

How Near Peer Mentoring Affects Middle School Mentees

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ABSTRACT

In response to the national demand to increase participation in CS, we argue that youth's interest in computer science (CS) can be sparked by providing them with role models who are relatable and who resonate with their identities. To that end, we developed a mentoring model in which we train high schoolers to be near-peer mentors for middle schoolers learning to program in summer camps. In this paper, we present results from a mixed-methods study where we examined the relationship between mentor relatability and middle school campers' self-efficacy and interest in CS. Pre- and post-surveys were used to measure campers' affective outcomes around computing and mentor relatability. In addition, interviews and observations were used to illustrate the mechanisms that led to change in affect. Our findings suggest that mentor relatability is a significant predictor of campers' self-efficacy and interest in CS. Results from the qualitative data further exemplify how mentor relatability was perceived and manifested in the camps.

ACM Reference format:

J. Clarke-Midura, F. Poole, K. Pantic, M. Hamilton, C. Sun, V. Allan. 2018. How Near Peer Mentoring Affects Middle School Mentees. In *Proceedings of ACM SIGCSE conference, Baltimore, MD USA, February 2018 (SIGCSE'18)*, 6 pages.

DOI: <http://dx.doi.org/10.1145/3159450.3159525>

1 INTRODUCTION

With the Bureau of Labor Statistics [7] projecting an increase in computer related jobs and US graduates being able to fill up only

about 30% of those openings [1], finding ways to get youth interested in CS has become a national priority [3]. While we acknowledge the effectiveness of a variety of strategies already identified in literature, in this paper, we argue that one way to increase youth's interest in CS is to provide them with role models who are relatable and who resonate with their identities. Such connections may help them envision their future selves and CS as a possible path. Bandura [3] wrote that "seeing or visualizing people similar to oneself perform successfully, typically raises self-efficacy beliefs in observers that they themselves possess the capabilities to master comparable activities" (p.87). However, if the model does not seem similar or the youth perceives the model to have disparities in experience they "are likely to view skills exemplified by an experienced model as beyond their reach and are thus declined to invest the effort needed to master them fully" (p. 234) [2]. Youth are thus more likely to imitate those who they perceive as similar to themselves [3]. We argue that near-peer mentors, who resemble their protégés in age, status, skills, and/or interest, will make more credible role models in comparison to non-peer mentors, such as university professors or undergraduates, who are not considered "near peers."

For the past three years, we have been offering summer camp programming experiences for middle and high school youth using App Inventor. We have been using a near-peer mentoring model through which we train high school students to be near-peer mentors for middle school aged campers. We have written about the success of this model for the mentors themselves in increasing their self-efficacy and interest in computing [10, 11]. In this paper, we explore how working with near-peer mentors affects campers' self-efficacy and interest in computing. In the following sections, we review previous work around near-peer mentoring. We then describe our camps, research, and findings.

2 RELATED WORK

The cognitive processes explaining the relationship and methods for learning in a mentor/mentee model are difficult to define because mentors operate in a social space between formal teacher, friend, role model, and coach [15]. In this research, we

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SIGCSE'18, February 21-24, 2018, Baltimore, MD, USA.

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ACM ISBN 978-1-4503-5103-4/18/02...\$15.00.

DOI: <http://dx.doi.org/10.1145/3159450.3159525>

use the lens of social competency modeling, based on Bandura's social cognitive theory [3]. According to Bandura [4-5], a mentee's self-efficacy is directly impacted by (1) the social relationships with those who act as models (e.g. mentors, etc.), (2) the similarity they perceive between themselves and their models, and (3) watching a credible model effectively perform a task. As such, we expect that mentors who share common traits or backgrounds salient to participants' concept of self will be more credible models and, will therefore, stimulate greater enthusiasm and improve self-efficacy in CS. However, it is critical to identify the contexts in which positive attitudes are fostered as well as the mechanisms that support or hinder attitudes. Role models must also resonate with campers' identities and help them envision their future selves and CS as a possible pathway.

