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What are the most important predictors of computer science students' online help-seeking behaviors?



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ABSTRACT

This study investigates the most important predictors of computer science students' online help-seeking behaviors. 203 computer science students from a large university in southeastern United States participated in the study. Online help-seeking behaviors explored in this study include online searching, asking teachers online for help, and asking peers online for help. Ten-fold cross validation was used to select the most significant predictors from eight potential factors, including prior knowledge of the learning subject, learning proficiency level, academic performance, epistemological belief, interests, problem difficulty, age and gender. Problem difficulty was selected as the most important predictor for all three types of online help seeking, while learning proficiency level, academic performance, and epistemological belief were selected as the most important predictors for both online searching and asking teachers online for help. Based on the selected factors and their relationships with online help seeking, the study provides guidance on targeted training for online help seeking in an era of mass higher education.

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1. Introduction

Since the late 20th century there has been a mass expansion of higher education on a global scale. In the United States, 41.0% of 18–24 years old were enrolled in degree granting institutions in 2012, compared to 35.5% in 2000, 32.0% in 1990, and 25.7% in 1980 (National Center for Education Statistics, 2015). A further expansion in higher education is crucial to ensure that youth are equipped with skills to find gainful employment and to support the long-term economic competitiveness of the country (Brynjolfsson & McAfee, 2014; Goldin & Katz, 2009; Kearney, Hershbein, & Boddy, 2015). Nevertheless, this expansion has inevitably accompanied a range of stressors to the infrastructure of higher education, especially in terms of the resources and support per-student that institutions can provide. Such pressures have hastened a transition to new forms of teaching and learning, which rely heavily on the Internet and other forms of technologies (Allen & Seaman, 2013;

Bernard et al., 2009; Yang & Cao, 2013).

In this environment, pro-active online help seeking is likely to become increasingly important to the academic success of college students (McInerney & Roberts, 2004; Newman, 2008; Rakes & Dunn, 2010). Help seeking has been identified as an effective learning strategy and is associated with a capacity for self-regulated learning (Lee, 2007; Roll, Alevan, McLaren, & Koedinger, 2011). Online help seeking, more specifically, refers to help seeking facilitated by online tools, including search engines and communication platforms. Online help seeking offers a range of potential advantages compared with help seeking in traditional classroom contexts. For instance, students often hesitate to approach potential helpers due to lack of self-confidence in classroom contexts, while these problems are less prevalent in either searching or asking questions anonymously online (Karabenick, 2003; Kozanitis, Desbiens, & Chouinard, 2007; Ryan & Shin, 2011). However, online help seeking also poses new challenges to students. As an example, search engines remain rather limited in their capacity to respond to students' problems if students fail to input accurate keywords or phrases.

It is crucial, therefore, to have guidelines that can inform

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educators about teaching students to seek help online effectively, given its potentials and challenges. To ensure the effectiveness of such guidelines, there is a need for a better understanding of what factors influence the online help-seeking behavior of students. In response, this study investigated the most significant predictors for computer science students' online help seeking. There are two major reasons why we started with computer science students: a) There are relatively more online learning resources, such as tutorials, digital books, or help forums, for computer science than other majors due to its field nature (Dichev & Dicheva, 2012). b) Undergraduate computer science education is relatively well standardized in comparison to other fields, which makes the generalization of its research less difficult (Kadijevich, Angeli, & Schulte, 2013).

This paper starts with reviewing the existing literature on online help seeking and potential factors associated with online help seeking, then follows with the methodology and results, and finally discusses the main findings with references to the existing literature. The results of this study will contribute to the development of guidelines informing educators about how to best guide students to seek help online.

2. Literature review

2.1. Online help seeking

Help seeking is a cognitive skill involving a set of actions including realizing the need of help, identifying problems, and forming questions to solicit help (Aleven, McLaren, Roll, & Koedinger, 2006; Newman, 2008). Online help seeking specifically refers to help seeking supported by online tools, such as search engine, emails or question & answer forums.

