

Green Dolphin: an Educational Questions and Answers Website

by

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ABSTRACT

Questions and answers boards are popular among enterprises. A dedicated question and answer site called Piazza is in widespread use in the educational domain. We present the design of an educational Q & A system called Green Dolphin and report on a controlled study of its usage and impact in a graduate level Computer Science course. In particular, we implemented a delay in the publication of the instructor's answers to questions in order to encourage students to answer questions from their peers. We also implemented a technique to automatically identify "expert" students from their question asking and answering behaviors, and a point-based reward system for asking and answering questions. We compared Green Dolphin usage patterns with those of Piazza. We found that delaying instructor answers increased students' participation, the reward system motivated students, and students felt pride in being identified by Green Dolphin as experts.

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CHAPTER 1

INTRODUCTION

Question and answer sites are popular on the Internet. Question and answer websites are online crowd-sourcing communities for people to solicit answers. Many enterprises created question and answer boards to support their customers. Quora, Yahoo! Answer, Baidu Knows, Naver, and Stack Overflow have large numbers of visitors every year (Liu, et al., 2011). Yahoo Answer had more than 20 million users in the United States and 120 million outside the United States. Stack Overflow is an example of a successful and fast question and answer website. Seven million users visited Stack Overflow in August 2010 (Mamykina, Manoim, Mittal, Hripcsak, & Hartmann, 2011). Many users collected reputation points to enable them to advance to the level of a moderator. Users thought of the reputation system was a game to encourage them to visit and participate in the website. This popularity resulted in many researchers investigating and reporting their findings on question and answer site (Bouguessa, Dumoulin, & Wang, 2008; Hsieh & Counts, 2009; Liu, et al., 2011; Mamykina, Manoim, Mittal, Hripcsak, & Hartmann, 2011).

This system is applicable to education. Piazza is a popular question and answer site (Barr & Gunawardena, 2012). Piazza provides a question and answer service for a class. Many professors have used it to assist students. Students post questions and receive answers from students and lecturers. Students and teachers can discuss questions and answers. Thus, students can learn from classmates' and instructors' responses. Piazza benefits users as an educational

tool, but it has some room for improvement. For example, Piazza does not have gamification to motivate users like professional question and answer websites.

If users in Naver see experts' answer questions, they will not answer those questions (Nam, Ackerman, & Adamic, 2008). Therefore, experts' answers can decrease users' answers. Researchers have not solved this problem. We observed that this problem occurred in Piazza. If instructors, who are experts, answer questions, students, who are novices, will stop posting their answers. We built the educational question and answer website called Green Dolphin. We designed Green Dolphin to solve the problem of instructors' answers affecting students' answers. Green Dolphin had a delay feature to abate effects of experts' answering in an educational question and answer site. The delay feature consisted of four unique features. Green Dolphin had a minimal user interface design to show multiple perspectives. Green Dolphin delayed presenting instructors' and teacher assistants' answers. Moreover, it had a reward system for students' to read teachers' answers without delay. Green Dolphin could suggest student experts for other users to ask questions. However, we developed many research questions and hypotheses about benefits and users' satisfaction regarding features of Green Dolphin.

We conducted an experiment to test these hypotheses. The experiment had two phases, and ran for 8 week with 35 students participating. In the first phase, students used Piazza for 4 weeks, and then they answered surveys. In the second phase, the students used Green Dolphin for 4 weeks, and then they did surveys. We found that the delay feature increased the number of students' questions and answers. However, 50% of students were not satisfied with the delaying of teachers' answers. The reward system increased students' answers and questions. Students were proud to be identified as expert students by the system.

CHAPTER 2

BACKGROUND

2.1 Activity Theory

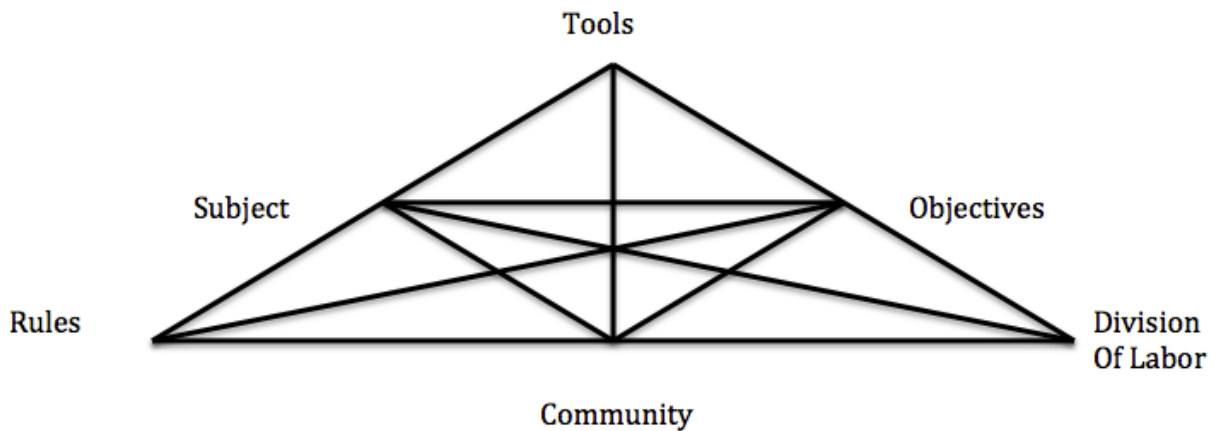


Figure 1 Yrjö Engeström Activity System Mode (Kaptelinin, 2013)

Activity Theory is a framework to analyze computer-supported collaborative learning tools or community (Bryant, Forte, & Bruckman, 2005; Kuutti, 1996; Resta & Laferrière, 2007). Activity Theory has 6 independent aspects (Kaptelinin, 2013).

1. Subject is an individual member of a community engaged in activities. Subjects of Green Dolphin are regular students, expert students, teaching assistants (TAs), and instructors.
2. Tools are artifacts used by subjects to accomplish their objectives. Green Dolphin is a tool for subjects to get their questions answered.

3. Objectives are subjects' goals in carrying out the activities. Regular students seek informative and accurate answers to their questions and to learn new knowledge. Expert students, besides seeking answers to questions they might have, also want to help novice students by answering their questions. TAs and instructors want students to learn.
4. Rules are laws and guidelines that mediate the interactions between subjects and the larger community. Green Dolphin, through its interface design, implements rules regarding asking and answering questions, commenting on answers, choosing an answer as the best answer, voting for good questions and answers, and earning points through participation.
5. Community is the group of people who participate in the collective activity. Green Dolphin has one community per course, consisting of registered students, TAs and instructors.
6. Division of labor explicates the relationship between the community and objectives in the model. Green Dolphin has roles for users: regular students, expert students, TAs and instructors. Though any user can ask a question, post an answer, vote an answer to be the best answer, post a comment and vote for high quality answers and comments, these roles implicitly encode a division of labor. Regular students ask more questions than provide answers. Expert students provide more answers than ask questions. TAs and instructors answer most of the questions, but rarely ask questions.

We used Activity Theory to understand users' requirements and their activities in Green Dolphin. An educational Q & A site must increase the flow of knowledge not only between students and TAs/instructors but also among students themselves. This is the key motivation behind crowdsourcing the task of answering student questions (Hickey, Langton, & Alterman, 2005).

A question and answer website increases the flow of knowledge among students and between students and instructors. Figure 2 illustrates the knowledge flow in Green Dolphin. Students gain knowledge from reading, asking, and answering questions. Students gain various perspectives from conversations as professionals do in professional question and answer websites. Student can learn from others' mistakes (Hickey, Langton, & Alterman, 2005). Students can practice communication skills from question and answer websites. Students have to explain their problems to other users in questions. Students have to answer questions or request more information from askers. Students have chances to practice problem-solving skills when they answer questions. They have to analyze and understand questions to find answers. Students can practice debugging skills and programming skills to provide solutions (Ahmadzadeh, Elliman, & Higgins, 2005). Thus, a question and answer board provides students' a variety of opportunities to gain more experience and sharpen their skills.

2.2 Knowledge Flow

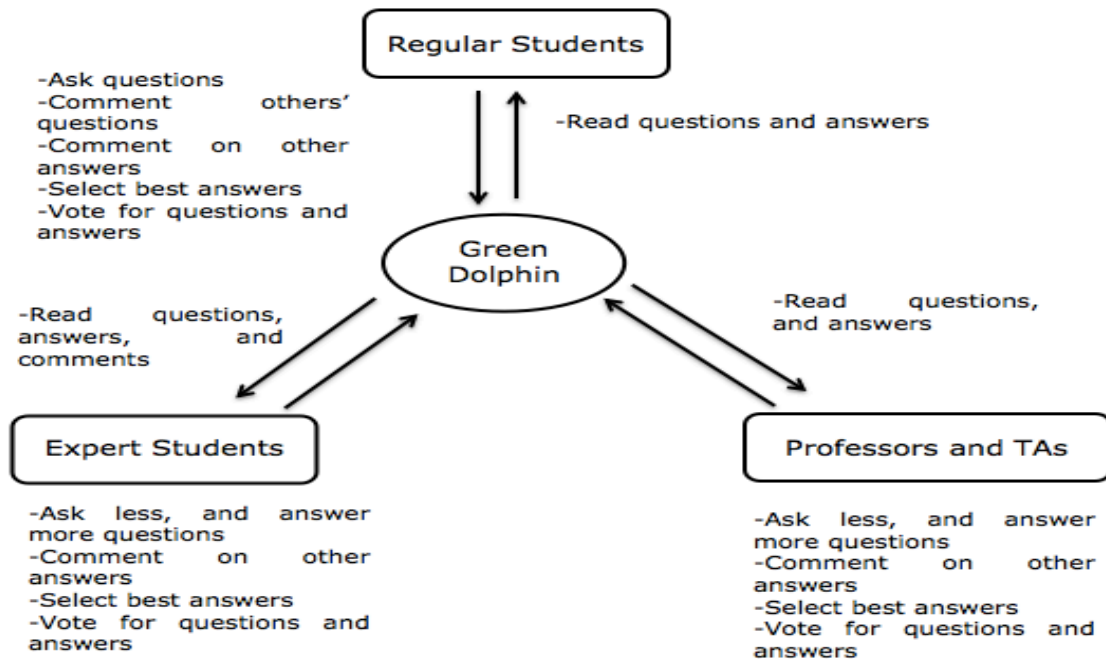


Figure 2 Knowledge Flow

2.3 Expert Identification

2.3.1 Expertise Network in Online Communities

Posts and replies can be represented as a directed graph that has the edge from a user who created an initial post to users who reply to the post. It reflects the shared interests between the poster and the repliers (Zhang, Ackerman , & Adamic , 2007). In a question and answer website a user answering a question is more expert than a user who asked the question. The community expertise network is distribution of expertise and the network of responses in such a web site. A question and answer site is an expert network because links in the network correlate with users' expertise (Bouguessa, Dumoulin, & Wang, 2008; Zhang, Ackerman , & Adamic , 2007).

2.3.2 Characterizing the Java Forum

The Java Forum expertise graph had 13,739 nodes and 55,761 edges. The graph had a bow tie structure that had four components, Core, In, Out, and 'Tendrils' and 'Tubes'. The 'Core' had users who usually help each other. The 'In' aspect had users that always asked questions. The 'Out' contained users that usually answered questions posted by users in the 'Core'. 'Tendrils' and 'Tubes' users did not interact with the Core. They answered questions asked by 'In' users, or their questions were answered by 'Out' users. Half of all users in Java were in 'In' or ask only questions, and about 13% of users answered questions or were 'Out' users. The 'Core' had 12.31% of users. The Java forum had more askers than users who answered questions (Zhang, Ackerman , & Adamic , 2007). However, the Java forum had users who answered a lot of questions. Its correlation plot showed that experts who had high degree nodes answered everyone's questions, but novice users who had low degree nodes did not answer experts' questions.

2.3.3 Expertise Ranking Algorithms

Researchers tested network-based ranking algorithms. They compared between simple statistical measures, Z-score measures, ExpertiseRank Algorithm, and HIT Authority. These are four ways of automatically identifying expert users, as reported in the literature. These simple statistics are based on how many questions and answers users posted and how many other users were helped by individual users. In the following paragraphs, we briefly describe several approaches to expert identification as discussed by Zhang, Ackerman and Adamic (2007).

2.3.3.1 Z-score Measures

Experts reply to a lot of questions, and novices ask a lot of questions. Therefore, Z-score of a user is calculated from the number of answers (a) and questions (q) posted by that user.

$$z = \frac{a - q}{\sqrt{a + q}}$$

Researchers calculate the z-score of a user (Z_{number}) and the number of other users that users answered and gained answers from (Z_{degree}).

2.3.3.2 ExpertiseRank Algorithm

ExpertiseRank Algorithm is like a PageRank algorithm, and it computes the Z number. It considers how many other people users assisted and whom they helped.

2.3.3.3 HITs Authority

HITs authority is similar to PageRank, but it assigns a hub score and authority score to each node in the expertise network. In this context, a good hub is a user who is assisted by many experts, and a good expert is a user supporting many good hubs.

2.3.4 Results

The researchers compared these various methods of expert ranking with human generated ranking. Raters generated a “gold standard” from randomly selected 124 users in the Java forum

for comparison. Researchers categorized users into top Java expert, Java professional, Java user, Java learner, and Newbie. A top Java expert knew the core Java theory and advanced topics. A Java professional could answer all Java concept questions, and knew some sub topics. A Java user knew advanced Java concepts and could program. A Java learner knew only basic concepts and could program. A newbie started learning Java. Two Java programming experts ranked 135 users' expertise. Researchers compared human ranking to all algorithms. The Z-score-based ranking produced better result than the other methods.

2.3.5 Network Model

Researchers created a network model from four rules to simulate the Java forum.

- The majority of users created few posts because they were new or had low expertise.
- Some experts usually answered and hardly asked questions.
- Users answered questions according to their expertise.
- Users joined the community randomly.

Under this model, Indegree and Z-score performed better than ExpertisRank and HITs.

The researchers then added one more rule to the model. Users, who have a little bit more expertise than question askers, have more ability to answer questions than users who have low expertise. Under this model, ExpertiseRank and Z_score had the highest performance, but HITs had the worst one. The researchers reported that based on these analyses, some simple measures were as good as complex algorithms (Zhang, Ackerman , & Adamic , 2007). Based on these results, we chose to use the Z-score as the means to identify student experts in Green Dolphin.

In the following sections, we discuss several educational tools that support collaboration and question answering. These tools and their features were reviewed prior to the design of Green Dolphin.

2.4 Educational Tools

2.4.1 HelpMeOut

HelpMeOut is a crowdsourced recommender system inside a programming development environments (IDE) to assist users to debug from peers' suggestions. Novice programmers have problems in understanding errors and need additional information, but people are good at solving problems by analogy. Showing examples of how to fix problems produces analogical problem solving (Hartmann, MacDougall, Brandt, & Klemmer, 2010).

HelpMeOut consists of four elements.

- A component tracks code version and gathers changes of code before and after fixing errors.
- A database contains solutions and the most related examples can be retrieved.
- A user interface suggests to users a list of solutions with its errors. The user interface also assists a user to apply a fix to a code.
- A web interface for experts collects experts' explanations of fixes.

2.4.1.2 Scenario

A student compiles his code, and an IDE displays an error message. HelpMeOut can detect compilation and run time errors. He consults HelpMeOut, and HelpMeOut provides a list of suggestions. He selects the first one and clicks at "copy fix button". HelpMeOut modifies his code to eliminate an error. He thinks that this explanation of the suggestion is useful, so he clicks the "vote up" link. Experts visit the HelpMeOut website to select a fix that is frequently queried from a list and write explanations of an errors.

2.4.1.3 Results

Researchers conducted an experiment in two three-hour workshops. All students were novices. HelpMeOut used code and error messages to find solutions and suggest those to users.

HelpMeOut returned 247 queries to students, and 229 queries (84%) had at least one suggestion, so HelpMeOut covered common errors in a couple of hours. Compiler errors were 238, and runtime errors were 36. Students created 101 fixes, but HelpMeOut reused them to help other users. In the experiment, students voted 48% of queries to be useful, 25% of queries were not useful, and 23% of queries did not have users' votes (Hartmann, MacDougall, Brandt, & Klemmer, 2010). However, HelpMeOut could not create useful suggestions of "miscellaneous" punctuation syntax errors because the errors caused many different error messages in various locations in code. Moreover, some queries did not return useful suggestions. Researchers believed that HelpMeOut could assist users to learn how to program.

2.4.2 Stench Blossom

Stench Blossom assists programmers to detect code smells. Novices cannot identify smells as well as professional programmers, but some experts have problems in finding smells too. Stench Blossom has three views (Murphy-Hill & Black, 2010).

- Ambient View displayed an indication of the strength of smells in code while a programmer was coding.
- Active View presented names of displayed smells.
- Explanation View gave more detail about a smell.

Stench Blossom is an eclipse plug-in to detect code smell. It detects code smell and shows detected code smell in Ambient View or using a circular icon design. If code smell is obvious, the circular icon will point down. If code smell is not obvious, the circular icon will point up. Each direction on the icon is divided by a gradient between blue and orange. Blue is the most obvious code smell, while orange is the least obvious code smell. Users can put a mouse over a circular shape to view Active View or more code smell information. If users click on the icon, Stench Blossom will display Explanation View or a construction guide to refactor the code.

2.4.2.1 Results

Six graduate students and six professional Java developers used Stench Blossom. Researchers divided users into four groups. Two groups did tasks without Stench Blossom, and then completed tasks using Stench Blossom. However, the other two groups used Stench Blossom first, and then did tasks without it. Stench Blossom found more smells than humans ($p=0.003$, $df=11$, $z=2.98$). Stench Blossom could identify smells that subject could find, and found some smells that subjects could not. In addition, smells were subjective because users had their own definitions for each smells. Users felt more confidence when they used Stench Blossom than when they did not use it. Ten out of 12 users said that the plug-in could increase their confidence to refactor their code, and 11 out of 12 said that Stench Blossom supported their decision. Subjects felt that code smell detectors were important (Murphy-Hill & Black, 2010).

2.4.3 Collabode

Collabode is web-based Java integrated development environment. Researchers developed the user interface of Collabode using HTML and Java, so users can use this IDE in a browser. Collabode uses Eclipse on the server side to manage a project and integrate the IDE functions. Collabode uses EtherPad for collaborative programming. Users can edit a code in nearly real time in Collabode, and this software supports three models (Goldman, Little, & Miller, 2011).

Micro-outsourcing is the first model. Programmers divide the project into small tasks and distribute them to members. Programmers make small contributions to the project, and a programmer puts all code together. The second model is test-drive pair programming. Two programmers work on the same code. A programmer dose programming, and the other tests the code. Collabode implements continuous testing, so a tester is able to test a code without

interruption from development. Mobile instructor is the last model. Teachers use Collabode in a class, so they can monitor students' code without interrupting students.

2.5 Educational Collaboration Tools

2.5.1 Google Wave (Wave in a Box)

Google created Google Wave in 2009. Google handed over Google Wave to Apache Software Foundation in 2010, and changed its name to Wave in a Box. Google Wave is a real-time collaborative editing online editor. It has an inbox similar to an email, and users can add other users to collaboratively edit or reply to a message. Google Wave displays every user's actions in real-time, so users can see other users editing content. Users can view version of a message by scrolling the history scroll bar on the top of the message. However, Google Wave has features similar to Google Documents in which users can also edit a document collaboratively, so Google stopped developing Google Wave in 2010.

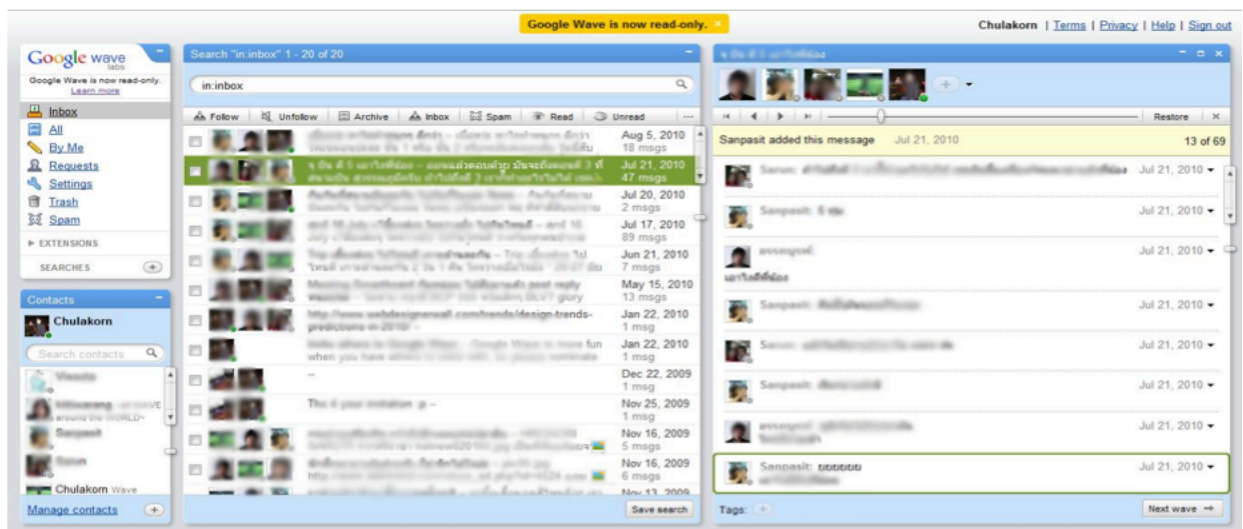


Figure 3 The user interface of Google Wave in 2010

2.5.2 Canvas

Canvas is an online class management system. Instructors can use Canvas to announce news, collect homework, share files, and track students' scores. Canvas has three user roles, an

instructor, a teacher assistant, and a student. It also has a calendar for users to track their activities in a class. Canvas provides a message system, a chat room, a collaborative editing system, and a discussion board for communication. The message system is similar to an email. Users can send messages to a user or a group of users. It has an inbox, which has all messages on the left and content of message on the right. Users are able to use a chat room to chat or have a videoconference with classmates. In addition, users edit a document together in a collaborative editing system, which is like Google Wave. Canvas has a discussion board, so users can post messages or questions in it to discuss with other users.