2.1 Defining Near-Peers

We found inconsistencies in how the term near-peer was used and defined (e.g. [6], [17], [27]). In the context of our study, we define near-peers as mentors who are proximal in age but slightly more skilled in programming. If we consider programming skills and expertise on a spectrum, the mentor's expertise would fall somewhere between the skill level of mentees and experts. This distance from mentees grants near-peer mentors with an ample knowledge base to provide the appropriate guidance and aid to a mentee. At the same time, the proximity in skill level allows the near-peer mentors to be more relatable and approachable.

2.2 Effectiveness of Near-Peer Role Models

Research on near-peer role models has lent support to our claim that near-peers are credible role models [18-22, 27]. However, the majority of studies on near-peer mentoring were conducted in the sciences and/or medical settings (e.g., [22-26, 30]), with only a few studies in CS (e.g., [8, 10, 14, 17-18]). In addition, most research focused on older populations such as high school students, undergraduates and graduate students. Only a few studies (e.g., [27]) have looked at the impact of near-peers on middle school mentees. To the best of our knowledge, no study has focused primarily on the relationship between high school mentors and middle school mentees in CS. In addition, many studies tend to focus on highly skilled mentors with in-depth experience who are usually treated as experts, rather than mentors with comparatively higher expertise than the mentees. Thus, in our study, we expand on the near-peer mentoring research by exploring the effect of high school aged near-peer mentors on middle school youth in the context of CS.

3 METHODS

The purpose of this study was to explore the effect of near-peer mentoring on the mentees' self-efficacy and interest in CS. The research questions that guided our study were: (1) *Is there a relationship between the campers' connection with near-peer mentors and their intrinsic interest in computing?* (2) *In their self-efficacy?* (3) *How do campers describe their relationship with their near-peer mentors?*

We used a mixed-methods approach to answer our research questions. Mixed-methods approaches are often used in educational settings in which relationships between constructs

can be very complex [12]. Given the complex nature of the relationship between mentor and mentee, we first used survey data to determine if there was a relationship between camper perceptions of their mentors and their change in affect. The interview data was analyzed to provide further insight into how campers perceived their relationship with their near-peer mentors.

3.1 App Camps

During the summer of 2017, we ran five camps on learning how to program using App Inventor. In the first camp, we trained high school students to use App Inventor and how to be a mentor. Then, mentors helped us run four additional camps for middle school youth.

3.1.1 Mentor Training. The mentors received a five-day training on programming in App Inventor and mentoring (6 ½ hours per day). During training, the mentors learned to program 11 apps that built on several key concepts. As the training progressed, the apps progressed in complexity and difficulty. By the end of the week, mentors were expected to create their own apps without instructions. They also completed debugging activities in which they learned to troubleshoot erroneous scripts which simulated problems that mentees may encounter in practice. For a full description of the apps, as well as which skills and concepts each of them targeted, see our website [<http://appcamp.usu.edu/>]. In addition, we had lead mentors help with mentor training. Lead mentors were youth who participated as mentors the previous summer and returned only for the week of mentor training. Each lead mentor worked with five mentors during the training. During mentor training, the mentors were exposed to three types of activities: social activities with their lead mentors, modeled behavior from their lead mentors, and mentor training activities. Each day started with social activities (e.g. Scavenger hunt, etc.) with the lead mentors. The goal of the social activities was to emphasize the importance of putting in the effort to get to know your mentees and help them feel more comfortable around you. Lead mentors also modeled desired behavior for the mentors in training, such as asking constructive questions, and being available, helpful and encouraging. Finally, each day of the camp, mentors would engage in a mentor training activity: *How to help someone debug*, *Role Play: good mentor/bad mentor scenarios*, *Questioning strategies*, *Mentoring practice*, and *Constructive feedback*. For instance, on Day 3, in the Questioning strategies activity, they were trained to recast questions as learning opportunities and guide their mentees through the problem-solving process rather than simply providing a direct solution. Similarly, on Day 5, in the Constructive feedback activity, we asked them to reflect on different types of feedback. Relying on those examples, we came up with several strategies for providing constructive feedback.