Two classification standards were proposed for online help seeking, including the nature of helpers, such as human beings or machines, and the relationship between helpers and help seekers, such as peers or teachers (Cheng & Tsai, 2011; Le Bigot, Jamet, & Rouet, 2004; Puustinen & Rouet, 2009). Three types of online help seeking emerged based on the above two classifications (Cheng & Tsai, 2011):

1. Online searching
2. Asking teachers for help online
3. Asking peers online for help

Online help seeking has different characteristics compared with help seeking in other contexts. Firstly, online help seeking is more open and "messy" than help seeking in tutor-system environments (Karabenick, 2011). Increasingly ubiquitous, regardless of locations and devices, online environments offer abundant access to information and help from experts around the world. In contrast, tutor systems typically provide limited on-demand hints and glossaries in a closed environment. Secondly, many factors important to face-to-face help seeking are much less important for online help seeking. Both searching and asking questions anonymously online are much less threatening the self-esteem of students than face-to-face help seeking in classroom contexts (Kumrow, 2007). Thirdly, online help seeking poses new and significant challenges to learners. Search engines are limited in adapting to students' questions if students fail to provide accurate queries. In addition, asynchronous communication on question & answer forums with other users can be prone to misunderstandings and thus may not yield the desired information.

2.2. Potential factors influencing online help seeking

This section of the paper reviews the literature on the

potentially influential factors on online help-seeking behavior, including prior knowledge of the learning subject, learning proficiency level, academic performance, epistemological belief, interests, problem difficulty, age and gender. Research on online help seeking is still lacking, although help seeking has been studied extensively in classroom environments (Cheng, Liang, & Tsai, 2013). Given the potential advantages and challenges of online help seeking, the gap in the literature on this topic is significant.

Prior knowledge of the learning subject refers to learners' prior knowledge of the current learning content. Aleven, Stahl, Schworm, Fischer, and Wallace (2003) and Li and Belkin (2010) found that students with less prior knowledge are less likely to know when to seek help, how to organize information and how to form questions. Therefore, they are expected to seek help online less frequently. Different from prior knowledge of the learning subject, learning proficiency level refers to the general learning aptitude and experience of a student, which can be used to differentiate novice and expert learners. Novice learners are often more dependent on authorities and less able to find answers themselves (Kitsantas & Zimmerman, 2002; Yang & Taylor, 2013). Conversely, expert learners are associated with better self-regulation and help-seeking strategies. Notably, Karlsson et al. (2012) found that expert learners have superior skills at online searching. Cheng and Tsai (2011) claimed that student with more experience of online help-seeking activities are likely to have greater confidence and preferences for online help-seeking.

Academic performance has been found an important factor related to face-to-face help seeking in classroom contexts. Studies conducted by Karabenick and Knapp (1991), Karabenick (1998), and Kitsantas and Chow (2007) indicated that students with superior academic achievements generally had higher levels of confidence. As a result, students tended to seek help more frequently, and help seeking in turn consolidated strong academic performance. Nevertheless, in contrast to face-to-face help seeking, it is possible to remain anonymous when seeking help online. Therefore, confidence may be a less important factor for online help seeking.

Epistemological beliefs refer to the personal beliefs of knowledge and knowing. Belief about the source of knowledge, as a component of epistemological belief, is the focus of this study. As an example, Cheng and Tsai (2011), Muis and Franco (2009), and Strømsø and Bråten (2010) noted that students with a perception that knowledge is transmitted from expert external authorities tended to ask teachers online for help rather than search or ask peers for help online. Moreover, Aleven et al. (2003) argued that students with simpler epistemological beliefs might over-estimate their understanding of an issue and be less aware of the need for help.

Relationships between interests in the learning topic and help seeking have been mainly studied in classroom contexts. Though most studies to date indicated that students with higher levels of interests engaged in more face-to-face help-seeking activities (e.g., Beal, Qu, & Lee, 2008; Boscolo & Mason, 2003), Bartholomè, Stahl, Pieschl, and Bromme (2006) found that interests had little effect of help seeking in tutor-system contexts. Aleven et al. (2003) also note that a focus on academic performance over interest can lead to avoiding help seeking to limit embarrassment of needing help from others, which is more likely to happen in face-to-face classroom environments rather than in anonymous online environments. Given the difference between online help seeking and other forms of help seeking, different results may emerge on the relationship between interests and online help seeking.

