their own initiative; or 3) distribute to students in their classes. Meanwhile, students do not report requesting additional copies to give out in formal educational contexts (i.e., to give to fellow students in their classes). Instead, we find that students are likely to request a single copy of the magazine, or if they request multiple copies these additional copies are to give to friends or family members who share their interest in computing.

These findings show that by emphasizing enjoyable, interesting content in an accessible, lively style, within an attractice format, cs4fn offers students and teachers flexibility in its uses. While not targeted as a form of curriculum support, the analysis of comments shows that the magazine does support teachers and students alike as a way to give greater depth of understanding of syllabus topics across a variety of learning scenarios, where it can be linked to computer science courses and materials. In addition, both students and teachers offer comments supporting that the magazine can be a tool for developing intrinsic motivation in and passion for computer science, and they write about enthusing others rather than strictly teaching them. Comments demonstrate that public engagement efforts that focus on celebrating the subject can have a meaningful effect on students and teachers both inside the classroom and in sparking their intellectual curiosity.

The popularity of the magazine by computing/ICT teachers as well as those teaching other subjects is in part due to cs4fn’s interdisciplinary approach. However, it also goes some distance in demonstrating at least two major points: firstly, that teachers across subjects are interested in interdisciplinary computer science resources and secondly recruitment into computer science programs could be achieved via a variety of disciplines including the humanities, fine arts, and social sciences.

The success of cs4fn shows that there is room for flexible tools to ignite interest in computing. Content that can be used and adopted in different ways can provide students and teachers with material that appeals to a wide and diverse global audience. cs4fn shows that such flexible resources are a possibility. cs4fn’s public engagement approach is a powerful form of outreach, encouraging tens of thousands of readers to think about computer science in new ways, both directly and through supporting teachers.

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8. REFERENCES