3.1.2 AppCamp. Middle school aged youth attended a five-day camp on programming in App Inventor (3 hours per day). The campers were provided with a similar curriculum as the mentors in which they programmed the same 11 apps. They did not engage in as many open-ended projects as the mentors; however, they did engage in some debugging activities.

3.2 Sample

All the participants in this sample came from a rural area in the Intermountain West of the United States.

3.2.1 Mentors. We selected twenty-five students to be mentors (6 males and 19 females, average age = 16). They were selected based on availability and their response to why they wanted to be mentors. Mentor ethnicities included Asian/Pacific Islander (16%), Native American (4%), Latino/a (4%) and Caucasian (76%). Thirty-two percent of our mentors reported being on free or reduced lunch.

3.2.2 Campers. We recruited 112 campers to attend our camps. One camper was excluded from the research due to lack of parental consent. The sample used for this research was 111 campers (40 males and 71 females) ranging in age from 10 to 14 years (average age = 11.98). Camper ethnicities included Asian/Pacific Islander (1%), Native American (4%), Latino/a (5%), Other (2%) and Caucasian (88%). Seventeen percent of our campers reported being on free and reduced lunch.

3.2.3 Camp Assignments. We ran four camps: two mixed gender and two single gender (girls only) camps. Each camp either had all female or mixed gender (males and females) mentors. The breakdown of each camp can be found in [Table 1](#).

Table 1: Camp Description ($N_{\text{mentor}} = 25$, $N_{\text{camper}} = 111$).

Camp	Mentor	N_{mentor}	Camper	N_{camper}
1	Female	(9F)	Mixed	(19M, 15F)
2	Mixed	(2M, 3F)	Female	(21 F)
3	Female	(4F)	Female	(20 F)
4	Mixed	(4M, 5F)	Mixed	(21M, 16F)

3.3 Data Collection Procedures

3.3.1 Surveys. Students took an affective survey prior to the camp on day 1 (pre) and then again on the last day of camp (post). Surveys were administered via the online survey software Qualtrics. Please see measures for more details.

3.3.2 Interviews. Forty-two campers across the four camps were randomly selected to be interviewed on the first day of camp and then again on the last day. Interview protocols focused on interest, self-efficacy, perceived support and camp experience. All interviews were audio recorded and transcribed verbatim.

3.4 Measures

The affective survey contained 32 items and asked students to rate the items on a scale of 1 to 8 from strongly disagree to strongly agree. The items were modified from existing surveys [9, 13, 16] and focused on campers' self-efficacy, interest, utility value, technical curiosity, and perceived support in CS. The post survey contained 7 additional questions developed by the research team that focused on the campers' experience with the mentors.

Composite scores were derived by averaging responses for each construct (three to six items). We ran analyses to confirm unidimensionality of the constructs and conducted Cronbach's alpha, a measure of internal consistency. For the purpose of this paper, we focus only on interest and self-efficacy. Descriptive statistics and pre-post differences are presented in [Table 2](#).

Table 2: Descriptive Statistics of Results from All Camps

	N	M	SD	Alpha
Self-Efficacy (Pre)	109	5.00	1.70	0.87
Self-Efficacy (Post)*	107	6.29	1.45	0.90
Interest (Pre)	109	6.76	1.09	0.78
Interest (Post)*	107	7.09	1.07	0.85
Mentor Relatability (Post)	107	6.11	1.48	0.81

Note. M=Mean. SD= Standard Deviation. Alpha = Cronbach's alpha. *Indicates a significant difference between pre-and post- scores.