Difficulty of problems being tackled may also influence the extent to which students engage in online help seeking activities (Jonassen & Hung, 2008; Li & Belkin, 2010). A study by Li and Belkin (2010) found that students facing problems perceived as difficult

tended to increase their dependence on experts rather than finding helpful information on their own. Reflecting this, it is likely that students will rely more on asking help online from teachers when problem difficulty increases.

Age and gender have been found influential factors on help seeking in face-to-face classroom contexts. Though help-seeking abilities have been consistently found to be positively related to age (e.g., Newman & Schwager, 1995; Ryan & Pintrich, 1998), to what extent age influences online help seeking has not been explored. Comparatively, the relationship between gender and help seeking is less clear. A growing body of literature has, however, noted that a positive femininity can be more conducive to face-to-face help seeking (Eccles & Blumenfeld, 1985; Kessels & Steinmayr, 2013; Marchand & Skinner, 2007). The extent to which gender influences online help seeking has not been investigated either.

3. Research questions

The research question that guided this study is:

- What are the most important predictors of college students' online help seeking behavior (online searching, asking teachers online for help, and asking peers online for help) among the proposed factors (prior knowledge of the learning subject, learning proficiency level, academic performance, epistemological belief, interests, problem difficulty, age and gender)?

4. Research method

4.1. Participants

Two groups of 203 undergraduate students from a large research university in southeastern United States participated in this study. One group included 162 students enrolled in an entry-level course of computer science. This group of students were identified as novice learners. The other group included 41 students enrolled in an advanced course of computer science. This group of students had taken 5 different prerequisite courses in computer science before enrolling in the current course, so they were identified as expert learners. Both courses were supported by an online help forum called Piazza (<https://piazza.com/>) for help seeking or communication among students, teachers and teacher assistants. Teachers and teaching assistants were also accessible for queries through emails.

4.2. Research design

A survey developed by the authors was used to measure participants' frequency of different online help seeking behavior and six of the proposed factors (age, gender, epistemological belief, interest, prior knowledge of the learning subject, and problem difficulty). The seventh factor, learning proficiency level, identified which group participants belonged to. The eighth factor was academic performance. All students' grades were collected by the end of the semester and standardized to represent their academic performance. Students' grades were calculated based on their performance on the followings: a) Individual assignments, b) Individual projects, c) Group projects, d) Midterm exams, and e) Final exam.

There were 15 questions divided into 3 sections in the survey. The first section had questions on participants' basic personal information, including gender and age. The second section had questions measuring the frequency of students' online help

seeking activities. The third section had questions measuring the four potential factors influencing online help seeking, and each factor was measured by two or three questions. All questions adopted the design of a four point Likert-scale format (see Appendix 1).

5. Results

5.1. Factor analysis of survey on online help seeking

Data from 203 participants were collected, while 4 participants were excluded from analysis due to missing information in their survey. Descriptive summaries of how students seek help online are presented in Table 1.

Exploratory factor analysis was conducted on 10 questions in section 3 of the survey measuring the proposed four factors with oblique rotation (varimax). The Kaiser-Meyer-Olkin (KMO) measure verified the sampling adequacy for the analysis (KMO = 0.60). Overall reliability α is 0.61. Four factors with eigenvalues over Kaiser's criterion 1 emerged, and explained 54.13% of the variance in total (Table 2).

5.2. Most important predictors of online help seeking

Cross-validation was used for predictor selection. In contrast to other predictor-selection methods, like stepwise regression or lasso, cross-validation provides direct estimates of test errors and makes fewer assumptions about true underlying models, which lead to a more accurate result of predictor selection. Multicollinearity diagnostics were conducted on each regression model presented in the following sections. The Variance Inflation Factor of all the predictors was smaller than 2.5 in each model.

5.3. Online searching

Ten-fold cross-validation was used to determine the number of most important predictors by comparing the test errors of models with different combination of predictors. In our case, ten-fold cross-validation was applied 1000 times to avoid the randomness of one result. 63.4% of all the cross-validation results selected 4-factor models as the ones with lowest test error rate.