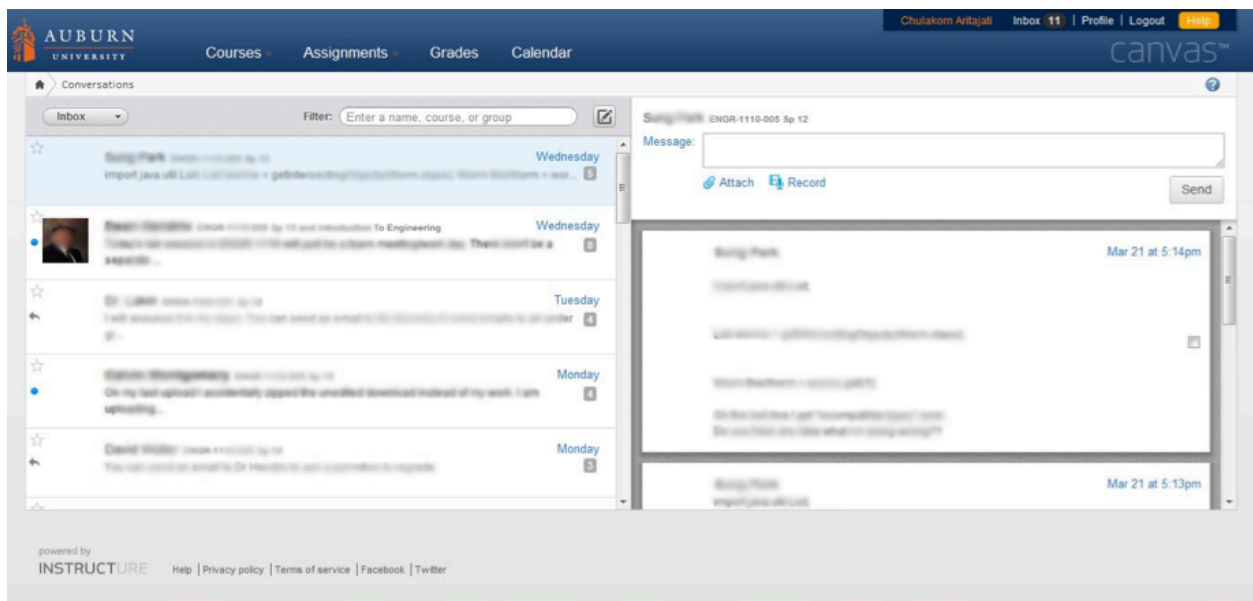


Figure 4 A message system of Canvas

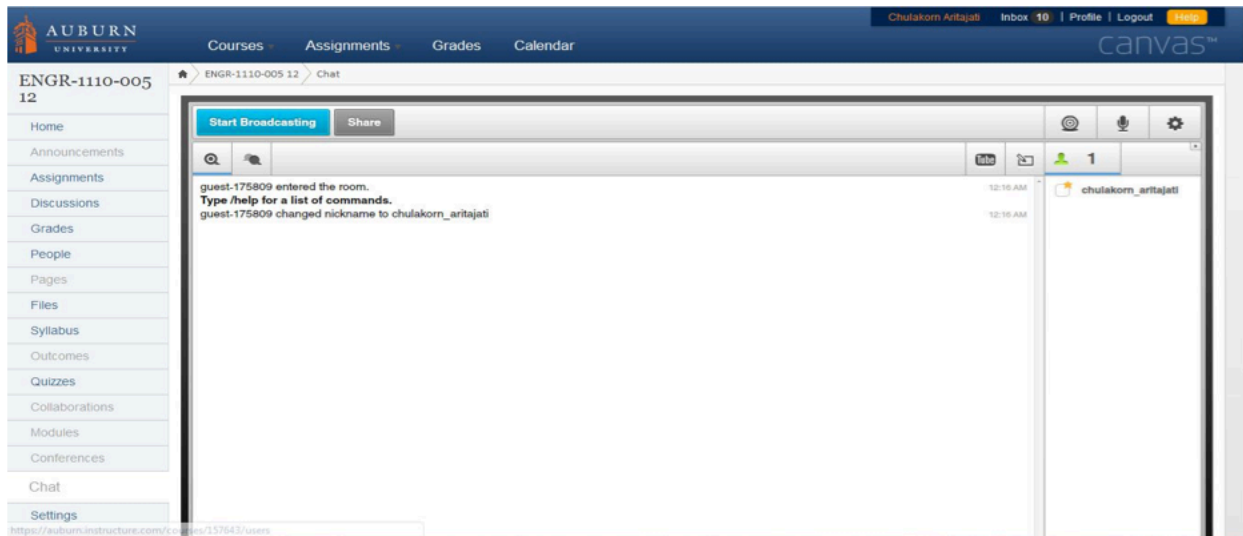


Figure 5 A chat room of Canvas

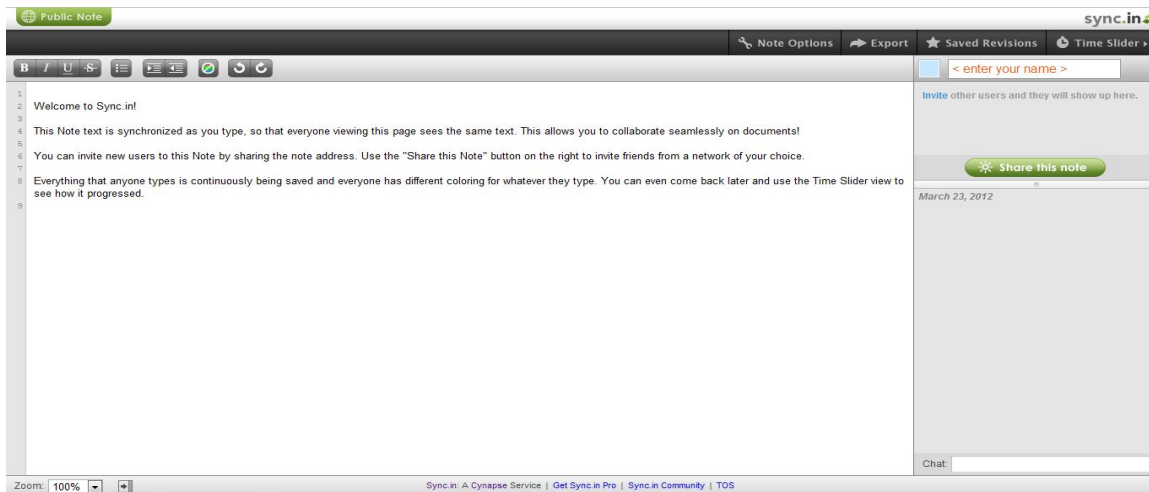


Figure 6 A collaborative editing document of Canvas

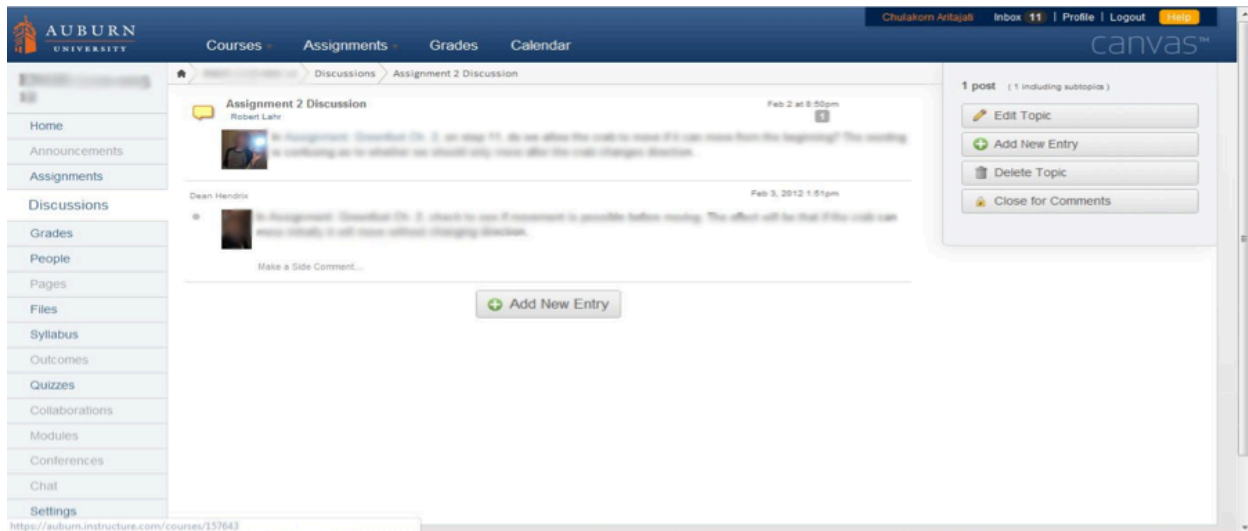


Figure 7 A discussion board of Canvas

2.5.3 Coursekit (Lore)

Coursekit is a course management system and a toolkit for courses. Coursekit has two user roles, an instructor and a student. It has a calendar and a list of events for users to track activities in a course. Users can share a note, a link, a photo, or media in Coursekit. Users can have discuss about a post or add tags to it. They are able to pin a message. Coursekit has a chat for users to communicate with each other. Coursekit is a competitor of Canvas. However, Coursekit was changed to Lore in 2012, and Lore focuses on supporting an educational community to share and gain knowledge. Users post information or share documents in Lore. Users can participate in discussions about a post that appear under each post. Therefore, Lore is similar to Piazza, which is discussed later in this document.

PDDN-1000 - Edwin Land, Steve Jobs - University of Pennsylvania Edwin Land | LOG OUT

Product Design

STREAM CALENDAR RESOURCES SYLLABUS PEOPLE SUBMISSIONS GRADEBOOK SETTINGS

Prototyping 10:00am - 12:00pm **4/4** Product Architecture 10:00am - 12:00pm **4/11** Faculty Project Consulting 10:00am - 12:00pm **4/18** [More](#)

POST: [NOTE](#) [LINK](#) [MEDIA](#) [FILE](#) [QUESTION](#) [BLOG](#)

Note

Nov 29 **Charles Eames** 12:37pm Like 2 Comment 5 Delete

The details are not details. They make the product. The connections, the connections, the connections. It will in the end be these details that give the product its life.

Edwin Land commented Nov 29 12:46pm
Thanks for posting Charles. I agree. It's all about how people experience it.

[Tags: Product Planning](#)

Dieter Rams 10:57am Liked 5 Comment 2 Delete

Wanted to share progress on my project. I've come up with 9 principles that I believe constitute good design: is innovative, makes a product useful, is aesthetic, makes a product understandable, is unobtrusive, is honest, is long-lasting, is thorough...

[Read more](#)

[Tags: Industrial Design](#)

Aug 24 **Edwin Land** 4:12am Like 3 Comment 2 Delete Pin Post

Before the course starts, please check out this video for some background on what I am passionate about... [Read more](#)

Note X

Charles Eames
Nov 29 12:37pm Like

The details are not details. They make the product. The connections, the connections, the connections. It will in the end be these details that give the product its life.

Likes (2)

Comments (5)

Edwin Land Nov 29 12:46pm Delete

Thanks for posting Charles. I agree. It's all about how people experience it.

Anna Wintour Nov 29 12:55pm Delete

Needs to be identifiable to others

Ben Franklin Nov 29 12:58pm Delete

Very deep Charles

Steve Wozniak Nov 29 1:04pm Delete

Love this Charles. Would love to share this but 171 characters isn't going to cut it...

Jack Dorsey Nov 29 1:05pm Delete

Figure 8 The user interface of Coursekit

Create course [Log in](#)

Intermediate Microeconomics

Northwestern University · Instructors: jeff ely, Davide Cianciaruso, Arkadiusz Szydowski

Search

Discussion

Calendar

People

Library

Syllabus

Davide Cianciaruso posted 6 months ago

This is the points distribution for the final exam:

25.00%	35.5
50.00%	44
75.00%	55.25
mean	44.75

jeff ely posted 6 months ago

Hi Everyone, I hope the final exam didn't ruin your day. Thanks for a great quarter. Hope to see you again in the future.

3 LIKES

Devashish Singal posted 6 months ago

Is the final going to take place in Annenberg G15?

Arkadiusz Szydowski

Yes.

[Fall_exam_schedule.pdf](#)

Upcoming events

There are no upcoming events.

[View course calendar](#)

Figure 9 The user interface of Lore

2.5.4 Salon Classroom

Salon Classroom is a collaborative online editor (Barr & Gunawardena, 2012) for education. It has two roles, an instructor, and a student. Instructors create documents, and students can highlight text to write comments about that text. Salon Classroom displays users' performance and statistics. Users can support a comment by clicking a "useful" button. Salon Classroom also has users' profiles and presents a user's activities feed.

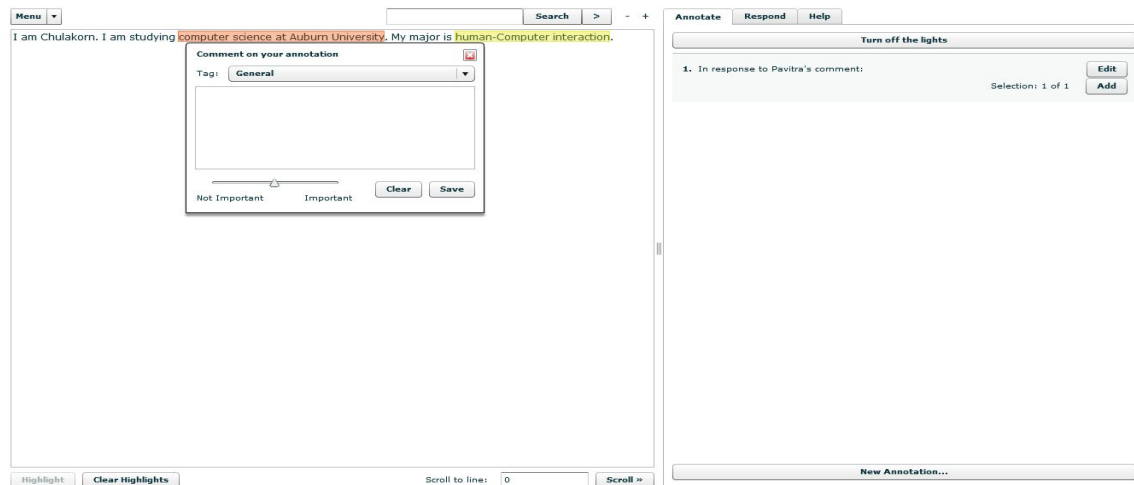


Figure 10 A student can annotate his information in a document.

2.5.5 Piazza

Piazza is an educational question and answer system. The user interface of Piazza is akin to Google Wave. Piazza displays all messages on the left side of the screen and a question that a user selects to view on the right. Piazza provides the history scroll bar, which is similar to the one in Google Wave, for users to view the history of users' activities in a question. Piazza has two user roles, an instructor, and a student. It focuses on supporting instructors to save their time managing courses. Instructor can share information or document. Users can post a note or question in Piazza. Piazza displays only the newest student's answer and the instructor's answer in each question. Moreover, users can have a discussion about a question. If an instructor saw a

correct student’s answer, he can endorse it. Piazza provides various statistics on user performance.

The following table lists features found in various collaborative and question and answer systems, and provides a comparison of the various systems discussed above in terms of these features.

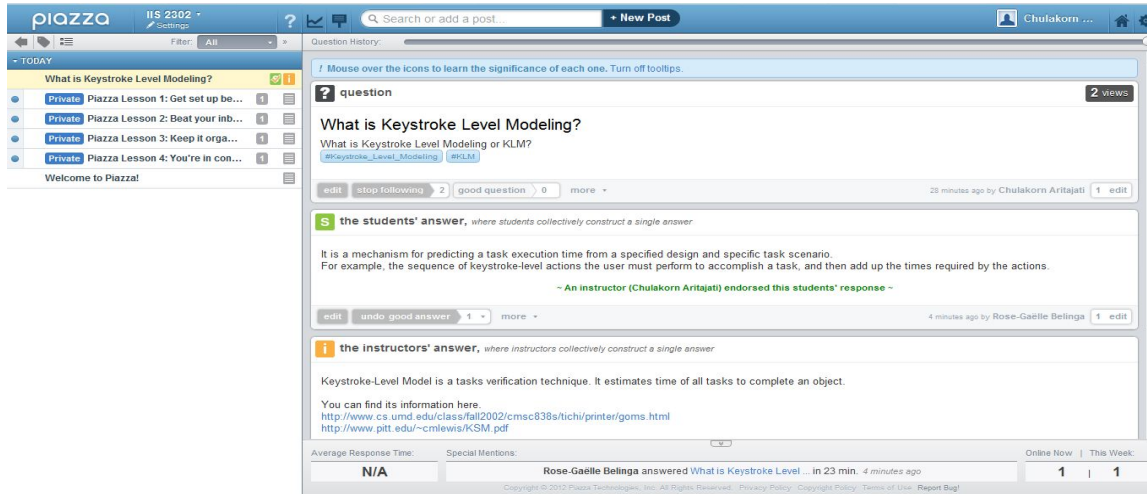


Figure 11 The user interface of Piazza

	Piazza	Google Wave	Salon Classroom	Canvas	Coursekit
Feed	Yes	Yes	Yes	Yes	Yes
Question	Yes	Yes	Yes	Yes	Yes
Note	Yes	Yes	Yes	Yes	Yes
Poll	Yes	Yes	No	No	Yes
Anonymous	Yes	No	No	No	No
Private	Yes	Yes	Yes	Yes	No
Tags	Yes	No	Yes	No	Yes
Add Instructors/Ts	Yes	Add Friends	Yes	Yes	Yes
Add Students	Yes	Add Friends	Yes	Yes	Yes
Facebook Connect	Yes	No	No	Cannot log in	No

Hyper link between post	Yes	No	No	No	No
History	Yes	Yes	Yes	No	No
Math Format	Yes	No	No	No	No
HTML		Text editor	Text editor	Text editor	No
Tags inline	Yes	No	No	No	No
Embedding image	Yes	Yes	Yes	Yes	Yes
LaTeX Support	Yes	No	No	No	No
Code Block	Yes	No	No	No	No
Referencing Other Posts	Yes	No	No	No	No
Tables		No	No	Text editor	No
Links	Yes	Yes	No	Yes	Yes
Search	Yes	Yes	Yes	No	No
Pin	Yes	Yes	No	No	No
Classes	Yes	No	Yes	Yes	Yes
Profiles	Yes	Yes	Yes	Yes	Yes
Notifications	Yes	Yes	Yes	Yes	Yes
Comments	Yes	Yes	Yes	Yes	Yes
Inbox	No	Yes	No	Yes	No
Chat	No	No	No	Yes	Yes
Sharing Document	No	Yes	Yes	Yes	No
Statistics	Yes	No	Yes	No	No

Table 1 Comparison of educational collaboration tools

2.6 Question and Answer Websites

Now we discuss several general purpose questions and answer websites. Many researchers found that 60% to 90% of questions in a general purpose question and answer website received answers.

Users in question and answer sites have two types of motivation to participate in websites (Mamykina, Manoim, Mittal, Hripcsak, & Hartmann, 2011).

1. Intrinsic value: users would like to help others learn new knowledge.
2. Extrinsic value: users would like to gain reward or reputation.

2.6.1 Stack Overflow

Stack Overflow is a question and answer site for programmers. All questions in Stack Overflow are related to programming and computer science. Stack Overflow displays all questions in the question feed. A question can have many tags. Users can search questions or select a tag to see all questions with that tag. Stack Overflow has a point system and a badge system. Users can gain points from other users voting up on their questions or answers. A question owner can select the best answer, and the user who provides the best answer gains points. Users need to collect points to obtain privileges of a moderator, so users who have many points can make various types of contributions. Stack Overflow promotes a user who has earned a high number of points to be a moderator. Users can give points to other users who answer their question. They are able to vote up or down on a question and an answer. Stack Overflow provides syntax highlighting for code, so a programmer can post their source code in a highly readable format.

Question and answer websites have three types of questions, according to some researchers (Mamykina, Manoim, Mittal, Hripcsak, & Hartmann, 2011).

1. Factual: users seek objective data.

2. Advice: users seek recommendation.
3. Opinion: users seek others' feedback.
4. Non-question: a question that is actually spam.

Stack Overflow shows excellent performance. More than seven million users visited Stack Overflow in August 2010. Users answered 92.6% of questions in Stack Overflow, and 63.4% of questions had more than one answers. The median time for a question to receive the first answer was 11 minute. Users posted most of their answers in the first few hours after questions were posted. Its reputation system helped generate fast and high quality answers to user questions. Stack Overflow succeeded because of its design and daily involvement of the design team (Mamykina, Manoim, Mittal, Hripcsak, & Hartmann, 2011).

Successful aspects of Stack Overflow are the following:

- Stack Overflow made competition productive. Its reputation mechanism created a competitive environment to encourage users to participate in the site and sustain their long-term contributions.
- The founder has credibility in the community. Users trusted and believed in the founder's vision.
- Stack Overflow has an evolutionary design approach. Developers continue to improve Stack Overflow carefully through ongoing iterations.

Stack Overflow uses extrinsic value to motivation users to encourage to participate in the website and relied on users as moderators. Stack Overflow uses users' voting, editing, and moderating actions for its moderation of knowledge flow (Stack Overflow). About one quarter of the users have not made any contribution on the site, but 48.5% of users have answered questions. However, infrequent users have asked fewer questions than answers, and frequent users had more questions than answers. Stack Overflow had four types of users (Mamykina, Manoim, Mittal, Hripcsak, & Hartmann, 2011).

The screenshot displays the Stack Overflow homepage. At the top, there is a navigation bar with the Stack Overflow logo, a search bar, and links for 'Questions', 'Tags', 'Users', 'Badges', 'Unanswered', and 'Ask Question'. Below the navigation bar, the 'Top Questions' section is visible, featuring a list of questions with their respective vote counts, answer counts, view counts, and tags. The questions include: 'How do I call a non static method from a main method?', 'Android : getSupportLoaderManager().getLoader(id) doesn't return previously used loader', 'What is the current situation with @NotNull annotations in Java?', 'Regex join elements if directly next to each other', 'URL decoding inside AWK', 'PHP \$_POST empty when passing data through Android', 'Prevent/Cancel closing of primary stage in JavaFX 2.2', 'Why JVM keeps loading the same (GUI) classes again and again with every instantiation?', and 'Android: Show image inside WebView glitchy double tap & button zoom'. On the right side, there is a 'Favorite Tags' section with a list of tags and their counts, such as 'java' (65), 'c#' (60), 'python' (52), 'javascript' (51), 'php' (42), 'c++' (41), 'jquery' (36), 'android' (32), 'c' (24), 'mysql' (24), 'html' (23), 'css' (23), 'sql' (19), 'ios' (13), 'regex' (11), 'arrays' (11), 'multithreading' (11), 'linux' (10), 'swing' (10), 'asp.net' (9), 'node.js' (9), 'ajax' (9), 'winforms' (8), and 'haskell' (8).

Figure 12 The user interface of Stack Overflow

- Community Activists: Users who have high activities for several months.
 - Shooting Stars: Users who have high activities for a short period of time, and then they have low activities.
 - Low-Profile Users: Users who have a medium level of activity.
 - Lurkers or Visitors: Users who have not asked or answered a question.
- Users generally did not answer four types of questions.
- Questions related to technologies that have few users.

- Questions that were boring.
- Questions about issues that were hard to solve.
- Questions that did not have obvious answers and created discussion.

The voting mechanism assisted users in identifying correct answers fast. Users said that they visited Stack Overflow often because they were addicted to the reputation system. The point system encourages users to be proactive in participating effectively. However, Stack Overflow was not friendly for new users. It was successful because the communities purposed and adhered to obvious topic boundaries, had commitment to the project, and made contributions.

2.6.2 Quora

Quora is another question and answer system. It uses points as currency. Users used to have to pay points to ask a question, but Quora recently changed this rule. Now users do not have to spend points to ask a question (Quora). They gain or lose points from other users' voting on their questions or answers. Users have to spend points to use special features, such as asking an expert or promoting their questions. Users can vote up or down on a question or an answer. Users are able to create topics or follow interesting topics or questions. The information feed of Quora displays questions from users' interest topic and their friends' activities. Therefore, Quora has a social network style interface. Users have their profiles that display their demographics and activities in Quora. They can search questions and topics. A question can be in on any topics.