4 RESULTS

In order to answer our first two research questions, we conducted two multiple linear regression analyses in R [23]. To ensure there were no violations of assumptions of normality, linearity, multicollinearity, and homoscedasticity, preliminary analysis were first conducted. In both models, post-test scores were used as the dependent variables. Then pretest scores were entered into the model to control for pre-camp differences in self-efficacy and interest in CS. Gender of the participant and camp type (e.g. mixed vs. single-gender camps) were also added to the null model to account for differences in context. Mentor relatability was then added to the model, and an ANOVA was run to determine if the added variable significantly increased the amount of variance explained by the model.

Intrinsic Interest		
Dependent variable:		
	Null Model	Full Model
Intrinsic Interest (Pre)	0.441*** (0.266, 0.617)	0.323*** (0.168, 0.477)
Gender (Male)	-0.190 (-0.668, 0.287)	0.070 (-0.347, 0.487)
Camp (Same-Gender)	0.131 (-0.338, 0.601)	0.186 (-0.216, 0.587)
Mentor Relatability		0.327*** (0.223, 0.431)
Constant	4.121*** (2.907, 5.335)	2.825*** (1.708, 3.942)
Model Fit (ChiSq)		.000***
Observations	105	105
R ²	0.202	0.423
Residual Std. Error	0.976 (df = 101)	0.834 (df = 100)
F Statistic	8.545*** (df = 3; 101)	18.296*** (df = 4; 100)

Note: *p<0.05; **p<0.01; ***p<0.001

Figure 1 Intrinsic Interest Model

4.1 Mentor Relatability and Interest

Our first research question asked about the relationship between campers' connection with near-peer mentors and their intrinsic interest in computing. [Figure 1](#) shows the results of the analyses.

The full model with the addition of mentor relatability explains significantly more variance in intrinsic interest than the null model ($\chi^2(1) = 40.37$, $p < .001$) and is significant ($F(4, 100) = 18.29$, $p < .001$), with an R^2 of .423. The addition of mentor relatability accounted for approximately 22.1% more variance than the null model. In this model, a one-unit increase in mentor relatability on an 8-point scale is associated with a .327 increase in intrinsic interest. In other words, in our sample, as campers' perceptions of mentor relatability increased, their intrinsic interest in CS increased. In the full model, gender of the participant and type of camp were not significant predictors. However, mentor relatability was a significant predictor of change in intrinsic interest.

4.2 Mentor Relatability and Self-Efficacy

Our second question asked about the relationship between campers' connection with near-peer mentors and their self-efficacy in computing. For the self-efficacy model, similar dependence on mentor relatability was discovered. The full regression model for self-efficacy with the addition of mentor relatability explains significantly more variance in self-efficacy than the null model ($\chi^2(1) = 38.12$, $p < .001$) and is significant ($F(4, 100) = 33.52$, $p < .001$), with an R^2 of .573. The full model accounted for approximately 17.3% more variance than the null model which included the pretest, gender and camp type. In this model, for a one-unit increase in mentor relatability on an 8-point scale, self-efficacy increases by .396. In other words, in our sample, as campers' perceptions of mentor relatability increased, their self-efficacy increased. In this final model, gender and camp type were not significant. However, mentor relatability was a

significant predictor of self-efficacy. [Figure 2](#) shows the results of the analyses.

4.3 Relationship with Near-Peer Mentors

Our third research question focused on how campers describe their relationship with their near-peer mentors. In order to answer this question, we analyzed interview and observation data. We conducted a thematic analysis of 42 post-interviews with campers and observation notes collected from the four middle school camps, which resulted in 105 units of analysis. Four themes emerged from the data: positive relationships mentors built with their mentees (Approachability) ($n=43$), the similarities campers perceived between themselves and their mentors (Similarities) ($n=24$), performance effectiveness that mentees perceived (In the Trenches: Credible Models) ($n=19$) and seeing the mentors as role models (Role Models) ($n=19$). In the following sections, we illustrate these themes through examples from camper interviews.

