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The effectiveness of self-directed learning vs. teacher-led learning on gifted and talented vs. non-gifted and talented students

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Abstract
As the Internet has made virtually unlimited resources available to people to learn on their own, more and more people are engaging in self-directed learning to enhance their educations. Researchers have investigated self-directed learning for years, focusing on variables such as design of content and learner attributes such as motivation and self-efficacy as predictors of learning success. The present paper looks at student aptitude as a predictor of student performance in a self-directed learning context. 33 middle and high school students, who were or had been in either gifted and talented or mainstream educational programs in school were taught how to program websites. They were either taught by a teacher or by watching videos (the self-directed learning condition). At the end of the instructional period, all students were asked to create a website about themselves and the quality of their work was graded by experienced computer programmers. Results showed that gifted and talented students performed equally well with or without a teacher while non-gifted and talented students performed at a level equal to the gifted and talented students when they had a teacher but lower when they did not. Results suggest that self-directed learning may be equally effective as teacher-led education for gifted and talented students, but non-gifted and talented students may benefit more from traditional education than self-directed learning.

Keywords: self-directed learning, teacher-led learning, internet

Introduction

In many ways, education in the schoolhouse has remained fairly constant with teachers and textbooks being the primary way that students learn while at school. However, the explosion of the Internet in recent years has created virtually unlimited opportunities for people to take learning into their own hands by utilizing the plethora of online learning resources available. Indeed, people are now even pursuing the equivalent of college level educations using online sites such as Coursera and EdX where they select the courses they want to take, watch instructional videos and take automated tests.

While self-directed learning (SDL) has been investigated within the research community for years, its importance has increased dramatically as more and more people turn to SDL as a way to increase their knowledge. Much of the previous work in SDL can be broken down into three main categories: research that looks at the characteristics of SDL programs that increase effectiveness (cf., Firat, Sakar, and Yurdakal, 2016; Sumantri and Satriani, 2016) [2, 10], research that looks at student interest and motivation (cf., Oladoke, 2006; Pintrich, 2004; Song and Bonk, 2016) [4, 6, 9], and research that looks at student self-efficacy/metacognitive strategies (cf., Dagal and Bayindir, 2016; Saeid, and Eslaminejad, 2017; Schunk, 2008) [1, 7, 8].

Much of the work that has been done in the area of SDL has focused on adult populations. We believe more research should be conducted on child learners, especially given that many of them are turning to the Internet to supplement their school-based educations by learning topics of interest to them such as computer programming. Moreover, since historically, children have depended on adult teachers to guide their education, it is of interest to investigate other learner characteristics that affect how well children can learn on their own. One such factor may be student aptitude.

Currently, many school districts test their students' aptitude and those who score highly are placed in advanced or "gifted and talented" programs. Such students receive advanced curricula, often studying above-grade level work. However, in such programs, students are often taught primarily by their teachers. It is of interest to see whether such students could fare equally well on their own, and in doing so, could perhaps advance beyond what they normally do in their traditional academic settings.

The present study investigates how well gifted and talented (GT) students learn on their own (self-directed learning) compared to being taught by a teacher vs. how non-gifted and talented students fare under similar circumstances. There is some previous work that suggests that GT students may fare equally well on their own or with a teacher. Research looking at adult medical students (Pai *et al*., 2014) [5], who may be considered to be in a "GT" program since medical school is among the most selective program one could attend, found that first year medical students were able to learn physiology using SDL as well as those who were taught in a traditional classroom environment.

Accordingly, the present research investigates whether GT and non-GT students can learn equally well in both teacher-led and SDL settings. The topic of programming websites is

chosen as the subject matter since this is a topic of general interest to school-aged children and one that people often learn to do on their own as well as learn through formal classroom settings. We hypothesize that there will be an interaction effect with GT students learning equally well in both SDL and teacher-led settings and non-GT students learning better in a teacher-led setting than in an SDL setting.