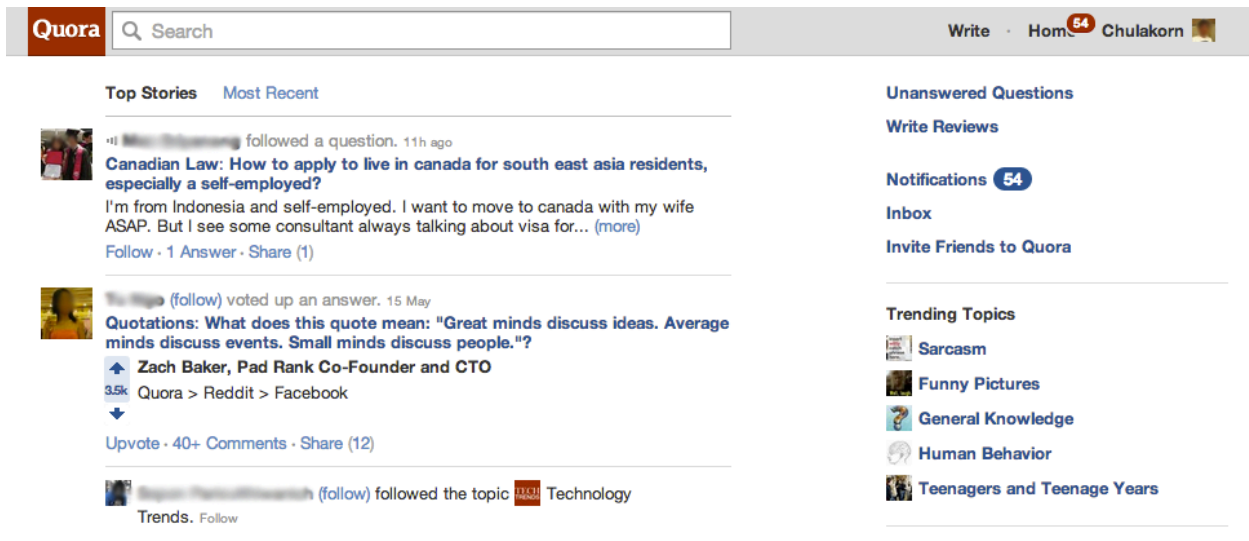


Figure 13 The user interface of Quora

2.6.3 Yahoo Answer

Yahoo Answer is a popular question and answer site. It has many categories of questions. Users answered 88.2% of questions in Yahoo Answer (Mamykina, Manoim, Mittal, Hripesak, & Hartmann, 2011). Yahoo Answer uses points as currency. Users have initial points to ask questions, and gain points from answering questions or from other users' votes. They can also support an answer by voting it up. A question owner can select the best answer, and the user who answers the best answer gains points. Yahoo Answer ranks users from level one to seven, and users in higher levels have more system features available to them for contribution than users who are in lower ranks (Yahoo! Inc.). Users can browse through categories or search questions. Yahoo Answer has users' profiles that display users' statistics.

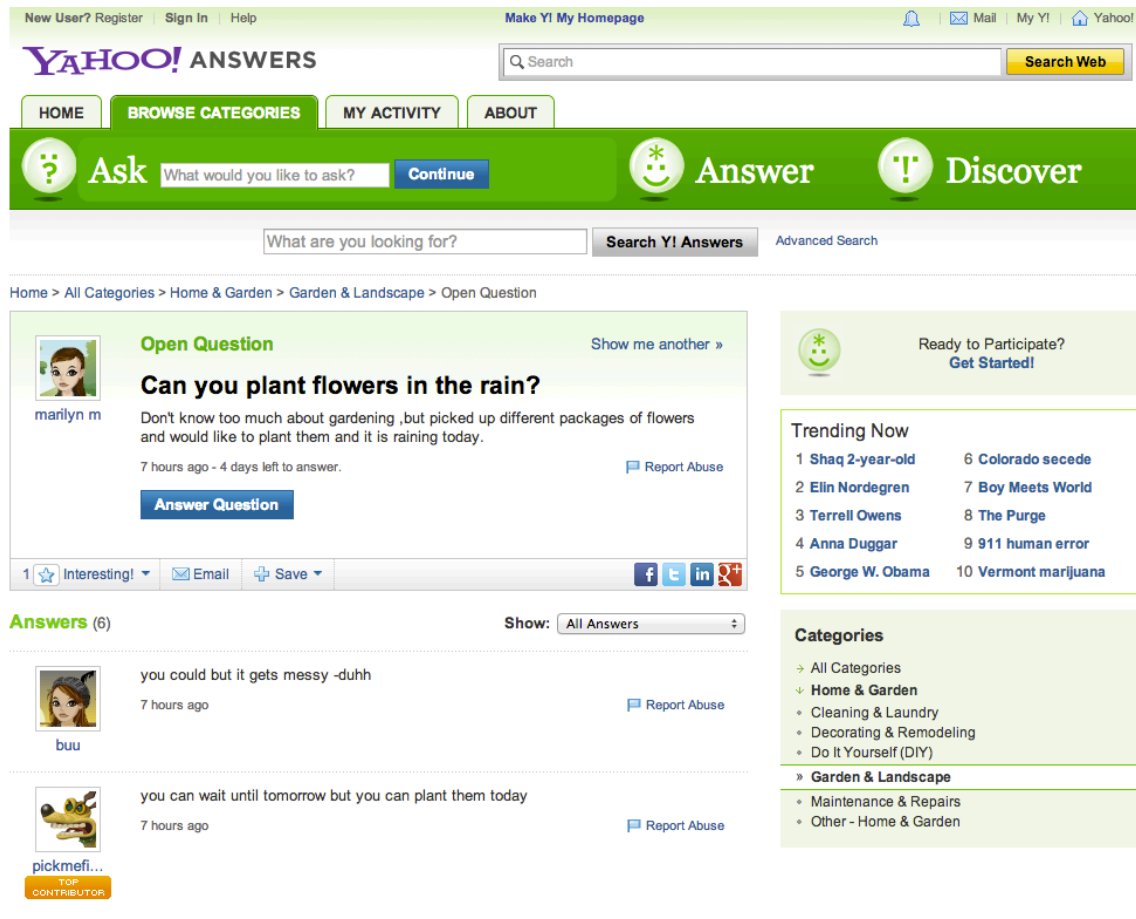


Figure 14 The user interface of Yahoo Answer

2.6.4 Naver Knowledge-iN (KiN)

The main page of this question and answer site displays the popular questions, questions without answers, and questions that need the asker to select an answer. Users can browse questions by categories or search questions. Users can comment questions or answers. Users answer 66% of questions in KiN. KiN has a point system. If users answer a question, or question owners selected the users' answers, they will get points (Nam, Ackerman, & Adamic, 2008). Users can give points to other users who answer their questions. So users are likely to answer questions that give a high reward. Users generally set the reward based on how much they need the answers. Users in KiN tend to answer question fast to gain more points. KiN has 5 types of questions (Nam, Ackerman, & Adamic, 2008):

- Factual questions
- Procedural questions
- Opinion oriented questions
- Task oriented questions
- Advice

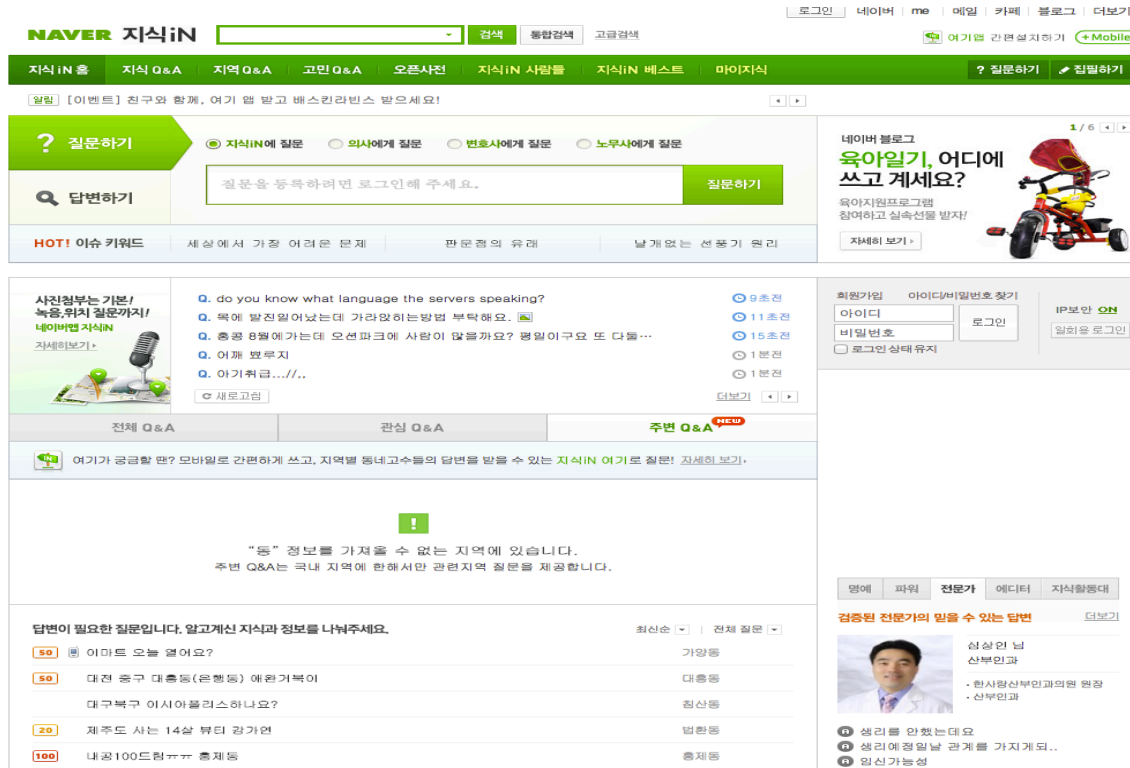


Figure 15 The user interface of KiN

Top users competed for the best answer. Researchers report that users in KiN had multiple motivations: they wished to help people, to learn and revise knowledge, to collect points in the system, to do business purpose, and as a hobby (Nam, Ackerman, & Adamic, 2008).

1. Altruism: Many users would like to help other people by answering questions. This motivation is common in an online community.
2. Education: Users want to gain or revise knowledge from answering questions.
3. Points: The point system in professional website encourages users to participate the site to gain point rewards in short and long term. The system provides a venue for friendly

competition among users in online community, and their points represent their reputation in their community. Some people think that it is a game and become addicted to it (Mamykina, Manoim, Mittal, Hripcsak, & Hartmann, 2011; Nam, Ackerman, & Adamic, 2008).

4. Business motivation: Their reputation in the online community can promote users' business and help them obtain new clients, especially in the medical and finance fields.
5. Hobby: Users in this category were initially motivated by one of the other motivations, but after they used the website for while their online activities developed into their hobby. Such users would participate in a site consistently.

Nevertheless, users in KiN lacked a sense of community. They posted and answered questions, but they did not engage in other social interactions. KiN has three successful features (Nam, Ackerman, & Adamic, 2008).

1. Users could quickly view questions that did not have an answer, encouraging them to answer these questions.
2. The point system also encouraged users to answer questions.
3. Users could search questions to find existing information, before they posted questions.

Some users had high scores, but they had few best answers. KiN also had the problem that if users saw an expert's answer in a question, they stopped answering that question.

However, KiN did not have questions that required much expertise to answer them.

2.6.5 Mimir

Mimir is a market-based real-time question and answer service. Mimir has a user interface like chat software. Users paid some mims, which is the currency in the system, to ask questions. Users who provide the best answers receive mims from askers. If a question does not have answers, a question owner will get a full refund of the mims he spent to ask the question. If

a question has some answers, but it does not have the best answer, askers will get a partial refund. Researchers who compared two versions of the system, one using the currency and the other without the currency, found that though the market-based system reduced non-serious questions and low quality of answers, overall questions and answers in the market based-version were fewer than the no market based one. Currency also decreased the sense of community and enjoyment of the users (Hsieh & Counts, 2009).

The following table lists features found in various systems described above, and provides a comparison in terms of these features.

	Piazza	Stack Overflow	Quora	Yahoo Answer
Point System	No	Yes	Yes	Yes
Badge System	No	Yes	No	No
Vote Up	No	Yes	Yes	Yes
Vote Down	No	Yes	Yes	Yes
Pay Points to Ask a Question	No	No	No	Yes
Gain Points from Vote	No	Yes	Yes	Yes
Spend Points for Special Features	No	Yes	Yes	Yes
Collect Points to Unlock Features	No	Yes	Yes	Yes
Tags or Categories	Tags	Tags	Tags	Categories
User Profile	Yes	Yes	Yes	Yes
Follow a Question	Yes	Yes	Yes	Yes

Table 2 Comparison of question and answer websites

2.7 Gamification

The term gamification is used to mean incorporating elements of game design in non-game software to motivate users' behavior. Most of gamification implementations reward users with virtual tokens. The systems that implement gamification need to have intrinsic value in

order to be effective (Deterding, 2012). Users interact with the systems to gain intrinsic value, and gamification enhances users' experience and increases their participation. Gamification creates friendly tournament in a class (Burguillo, 2010). For example, when researchers created a tournament in a class the friendly competition improved students' performance (Burguillo, 2010). However, developers should design a game carefully because an incorrect implementation can lower users' engagement and encourage users to game the system (Baker, Walonoski, Heffernan, Roll, Corbett, & Koedinger, 2008; Denny, 2013; Deterding, 2012; Farzan, DiMicco, Millen, Dugan, Geyer, & Brownholtz, Results from deploying a participation incentive mechanism within the enterprise, 2008). We now describe two systems that successfully employed gamification.

2.7.1 Beehive

Beehive is a social network for IBM employees. Beehive gave points to users based on their profile information, photos, lists, and comments on responses. Beehive ranked users into five levels based on their scores and displayed a leaderboard with the top ranked users. Some users gamed the system to collect a lot of points. A user even wrote an automated script to add comments to his photo to gain points. Thus, this illustrated a disadvantage of the point system (Farzan, DiMicco, Millen, Dugan, Geyer, & Brownholtz, Results from deploying a participation incentive mechanism within the enterprise, 2008; Farzan, DiMicco, Millen, Brownholtz, Geyer, & Dugan, When the experiment is over: Deploying an incentive system to all the users, 2008).

2.7.2 PeerWise

PeerWise, an educational online community implemented a badge system and a point system with scores. Students create multiple choice assignments for other students to answer in PeerWise. Students could gain knowledge from writing questions and answering them. Researchers found that the badge found that the badge system increased answers and number of

user visits in PeerWise, but the badges did not increase quality of students' answers in PeerWise.

Students enjoyed pursuing badges in PeerWise (Denny, 2013).

CHAPTER 3

PROBLEM STATEMENT

Researchers have developed many techniques to support education. Social networks and tools supporting collaboration are popular. People use social networks, such as Facebook, Twitter, and Google+, to communicate with their friends. Enterprises installed tools to support employees' collaboration. Developers use collaborative repositories to develop open source software. Many companies and researchers have created tools to support educational collaboration (Barr & Gunawardena, 2012), such as Piazza and Salon Classroom. Students can ask and answer questions in these sites. However, our extensive survey of professional and educational collaborative, question and answer, and learning management systems show that existing educational question and answer sites do not implement many techniques to encourage students to participate more and learn from using these sites.

Some researchers found that if users in a Korean question and answer website (KiN) saw an expert's answer, they would not answer that question that had an expert's answer (Nam, Ackerman, & Adamic, 2008). We expected that this users' behavior in a professional website could also occur in an educational question and answer site. However, we found no research on this issue. If lecturers answer students' questions immediately, students may stop answering questions, and miss opportunities to learn from answering questions. Designing, implementing and testing a technique to solve this problem and increase students' participation is one of the problems addressed in this research.

We designed a system that delays instructors' and teacher assistants' answers to give time for students to answer questions. Therefore, students would have chances to gain knowledge from answering questions and developing corresponding skills. Question owners however expect fast answers from teachers, so the delay system could decrease users' satisfaction and enjoyment.

Gamification is a popular technique to increase users' participation in a community (Deterding, 2012). Some researchers have implemented gamification in their education software. It has been found that gamification could increase users' contribution and enjoyment in the system (Denny, 2013). Trying to replicate this effect in an educational question and answer system is another issue addressed in this research.

We used the points system in Green Dolphin to provide alternative ways to ask questions, and increase users' responses. Users can spend points to directly ask an expert a question. Users can also spend points to obtain fast answers from teachers without delay. These features may counteract the negative effects of the delay system.

The purposes of our research are: (1) to design, implement and test a new educational question and answer system that incorporates beneficial features from a variety of existing professional and educational tools, (2) to study whether students would stop answering questions if they saw that those questions already had teachers' answers, (3) to test performance of proposed points system and leaderboard, and (4) to gain users' feedback about the Green Dolphin.

CHAPTER 4

SYSTEM DESIGN

Green Dolphin was designed by considering users' motivation in professional question and answer websites. We aimed to design a user interface that is user friendly and has low friction for students to participate it. We implemented a point system as another motivator in Green Dolphin to increase students' participation and visits.

4.1 Users Roles

Green Dolphin has 5 roles for users, an expert, a student, an instructor, a teacher assistant, and an administrator. Green Dolphin users roles to give users authorization to do various activities. An administrator is a power user. Users who have the administrator role can do all available activities in Green Dolphin and also access the user list. Other roles identify users' roles in an academic class. An instructor and a teacher assistant can delete a question or an answer. Students can edit or delete only their questions or answers. Green Dolphin gives an expert role to students that it identifies as active in questions or answers. Roles in Green Dolphin represent roles in the physical world.

4.2 Automatic Feedback

Novice programmers do not know the best practices and need feedback on the quality of their code from professionals. Therefore, teachers who teach a basic programming class have to give feedbacks on students' code. A code feedback capability has been built into Green Dolphin

to assist instructors save time by automating the process of giving simple feedback on code quality so that they can focus on answering students' questions. Green Dolphin will detect "code smell" in students' code, and give students advice on how to refactor their code (Umphress, 2012). Green Dolphin shows a badge for each code smell on students' question pages, so students notice that any code they submitted to Green Dolphin has one or more smells, and can learn from mistakes (Hickey, Langton, & Alterman, 2005). The badges encourage students to refactor their code to remove their negative badges. This feature, though implemented, has not been tested in a class.

4.3 A Survey of Points Systems

Prior to describing the point system of Green Dolphin, we undertake a survey of such reward features in existing question and answer sites.

4.3.1 The Reputation System of Stack Overflow

Users get reputation points from users' votes and need to collect reputation points to enable additional privileges. If a user votes up a question or an answer, its owner will get some reputation points. If a user accepts an answer, the owner of that answer and any voter will get some points. If a user votes down on a question or an answer, the owner will lose some reputation points (Stack Overflow). A user can offer their reputation points to motivate others to answer a question (Stack Overflow).

4.3.2 Mirmir

A user pays mims, the currency in the system, as a reward for another user providing the best answer. If a user asks a question for a day and does not get any answer, the system will fully refund mims and remove the question. If a user asks a question for three days and get some answers without any best answer, the system will refund partial mims to the owner of question.

4.3.3 Quora Credits

Users use credits for special features in Quora. If users vote or follow responses, owners of those responses will get some credits. Users can use credits to promote their contribution to other users. They are able to offer credits to select users and ask them a question. Users do not have to pay credits to ask a question, but in the past they had used to pay 50 credits to ask a question (Quora).

4.3.4 Yahoo Answer

Users get 100 initial points. They must spend 5 points to ask a question but will get them back if no voters select a best answer. In addition, they get 3 points to select a best answer for their question. They gain two points by answering a question and one point from a user's vote. If users vote an answer to be the best answer, the answer owner will get 10 points and one point per thumbs-up ratings. Users receive one point per day after logging in the system. Yahoo Answer ranks users from one to seven and has a leaderboard (Yahoo! Inc.).

4.4 Reward System Design in Green Dolphin

The purpose of the reward system is to create a friendly competition among for students to motivate them (Burguillo, 2010). It is similar to a credit card reward system that gives customers points when they use the cards, and clients can use these points to get some services or goods. The point system is suitable for a question and answer site because it has intrinsic value (Deterding, 2012). Intrinsic value of a question and answer is that it contains students-generated knowledge. The reward system in Green Dolphin is a game that is intended to make students visits it often. The point system of Green Dolphin gives points to students for their contributions, but does not have any penalty features because penalty can create negative motivation in the system. The point system of Green Dolphin consists of three features, earning points, spending points, and the leader board. Green Dolphin awards points to users as per the table below. Value

of points assigned to each activity depends on the time that students have to spend on it and its value to the community. For example, answering question is worth more points than voting an answer as “useful” because students have to spend time on answering a question more than clicking a voting button. The point system is different from Stack Overflow in that Stack Overflow has a vote down button for users to give a penalty to other users. In Green Dolphin students can spend points to view instructors’ answers as soon as they are posted or to directly ask expert students, so students may like collecting points for utilizing these special functions. This function can potentially decrease low quality questions that are sent to instructors or expert students (Hsieh & Counts, 2009).

4.5 Notification System

Green Dolphin has an email notification system. The notification updates users about new activities happening in Green Dolphin via email as well as displaying the number of notifications sent to each user on the left of the navigation bar. Users click on the number of notification to go to a notification page. The notification page displays all of the users’ notifications that are not older than a week. Green Dolphin connects to an email server. After Green Dolphin creates a notification, it sends a message to the email server to send an email to the user who is to receive the notification. Green Dolphin sends notifications emails to users when they gain useful votes on their questions or answers, or when other users answer their questions or post comments on their answers. Additionally, when students directly ask an expert student, that student is sent a notification. When a question owner selects a user’s answer to be the correct answer, that user is sent a notification. After Green Dolphin promotes students to be experts, the system sends notifications to congratulate them. All these notifications are meant to encourage students to participate in Green Dolphin. Finally, instructors and teacher assistants are sent notifications when they have not answered a posted question.

Activities	Points
A student answers a question.	The student gets 10 points.
A student's answer was voted to be the best answer.	The answer owner gets 10 points.
A student selected the best answer.	The student gets 5 points.
An expert student answers a question that another student asks by the expert system.	The expert student gets 20 points.
A student asks a question.	The student gets 5 points.
A student votes a useful question or answer.	The student gets 2 points.
A student uses a fast answer feature.	The student spends 10 points to use the feature.
A student asks an expert student.	The student spends 5 points to ask an expert student.

Table 3 The point system rules of Green Dolphin

4.6 The Delay Mechanism

4.6.1 Fast Answers are Not Always Better

Users expect fast answers from question and answer websites. Many question and answer sites provide features to assist users to receive answers as fast as possible, and use this criterion as an indication of good performance. Users received first answers to their questions in about 11 minutes in Stack Overflow. Stack Overflow gives a fast answer more reputation points than a regular one (Mamykina, Manoim, Mittal, Hripcsak, & Hartmann, 2011). Piazza always shows how fast users receive the first answer to their questions. Thus, all companies have developed

question and answer boards to assist users to receive answers as fast as possible without considering other issues.

Sometimes fast answers can decrease user participation. Some researchers found that users in Naver did not answer questions that had experts' answers (Nam, Ackerman, & Adamic, 2008). However, designers design all question and answer sites without considering this particular user behavior, so this problem happens in all websites, especially in educational ones. Students obviously think lecturers are experts, and they may not answer after seeing lecturers' responses. If teachers answer faster than students, students may miss an opportunity to learn from answering and thus developing their technical and communication skills. Questions that have only lecturers' answers lack students' perspectives. Students are novices, so they need time to solve problems. Therefore, we felt that an educational question and answer site should delay the publication of experts' answers for a reasonable time to increase students' contributions.

4.6.2 The Delay System of Green Dolphin

Students' objective is to receive fast and high quality answers. We designed Green Dolphin for students to gain classmates' answers immediately, but Green Dolphin delays instructors' and teacher assistants' responses. The delay may be viewed as a rule in Activity Theory framework that alters the interaction of subjects, students, teacher assistants, and lecturers. This rule makes it harder for some subjects, students, to accomplish their objective of obtaining an answer as quickly as possible, and can possibly decrease their satisfaction of with the system. We did not ignore this negative consequence of the delay mechanism, but we felt that increasing that high students' participation by delaying the teachers' answers would outweigh any other negative consequence. Moreover, we tried to counteract this negative effect by the two other features to be discussed later, the expert system, and the fast answer facility.