The selection of the 4 predictors was performed on the full data set to ensure the accuracy of predictor coefficient estimates. The selected predictors include learning proficiency level, academic performance, epistemological belief and problem difficulty. The four factors explained 29.9% variance of online searching ($R^2 = 0.299$, $p < 0.00$) (Table 3). In contrast, all eight proposed factors explained 31.1% variance of online searching ($R^2 = 0.311$, $p < 0.00$). All predictors were significant in the four-factor regression model.

Table 1
Descriptive analysis of online help seeking.

	Novice students		Expert students		Total	
	Mean	SD	Mean	SD	Mean	SD
Online searching	2.87	0.83	3.45	0.78	2.99	0.85
Asking teachers online for help	2.03	0.80	2.28	0.82	2.08	0.81
Asking peers online for help	2.55	0.90	2.88	0.76	2.62	0.88

Table 2
Exploratory factor analysis on 10 questions on online help seeking.

Item	Pattern matrix			
	Interest	Prior knowledge	Epistemological belief	Problem difficulty
1 LearnLike	0.84			
2 LearnWill	0.75			
3 CourseWill	0.66			
4 PriorKnow		0.98		
5 PriorExp		0.67		
6 DifIncAsk				0.87
7 DifIncSearch				0.46
8 SelfLearnPerc			0.51	
9 SelfLearnLike			0.90	
10 ClassLearnDis			0.23	
Reliability Coefficient (α)	0.78	0.80	0.54	0.57

Overall $\alpha = 0.61$, total variance explained = 54.13%.

LearnLike Interests in course content, LearnWill Willingness to master course content, CourseWill Willingness to take such an elective course, PriorKnow Prior knowledge, PriorExp Prior learning experience, DifIncAsk Willingness to ask for help online when difficulty increases, DifIncSearch Willingness to search online when difficulty increases, SelfLearnPerc Perception of self-learning, SelfLearnLike Preference of self-learning, ClassLearnDis Dislike of classroom learning.

Table 3
Multiple regression analysis on best subset model of online searching.

	R ²	R ² _{adj}	ΔF	β	t
Online searching	0.299	0.285	20.7		
Academic Performance				0.15***	2.87
Learning proficiency level				0.54***	4.22
Epistemological belief				0.35***	5.87
Problem difficulty				0.20***	3.37

* $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$.

5.4. Asking teachers online for help

The same procedures of predictor selection for online searching were applied for asking teachers online for help. 70.9% of the 1000 cross-validation results had 5-factor models as the ones with lowest test error rate. The selected predictors include learning proficiency, academic performance, gender, epistemological belief and problem difficulty.

The five factors explained 8.3% of variance of asking teachers online for help ($R^2 = 0.083$, $p < 0.01$) (Table 4). In contrast, all eight proposed factors explained 8.4% variance of online searching ($R^2 = 0.084$, $p < 0.01$). Three predictors, including academic performance, learning proficiency level, and problem difficulty, were significant in the five-factor regression model.

5.5. Asking peers online for help

The same predictor selection procedures were applied for asking peers online for help. 81.1% of 1000 cross-validation results had 2-factor models as the ones with lowest test error rate. The selected predictors include epistemological belief and problem difficulty.

Table 4
Multiple regression analysis on best subset model of asking teachers online for help.

	R ²	R ² _{adj}	ΔF	β	t
Asking peers online for help	0.083	0.059	3.48		
Gender				0.21	1.52
Academic Performance				0.10*	1.77
Learning proficiency level				0.26*	1.85
Epistemological belief				-0.10	-1.56
Problem difficulty				0.15**	2.24

* $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$.

The two factors, including epistemological belief and problem difficulty, explained 19.2% of variance of asking peers online for help ($R^2 = 0.192$, $p < 0.01$) (Table 5). In contrast, all eight proposed factors explained 23.2% variance of online searching ($R^2 = 0.232$, $p < 0.01$). Both of the two predictors were significant in the model.

6. Discussion

6.1. Selected predictors of online help seeking

Problem difficulty was selected as an important predictor for all three types of online help-seeking behaviors. Three factors, including epistemological belief, learning proficiency level, and academic performance, were selected as important predictors for two types of online help-seeking behaviors, including online searching and asking teachers online for help. The below section will discuss the findings with reference to the existing literature on these four factors and online help seeking.