Methods

Participants

Participants were 33 middle and high school students from Fairfax and Loudoun counties in Virginia. No student had previous experience programming in HTML or CSS, programming languages used to create websites. Of these students, 16 were or had been enrolled in a gifted and talented program (in Fairfax and Loudoun counties, the gifted and talented (GT) programs run through middle school) and 17 were or had not been. In Fairfax and Loudoun counties, all students are given two aptitude tests, the Cognitive Abilities Test (Cog AT) and the Naglieri Nonverbal Ability Test (NNAT). The CogAT test has three subscores: verbal, quantitative, and non-verbal (visual/spatial reasoning) and the NNAT measures non-verbal skills. To qualify for the GT programs in these counties, students must score roughly in the top 2% on the aptitude tests, maintain top grades and be recommended by their teachers. All students who meet these criteria are selected into the GT program, meaning that there are no students who were otherwise qualified but were not selected due to space limitations. Because the qualifications for selecting students into the GT program are rigorous and consistent across counties and all qualified students were admitted into the GT programs, we were confident that participation in the GT program was an acceptable criterion for determining high aptitude students.

Participants responded to an advertisement for a free class in web-development programming. While it is generally regarded that people responding to such recruitment efforts do not represent a random sample of the population, we consider this population subset to be the most relevant to our research. The focus of the present research is to compare the effectiveness of self-directed learning compared to teacher-directed learning. Therefore, the appropriate students to use were those who sought out opportunities to learn outside the classroom. Students who pass up opportunities to learn outside the classroom would not benefit from any research on how to optimize self-directed learning and are not relevant to the present study.

Instructional Videos

There were fifteen videos used in the self-learning condition that taught students how to create websites. They were taken from the following two websites: https://thenewboston.com/videos.php?cat=43&video=18818 and https://www.khanacademy.org/computing/computer-programming/html-css. The videos were (in the order they were viewed by participants):

1. The New Boston – "Creating a Basic Template" – Tutorial #2
2. The New Boston – "Setting up the body" – Tutorial #3
3. Khan Academy – "HTML: Lists"
4. Khan Academy – "HTML: Images"
5. Khan Academy – "CSS: Selecting by class"
6. Khan Academy – "HTML links"
7. Khan Academy – "HTML internal links"
8. The New Boston – "Attribute Selectors" – Tutorial #5
9. the new Boston – Sweet New CSS3 Selectors" – Tutorial #8
10. Khan Academy – "CSS font styles and shorthand"
11. The New Boston – "Start the Styling" – Tutorial #10
12. Khan Academy – "More CSS text properties"
13. Khan Academy – "CSS box model"
14. the new Boston – "Finish the Layout" – Tutorial #13
15. Khan Academy – "Project: Recipe book"

Procedure

There was a total of six separate one-day sessions that were advertised for the free web-design class. Each session represented the complete course, so students signed up for only one session. Sessions were conducted over three days with two sessions per day. Of these two sessions, one was randomly designated as the teacher-taught class and the other was designated as the student-learning class. Students attended the class they signed up for, not knowing ahead of time whether the class would be teacher-directed or self-directed. However, a teacher was present in both cases, as will be explained shortly.

Each session lasted three hours and forty-five minutes. The first fifteen minutes were devoted to registration and to allow for late comers. The next hour and fifteen minutes was the instructional phase. In the teacher-led groups, the teacher taught the students, in a lecture format, how to create a basic website using both HTML and CSS. In the self-directed learning groups, students watched the 15 videos described in the previous section and in the order shown there on their own laptops. Upon completion of the instruction, the teacher spent five minutes telling students that their next task was to create a three-page website that described themselves that features a general page about themselves and one page each on their favorite animals and favorite foods. Students were instructed that their websites should include text, background colors, pictures and links. Students used their own laptops for this task. Students were given one hour and fifteen minutes to perform this task with no outside help. The role of the teacher at this point was to insure that each student worked independently and did not receive help from other students or other outside people (e.g., through phone calls).

Upon completion of the programming task, the experiment was concluded from our perspective. The students were given a break while the teacher reviewed the programs the students wrote. When the students returned from their break, the teacher went over the programs the students had turned in and provided the students with feedback. Students did not make any changes to their programs. Rather, this last review process was to enhance the educational value of the experience for the students.