Green Dolphin sends email notifications to all students in all students 30 minutes after a student posts a question. Students could answer questions immediately. However, Green Dolphin applies a delay time to the publication of answers from teacher assistants and lecturers. The delay time for teacher assistant is 3 hours, and the delay time for lecturers is 6 hours. Our experience with Piazza showed that students typically posted the first answer to a question 30 minutes on average after it was posted, so we felt 3 hours and 6 hours were enough for students to read a question, collect their thoughts, and post an answer, without being intimidated by the answer from a teacher assistant or lecturer. Green Dolphin would send emails to teacher assistants 3 hours and lecturers 6 hours after a question was posted, if there was no answer from the teacher assistant or lecturer within these delay periods respectively. If either or both answered a question during the corresponding delay periods, the answers would not be visible to anyone other than the person who posted it. Green Dolphin would show only a progress bar to a question owner, so he or she has a correct mental model, i.e., knows that an answer has been provide by a teacher assistant or lecture. The bar would also show the time remaining before that answer would become visible. Other students would not know that a question had received teachers' responses before it is actually published. Thus, other students have 3 hours to post answers before the teacher assistant's answer is shown, and 6 hours before the lecturer's answer is shown. However, the delay method could decrease users' satisfaction, so we needed to provide alternative methods for students. These are the expert system and fast answer feature, to be discussed next.

4.6.3 Expert System

The expert system is another way to gain high quality and fast answers. Students can send emails to directly ask expert students their questions. If a student asks an expert, the student has to spend points, and Green Dolphin sends an email to the selected expert immediately. Others are notified as usual. i.e., Green Dolphin sends emails to all other students 30 minutes after the

student posts the question for experts. Green Dolphin also sends emails to the course instructor and a teacher assistant after 6 and 3 hours respectively.

Green Dolphin selects expert students with the expert identification algorithm. We selected an automatic approach, because students are generally willing to rate their classmates (McDonald & Ackerman, 2000). The expert identification algorithm uses the premise that a user who answers questions more than asking questions, that user may be an expert student. We use the Z-score described earlier in this document for expert identification. The Z-score of a user is:

$$z = \frac{a - q}{\sqrt{a + q}}$$

Here “a” is the number of answers provided by a student user and “q” is the number of his/her questions (Zhang, Ackerman , & Adamic , 2007). According to the literature, if one’s Z-score is more than 1.29, he or she is in the 60th percentile of users in terms of question answering/asking behavior, so it is likely that the user will be an expert user. Such students are publicly identified as expert students by Green Dolphin, so that students can directly ask these “expert” students questions. We expected that this feature would be an alternative way for a student to receive quick and high quality answers from their friends who may be more knowledgeable or at least more ready to help. Expert students on the other hand have chances to learn from answering questions.

4.6.4 Fast Answer

We provided this special feature for students to gain fast answers from an instructor or a teacher assistant. If a student spends point to use the Fast Answer facility, Green Dolphin will send notification to lecturers immediately after the student posts a question rather than wait for 6 hours.

4.7 System Architecture

We used Ruby on Rail to develop Green Dolphin. Ruby on Rail has excellent ecosystem and user community, and many developers have used it. People have developed open source Gems, which is a plug-in for Ruby on Rail. For example, Devise is an authentication gem. Developers can use the Device gem to control each user's authentication and authorization (Devise). Ruby on Rail allowed us to focus on unique features of Green Dolphin. We developed Green Dolphin in 8 months. Kanban was the software development process used for Green Dolphin (Wikipedia). We deployed a beta version and a production version of Green Dolphin in Heroku, a cloud platform as a service for Ruby on Rail. We selected Heroku as a server because Heroku is scalable and has many plug-ins to manage the server, such as an email service, a logging system, and a monitoring tool (Heroku). Green Dolphin consists of two web "dynos", which is a container running a single user's command, and one "worker", which processes a queue. Green Dolphin used the worker to delay notifications for the delay mechanism. Green Dolphin relies on SendGrid, which is an email server (Sendgrid). The application server of Green Dolphin connects to the database and the email server.

4.8 The User Interface

We used Twitter Bootstrap, which is a responsive CSS framework, to build the user interface of Green Dolphin. We chose Twitter Bootstrap because it supports a browser in a tablet and a mobile phone. Twitter Bootstrap adjusts a page of Green Dolphin to fit the resolution of the client device. Twitter Bootstrap supports wide resolutions of devises that are below 480px, below 767px, above 768px, above 980px, and above 1200px (Twitter). We wrote code on top of Twitter Bootstrap edited by Bootswatch (Park). We tested the user interface of Green Dolphin on an iPad and an iPhone. We tested the site also on Firefox and Chrome on a desktop, so Green Dolphin supports browsers in desktops and mobile devices.

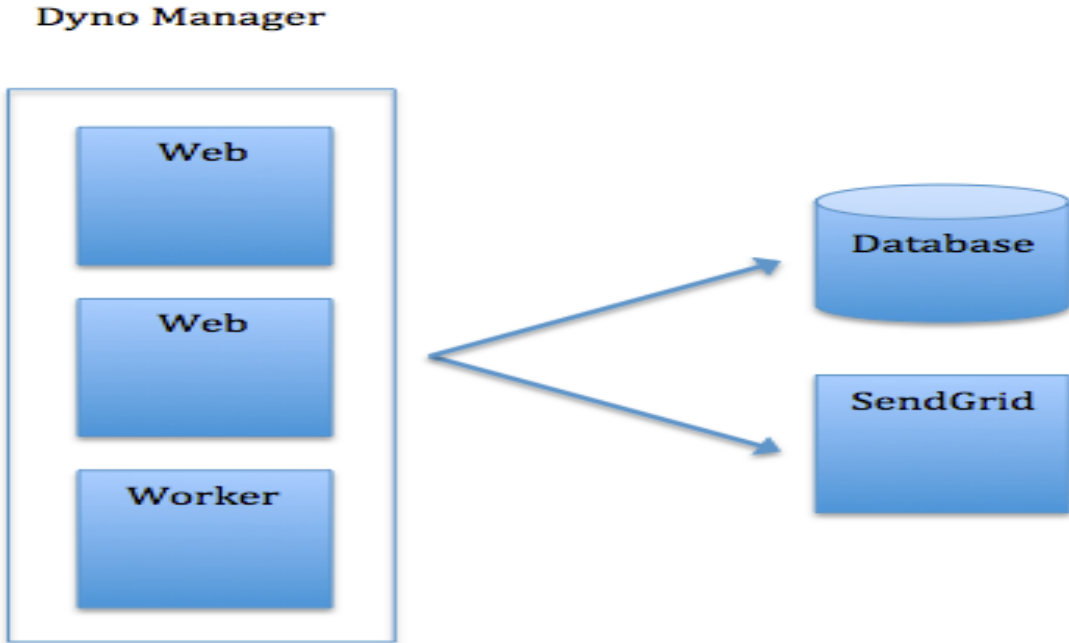


Figure 16 Architecture of Green Dolphin

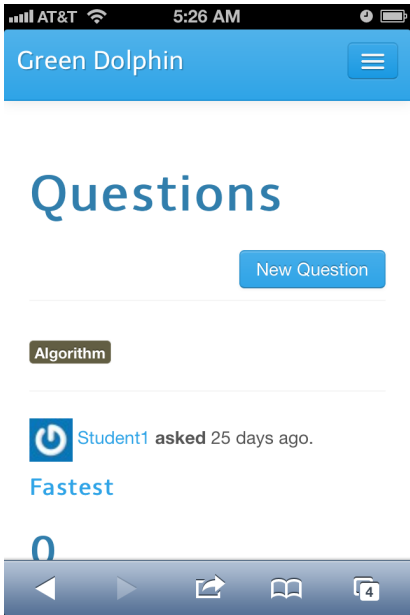


Figure 17 The mobile phone user interface of Green Dolphin

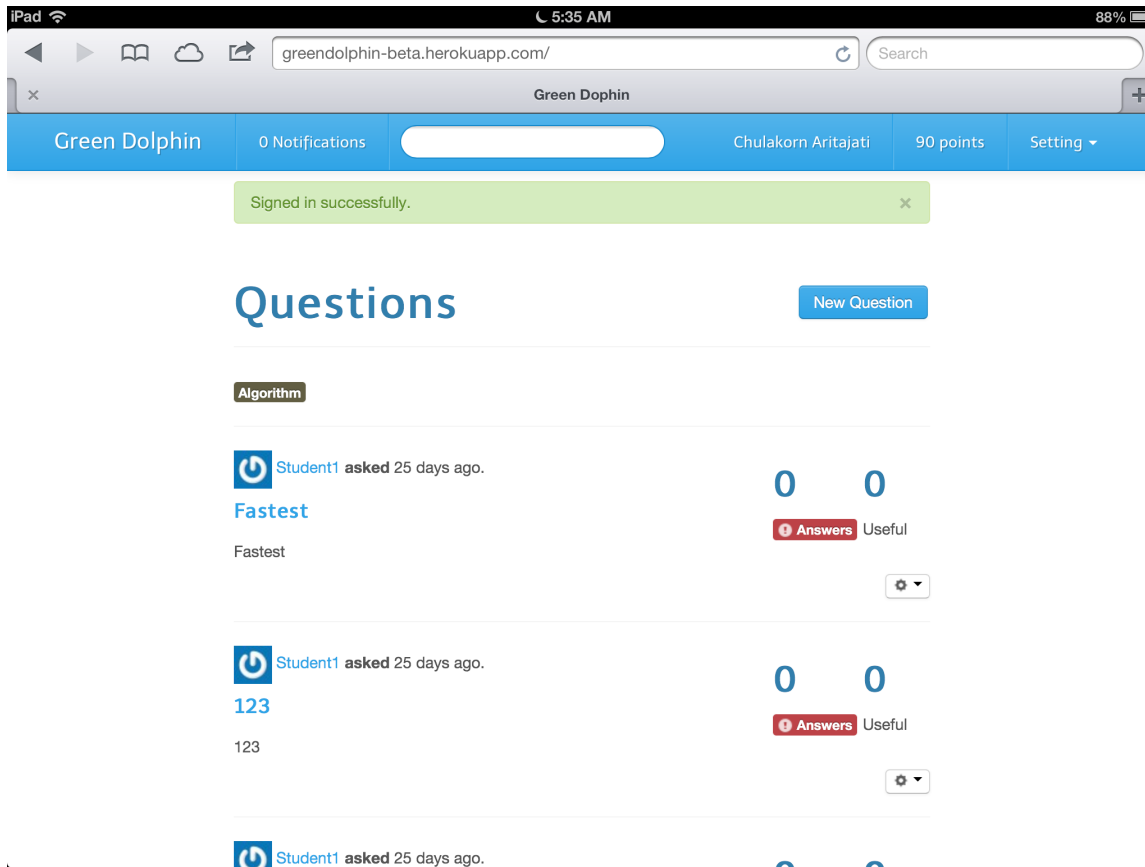


Figure 18 The tablet user interface of Green Dolphin

Green Dolphin has a minimal and clean design. There is a navigation bar on top of every page. After a user logs in, Green Dolphin presents a list of all questions asked by all users. The navigation bar displays the number of current notifications, a search box, a link to the user's profile, a link to the leaderboard, and a link to settings. Users can click on the number of notification to view all new notifications. The user's profile displays the user's demographics, email, points earned, number of questions and answers. Users may click the leaderboard link to view overall performance of the class and their contribution statistics. The leaderboard presents the number of questions and answers in Green Dolphin. Moreover, it displays a comparison of the user's response to the mean for the class, so the user knows how his/her personal performance compares with that of the class. Students can compare their points and positions with their classmates in the leaderboard page since all students are shown ranked by their points.

The user's profile lists all questions and answers of that user, so students can check others' contributions to the questions he or she asked. Each question displays a title, content, useful votes, and number of answers.

The screenshot shows the 'Questions' page on the Green Dolphin platform. The header includes the user's name 'Green Dolphin', '0 Notifications', the user's name 'Chulakorn Aritajati', '101 points', and a 'Setting' menu. The main heading is 'Questions' with a 'New Question' button. The first question is titled 'Efficient algorithm for finding all maximal subsets' by 'Student1', asked 6 months ago. It has 2 answers and 1 useful vote. The question text describes a problem with unique sets and includes a code snippet for a Python algorithm. The second question is titled 'Algorithm to quickly find animals away from the herd' by an anonymous user, also asked 6 months ago. It has 5 answers and 1 useful vote. The question text describes a simulation program and includes a reference to a picture.

Figure 19 The list of questions

Users can post a question by clicking on the link on the top of the list of question page. A user writes a title, content, and can include code with a question. He then adds tags to a question and answers anonymously. A user can spend points to use the fast answer or ask an expert features. After a user clicks the button to post a question, Green Dolphin presents the question. From the list of question page, users click on each question to navigate to a page with details about that question the answers it garnered and any responses or discussion of the answers. Users can write their answer in a text box. Users can vote or comment on others' answers. Green

Dolphin provides the “useful” vote system for users to rate the quality of answers. More votes means higher quality. Green Dolphin does not sort answers to a question using the number of useful votes each answer has because this has been shown to prevent users from voting on answers that already have useful votes (Mamykina, Manoim, Mittal, Hripcsak, & Hartmann, 2011).

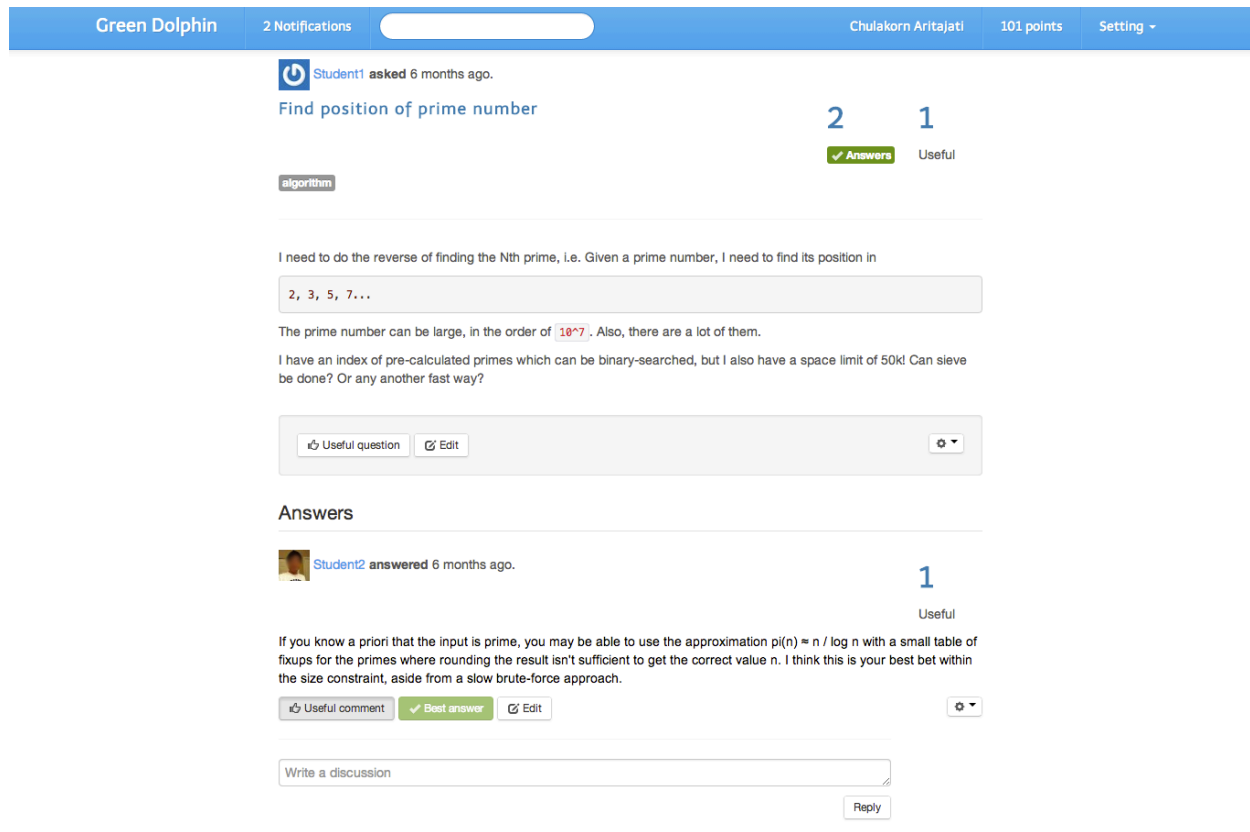


Figure 20 The question page

Green Dolphin displays the contents of an answer and its votes for each answer. We used Aloha Editor (Aloha Editor), which is a HTML editor, to allow students to format their answers. Aloha Editor supports all HTML document and Mathematics symbols. Aloha Editor assists users to format their content. Users can answer anonymously or using their usernames. Users also post comments under answers, thus creating discussion. There is a vote button under each answer. A question owner can select one of the answers to be a correct answer by clicking on a correct answer button under an answer.

Green Dolphin provides tags and a search function. There are two types of tags, a question tag, and a personal tag. An administrator has to create tags for a question, but users can create users' tags in their profile to show their identity. Users click on a tag, and then Green Dolphin displays a list of questions or users that have the tag. Green Dolphin shows the tag cloud on the list of questions page. The search textbox is on the navigation bar on top of every page. A user can type in a keyword and Green Dolphin will present a list of questions that have the keyword. Users can search a string in the titles and contents of questions.

We designed the interface of delay mechanism to present a correct users' mental model to users. Green Dolphin delays lecturers' answers, so it has to notify a question owner that he has received lecturers' answers. Other students do not see this information. Green Dolphin displays the status of a teachers' answer by using progress bars. Lecturers can see when Green Dolphin will present their answers to all students on a progress bar. It displays how much time has to elapse before Green Dolphin will post the teacher's answer. The question owner can see this progress bar too, but not any other students. Question owners thus know that they have received answers from teachers, and can estimate the time that they will need to wait to see those. Lecturers know when all students will view their answers. The developer chose a progress bar that with backwards ribbing affects animation, because users perceive that such a bar moves faster than a normal progress bar (Harrison, Yeo, & Hudson, 2010). This was done to reduce any negative feeling on the part of the question owner in having to wait to see the teacher's answer.



Figure 21 The progress bar

4.9 Redesign

4.9.1 Point System Redesign

After the first version of the points system was implemented in Green Dolphin, we found from the study reports in Chapter 5 that students posted low quality answers simply to get more points and did not use the useful voting button as often as expected. Students complained about the low quality of these answers. In Stack Overflow and Quora, users earn points from other users' votes, but users do not get points from simply submitting their answers, to prevent this type of gaming the systems. Also, students did not use the useful voting mechanism too much. Lower than 10% of the students who used the system voted. This meant that students could not quickly identify quality of answers based on the voting mechanism. In addition, some students also suggested that Green Dolphin should give points to users if they get useful votes. Therefore, we decreased the point reward for posting an answer from 10 to 3 points, increased the points awarded for voting from 2 to 3, and allowed answer or question owners to get 5 points from every useful vote, so that the point rewards better reflected quality of the content. The new rules shown in the table below increased useful responses and decreased low quality questions and answers.

4.9.2 Notification Redesign

Based on the instructor's feedback during the study that he could not easily identify notifications when a student asked for a fast answer from among all the other notifications, we added the phrase "[Need a Fast Answer]" to the subject of such email notifications.

Activities	Points
A student answers a question.	The student gets 3 points.
A student's answer was voted to be the best	The answer owner gets 10 points.

answer.	
A student selected the best answer.	The student gets 5 points.
An expert student answers a question that another student asks by the expert system.	The expert student gets 13 points.
A student asks a question.	The student gets 5 points.
A student votes a useful question or answer.	The student gets 3 points.
A question or answer is voted to be useful.	The question or answer owner gets 5 points.
A student uses a fast answer feature.	The student spends 10 points to use the feature.
A student asks an expert student.	The student spends 5 points to ask an expert student.

Table 4 The redesigned point system rules of Green Dolphin

CHAPTER 5

SCOPE OF THE RESEARCH STUDY

In this chapter we discuss the hypotheses and research questions of the evaluation study we conducted to test Green Dolphin.

5.1 Hypotheses

We expected that the delay problem had same effects in an educational question and answer website. We tested the delay could solve the delay problem and did not decrease users' satisfaction. All functions had advantages and disadvantages. We compared performance and users satisfaction between Green Dolphin and Piazza, which is the most population question and answer website.

Hypothesis 1: Instructors Answering Questions Discourages Students from Answering Those Questions.

We expected that the impact of experts' answer, as seen in the Naver (Nam, Ackerman, & Adamic, 2008), would be seen in Green Dolphin as well. If it happened in Naver that when users perceived as experts posted answers this discouraged other users from posting their answers, we expected that this would happen in Green Dolphin where there are obvious experts, lectures and teacher assistants, and also students that the system identifies as experts. The data we collected from Piazza during the first phase of the study lent support to this expectation. We selected questions that the teacher assistant or the lecturer answered in Piazza and compared the

number of students' answers before and after the teachers' answers appeared, and found that students answers decreased considerably after lecturer's answers.

Hypothesis 2: The Delay Answers Feature and its User Interface Increase Students' Answers.

We expected that the delay system in Green Dolphin would increase students' answers. We would test this hypothesis by comparing answers to questions where lecturers' answers were delayed (Green Dolphin) and not delayed (Piazza).

Hypothesis 3: Students will Find the Identification of Expert Students in Green Dolphin a Useful Feature and will Spend Points to Ask Questions to These Experts or to Get Fast Answers from Instructors.

The expert system is an aspect of the delay system in Green Dolphin. The expert identification technique assists students in receiving high quality response quickly from the expert students. We asked students about their satisfaction with this system in a survey. We expected that this alternative way to ask a question, and to ask for fast answers from the instructor, would be of benefit to students and that they would use it even if it meant that they had to spent points to ask questions of expert students.

Hypothesis 4: Green Dolphin Finds Experts Correctly.

The expert identification algorithm was tested by researchers using data from a large question and answer website, who compered its performance with humans' rating and other techniques (Zhang, Ackerman , & Adamic , 2007). We expected that the algorithm would work well in identifying students who are experts by looking at those students' grades. If the algorithms identified students who went on to get an A in the course, we could say that it was effective in finding expert students.

Hypothesis 5: Students Prefer the User interface for Answering a Question in Green

Dolphin over Piazza.

This hypothesis is about users' satisfaction with Green Dolphin and Piazza. Green Dolphin had several different features from Piazza, and its user interface is cleaner and simpler than Piazza. Piazza is a popular educational question and answer website, so it is a good benchmark for comparison. We asked students to choose which site they preferred in a survey. We expected that students would prefer Green Dolphin to Piazza.

Hypothesis 6: The Delay Answers Mechanism and Its User Interface do not Produce User Dissatisfaction.

The mechanism of delaying lecturers' answers could potentially decrease users' satisfaction. However, we provided an alternate route to students, in that they could get fast answers from system-identified student experts. We asked students in a survey about their satisfaction about the delay system. We expected that delaying experts' answers would not impact users in a negative way.

Hypothesis 7: Green Dolphin is Easier to Use and Learn than Piazza.

Even though Green Dolphin had more features, such as the reward and expert identification systems, than Piazza, we felt that the cleaner and simpler interface design and the added functionalities would result in it being found easier to use than Piazza. We asked students to share their experiences in both systems.

Hypothesis 8: Green Dolphin will Encourage More Student Participation than Piazza.

We measured over all students' questions and answers in Green Dolphin and Piazza. We expected that students would ask and answer more questions in Green Dolphin than Piazza.

5.2 Research Questions

In addition to these hypotheses, we developed two research questions to be answered using data collected during the evaluation study.