Firstly, problem difficulty is positively related to all types of online help-seeking behaviors. While the students sought help online more frequently as problem difficulty increased, their preferences among the three approaches of online help seeking varied. Notably, students preferred to ask peers online for help more than search online. This finding may indicate that online searching poses more cognitive challenges for students than asking other people for help. Although students tended to seek more help online from human beings as the problem difficulty increased, participants in this study did not demonstrate a strong dependence on teachers compared to the study of Li and Belkin (2010).

Secondly, epistemological belief is an important predictor for two types of online help-seeking behaviors. Students who preferred independent learning tended to search online rather than ask teachers for help, while students who preferred classroom

Table 5
Multiple regression analysis on best subset model of asking peers online for help.

	R ²	R ² _{adj}	ΔF	β	t
Asking peers online for help	0.192	0.184	23.32		
Interest				-0.26***	-4.19
Problem difficulty				0.35***	5.38

* $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$.

learning tended to ask teachers online for help more frequently. This finding shows the strong effect of epistemological belief on students' online help-seeking behavior, and indicates that instructional designs involving online help seeking should take students' acceptance of independent learning into consideration for their designs.

Thirdly, academic performance was also an important predictor for two types of online help-seeking behaviors. This result was consistent with the findings of Karabenick and Knapp (1991) and Karabenick (1998) that students with better academic achievements tended to seek help more frequently. Nevertheless, more frequent online searching, in this study, was more likely to reflect better online searching skills rather than self-confidence. This is because online searching poses limited self-esteem threats, given that students can remain anonymous in online environments.

Lastly, learning proficiency level is the other important predictor for two types of online help-seeking behaviors. Expert learners tended to use all types of online help-seeking approaches more frequently than novice learners, especially online searching. This finding confirms that there is a discrepancy between expert and novice learners in online help seeking skills (see Karlsson et al., 2012), and thus necessitates deliberate training of such skills.

6.2. Trainings of online help seeking

The below section discusses the indications of our findings on online help-seeking trainings and related instructional design. The relationship between the selected predictors and online help seeking will be focused on.

Firstly, both academically-challenged and novice students need more help in terms of online searching. Such students, in this study, searched online and asked teachers online for help less frequently than others. It is well known that academic challenged students tend to avoid teachers for help due to self-confidence issues (Karabenick & Knapp, 1991; Kitsantas & Zimmerman, 2002). However, such reasons can not explain why the two group of students searched online for help less frequently. It is possible that academically-challenged and novice students have difficulties in performing key steps of online searching, such as identifying problems, turning problems to questions, or converting questions to search queries (Puustinen & Rouet, 2009). Therefore, they might have less successful experience in searching online for help and deem it not useful. Important in this regard, Karlsson et al. (2012) found evidence that novice students lacked necessary online searching skills. If help-seeking trainings can incorporate teaching and practice of basic online searching skills, it might be of great benefit to academically challenged students who hesitate to approach teachers for help.

Secondly, effective online help-seeking training should incorporate efforts to increase students' acceptance of independent learning. In this study, students who preferred independent learning tended to search online for help more frequently, while students who preferred classroom learning asked people online for help more frequently. Given the increasing ratio of students to teachers and the widespread use of large scale classes in higher education, help seeking can become more effective if more students can utilize online searching to solve their problems (Allen & Seaman, 2013; Bernard et al., 2009). Therefore, it can be beneficial to include the introduction of independent learning in help seeking

training, especially for students who only have classroom learning experience.

Thirdly, the selection of training examples for online help seeking should take both problem difficulty and help seeking types into consideration. Our study showed that students preferred asking people online more than online searching as problem difficulty increases. On the one hand, if the training focus is on online searching skills, easier examples would be more effective because difficult examples demand more cognitive efforts from students, and may interfere with their practice of essential online searching skills (Sharit, Hernández, Czaja, & Pirolli, 2008). On the other hand, if the training focus is asking peers online for help, the incorporation of examples at different difficulty levels would enrich the learning experiences of students.