Results

The participants' webpages were scored by experienced web designers according to a 27- point rubric. A total of two scorers were used. The rubric contained six dimensions. The dimensions and their maximum point values are as follows:

- Code Organization: 5
- Proper Syntax: 2

- Code Works: 5
- Website Usability: 5
- Website Prettiness: 5
- Met the Requirement for the Assignment: 5

Table 1 shows the mean scores given to participants' work, broken out by condition. As can be seen from Table 1, the mean scores in the teacher-taught conditions as well as the gifted and talent self-taught condition were close to each other while the mean score in the non-gifted and talented self-taught condition was much lower. A two-way analysis of variance was performed on the data. The analysis showed no main effect for type of instruction (teacher-taught vs self-taught), $F(1, 29) = 1.03$, ns, or type of student (gifted and talented vs. non-gifted and talented), $F(1, 29) = 2.12$, ns. However, the type of instruction vs. type of student interaction was statistically significant, $F(1, 29) = 4.22$, $p < .05$. To determine which means were statistically significantly different from each other, a Tukey Honest Significant Difference (HSD) test was conducted on the means. Results of this analysis revealed that the mean score of the non-gifted and talent, self-taught condition was significantly different from the other three mean scores, while the other three mean scores were not statistically significantly different from each other. This suggests that gifted and talented students learned equally well regardless of whether they were self-taught or had a teacher, while the non-gifted and talented students performed as well as the gifted and talented students, but did not learn as well when they were self-taught.

Table 1: Mean Score on Webpage Assignment Correctly Based on Condition

	Teacher Taught	**Self-Taught**
Gifted and Talented	19.06* (n=9)	21.56* (n=7)
Non-Gifted and Talented	20.50* (n=7)	13.08 (n=10)

Means with asterisks are not statistically different from each other at the .05 level.

Numbers in parentheses represent the number of students in each condition.

Discussion

The results confirmed the experimental hypothesis that GT students could learn equally well by themselves or when taught by a teacher while non-GT students would learn better when taught by a teacher than by themselves. What was slightly surprising is that GT and non-GT students performed equally well when taught by a teacher. This may be an artifact of the fact that the topic to be learned represented a basic level topic that was perhaps relatively easy to master when taught by an experienced teacher. It would be interesting to see whether and for how long this performance equality holds up as topics grow more complex and students advance through the subject areas.

The results may have implications not only for managing the learning process outside the traditional classroom, but also within the classroom as well. As noted in the Introduction, the current educational model heavily relies on teachers and textbooks as the primary method of delivering instruction in the classroom. Typically, all students in the class learn the same material. However, those students have different aptitudes and learn at different rates, something that a single classroom teacher cannot accommodate. As a result, the teacher often teaches to the "middle", where top students may feel bored and that they are not learning very much, while some other students may struggle and fall behind.

The present results suggest that the higher aptitude students may be able to pursue their own learning with minimal support from the teacher, who would then be freed up to devote more time to the students who need more attention. Many schools have laptops right in the classroom and many students have their own laptops or other devices with Internet access. The teacher could point those students to the appropriate online resources that cover the topics the students need to learn, much the way the teacher in the present study directed the self-directed learners to the videos they needed to watch to learn how to program websites. The teachers could still be available to review student work (as they did in the present study—although in our case, the review was done after the programs were turned in so as not to bias the data in the SDL conditions). The outcome of this paradigm might be that high aptitude Students advance farther than they would under a traditional educational paradigm because they are not slowed by the teacher focusing on the "middle", while the struggling students may advance as well as they receive more attention from the teacher.

Conclusion

As noted in the Introduction, there is an increasing trend for people to take learning into their own hands using the plethora of educational resources available on the Internet these days. Researchers are investigating ways to enhance the effectiveness of self-directed learning by examining best practices for designing self-directed learning content and by looking at learner characteristics such as motivation and self-efficacy that lead to increased self-directed learning performance. The present findings indicate that student aptitude may also play a role in how effective self-directed learning can be by suggesting that a certain aptitude level may be necessary in order for a student to gain proficiency in a subject area he or she is studying without the aid of a teacher.

Additional research is needed to determine how far both high and average aptitude students can progress without the aid of a teacher. The present research suggests that average aptitude students may not be able to progress very far, but it is unclear to what level of advancement a high aptitude student can achieve. Anecdotally, there are stories of famous inventors such as Thomas Edison and Henry Ford who had little formal education yet literally transformed society through their inventions.

A second area of research in today's technological era is to investigate the extent to which the technology itself can act as a surrogate for the teacher and therefore boost self-directed learning performance in average aptitude students. Artificial intelligence (AI) is an active area of research these days and its application to education as a surrogate teacher may show considerable promise in the self-directed learning context. For example, Kindi *et al*. (2016) [3] found that using AI to support students' learning of Algebra II level mathematics by reviewing their step-by-step problem solving and providing remedial instruction for mistakes after the students had viewed

instructional material resulted in students scoring nearly twice as highly as those using the SDL website Khan Academy, but without the AI support.

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