Research Question 1: What Encourages Students to Answer their Classmates' Questions in Green Dolphin?

Green Dolphin has many features that affected users satisfaction and users' participation. We want to find which functions were popular or what motivated students to answer questions. We provided the open-ended questions for students to describe their thoughts on these in a survey.

Research Question 2: Which Devices are Popular for Accessing Green Dolphin - Desktops, Mobile Phones, or Tablets?

Mobile device are popular now. We want to discover how often students accessed Green Dolphin from a mobile device as opposed to traditional desktops or laptops. We used Google Analytic to detect the kinds of devices that students used to access Green Dolphin.

Research Question 3: What Types of Questions do Students Ask?

We needed to know what types of questions students asked in a system like Green Dolphin. We analyzed questions posted in Green Dolphin to identify what type of questions students asked.

CHAPTER 6

EXPERIMENTAL DESIGN AND PROCEDURE

6.1 METHODOLOGY

6.1.1 Participants

We did the an experiment in two coupled graduate courses, COMP7270 and COMP7276, which were taught at Auburn University in Spring 2013. The professor and a teacher assistant taught those classes. The instructor taught COMP 7270 on the Auburn University campus, but COMP7276 was an online course for distance education students. The class had 53 students, and 35 students participated in the experiment. 10 students were female, and 25 students were male. Two students were from COMP7276. All students were graduate students. Students were asked to use Piazza in the course for some time, then given a survey and asked to use Green Dolphin for the same duration and given a survey. Thirty-three students who used Piazza took the survey, 34 students who used Green Dolphin did the survey.

6.1.2 Materials and Apparatus

We created a classroom in Piazza for students to use it. We developed Green Dolphin using Ruby on Rail. Green Dolphin runs in Heroku, a Ruby on Rail cloud server. We used Google Analytics to track students' usage and Public_Activity gem to write each users' log. Students could access Piazza and Green Dolphin from mobile phones, tablets, and computer desktops.

6.1.3 Procedure and Design

COMP7270 and COMP7276 were advanced algorithm courses. We provided 5 extra points for students to participate in the study. These points were allocated as follows. If a student consented to participate in the research, that student would gain 1 point. If a student asked or answered a question in Piazza and Green Dolphin, that student would get 1 point for each. Similarly, 1 point was allocated to taking each of the two surveys. The experiment consisted of two phases of 34 days each, days from March 1 to April 3. Students used Piazza in the first phase because we needed data from Piazza to adjust the parameters of the expert identification algorithm and to test whether the experts' answer problem existed. Based on data from this first phase, we set the answer delay time of Green Dolphin to 3 hours for teacher assistants' answers and 6 hours for instructors' answers. We set the Z-score threshold for expert identification to be 1.29 because a Z-score analysis of data from Piazza suggested that this would detect at least ten expert students. We wanted students to have a choice of expert students to ask questions. The first phase of the study included one course assignment and the mid term exam. After students used Piazza for about a month, they had to do the survey about Piazza. Students used Green Dolphin in the second phase for 34 days, April 3 to May 6. The second phase had two assignments and the final exam. After students used Green Dolphin for about a month, they had to do the survey about Green Dolphin.

CHAPTER 7

RESULTS

Students used Piazza for 4 weeks. They asked 28 questions and provided 44 answers. Lecturers answered 17 questions. Almost all questions got answers (86%). After 4 week of Piazza usage, students did the Piazza survey, and then they used Green Dolphin for 4 weeks. Students posted 63 questions and 181 answers. Teachers answered 22 questions. All questions received answers.

	Piazza	Green Dolphin
Number of questions	28	63
Number of students' answers	44	181
Average number of students' answers	1.571 (SD = 0.959)	2.873 (SD = 1.581)
Median number of students' answers	2	3
Mode number of students' answers	2	3

Table 5 Usage comparison between Piazza and Green Dolphin.

Hypothesis 1: Instructors Answering Questions Discourages Students from Answering Those Questions.

We found that in Piazza the number of students' answers before the teacher assistant's or the lecturer's answers were significantly more than the number of students answers after the lecturers' to the teacher assistant's answers appeared. The average number of students' answers before teachers' answers was 0.941 (Standard Deviation, SD= 0.659). The average number of students' answers after teachers' answers was 0.2353 (SD= 0.437). The average number of students' answers before teachers' answers was significantly more than the number of students' answer after lecturers' answers ($t(17)= 3.681, p=0.001$).

A majority of students (81.81% of students, 27 students, in Piazza, and 73.53% of students, 25 students, in Green Dolphin) selected agreed (Likert scale value 4) or strongly agreed (Likert scale value 5) that if they saw instructors' answer for questions, they would stop answering the questions. However, three students in Piazza and five students in Green Dolphin disagreed (Likert scale value 2) with this statement. This supports the hypothesis that instructors' answers discourage students from answering questions. Some students stated directly in open-ended responses that they did not answer a question that teachers answered.

“The instructor of TA already answered the questions.”

“Either those were already answered correctly or they were answered by the TA or instructor.”

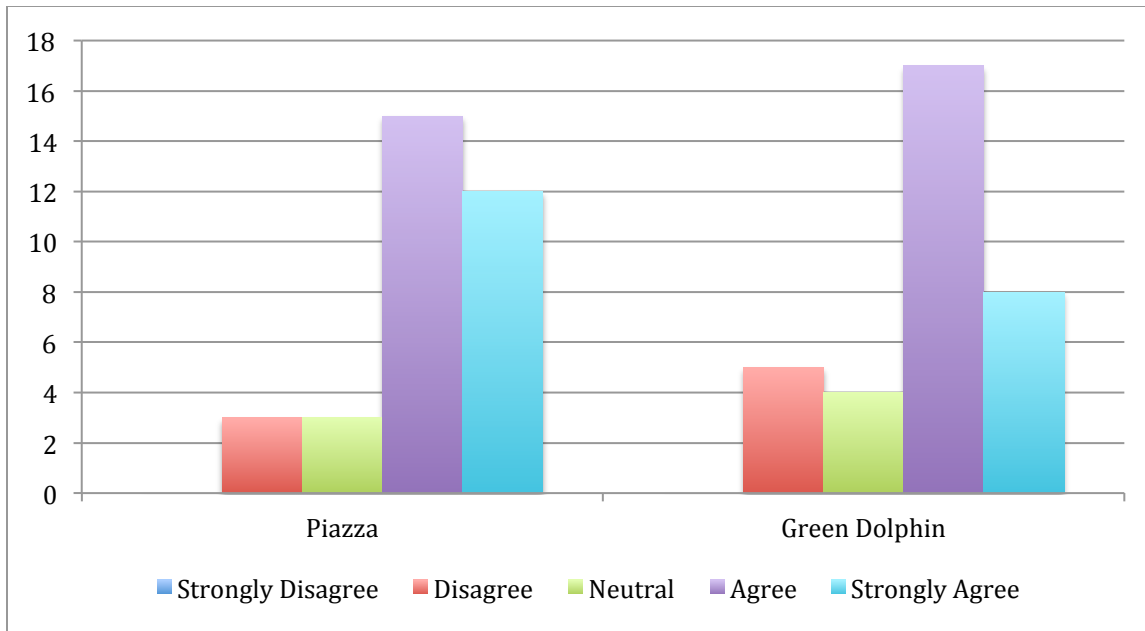


Figure 22 You would not answer someone's question in Piazza or Green Dolphin if you saw that the professor or the TA has already answered it.

Outstanding students' answers did not have a big impact to users in both systems. Some students in Piazza (30.30%) and some students in Green Dolphin (35.29%) chose agree or strongly agree to the statement in the surveys that if they saw outstanding students' answers, they would not answer questions that had outstanding students' answers. However, this result was not statistically significant. Thus, outstanding students' answers do not seem to stop other students from answering a question.

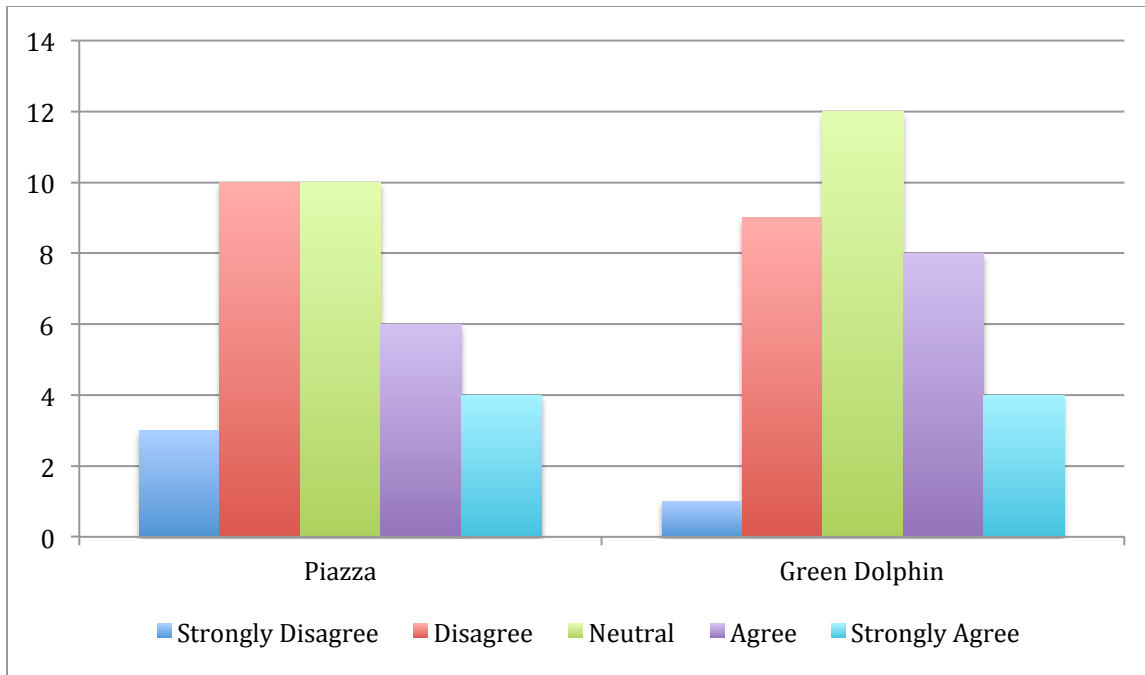


Figure 23 You would not answer someone's question in Piazza or Green Dolphin if you saw answers from outstanding students.

However, if students thought that a question already had a correct answer, they would not answer the question. Twenty-eight students, 84.85% of students, in Piazza and 26 students, 76.47% of students, in Green Dolphin chose agree (Likert scale value 4) or strongly agree (Likert scale value 5) with the statement in the surveys that if they saw a correct answer, they would stop answering that questions. Four students in Piazza and three students in Green Dolphin disagreed (Likert scale value 2) with this sentence. These are some examples of the students' open-ended responses to say why they would not answer a question:

“Other answers to the question sounded more correct than mine, so I avoided saying that other students were wrong”

“The question is not clearly stated, or current answers are good enough.”

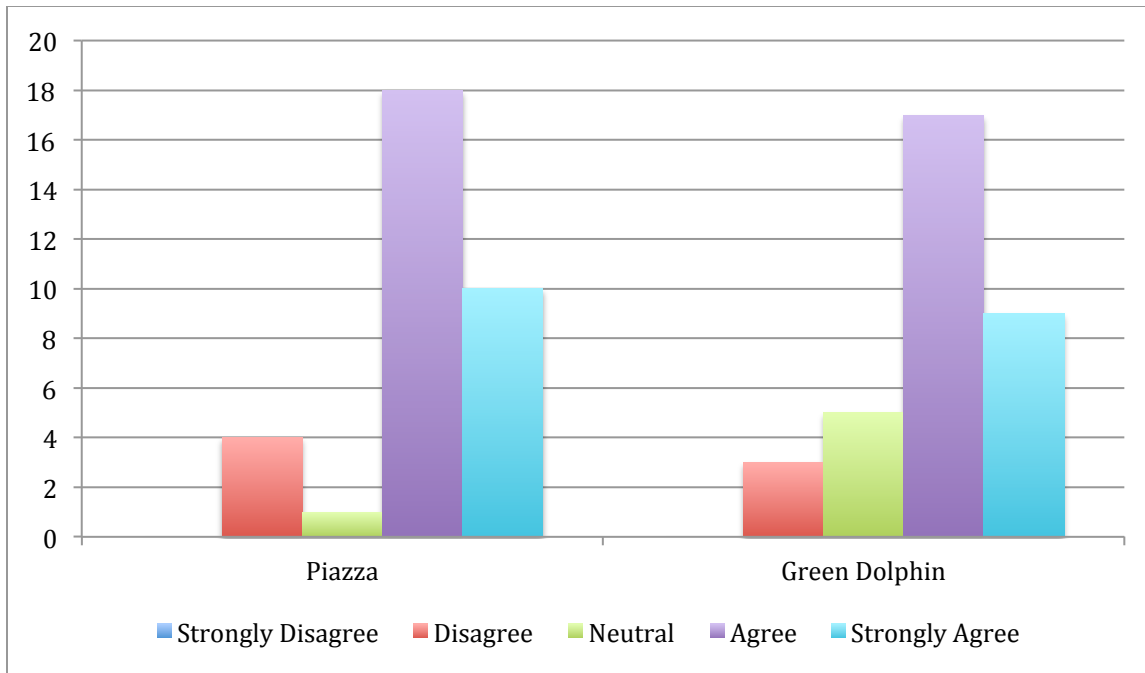


Figure 24 You would not answer someone's question in Piazza or Green Dolphin if you saw there was already a correct answer.

The open-ended questions that asked why students did not answer questions in Piazza and Green Dolphin supported this observation: 57.58% of students in Piazza did not answer questions because they thought that questions had useful answers, and 38.24% of students in Green Dolphin provided the same reason.

Students thought that their classmates achieved their objective to getting correct answers to their questions, and believed that instructors' answers were correct answers. Thus, they stopped contributing to questions that had an instructors' answer or a response that they thought was correct.

Hypothesis 2: The Delay Answers Feature and its User Interface Increase Students' Answers.

Piazza presents instructors' answers immediately, but Green Dolphin will display a teacher assistant's answer only after 3 hours, and an instructor's answer after 6 hours. We compared students' answers to questions that had the instructors' and teacher assistant's answer.

If a question gained a teacher assistant's answer before the instructor's answer or had only the teacher assistant's answer, we counted students' answers posted during the first 3 hours after the question was posted. If a question gained the instructor's answer before a teacher assistant's answer or had only the instructor's answer, we counted students' answers posted during the first 6 hours after an asker posted the question. Then we compared these counts for Piazza, which posted the instructor's and teacher assistant's answers immediately, with the counts for Green Dolphin, which delayed these answers. The delay system and its user interface increased students' answers significantly ($t(32.46) = -3.507, p = 0.001$). The average number of students' answers in Piazza was 0.882 (SD= 0.6). The average number of answers in Green Dolphin was 1.909 (SD= 1.192). This evidence supports the hypothesis.

However, other factors may have impacts on this result. For example, the time at which a question was asked. Students asked a lot of questions before an assignment or exam compared to the rest of the study period. The second factor is the quality of questions. Students also did not answer low quality questions. Students in Piazza (6.06%) and Green Dolphin (14.71%) stated in the surveys that they did not answer questions because the questions had low quality.

Hypothesis 3: Students will Find the Identification of Expert Students in Green Dolphin a Useful Feature and will Spend Points to Ask Questions to These Experts or to Get Fast Answers from Instructors.

This hypothesis was not supported. We observed that students were not using this feature during the second phase of the experiment, so we asked students about in the survey. A lot of students who answered this question in the survey (86%) had not used "ask expert student" function. Some students (17.65%) thought that classmates' answers were fast and could fulfill their need. They did not want to ask expert students. They thought that these features were not worth to spending points, and classmates' answers were fast and could fulfill their need.

“I didn't spend points because I didn't see the need to. The discussion on the questions was already satisfactory for getting the information I needed.”

“No. Even I didn't use points to use the fastest answer, some other students still answer questions very quickly.”

“I didn't spend points because I didn't see the need to. The discussion on the questions was already satisfactory for getting the information I needed.”

Answers to questions in the survey about Green Dolphin suggested that students were satisfied with their classmates' answers. No students disagreed that they were satisfied with classmates' answer in Green Dolphin. Average Likert scale value for the corresponding question in the Green Dolphin survey was 4.15 on scale of five. Almost all students in Green Dolphin (88.24%) chose agree (Likert scale value 4) or strongly agree (Likert scale value 5) on this topic. Four students, 11.76% of students, in Green Dolphin felt neutral on classmates' answers. Students agreed that classmates answered their questions quickly. Average Likert scale value for the corresponding question in the Green Dolphin survey was 4.18 on scale of five. No student disagreed that answers had good quality in Green Dolphin. The number of students who selected agree (Likert scale value 4) or strongly agree (Likert scale value 5) with the statement that answers were of good quality was 82.35%. Students were satisfied with their classmates' quick answers and their quality in Green Dolphin. However, some students complained that they saw low quality answers.

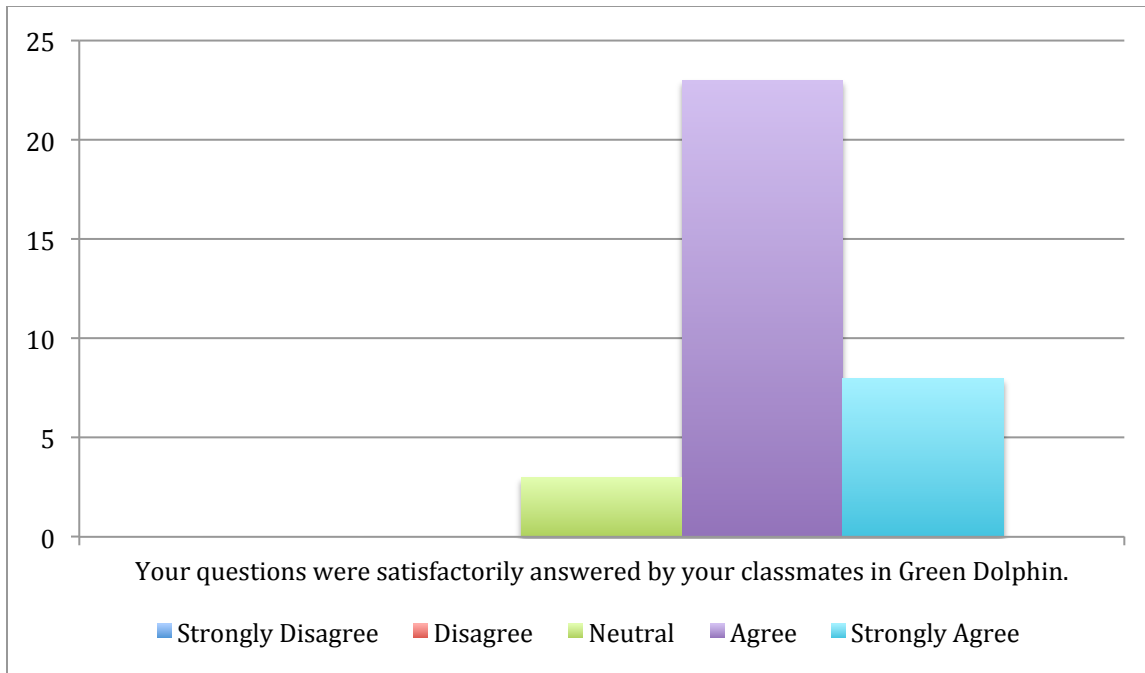


Figure 25 Your questions were satisfactorily answered by your classmates in Green Dolphin.

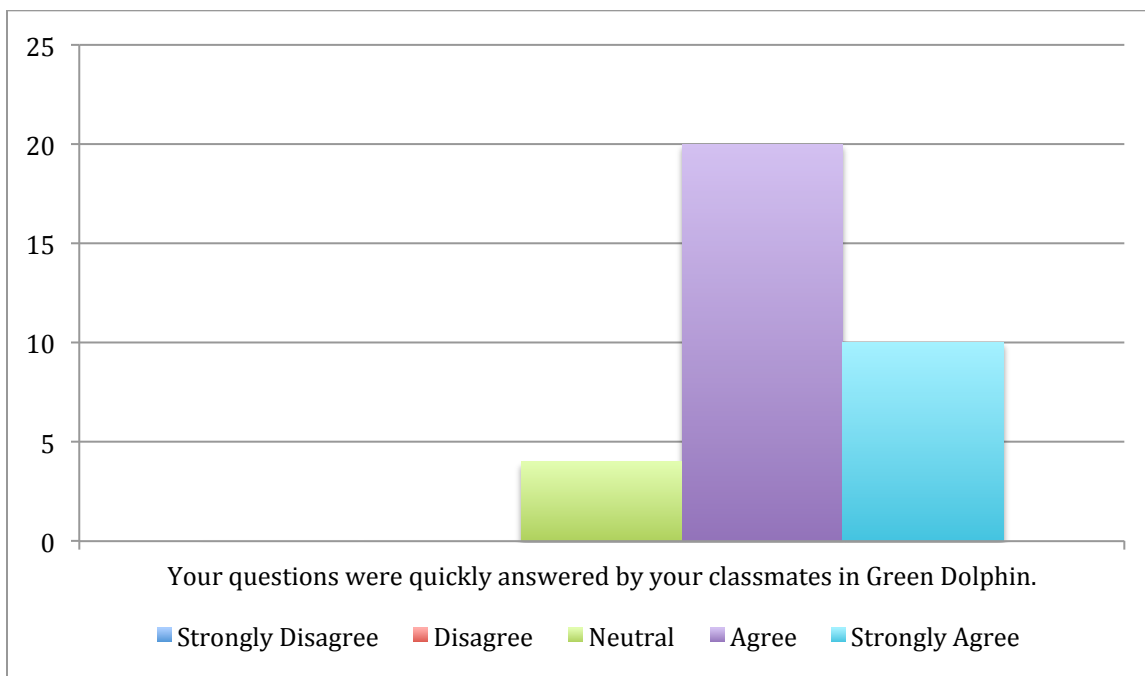


Figure 26 Your questions were quickly answered by your classmates in Green Dolphin.

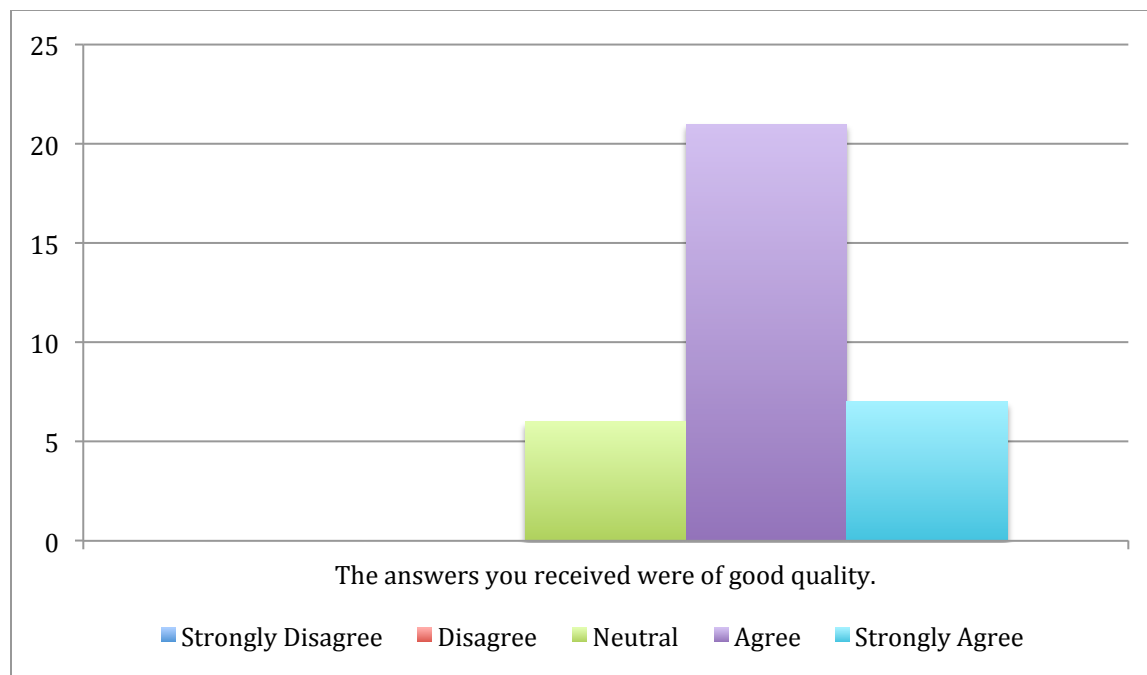


Figure 27 The answers you received were of good quality.