4.3.1 Approachability. The most prominent theme in campers' interviews was approachability of the mentors. The fact that mentees established a good relationship with their mentors was evident from the data as they were described as "easy to talk to", "nice", "fun", "friendly", "kind", "approachable", or a combination of a few of those adjectives. More importantly, no one labeled their mentor as annoying, rude or unapproachable. The campers seemed to have appreciated the fact that the mentors made an effort to get to know them on a more personal level. This effort made the campers comfortable to address the mentors or ask them questions. As an example, one camper said that her mentor made an effort to talk to her about their mutual interest, such as books, in addition to programming. This was important to her as she felt a mentor who knew her better could help her better. In other words, this camper felt connected to her mentor, because her mentor took the time to get to know her. This is important as it testifies that social relationships were established between campers and mentors, which is important to Bandura's social competency modeling framework [4-5].

4.3.2 Similarities. The second theme that emerged in our analysis were the similarities the mentees perceived between themselves and their mentors. In other words, many campers felt that they had a lot in common with their mentors. These similarities ranged from simple to more complex, such as age, personality traits (e.g. "laid back", "shy", "likes helping people" or "cheerful"), likes/dislikes, background (e.g. they went to the same school or came from a small town), and/or programming experience and skill level.

As an example, one camper expressed excitement that one of the reasons she really liked her mentor was because she felt they had similar personalities and they were very much alike. She saw her mentor as someone who was "not that much older than her" and who "always knows that there is a way past something. Like if the computer isn't working and it's hard to fix, you know? Like it has a bug or something. She'll call [someone] over. They'll work together. They'll get it working again." As a result of all the perceived similarities she enjoyed working with her mentor. Even though we do not know if these similarities were realistically present or just perceived, the fact that they were

	Self-Efficacy	
	Dependent variable:	
	Self-Efficacy (Post)	
	Null Model	Full Model
Self-Efficacy (Pre)	0.556*** (0.423, 0.689)	0.454*** (0.336, 0.571)
Gender (Male)	-0.389 (-0.952, 0.174)	-0.062 (-0.550, 0.427)
Camp (Same-Gender)	-0.210 (-0.764, 0.345)	-0.125 (-0.595, 0.346)
Mentor Relatability		0.396*** (0.274, 0.518)
Constant	3.702*** (2.951, 4.452)	1.663*** (0.769, 2.558)
Model Fit (ChiSq)		.000***
Observations	105	105
R^2	0.400	0.573
Residual Std. Error	1.148 (df = 101)	0.974 (df = 100)
F Statistic	22.468*** (df = 3; 101)	33.516*** (df = 4; 100)
Note:	*p<0.05; **p<0.01; ***p<0.001	

Figure 2 Self-efficacy Model

perceived stands as a testament that the campers related to their mentors. This is important as it has been shown to contribute to an increase in self-efficacy [5].

4.3.3 In the Trenches: Credible Role Models. Next, we learned that the level of expertise of the mentors, or their level of effectiveness in completing programming and mentoring tasks made learning enjoyable for the mentees, which consequently, allowed them to relate to their mentors. For some, the fact that mentors were good programmers, knew what they were doing and were able to provide help was comforting, inspiring and more importantly, they felt like it boosted their self-confidence, or got them more interested in programming. As an example, one camper explained how seeing her mentor's projects made her more interested in what she herself could do with programming:

"Faith was showing us an app that she had made. It was a game where there was like cats coming down from the sky, and you had to catch them in a little basket. I thought that was way cool. I have no idea how you could do that. I wanna figure it out."

Faith was one of the most advanced mentor programmers that we had in the camp. As seen from the excerpt above, seeing her game provided some campers with a better understanding of what can be done with programming. As we mentioned, the level of experience mentors possess is on a spectrum. While Faith was possibly closer to expert on the spectrum than other mentors, the mentees were still able to relate to her.

About a third of the campers we interviewed felt encouraged by the fact that the mentors did not know everything, were not yet the best programmers or were not afraid to ask for help themselves. This encouraged the campers to keep mastering the skill and made them feel better about their own confusions or "failures". As an example, one camper described his mentor in the following manner:

"The [mentor] that I was working with was nice. She showed me what she did and helped me out when I was really stuck. She got confused, too, so I wasn't the only one being confused."