7. Conclusion

Higher education in the United States has long since transitioned into the upper end of what Martin Trow (1976), the prominent writer on the global expansion of higher education, defined as a "mass system" (i.e., enrollments of 15–50 percent of the age cohort). As previously noted, further growth in enrollments is arguably required to ensure that young people are equipped with the requisite skills to participate in the labour market and to drive economic growth. It seems inevitable, however, that teaching and learning in colleges need to adjust as enrollments increase and resources on a per-student basis come increasingly under strain. Notably, Trow (2007) foresaw a progressive decline in personal relationships between students and lecturers alongside a heavier reliance on distant learning and other forms of technological aids to instruction.

Reflecting this, there has been mounting interests in the role of online learning for college students in recent years, including the much discussed emergence of Massive Open Online Courses (MOOCs) and on e-learning at "bricks and mortar" colleges across the country (Allen & Seaman, 2013; Bernard et al., 2009; Yang & Cao, 2013). In this emerging context, pro-active online help seeking will continue to play an increasingly important role in the academic success of college students (Aleven et al., 2003; McInerney & Roberts, 2004; Newman, 2008; Rakes & Dunn, 2010). It is, therefore, crucial to better understand what factors influence students' engagement with online help seeking. This paper responded to this under-researched area of enquiry by illuminating that problem difficulty, epistemological belief, academic performance, and learning proficiency were the most important factors associated with computer science students' online-help seeking.

Among our findings, we wish to highlight that academically high-performing students (in terms of both academic performance and learning proficiency) in our study were more likely to engage in online help seeking. This finding indicates that there exists a discrepancy in online help-seeking skills between academically high-performing students and their counterparts. An implication is that deliberate training for online help seeking is necessary, especially for low academic performers. This will be crucial to facilitating an overall increase in academic standards as well as avoiding a growing disparity in academic outcomes between students who are better able to take advantage of online help seeking and those who may be reluctant to engage in such behavior.

Appendix I

Survey: What factors influencing online help seeking

Section 1

1. What is your gender?
A. male B. female
2. What is your age?

Section 2

1. When you find difficulties in solving problems (e.g., algorithmic problems - find the mode from an array of integers) in assignments, how often do you search online to learn about it?
A. never B. occasionally C. sometimes D. always
2. When you find difficulties in solving problems (e.g., algorithmic problems - find the mode from an array of integers) in assignments, how often do you email the teacher or teaching assistant for help?
A. never B. occasionally C. sometimes D. always
3. When you find difficulties in solving problems (e.g., algorithmic problems - find the mode from an array of integers) in assignments, how often do you ask your peers or some unknown experts online for help?
A. never B. occasionally C. sometimes D. always

Section 3

1. I am interested in the learning content of the class.
A. strongly disagree B. disagree C. agree D. strongly agree
2. I would like to master the learning content of the course I am taking.
A. strongly disagree B. disagree C. agree D. strongly agree

3. I would still like to take the course if it is elective.

A. strongly disagree B. disagree C. agree D. strongly agree

4. I have prior knowledge of the learning content of the course.

A. strongly disagree B. disagree C. agree D. strongly agree

5. I have related learning experience before taking the course.

A. strongly disagree B. disagree C. agree D. strongly agree

6. I will become more willingly to seek help from others online if the learning task I have problems with is very complex.

A. strongly disagree B. disagree C. agree D. strongly agree

7. I will become less willingly to search online if the learning task I have problems with is very complex.

A. strongly disagree B. disagree C. agree D. strongly agree

8. I believe that one can master knowledge and skills of certain subjects (e.g., coding) by learning independently with the open online resources and search engines.

A. strongly disagree B. disagree C. agree D. strongly agree

9. I think self-paced learning with search engines, online open resources, and helps from others online is a very important way to learn.

A. strongly disagree B. disagree C. agree D. strongly agree

10. I think learning with an expert (physically present) through lecture or class is the best way to learn.

A. strongly disagree B. disagree C. agree D. strongly agree

Appendix II. Supplementary Data

Supplementary data analysis script related to this article can be found at <http://rpubs.com/neo Hao/online-help-seeking>.

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