Thus, students accepted that most of their friends' answers were fast, and useful. These survey responses suggest that their peers' answers could accomplish students' objectives of obtaining fast and high quality answers, so they did not use the feature to receive answers from expert students or the feature to receive fast answers from the instructor.

Hypothesis 4: Green Dolphin Finds Experts Correctly.

Green Dolphin could not find experts correctly. Green Dolphin found 12 student experts. While six of these students gained the A grade, the others did not do well in the course. Thus the Z-score technique was not effective in finding expert students. Post-hoc analyses with other threshold value for Z-score did not improve the identification of students who earned high scores in the course. Thus, the Z-score was not suitable to identify experts in an educational question and answer site, and the hypothesis was not supported. One reason for this could be that the points system gave points to students for answering without considering quality of students' responses, so this function encouraged students to contribute many answers that might have improved their Z-scores, but this did not mean that they were necessarily knowledgeable. In

future research we will look into considering markers of quality, such as the number of votes received, to improve the Z-score formula.

Many students (70.59%) chose agree (Likert scale value 4) or strongly agree (Likert scale value 5) that they were proud to receive an expert role in Green dolphin. Students (26.47%) felt neutral, and one student disagreed on this topic. Students (58.82%) selected agree (Likert scale value 4) or strongly agree (Likert scale value 5) that the expert role increased their enjoyment to participate more than they would have otherwise. Some students (26.47%) selected neutral, and five students (14.71%) disagreed it. Students (61.76%) selected agree (Likert scale value 4) and strongly agree (Likert scale value 5) that the expert role increased their enjoyment to participate more than they would have otherwise. Some students (26.47%) felt neutral, and 8.82% of students, 3 students, disagreed on this sentence. Thus, the expert role could motivate some students to participate Green Dolphin, and students felt positive and proud to gain the expert role.

Hypothesis 5: Students Prefer the User interface for Answering a Question in Green Dolphin over Piazza.

Twenty students, 60.61% of students, selected agree (Likert scale value 4) or strongly agree (Likert scale value 5) that Piazza was enjoyable to use, but this was not statistically significant. Twenty-five students, 73.53% of students, selected agree (Likert scale value 4) or strongly agree (Likert scale value 4) that they enjoyed using Green Dolphin. Green Dolphin had more students who agreed that it was enjoyable to use than those who agreed that Piazza was easy to use. Twenty students, 60.61% of students, selected agree (Likert scale value 4) or strongly agree (Likert scale value 5) that they liked the user interface of Piazza. Five students chose strongly disagree or disagree with the statement about liking the user interface of Piazza. Twenty-two students, 64.7% of students, chose agree (Likert scale value 4) or strongly agree (Likert scale value 5) that they liked the user interface of Green Dolphin, but 14.7% of students,

5 students, disagreed on the sentence. Therefore, some students liked or disliked the user interfaces of both systems. If students dislike the user interface of software, they will not use it. A student stated that he/she did not answer or ask a question in Piazza because he/she did not like the user interface of Piazza. Other students liked both user interfaces. However, Green Dolphin had more students agree that it was enjoyable to use than Piazza. But this result did not reach statistical significance.

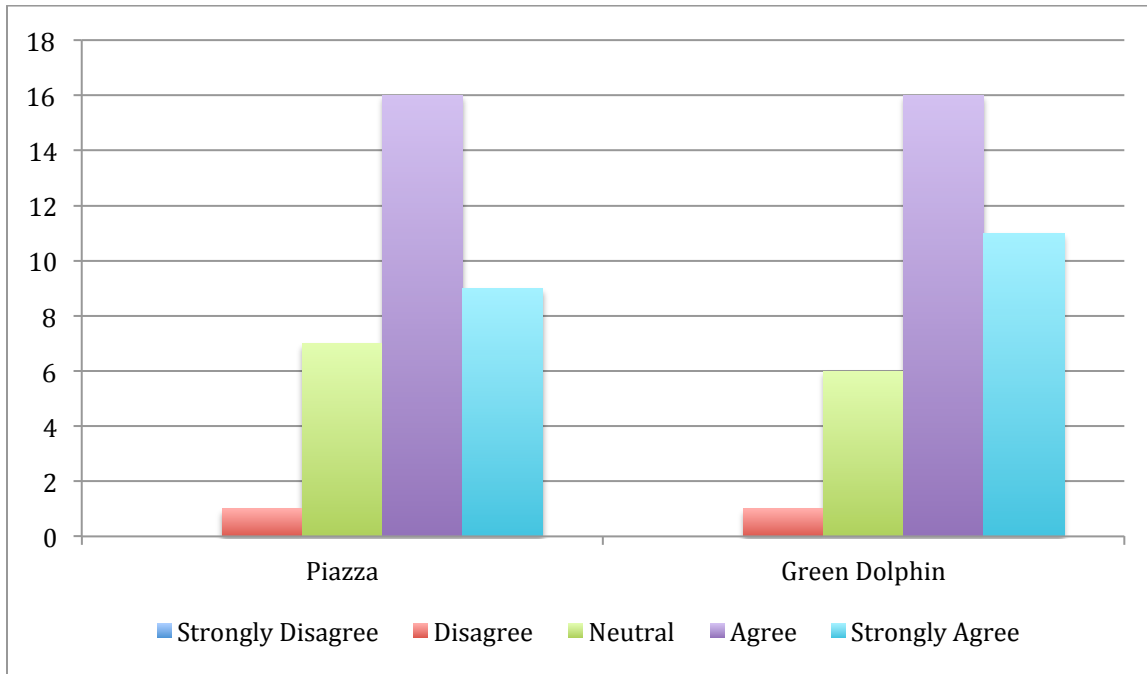


Figure 28 Piazza or Green Dolphin were easy to use.

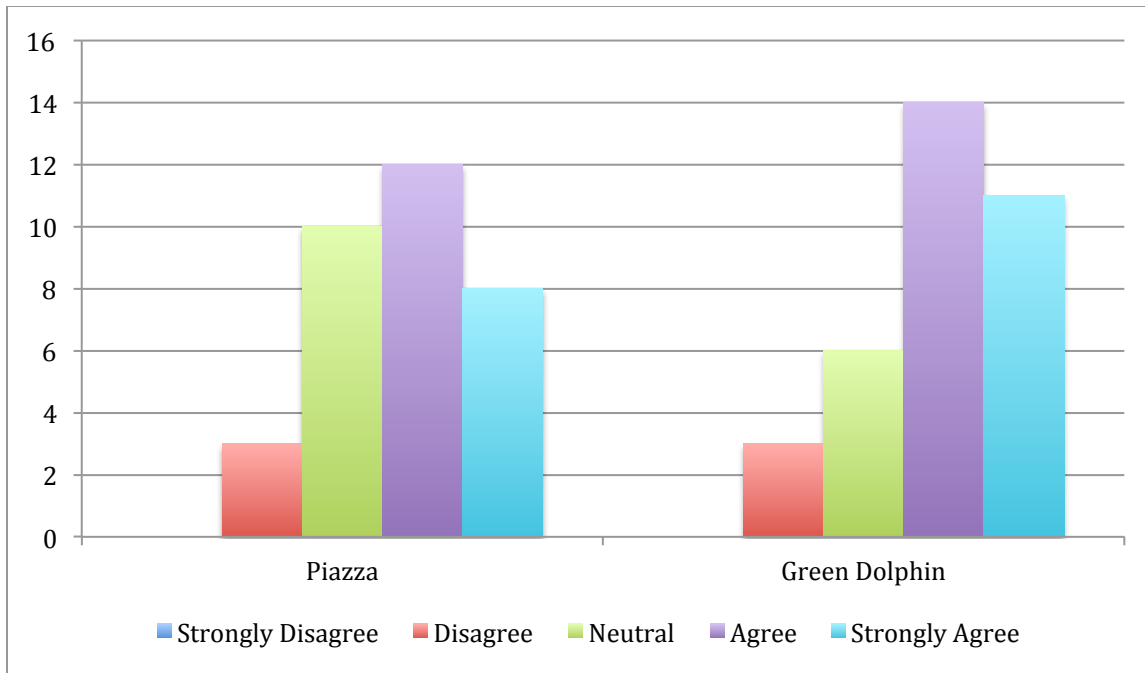


Figure 29 Piazza or Green Dolphin were enjoyable to use.

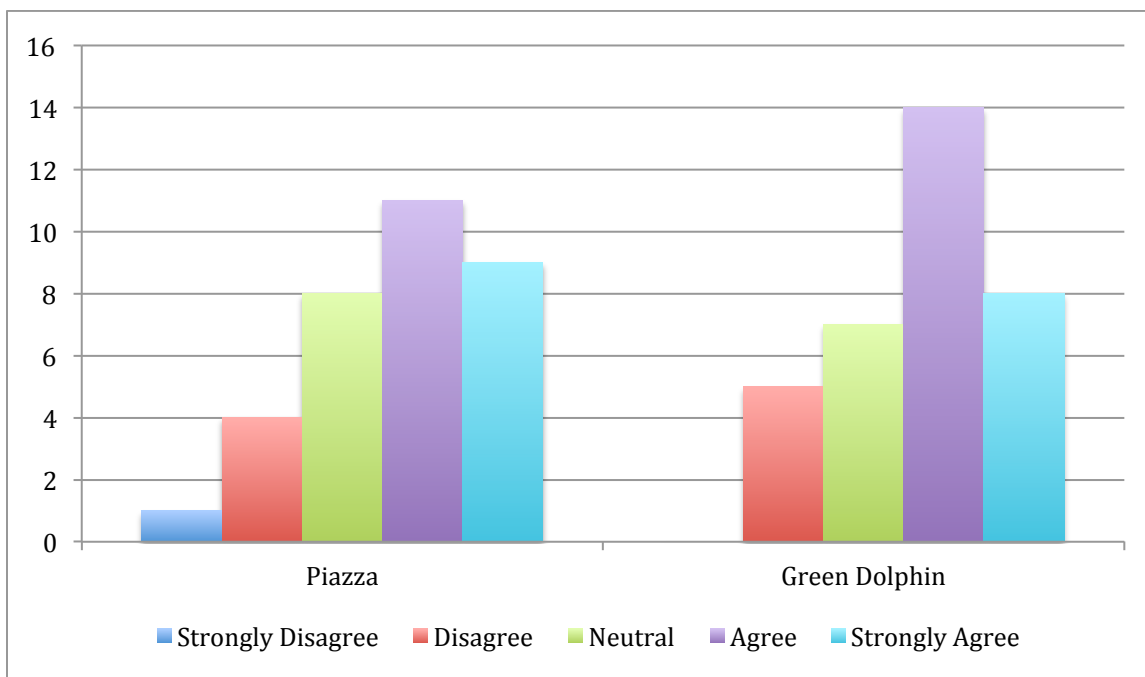


Figure 30 Students like the user interface of Piazza or Green Dolphin.

From the open-ended questions, we found that 51.52% of students said that they liked Piazza because of its user interface, but 57.58% of students said that they disliked its user interface. Some said that the user interface of Piazza was complicated, but that it was easy to navigate between questions.

“The interface was very easy to figure out and navigate, the tags for topics made it easy to find what you were looking for. Allowing an instructor to endorse a response.”

“The whole screen has too many things in it. It looks quite messy.”

Many students (32.35%) answered open-ended questions that they liked Green Dolphin because of its user interface, but 20.59% of students said that they did not like the user interface of Green Dolphin. The user interface of Green Dolphin is simple and clean, but students found it is hard to navigate between questions. This may be because, unlike Piazza, Green Dolphin shows the contents (question, answers and comments) of each question on a separate page.

“...simple layout and interface.”

“I did not like the presentation of the content. It felt like a WordPress blog. It was difficult to find previous questions and to know if a question was already answered correctly.”

A lot of students (55.88%) preferred the user interface of Green Dolphin to the user interface of Piazza (38.24%). Students liked the user interface of Green Dolphin, because it was clean and minimal.

“I preferred Green Dolphin's layout. It was cleaner and less cluttered than Piazza's interface.”

“I prefer Green Dolphin, because the user interface was easy to understand and use. It was very clear unlike piazza, where the screen was filled up with too many things.”

Students who preferred Piazza did so because they could navigate questions and answers easily. Piazza provided all questions on a single screen, so students did not have to navigate among pages.

“Piazza. It has a better interface. It is easier to navigate. ”

“Piazza. Cool interface and comprehensive functions can be done there.”

“Piazza, because its more intuitive to use. Green dolphin needs to make switching back and forth between ...”

One difference between the two systems is that Green Dolphin shows each student answer separately, with the student's name attached to each answer, whereas Piazza presents only one students answer, and lets other students to edit it. Students liked this feature of Green Dolphin. 58.82% of students, 20 students, chose agree or strongly agree that seeing their name on answers motivated them to answer more questions. Eleven students, 32.35% of students, feel neutral on this sentence, and three students disagreed on this sentence.

This hypothesis was not supported. Overall, students liked Green Dolphin because of its clean and simple interface and the display of separate student answers with authorship information, but did not like the fact that they had to navigate among question pages. Students liked Piazza because it showed all questions and answers in one page. In future redesign, we will reduce the need for navigating among pages to peruse questions in Green Dolphin.

Hypothesis 6: The Delay Answers Mechanism and Its User Interface do not Produce User Dissatisfaction.

This hypothesis was not supported. Sixteen Students agreed that the delay mechanism decreased their satisfaction, but it was not statistically significant. Still 50% of students disliked this system. This problem was a concern for us when we implemented the delay mechanism in Green Dolphin.

Hypothesis 7: Green Dolphin is Easier to Use and Learn than Piazza.

This hypothesis was not supported. Students agreed that both systems were easy to use. Average Likert scale value about this question was 4 out of five for Piazza and 4.09 out of five in Green Dolphin. Thus, Green Dolphin and Piazza were both easy to use and learn.

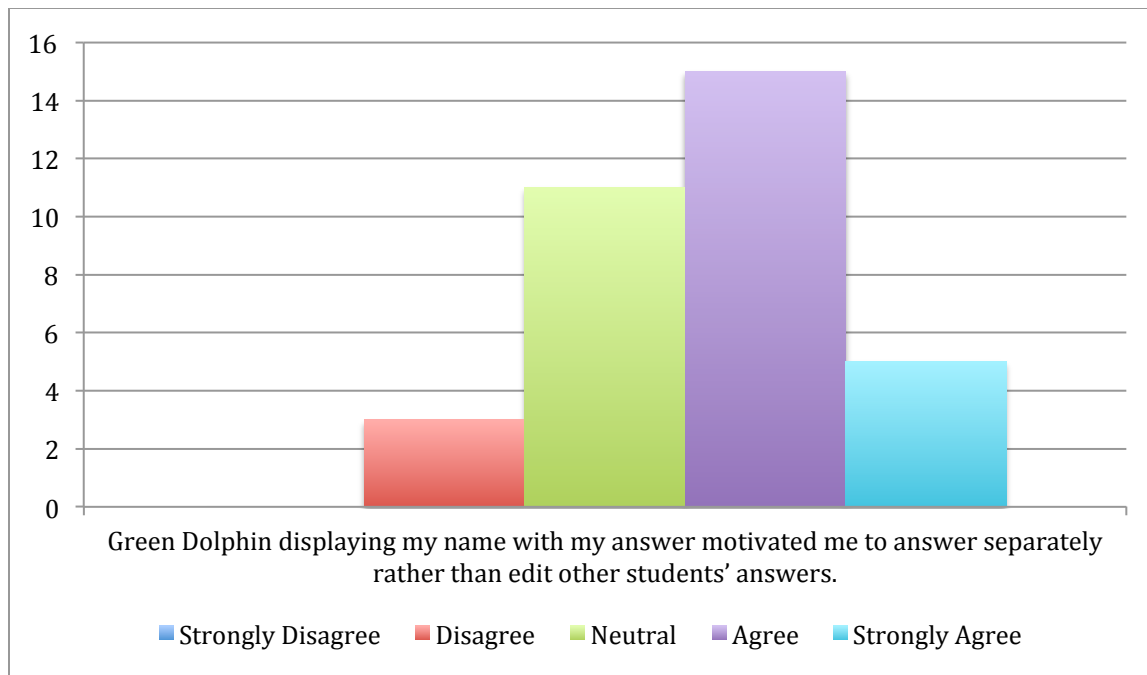


Figure 31 Green Dolphin displaying my name with my answer motivated me to answer separately rather than edit other students' answers.

Hypothesis 8: Green Dolphin will Encourage More Student Participation than Piazza.

Green Dolphin had more questions and answers than Piazza. Green Dolphin had 63 questions and 181 answers, whereas Piazza had 28 questions and 44 answers. The average number of students' answers in Piazza was 1.571 (SD= 0.959). The average number of students' answers in Green Dolphin was 2.873(SD= 1.581). The median number of students' answers in Piazza was 2, and the median number of students' answers in Green Dolphin was 3. The mode number of students' answers in Piazza was 2, and the mode number of students' answers in Green Dolphin was 3. Green Dolphin had significantly more students' answers than Piazza significantly ($t(89) = -4.031, p < 0.001$). Green Dolphin could motivate students to ask and answer more questions than Piazza. One confounding factors is the different number of assignments between first and second phases of the study, since the second phase had one assignment more than the first phase. We could not avoid this mismatch due to the course schedule. Therefore,

though this hypothesis is supported by the current data, it needs to be retested while keeping the student work constant.

Research Question 1: What Encourages Students to Answer their Classmates' Questions in Green Dolphin?

Students' motivations were similar to Naver users' motivations as reported in the literature. They answered questions because of altruism, education, earning points, and earning extra credit. Some students (17.65%) stated they would like to help their classmates to solve their problems. Students felt happy to assist their friends. Few students (8.82%) wished that if they helped others, their friends would in return help them in the future. Students (8.82%) said they learnt by doing, meaning participating in the web sites. Some students (29.41%) wanted to share their knowledge. Other Students (11.76%) said they verified their knowledge by answering questions. Some students (14.71%) said their motivation was collecting reward points to be on the top of the leaderboard. One student needed extra credit for the class. Another student participated because he/she enjoyed Green Dolphin. The following student quotes illustrate these motivations.

“I wanted to help other students and to better understand myself as well.”

“Spreading knowledge is a good feeling altogether.”

“I was willing to help others in the hope that if I needed help, someone else would help me like I was helping them.”

“If I know the answer then I would obviously answer the question, and those points for answering someone's question also motivated me a lot”

“Assisting with understanding. Gaining experience. Earning points (competing with other students)”

A lot of students realized the intrinsic value of a question and answer site. Thirty students, 88.24% of students, chose agree or strongly agree with the statement that they gained

new perspectives from seeing others students' answers or comments. Four students, 11.76% of students, felt neutral about this sentence. A question and answer board is useful in a class because students are able to gain new perspectives from friends' answers or questions. Students would like to be part of a community and to sustain it. All female students and most males talked about helping their friends and learning, but many men stated they answered questions because of reward points.

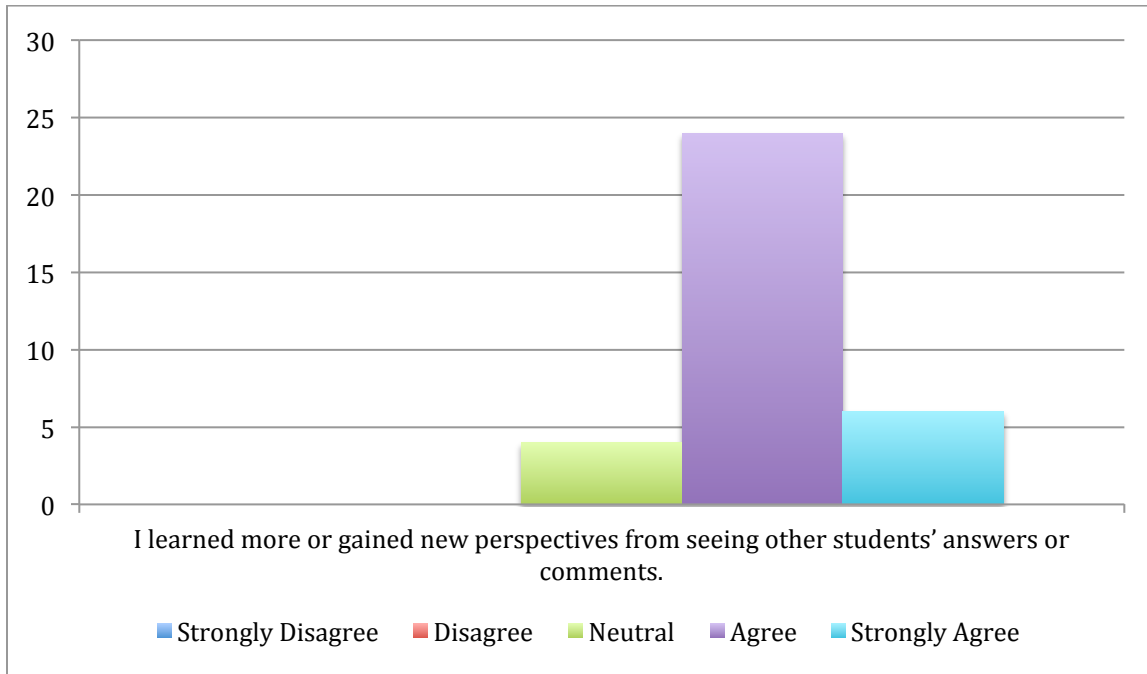


Figure 32 I learned more or gained new perspectives from seeing other students' answers or comments.

Research Question 2: Which Devices are Popular for Accessing Green Dolphin - Desktops, Mobile Phones, or Tablets?

Users visited Green Dolphin from computers 1222 times and from mobile devices for 287 times. The visits from mobile devices were 23.486% of all visits. The visits from tablets were 4.1% of all visits. The visits from mobile phones were 14.9% of all visits. A student complained that he did not use Piazza because it was hard to type an answer in Piazza on his

tablet. The data showed that visits from mobile gadgets were less than traffic from desktop/laptop computers, but it is still mandatory to support mobile devices.

Research Question 3: What Types of Questions do Students Ask?

Students asked 63 questions in Green Dolphin. There were seven types of questions in total. Questions about assignments were the majority, or 82.54% of questions. Students asked questions about topics in the class for (4.76% of questions). Questions about the exam were 3.18% of questions. Students asked the professor questions (3.18% of questions). One student asked a question to share knowledge about an advance algorithm (1.58% of questions). Another student shared his tips and tricks to submit an assignment. Thus, students used Green Dolphin to solicit classmates' help for their homeworks, exams and to share the knowledge they have with others.