Being confused or having a buggy program can be embarrassing. However, debugging and problem solving are an important part of programming. To that end, we emphasized the importance of modeling problem solving, which the mentors did through their own problem-solving techniques. This approach created an environment in which asking questions was okay, not knowing everything was okay and collaboration was welcome.

In addition, the campers liked that the mentors went through the same experience not that long ago, they still remembered what it was like to learn App Inventor, and they faced similar programming problems. For Becca, for instance, the crucial moment in developing a relationship with her mentor, Summer, was when Summer shared the "problems she had had when she was coding things and how she had fixed them". Summer talked openly about her own programming struggles, which helped her mentees relate to her. Other campers mentioned that working closely with someone closer to their age, as their mentor, who experienced similar struggles and is still cognizant of them, made them feel more confident about overcoming their own problems. They also believed younger mentors were more likely to

sympathize with their programming "troubles". This finding came as the biggest surprise to us. Though we hoped that having mentors closer to their age would help the middle schoolers relate better and build their self-confidence, we did not expect that a somewhat modest programming experience of the mentors would serve as a bonding experience for the campers. And yet, the campers not only liked it, but found it comforting and encouraging.

4.3.4 Role Models. The forth theme that we found confirms that some campers did develop a sense of future self throughout the camp. Approximately half of the campers interviewed perceived their mentors as role models. This happened for a variety of reasons. Campers mentioned looking up to their mentors, or wanting to program or mentor like them. Some of the reasons for those aspirations were mentors' subject matter expertise (e.g. "she is a good programmer"), ease of programming or an assumption that they started programming in a camp similar to the one they were attending.

Observing the work of mentors, "what they do and how they know all this stuff", as well as the amount of help they provided, encouraged one camper to put more effort into her programming, because she wanted to be a mentor one day.

Another camper was also interested in the prospects of being a mentor herself. To her, however, the mentor served as a teaching role model, because she felt that if she wanted to teach people about programming one day, she could "learn from [her mentor] about it."

During mentor training we emphasized the importance of being good role models for the campers, which included both being knowledgeable and being good teachers by modeling certain types of behavior. Campers did identify with their mentors and saw them as models of their future self, which provides another possible reason as to how mentor relatability affected campers' interest and self-efficacy.

5 DISCUSSION AND CONCLUSION

In this study, we set out to explore the effect of near-peer mentors on their mentees' affect gains during a one-week app camp. We found that middle school campers' perceptions of mentor relatability were shown to significantly predict both self-efficacy and interest gains. In other words, campers who perceived their mentor as more relatable were associated with higher gains in self-efficacy and intrinsic interest in computing when accounting for pre-camp affect differences, gender, and camp type (mixed-gender vs same-gender camps). Four themes were identified from the qualitative data that potentially explain why and how mentor relatability influenced self-efficacy and intrinsic interest gains. In line with Bandura's [3-4] argument for mentors as agents for self-efficacy and interest growth, we found that mentees perceived their mentors as both approachable and similar to themselves. Such perceptions were viewed as positive for the campers as they provided motivation to learn and a supportive learning environment. In addition, mentees noted the benefits of having a mentor who was both more knowledgeable than themselves, but not too much of an expert that they had disparate experiences [3-4]. Viewing the

mentors as more capable versions of themselves provided the mentees with a credible but attainable model that helped them increase their interest and self-efficacy in CS.

These findings suggest that when designing CS experiences, one must not only take into account factors that promote learning, but must also attend to social aspects that lead to identity formation and a sense of community and belonging. This can be done through near-peer mentors who are approachable, similar and credible. However, it also important to note that expertise should not be the only qualification for hiring mentors because mentors with less experience may have a lot to offer.

ACKNOWLEDGMENTS

This work was supported by a grant (#1614849) from the National Science Foundation. Any opinions, findings, and conclusions or recommendations expressed in this paper are those of the authors and do not necessarily reflect the views of the National Science Foundation, or Utah State University.

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