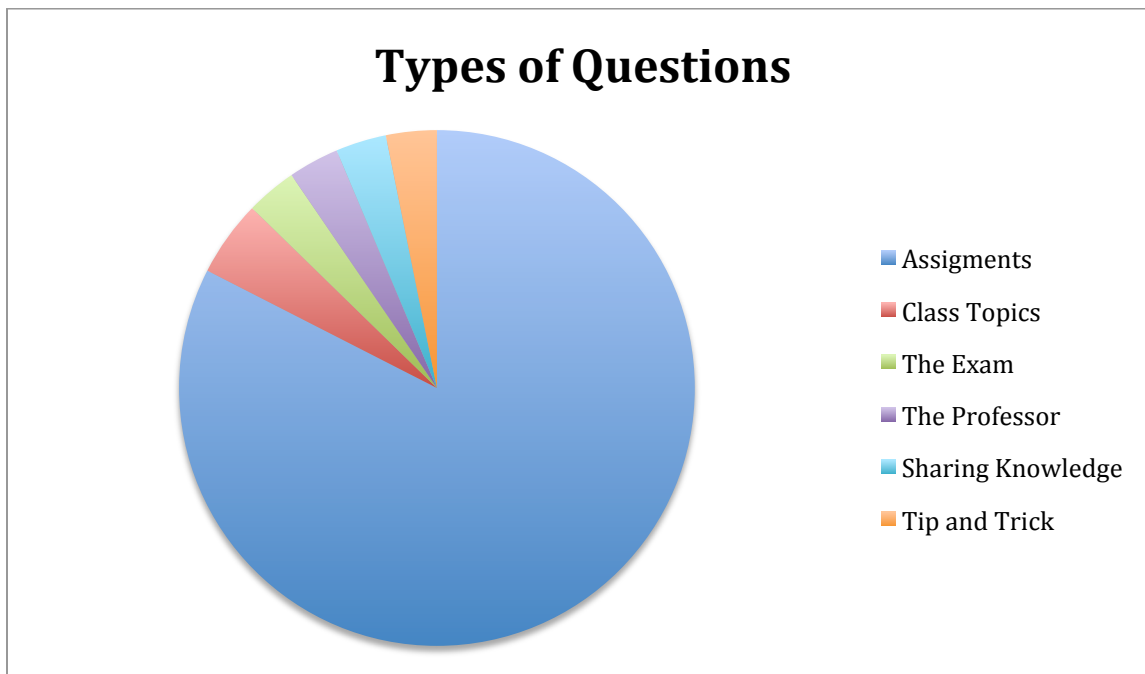


Figure 33 Types of questions in Green Dolphin

Threats to Validity

The experiment had two phases for Piazza and Green Dolphin. The lecturer taught different topics in both periods. Therefore, students may discuss more on some topics than other

topics. It was impossible to control for course topic difficulty, assignments, and exams, while the experiment was running. It was not possible to counter balance exposure to Piazza and Green Dolphin, so that half of the participants saw Piazza in the first phase and Green Dolphin in the second phase and the other half vice versa, because of time constraints. All students in the class were graduate students, so users' educational levels were not diversified. It is not clear whether these results would extend to an undergraduate course. The number of students who participated in the study was relatively small. The small sample size may mean that data is not normally distributed, which was an assumption used in our statistical tests. These factors need to be kept in mind when interpreting results of the experiment.

CHAPTER 8

CONCLUSIONS

We designed an educational question and answer website, named Green Dolphin. We conducted an experiment comparing Green Dolphin with a similar and popular commercial system, Piazza, in a graduate level class. We investigated the performance of the delay mechanism, which delayed teachers' and teacher assistants' answers, to encourage students to contribute more. Green Dolphin has an expert identification system, and a reward system. We compared Green Dolphin with Piazza. We found that the delay mechanism of Green Dolphin could increase students' participation, and that its point system encouraged students to ask and answer more questions. The expert identification did not work effectively, but students felt proud to be identified as experts. Moreover, students said that they learned new knowledge from both of the question and answer sites, so students realized the intrinsic value of a question and answer board. The most questions students asked were related to their homework.

8.1 Future Work

The expert system did not work as we expected. We need to consider the quality of students' questions and answers to identify truly expert students. This is one aspect of our future work.

The reward system of Green Dolphin created some low quality answers and questions. Many students complained in the surveys that the low quality of those contributions was annoying. This problem occurred, since students gamed the system to get more points by submitting low quality responses. We redesigned the reward system so that it considered the quality of students' answers or questions for earning points. Students could gain many points from other students' useful votes, but they would receive only a few points from their

contributions. Many professional question and answer websites use this technique to control quality of users' contributions. The redesigned reward system needs to be tested in future work.

We found that students did not click the useful vote button as much as we had expected. This means that Green Dolphin was not quite effective in harnessing users' feedback to identify quality of questions and answers. The average number of useful votes per question was 1.1667, and the average number of useful votes per answer was 1.2995. Less than 10% of students in the class used the voting mechanism. We think that adding a badge system may solve this problem. The badge system could increase users' responses without decreasing their quality (Denny, 2013). Students have to vote for many questions and answers to gain badges to represent their participation level. They may feel proud to earn badges. The badge system may encourage students to vote on more questions and answers, so users will have more information for judging the quality of questions and answers. Moreover, we may change the virtual incentive from points to snacks or soft drinks because students like food as reward (Heimerl, Gawalt, Chen, Parikh, & Hartmann, 2012).

An analysis of the email behavior of students, i.e., whether they opened a notification email and whether they clicked on links in such emails to take them to questions, answers, etc., showed that if Green Dolphin increased number of emails per week from 719 emails to 1767 emails, the percent of opened emails would drop from 49.10% to 34.56%. Many students wrote in the survey that they felt annoyed because they received too many emails per day, but some students liked Green Dolphin because of quick email notifications. Every student had a different threshold for emails per day. Thus, students should be able to adjust the number of emails, which they would like to receive per day by being able to select various digest options. An alternate approach would be that Green Dolphin should be able to send a daily summary email to users, so students will get only one email per day. This is part of future improvement of Green Dolphin.

The instructor and some students preferred inline tags. They would like to add tags in the content of a question or an answer, and create tags by themselves, somewhat similar to the hashtags of Facebook and Twitter. In future, Green Dolphin has to provide a HTML editor that supports an inline tag.

This concludes the discussion of future enhancements planned for Green Dolphin. In addition, the improved system needs to be reevaluated in larger courses taken by undergraduate as well as graduate students.

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APPENDIX A

QUESTIONS OF SURVEYS

Likert Scale Questions about Piazza

Each question has 5 scales, strongly disagree, disagree, neutral, agree, and strongly agree.

- Your questions were satisfactorily answered by your classmates in Piazza.
- Your questions were quickly answered by your classmates in Piazza.
- The answers you received were of good quality.
- Communication in Piazza is better than an email.
- Piazza is easy to use.
- Piazza is enjoyable to use.
- You like the user interface of Piazza.
- You would not answer someone's question in Piazza if you saw that the professor or the TA has already answered it.
- You would not answer someone's question in Piazza if you saw answers from outstanding students.
- You would not answer someone's question in Piazza if you saw there was already a correct answer.
- You feel that users in Piazza are willing to assist you.
- You like to help other students in the class by answering their questions in Piazza.

- You would like to use Piazza in a class in the future.
- You would like to recommend Piazza to an instructor to use in the future.

Open-Ended Questions about Piazza

- What are your motivations in answering other students' questions?
- What are some of the reasons you did not answer other students' questions?
- What do you like in Piazza?
- What do you dislike in Piazza?

Likert Scale Questions of Green Dolphin

Each questions has 5 scales, strongly disagree, disagree, neutral, agree, and strongly agree.

- Your questions were satisfactorily answered by your classmates in Green Dolphin.
- Your questions were quickly answered by your classmates in Green Dolphin.
- The answers you received were of good quality.
- Communication in Green Dolphin is better than an email.
- Green Dolphin is easy to use.
- Green Dolphin is enjoyable to use.
- You like the user interface of Green Dolphin.
- You would not answer someone's question in Green Dolphin if you saw that the professor or the TA has already answered it.
- You would not answer someone's question in Green Dolphin if you saw answers from outstanding students.
- You would not answer someone's question in Green Dolphin if you saw there was already a correct answer.
- You feel that users in Green Dolphin are willing to assist you.

- You like to help other students in the class by answering their questions in Green Dolphin.
- You would like to use Green Dolphin in a class in the future.
- You would like to recommend Green Dolphin to an instructor to use in the future.
- I found being able to earn “points for the leaderboard” increased my enjoyment of using Green Dolphin.
- The “points for the leaderboard” motivated me to participate more than I would have otherwise.
- I found being able to earn “expert role” increased my enjoyment of using Green Dolphin.
- The “expert role” motivated me to participate more than I would have otherwise.
- I felt proud if I were selected by Green Dolphin for the “expert role.”
- Green Dolphin displaying my name with my answer motivated me to answer separately rather than edit other students’ answers.
- I learned more or gained new perspectives from seeing other students’ answers or comments.
- I believe that students identified as experts by Green Dolphin can help answer my questions.
- Did the delay mechanism (delaying notifying instructor/TA of your question so as to give time to other students to answer) decrease your satisfaction in Green Dolphin?

Open-Ended Questions about Green Dolphin

- What are your motivations in answering other students’ questions?
- What are some of the reasons you did not answer other students’ questions?
- Did you spend points to use the fast answer facility or to ask experts?
- What do you like in Green Dolphin?

- What do you dislike in Green Dolphin?
- If you prefer one interface (Green Dolphin or Piazza) over the other, please explain why.

APPENDIX B

QUANTITATIVE DATA

Quantitative Data on Piazza Use

Thirty-three students answered the survey.

Question	Strongly Disagree (1)	Disagree (2)	Neutral (3)	Agree (4)	Strongly Agree (5)	Standard Deviation	Mean
Your questions were satisfactorily answered by your classmates in Piazza.	0	0	3	25	5	.496	4.06
Your questions were quickly answered by your classmates in Piazza.	0	0	11	17	5	.683	3.82
The answers you received were of good quality.	0	1	5	21	6	.684	3.97
Communication in Piazza is better than an email.	0	2	4	13	14	.882	4.18
Piazza is easy to use.	0	1	7	16	9	.791	4.00
Piazza is enjoyable to use.	0	3	10	12	8	.936	3.76
You like the user interface of Piazza.	1	4	8	11	9	1.104	3.70
You would not answer someone's question in Piazza if you saw that the professor or the TA has already answered it.	0	3	3	15	12	.914	4.09
You would not answer someone's question in Piazza if you saw	3	10	10	6	4	1.171	2.94

answers from outstanding students.							
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Question	Strongly Disagree (1)	Disagree (2)	Neutral (3)	Agree (4)	Strongly Agree (5)	Standard Deviation	Mean
You would not answer someone's question in Piazza if you saw there was already a correct answer.	0	4	1	18	10	.918	4.03
You feel that users in Piazza are willing to assist you.	0	1	4	23	5	.637	3.97
You like to help other students in the class by answering their questions in Piazza.	0	0	4	18	11	.650	4.21
You would like to use Piazza in a class in the future.	0	0	4	19	10	3	4.18
You would like to recommend Piazza to an instructor to use in the future.		1	2	21	9	.667	4.15

Analyzed Quantitative Data on Piazza Use

Question	Chi-Square	df	Asymptotic Significance
Your questions were satisfactorily answered by your classmates in Piazza.	26.909	2	.000
Your questions were quickly answered by your classmates in Piazza.	6.545	2	.038
The answers you received were of good quality.	27.970	3	.000
Communication in Piazza is better than an email.	13.667	3	.003
Piazza is easy to use.	13.909	3	.003
Piazza is enjoyable to use.	5.424	3	.143
You like the user interface of Piazza.	9.879	4	.043
You would not answer someone's question in Piazza if you saw that the professor or the TA has already answered it.	13.909	3	.003
You would not answer someone's question in Piazza if you saw answers from outstanding students.	6.545	4	.162
You would not answer someone's question in Piazza if you saw there was already a correct answer.	20.455	3	.000
You feel that users in Piazza are willing to assist you.	36.212	3	.000
You like to help other students in the class by answering their questions in Piazza.	8.909	2	.012

You would like to use Piazza in a class in the future.	10.364	2	.006
You would like to recommend Piazza to an instructor to use in the future.	30.879	3	.000

Quantitative Data on Green Dolphin Use

Thirty-four students answered the survey.

Question	Strongly Disagree (1)	Disagree (2)	Neutral (3)	Agree (4)	Strongly Agree (5)	Standard Deviation	Mean
Your questions were satisfactorily answered by your classmates in Green Dolphin.	0	0	3	23	8	.558	4.15
Your questions were quickly answered by your classmates in Green Dolphin.	0	0	4	20	10	.626	4.18
The answers you received were of good quality.	0	0	6	21	7	3	4.03
Communication in Green Dolphin is better than an email.	0	2	2	13	17	.843	4.32
Green Dolphin is easy to use.	0	1	6	16	11	.793	4.09
Green Dolphin is enjoyable to use.	0	3	6	14	11	.937	3.97
You like the user interface of Green Dolphin.	0	5	7	14	8	.994	3.74
You would not answer someone's question in Green Dolphin if you saw that the professor or the TA has already answered it.	0	5	4	17	8	.968	3.82
You would not answer someone's question in Green Dolphin if you saw answers from outstanding students.	1	9	12	8	4	1.048	3.15
You would not answer someone's question in Green Dolphin if you saw there was already a correct answer.	0	3	5	17	9	.886	3.94

Question	Strongly Disagree (1)	Disagree (2)	Neutral (3)	Agree (4)	Strongly Agree (5)	Standard Deviation	Mean
You feel that users in Green Dolphin are willing to assist you.	0	3	5	17	9	.558	4.15
You like to help other students in the class by answering their questions in Green Dolphin.	0	0	5	20	9	.640	4.12
You would like to use Green Dolphin in a class in the future.	1	2	3	17	11	.969	4.03
You would like to recommend Green Dolphin to an instructor to use in the future.	0	3	6	17	8	.005	3.88
I found being able to earn “points for the leaderboard” increased my enjoyment of using Green Dolphin.	1	5	7	15	6	1.048	3.59
The “points for the leaderboard” motivated me to participate more than I would have otherwise.	1	5	7	15	6	.925	3.59
I found being able to earn “expert role” increased my enjoyment of using Green Dolphin.	0	5	9	15	5	.864	3.74
The “expert role” motivated me to participate more than I would have otherwise.	0	3	9	17	5	.836	3.71
I felt proud if I were selected by Green Dolphin for the “expert role.”	0	1	9	14	10	.834	3.97
Green Dolphin displaying my name with my answer motivated me to answer separately rather than edit other students’ answers.	0	3	11	15	5	.849	3.65

Question	Strongly Disagree (1)	Disagree (2)	Neutral (3)	Agree (4)	Strongly Agree (5)	Standard Deviation	Mean
I learned more or gained new perspectives from seeing other students' answers or comments.	0	0	4	24	6	.547	4.06
I believe that students identified as experts by Green Dolphin can help answer my questions.	0	1	10	17	6	.758	3.82

Question	Yes (1)	No (2)	Standard Deviation	Mean
Did the delay mechanism (delaying notifying instructor/TA of your question so as to give time to other students to answer) decrease your satisfaction in Green Dolphin?	16	18	.507	1.47

Analyzed Quantitative Data on Green Dolphin Use

Question	Chi-Square	df	Asymptotic Significance
Your questions were satisfactorily answered by your classmates in Green Dolphin.	19.118	2	.000
Your questions were quickly answered by your classmates in Green Dolphin.	11.529	2	.003
The answers you received were of good quality.	12.412	2	.002
Communication in Green Dolphin is better than an email.	20.824	3	.000
Green Dolphin is easy to use.	14.706	3	.002
Green Dolphin is enjoyable to use.	8.588	3	.035
You like the user interface of Green Dolphin.	5.294	3	.151
You would not answer someone's question in Green Dolphin if you saw that the professor or the TA has already answered it.	12.353	3	.006
You would not answer someone's question in Green Dolphin if you saw answers from outstanding students.	11.000	4	.027
You would not answer someone's question in Green Dolphin if you saw there was already a correct answer.	13.529	3	.004
You feel that users in Green Dolphin are willing to assist you.	19.118	2	.000
You like to help other students in the class by answering their questions in Green Dolphin.	10.647	2	.005
You would like to use Green Dolphin in a class in the future.	28.353	4	.000
You would like to recommend Green Dolphin to an instructor	12.824	3	.005

to use in the future.			
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Question	Chi-Square	df	Asymptotic Significance
I found being able to earn “points for the leaderboard” increased my enjoyment of using Green Dolphin.	15.412	4	.004
The “points for the leaderboard” motivated me to participate more than I would have otherwise.	7.882	3	.049
I found being able to earn “expert role” increased my enjoyment of using Green Dolphin.	10.941	3	.012
The “expert role” motivated me to participate more than I would have otherwise.	13.529	3	.004
I felt proud if I were selected by Green Dolphin for the “expert role.”	10.471	3	.015
Green Dolphin displaying my name with my answer motivated me to answer separately rather than edit other students’ answers.	10.706	3	.013
I learned more or gained new perspectives from seeing other students’ answers or comments.	21.412	2	.000
I believe that students identified as experts by Green Dolphin can help answer my questions.	16.118	3	.001
Did the delay mechanism (delaying notifying instructor/TA of your question so as to give time to other students to answer) decrease your satisfaction in Green Dolphin?	.118	1	.732

APPENDIX C

QUALITATIVE DATA

Qualitative Data on Piazza Use

Thirty-three students answered the survey, but not everyone answered the open ended questions in it. These answers have been coded by the experimenter as shown below.

What are your motivations in answering other students' questions?

Answers coded as: Students answered and understood the subject.	
Gender	Users' answers
Male	By helping students I better understand the material I am explaining
Male	The fact that I would have a more familiar approach that would possibly help them understand my answer better. Also, when answering someone else's question, you often find that your understanding is better.
Male	Besides, answering other students' questions also helps me understand things better.
Male	Encouraging discussion leading to a deeper understanding of the topic.
Male	To know about what others also think about the same problem and come to know other point of views and approaches to solve one problem
Male	In some cases, I wanted to exercise my understanding of the question being answered and in others I just wanted to help. I think helping answering another student's question helps me have a better understanding as well.
Male	Help and talk with others. I will know the questions more clearly.
Female	By clearing the doubt I will clarify myself
Total	8 students (7 males and 1 female)

Answers coded as: Students would like to help their friends.	
Gender	Users' answers
Male	Help other students
Male	I also believe that I should help answer other students questions just as they have helped answer mine.
Male	and also help others
Male	To offer assistance and participate.

Female	To help out as much as possible
Female	It's a helpful community effort. We can all help each other understand concepts outside of the classroom without having to schedule meetups that are difficult because of everyone's schedules. Also, it's less intimidating to try to answer or ask a question online when you have some anonymity.
Female	For homeworks, it helps everyone to get the right answer
Female	give and take
Total	8 students (4 males and 4 females)

Answers coded as: Students shared their knowledge.	
Gender	Users' answers
Male	Spread of Knowledge. Both ways.
Male	share ideas with others
Male	By helping others even I would learn from the discussions.
Total	3 students (3 males)

Answers coded as: Students learnt new knowledge.	
Gender	Users' answers
Male	Help others to solve problem is also a way to learn more knowledge.
Male	improve others' and my knowledge
Male	Sharing knowledge is definitely a joyful thing to do.
Male	we help others and we even get to know new things in a discussion
Male	Objective is to learn and share. Also, if the question is logically intriguing, it makes me answer those questions.
Total	5 students (5 males)

Answers coded as: Students needed extra credits.	
Gender	Users' answers
Male	extra credit
Male	extra credit
Male	and get extra credits
Total	3 students (3 males)

Answers coded as: Students knew answers.	
Gender	Users' answers
Female	If I know an answer and I have time to do it, I will.
Female	If I know the answer for the question, and if the correct answer is not posted
Female	When I'm confident that the answer I know is correct and if no one has answered it yet.
Total	3 students (3 females)

Answers coded as: Students needed feedback.	
Gender	Users' answers
Male	Presenting my personal opinion, while helping others, I can also receive the feedback.

Male	To offer my insight and find out if I was wrong.
Female	I wanted to check whether my idea is right.(expecting other student's comment)
Total	3 students (2 males and 1 female)

Answers coded as: Students did not have motivation.	
Gender	Users' answers
Male	None really, except the hope that my questions will be answered if I have any.
Total	1 students (1 male)

What are some of the reasons you did not answer other students' questions?

Answers coded as: Questions gained useful answers.	
Gender	Users' answers
Male	Mostly if another answer was already post that I believed was the most correct or if I just didn't understand the question or answer.
Male	Either those were already answered correctly
Male	If there was already a correct answer
Male	Helpful answers were already posted.
Male	Other answers to the question sounded more correct than mine, so I avoided saying that other students were wrong
Male	Already have excellent answers
Male	or current answers are good enough.
Male	Other people had already given a detailed answer
Male	or something I thought was correct was already stated).
Male	Worried I would not be correct
Male	I also do not know
Male	I wasn't sure may be!
Male	I can not find the correct answers or some has given right answers.
Female	because I don't know the answer about questions
Female	I wasn't sure if my answer was correct
Female	Correct answers are already there.
Female	If I saw sth correct, I don't answer them.
Female	If the correct answer is alreday posted
Female	As an outreach student I am always a little behind the in class students getting to assignments. There was usually a correct answer already there by the time I accessed the question.
Total	19 students (13 males and 6 females)

Answers coded as: Students could not answer questions.	
Gender	Users' answers
Male	I don't know the answer.
Male	do not konw the answer
Male	, or I was unsure of the answer myself.
Male	I did not know the answer.

Male	Some questions are not easy to answer.
Male	1) Didn't know how to present my thoughts.
Male	they were already answered
Male	Questions directed directly towards TA or the professor.
Female	, when I don't know the answer and when I'm not confident that I answer I know is correct.
Female	I did not answer any questions to which I did not feel I had any knowledge or worthwhile contribution to. I answered questions that I was fairly certain I was correct about.
Total	10 students (8 males and 2 females)

Answers coded as: Questions had answers.	
Gender	Users' answers
Male	distance students were a week behind
Male	Someone else answered it already.
Male	2) Already answered
Male	Because they were already answered
Female	When the question has been already answered
Female	If it is related to mark
Total	6 students (4 males and 2 females)

Answers coded as: Instructors answered questions.	
Gender	Users' answers
Male	or they were answered by the TA or instructor.
Male	, or some questions did not need any answer.
Male	I did not feel I had something more to contribute (either a TA or the professor had already answered)
Female	The instructor of TA already answered the questions.
Total	4 students (3 males and 1 females)

Answers coded as: Questions were low quality.	
Gender	Users' answers
Male	The question is not clearly stated,
Male	And also if the question seems primitive and the answer seems obvious.
Total	2 students (2 males)

What do you like in Piazza?

Answers coded as: Students liked the users interface of Piazza.	
Gender	Users' answers
Male	Fancy graphic interfaces.
Male	Clear UI; easy to use; feeling motivated to communicate.
Male	GUI
Male	The mobile app give notifications each time a question is answered.
Male	Clarification of topics and confirmation of answers.

Male	Student-teacher interactions.
Male	History of the questions. LaTeX equation editor. interface.
Male	User interface was very logical and easy. Seamless flow.
Male	The whole interface for each question and its own discussion list for each question. Also involvement of instructors helps alot.
Male	The interface was very easy to figure out and navigate, the tags for topics made it easy to find what you were looking for. Allowing an instructor to endorse a response.
Male	I like convenience in Piazza.
Male	I like the mobile client (Android App) and the Latex equation support. I did like that each question had one answer and it was a community supplied answers. I also like the built in history, so if an answer was changed, you could go back and see what the previous answers were. I think the navigation was really good along with the icons that represented Unanswered, Answered, Instructor Answered next to questions.
Female	The interface
Female	easy to communicate with class students and have discussions
Female	I can easily navigate to different questions and different topics. I can also comment on answers given by different students.
Female	I like the intuitive user interface, the ability for the students to ask questions anonymously, and that both students and professors and TAs are available to answer questions.
Female	It was easy to use and replying functions(?) were very useful to communicate with other students. The recent notification was very good.
Total	17 students (12 males and 5 females)

Answers coded as: Students liked discussion of Piazza.	
Gender	Users' answers
Male	The fact that it allowed the class as a whole discuss the homework assignments and topics covered in class. Only students taking the course could view and contribute. It also made it easier for the entire class to see the instructor's response to certain questions, which reduces redundant questions.
Male	lots of feedback
Male	Members are actively participating in discussion.
Male	Getting to knowing others questions, which is helpful
Male	discussion
Male	Group interaction all at one place. Discussing issues and their probable solutions
Female	The way that everyone can comment and help each other on assignments like a group study session.
Total	7 students (6 males and 1 female)

Answers coded as: Piazza provided quick answers.	
Gender	Users' answers
Male	I can get my answer very quickly
Male	Problems getting solved in quick time.

Female	corresponding directly
Total	3 students (2 males and 1 female)

Answers coded as: Students would like to help their friends.	
Gender	Users' answers
Male	I like the collaborative environment it creates
Male	a group of people can help you if you had questions. So, if one does not know the answer. The other people can help you.
Male	and also I can get help from others
Female	With Piazza, I can get help from people even I don't know.
Total	4 students (3 males and 1 female)

Answers coded as: Students did not have any comments.	
Gender	Users' answers
Female	I need more time to assess Piazza
Total	1 students (1 female)

What do you dislike in Piazza? - Open-Ended Response

Answers coded as: Students did not like the user interface of Piazza.	
Gender	Users' answers
Male	The user interface need to be user-friendly or can connect to cell phone when someone answer related questions.
Male	The user interface and element placement.
Male	I don't like the user interface, as it is hard to tell when things have been edited, etc.
Male	Personally, I think if the questions may be classified a little bit.
Male	the equation editor as well as the formula editor
Male	Bland colors.
Male	"thanks!" button does not feel like inviting to be used; a reputation system would probably make users more motivated to involve.
Male	Email notifications did not seem to match what it said my settings were. Follow-up discussions should not always have to be labeled as "resolved"...sometimes they were just meant to be comments.
Male	Couldn't access via mobile was a big negative. Should be designed for mobile.
Male	every 4 hours there is an email to me
Male	The equations pattern.
Male	Allowing students to edit other posts
Male	Some of the advanced features did not work very well. Trying to reply to an answer using an equation did not work at all.
Male	interface
Male	User Interface
Female	user interface is not organized
Female	Its user interface.

Female	User interface can be improved.
Female	The whole screen has too many things in it. It looks quite messy.
Total	19 students (15 males and 4 females)

Answers coded as: Students did not have any comments.	
Gender	Users' answers
Male	There is nothing as of now which I dislike in Piazza. It is a learning facilitator, very easy to use and very effective.
Male	I don't dislike anything in Piazza
Male	Piazza is Ok and I like it.
Female	Nothing, I liked everything about it.
Female	nothing yet
Female	Nothing
Female	I need more time to assess Piazza
Total	7 students (3 males and 4 females)

Answers coded as: Students did not like the community.	
Gender	Users' answers
Male	When discussions and posts got off topic.
Total	1 students (1 male)

Answers coded as: Students did not like the schedule of the class.	
Gender	Users' answers
Male	not all students were on the same schedule
Total	1 students (1 male)

Qualitative Data of Green Dolphin

Thirty-four students answered the survey. Not everyone answered the open ended questions. These answers were coded as shown below by the experimenter.

What are your motivations in answering other students' questions?

Answers coded as: They would like to help their friends.	
Gender	Users' answers
Male	To be correct and help someone out
Male	To assist other students and help them learn
Male	Help others learn things;
Male	Because I know the answer, I should help others.
Male	Helping them
Female	I want to help
Total	6 students (5 males and 1 female)

Answers coded as: They would like to share knowledge.	
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Gender	Users' answers
Male	communicate to share ideas;
Male	Spreading knowledge is a good feeling altogether.
Male	interaction leading to exchange of knowledge
Male	To show my point of view for a question and to know others which may be correct.
Male	To share my idea, and justify if this is the same as others.
Male	If the question was meaningful
Male	Helping out classmates
Male	Assisting with understanding.
Female	If I know the answer, its good to share
Female	discuss with other students and share thought
Total	10 students (8 males and 2 females)

Answers coded as: They would like to collect reward points.	
Gender	Users' answers
Male	To get points!
Male	as well as the leaderboard system
Male	Earning points (competing with other students)
Female	increasing points
Female	If I know the answer then I would obviously answer the question, and those points for answering someone's question also motivated me a lot
Total	5 students (3 males and 2 females)

Answers coded as: They would like to check their knowledge.	
Gender	Users' answers
Male	I might as well learn from my mistakes I did while answering the questions.
Male	I wanted to help other students and to better understand myself as well.
Male	make sure my answer or line of thinking was in line with others'
Female	To check my thoughts
Total	4 students (3 males and 1 female)

Answers coded as: They helped friends to inspire them to help their each others.	
Gender	Users' answers
Male	Helping other students understand the material. If I help as much as I can, it might motivate others do the same.
Male	I was willing to help others in the hope that if I needed help, someone else would help me like I was helping them.
Male	I should help other students and others can also give me answers.
Total	3 students (3 males)

Answers coded as: They would like to learn.	
Gender	Users' answers
Male	enlarge my academic scope
Male	Gaining experience.

Female	Learning by teaching
Total	3 students (2 males and 1 female)

Answers coded as: They knew the answers.	
Gender	Users' answers
Female	If I know the answer then I would obviously answer the question.
Female	If I know an answer which is not already there, i will do it.
Total	2 students (2 females)

Answers coded as: They would like to get extra credits.	
Gender	Users' answers
Male	help others and earn credits
Total	1 student (1 male)

Answers coded as: They thought it was enjoyable.	
Gender	Users' answers
Male	a lot of fun
Total	1 student (1 male)

What are some of the reasons you did not answer other students' questions?

Answers coded as: They thought that questions had correct answers.	
Gender	Users' answers
Male	There were already satisfactory answers from the TA, instructor or other students
Male	If an answer supplied was already similar to mine, or if I felt the answer they had was better, then I wouldn't answer
Male	If they were already answered correctly.
Male	Good answers were sometimes already available.
Male	If another student had provided what I believed to be a correct answer.
Male	Distance students had a later due date, and the questions were already answered.
Male	A satisfactory answer had already been given
Male	[A question] is already answered so that more answers will not contribute to the knowledge base
Male	They were trivial or had already a better answer than mine.
Female	If some one has already answered the question with the same exact answer as I wanted to answer.
Female	I am an outreach student so there was usually already a correct answer posted by the time I got to the assignment.
Female	If a correct answer is already there.
Female	correct answer is already posted
Total	13 students (9 males and 4 females)

Answers coded as: Questions had an answer.	
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Gender	Users' answers
Male	They were already answered
Male	Answer was already there.
Male	or all ready many have answered
Male	Someone already answered it .
Female	and if there is already an answer
Female	or the questions have been answered
Total	6 students (4 males and 2 females)

Answers coded as: Questions were low quality.	
Gender	Users' answers
Male	Some of those questions were repeatedly asked. So of those questions were not seriously asked.
Male	Questionnaire was not useful
Male	If I did not feel the question was "Useful".
Male	Other times questions were so irrelevant and off topic that they did not deserve answers.
Male	When the question is for fun;
Total	5 students (5 males)

Answers coded as: Questions needed instructors' answers.	
Gender	Users' answers
Male	Some questions would be best answered by the instructor, as they were about the requirements.
Male	, or it can only answered by an instructor
Total	2 students (3 males)

Answers coded as: Students did not know answers.	
Gender	Users' answers
Male	don't know answer
Male	Didn't know the answer .
Male	If I did not feel a strong belief in the correctness of my answer.
Male	I don't know the answers.
Male	I don't know too
Male	do not know the answers
Male	I didn't know the answers
Male	I don't know the answer
Male	or I did know the answer.
Male	Sometimes, I am not sure the answers.
Male	Some may be hard, so I only wait for other's answers.
Female	I have no idea
Female	Wasn't sure of my own answer
Female	When I don't know the answer
Female	Because I was not sure.

Total	15 students (11 males and 4 females)
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Answers coded as: Students did not answer assignment answers.	
Gender	Users' answers
Female	if it demands direct answer for homework assignments
Total	1 student (1 female)

Answers coded as: Students did not have time.	
Gender	Users' answers
Male	or I don't have time
Total	1 student (1 male)

Did you spend points to use the fast answer facility or to ask experts? Please explain why you did or did not spend your points.

Answers coded as: Classmates' answers could fulfill students' need.	
Gender	Users' answers
Male	Nope - questions I had were already asked/answered.
Male	No. Even I didn't use points to use the fastest answer, some other students still answer questions very quickly.
Male	No, I didn't because I didn't feel the need to rush any answers.
Male	I didn't spend points because I didn't see the need to. The discussion on the questions was already satisfactory for getting the information I needed.
Male	I didn't use extra points since there are some very good students who can offer perspective answers.
Female	I have got my answers from students. I did not ask the expert at any time.
Total	6 students (5 males and 1 female)

Answers coded as: Students did not want to use special functions.	
Gender	Users' answers
Male	I dont want to ask any experts
Male	I did not use as I was not in necessary of using it.
Male	I did, but only as a test to ask myself (since the system had identified me as an expert). Other than that, I did not use this feature.
Male	I did not since I usually spoke to classmates directly rather than use a website.
Female	No. I didn't need to
Female	No. I think students would be willing to share their idea, so I do not need to ask an expert.
Total	6 students (4 males and 2 females)

Answers coded as: Students said no without reasons.	
Gender	Users' answers
Male	I actually did use that once by mistake where I asked one question to all experts and lost all my points. But i guess its really good option In case of immediate answers.
Male	No. I don't know why. Probably I don't know enough about everybody to ask

	individuals to answer a specific question. Quora has a profile page for each user so people get to learn about others more. When people know somebody excels in an area, they will ask him/her to answer questions in that area.
Male	I did not use it before.
Female	No I never required that option. I would have definitely used it if I there was any situation where I wanted to ask an expert.
Female	Not that much. Tt
Female	No
Total	6 students (3 males and 3 females)

Answers coded as: Students did not know how to use it or forgot to use it.	
Gender	Users' answers
Male	I forgot to use that.
Male	I did not know that we can spend points
Female	I didn't know that I could do that with points
Total	3 students (2 males and 1 female)

Answers coded as: Students needed instructors to solve every question.	
Gender	Users' answers
Male	No, because it is unclear what makes a student an expert student. Maybe if it was obvious that expert students were the ones with the most answers selected as the best answer or the most useful answer. I also felt like the instructor would address all the important issues, and did not feel the need to request urgent assistance.
Total	1 student (1 male)

Answers coded as: Students did not like the reward system.	
Gender	Users' answers
Male	No, I did not like the points currency system. It just seems out of place for a tool designed for learning.
Male	No. I think that the point system is extremely flawed, and it turned this from being a learning tool into more of a social competition.
Total	2 students (2 males)

Answers coded as: The expert system had bad performance.	
Gender	Users' answers
Male	I spent points once- but I didn't see very much quick response so it didn't hold much value in the accumulating them.
Total	1 student (1 male)

Answers coded as: Students did not have enough points.	
Gender	Users' answers
Male	I did not spend my points as one of the reasons was the deduction was a lot considering the points I had.
Total	1 student (1 male)

Answers coded as: Students would like to save their points.	
Gender	Users' answers
Male	No. I wanted to have the most points.
Total	1 student (1 male)

Answers coded as: Students used it, but they do not get feedback.	
Gender	Users' answers
Male	Yes
Male	yes
Total	2 students (2 males)

What do you like in Green Dolphin?

Answers coded as: Students like the user interface of Green Dolphin.	
Gender	Users' answers
Male	Good and friendlier interface. Easy to use.
Male	Speed and interface
Male	The simple layout and interface.
Male	User Interface
Male	The UI and the instructors answers which confirms the answer.
Male	UI was very like-able
Male	The interface is much cleaner than piazza, and the points system is nice
Male	interaction
Female	User Interface
Female	I loved the User Interface, the option of clicking "Useful comment" and yes of course the option where you can rename yourself with anything you want (people had come up crazy names)
Female	I liked the way that the questions were displayed and choosing one took you to a separate page that showed you all of the answers for that question.
Total	11 students (8 males and 3 females)

Answers coded as: Students liked the reward system.	
Gender	Users' answers
Male	and very intuitive points system
Male	The idea of the point system (not the implementation).
Male	I think the points systems is interesting but I'm not sure that the current implementation is the solution.
Male	voting system and reputation system is a good idea.
Male	Points system for correct answers and option to annouce someone's answer or question useful.
Male	Points. The competition aspect encouraged use.
Male	The points!
Male	the points system
Female	We could earn points by answering questions.
Total	9 students (8 males and 1 female)

Answers coded as: Students liked the notification system.	
Gender	Users' answers
Male	I like the quick notification and being able to use it on mobile devices. It is much easier than Piazza.
Male	email notification; search
Female	and the notifications stuff too.
Female	The way it send quick emails regarding questions and answers
Female	The notification part when my question or others' questions are answered
Total	5 students (2 males and 3 females)

Answers coded as: Green Dolphin had good performance.	
Gender	Users' answers
Male	fast answers from other students and many students can talk together
Male	I like that communicating between classmates and the instructors was made easier than just sending emails.
Total	2 students (2 males)

Answers coded as: Green Dolphin was enjoyable.	
Gender	Users' answers
Male	It's funny.
Female	name 'Green Dolphin' is attractive
Total	2 students (1 males and 1 female)

Answers coded as: Students liked to share knowledge in Green Dolphin.	
Gender	Users' answers
Male	Seeing students' insights into questions regarding homework.
Female	It was very useful to share an idea about course material without meeting.
Total	2 students (1 males and 1 female)

Answers coded as: Students felt neutral or no comments.	
Gender	Users' answers
Male	I was largely indifferent to green dolphin.
Male	Netrual.
Male	Yes
Total	3 students (3 males)

What do you dislike in Green Dolphin?

Answers coded as: Students dislike the reward system.	
Gender	Users' answers
Male	The point system. Instead of one good answer being posted, and that answer being voted up, you would get one helpful answer plus 4 irrelevant answers that were only there for users to get more points for themselves. The points also caused people to post stupid questions that had no place on the website to

	get points. There also needs to be some type of way to customize how often you get emails and what you get emails for. It was extremely annoying getting way too many emails just because people liked an answer. This frustration was compounded by emails that were the result of questions that had no business being posted. Questions were poorly organized on the site as well in terms of finding things.
Male	The other thing is that, lack of administrator leads to people doing all kinds of stuff crazily just for getting more points but without actually contributing to the knowledge base.
Male	points; "expert";
Male	The points system gave out too many unnecessary points. I feel like answering shouldn't be given any points until a user marks it as useful/correct/best answer
Male	The way points are awarded. A user is able to increase their point score without adding any value to the discussions.
Male	Also points were given to answers which didn't answer the question
Female	The points are not given in a good way.
Total	7 students (6 males and 1 female)

Answers coded as: Students disliked the user interface of Green Dolphin.	
Gender	Users' answers
Male	The topic is not categorized.
Male	The user interface could use some improvement on the main page just streamlining and reorganization on some of the buttons/forms.
Male	I did not like the presentation of the content. It felt like a WordPress blog. It was difficult to find previous questions and to know if a question was already answered correctly.
Male	The user interface was clunky and there NEEDS to be a way to setup notifications on a user level. For example, let the user decided whether they want an email everytime there is a new question or if they want an update every 4,8,12 hours with the new questions.
Female	The interface needs improvement
Female	The interface is not user friendly.
Female	Categorization of questions. For example there were a good many questions for hw4 but only a couple showed up when you clicked on the category. I think that maybe you should have the user pick a category when asking a question instead of leaving it optional. It would make it easier for users to see questions that had already been asked about an assignment and not re-ask items already answered.
Total	7 students (4 males and 3 females)

Answers coded as: The notification system decreased students' satisfaction.	
Gender	Users' answers
Male	Emails don't include question asked.
Male	Not much is to be disliked in Green Dolphin. Just that the TA or Professor are notified a bit late.
Male	send me email notificatgion frequently
Male	The email notification is kind of overwhelming and at the sametime not

	providing enough information. Providing 1) setting options for email preference; and 2) put some context and content in the email body; will be quite useful.
Male	Amount of emails. Normal graphic interface.
Male	It keeps on sending emails to you.
Total	6 students (6 males)

Answers coded as: Green Dolphin had issues.	
Gender	Users' answers
Male	BUGS
Male	security issues (you could enter the ID of a deleted question and it would still display).
Male	There were few bugs .
Male	Few operational bugs persist in the product
Female	There were some faults in the system some of them were fixed though. One can become an expert student only by clicking on "Useful Comment" which is not appropriate.
Total	5 students (4 males and 1 female)

Answers coded as: Green Dolphin lacked of features	
Gender	Users' answers
Male	Green Dolphin is still young and I would consider it in the development phase. It lacks some key features such as the ability for the instructor to endorse an answer, or reply to a specific comment. I like the concept of Green Dolphin, but I think it still has a way to go before it can be used by educators and students in the real world.
Male	May be some features like if I will declare someone's answer useful I was getting points rather than that person who answered correctly.
Female	Functionality is not efficient.
Total	3 students (2 males and 1 female)

Answers coded as: Students felt neutral.	
Gender	Users' answers
Male	no
Male	Nothing in particular
Male	N/a
Female	Nothing
Female	nothing
Female	None
Total	6 students (3 males and 3 females)

Answers coded as: The survey was long.	
Gender	Users' answers
Male	this long survey
Total	1 student (1 male)

APPENDIX D

SCREENSHOTS

The image displays several screenshots of the Green Dolphin website. At the top is a blue navigation bar with the text "Green Dolphin" on the left, and "Sign up" and "Login" on the right. Below this, the main content area is divided into several sections:

- Green Dolphin Learning by answering:** A large heading followed by a paragraph: "Green Dolphin (GD) is a question and answer website. It is designed to fulfill students' needs for collaborative learning by allowing them to interact with and ask questions of the professional community consisting of their classmates, professors and TAs."
- GD delays TAs' and professors' answers:** A screenshot showing a user interface with a progress bar and the text "TA User answered about 6 hours ago." and "0 Useful".
- GD has a point-based incentive system:** A screenshot showing a user profile for "Student2" with "10 Points", "1 Answer", and "0 Questions".
- Flowchart:** A diagram showing the interaction between "Students", "Green Dolphin", "Expert Students", and "Professors and TAs". Arrows indicate the flow of "Ask Questions", "Read and Answer Questions", and "Read and Answer Questions and Give Feedbacks".
- Questions Page:** A screenshot of a question titled "Bresenham Lines Drawing Algorithm" with a code block and a "1 Answer" / "0 Useful" status.
- Answers Page:** A screenshot of an answer to the same question, featuring a grid with red dots and the text "Here's a simple idea, (skimming approach) Put your animals in a grid based on their x,y values..."

Sign in

Email

Password

Remember me

[Sign up](#)
[Forgot your password?](#)
[Didn't receive confirmation instructions?](#)

The log in page

#	Avatar	Name	Answers	Questions	Contributions	Points
1		Student2	11	0	16	166
2		Student1	0	16	22	80
3		Eric	0	0	0	0

The leaderboard page

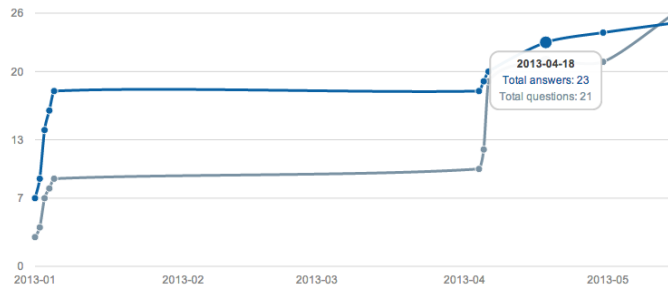
Your Notifications

- You got an answer from Chulakorn Aritajati 11 minutes ago x
[Faster](#)
- You got an answer from Chulakorn Aritajati 11 minutes ago x
[Faster](#)

The notification page

Leaderboard Performance

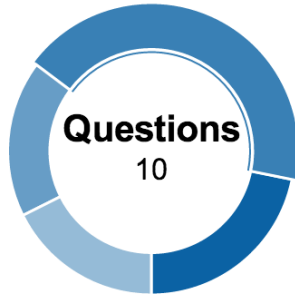
Total answers and questions



Total answered questions




Your activities



- You had 5 answers.**
Average: 6.25 Maximum: 11
- You had 10 questions.**
Average: 13.0 Maximum: 16
- You had 4 useful responses.**
Average: 3.0 Maximum: 4
- You had 4 replies.**
Average: 2.25 Maximum: 4

The user performance page

Edit User



You can change your profile picture at [Gravatar](#) by your email.

Name

Email

Password

Leave blank if you don't want to change it

Password confirmation

School

Sex

Level

Admin **Algorithm** **noob** **Instructor** **ta** **smart**

Tag list

Each tag is separated by a semicolon. Ex: algorithm, student, auburn

* Current password

We need your current password to confirm your changes

The editing user page

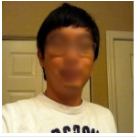
Chulakorn Aritajati
cza0012@auburn.edu

School
Auburn University


Level Graduate Role Admin

Z-Scores
0

Expert tags
admin algorithm





101 Points
6 Answers
9 Questions

 Chulakorn Aritajati answered 1 minute ago.

Faster **0**
Useful


Fastest



 Chulakorn Aritajati answered 1 minute ago.

Faster **0**
Useful

hi



The user profile page

Write your question

Title

Content

Code

Tag list

Algorithm

- Ask a question anonymously
- Ask a fast question (You need to spend 10 points to use this function.)

Ask experts

Name	Asked	Expert tags
Eric 	0	
Instructor User	0	
TA User	0	 
Student2	0	

You have 90 points. You need to spend 5 points to use this function.

Ask an expert

Ask an expert

Cancel

Post

The asking question page

APPENDIX E

RUBY ON RAIL GEMS IN PRODUCTION

- jquery-rails (<https://github.com/indirect/jquery-rails>)
- haml (<http://haml.info/>)
- devise (<https://github.com/plataformatec/devise>)
- cancan (<https://github.com/ryanb/cancan>)
- rolify (<https://github.com/EppO/rolify>)
- bootstrap-sass (<https://github.com/thomas-mcdonald/bootstrap-sass>)
- simple_form (https://github.com/plataformatec/simple_form)
- will_paginate (https://github.com/mislav/will_paginate/wiki)
- daemons (<https://github.com/ghazel/daemons>)
- delayed_job_active_record (https://github.com/collectiveidea/delayed_job_active_record)
- redcarpet (<https://github.com/vmg/redcarpet>)
- pygments.rb (<https://github.com/tmm1/pygments.rb>)
- acts-as-taggable-on (<https://github.com/mbleigh/acts-as-taggable-on>)
- bootstrap-will_paginate (https://github.com/yrgoldteeth/bootstrap-will_paginate)
- dj_mon (https://github.com/akshayrawat/dj_mon)
- public_activity (https://github.com/pokonski/public_activity)