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THE EFFECTIVENESS OF SELF-DIRECTED LEARNING VS. TEACHER-LED LEARNING OF ADVANCED SUBJECT MATTER ON GIFTED AND TALENTED VS. NON-GIFTED AND TALENTED STUDENTS

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ABSTRACT

In the age of the Internet, where information is readily accessible, many people are expanding their knowledge through self-directed learning without being in the traditional classroom setting. This raises the question of how well people can learn on their own without the aid of a human teacher. In our previous work (Leddo et al., 2017), we found that gifted and talented (GT) students learned basic computer programming equally well on their own or when taught by a human teacher while non-GT students learned better when taught by a human teacher than on their own. This raises the question of how well students can continue to learn on their own as the subject matter becomes more advanced. The present study investigates this question by having 26 high school students learn an advanced topic in biology, taught either by a teacher or by reading articles and watching videos (self-directed learning-SDL). Whether students were designated GT or not designated GT by their respective school districts was also an independent variable in this study. Results showed no main effect on learning based on whether students were taught by a teacher or engaged in SDL or were designated GT or non-GT. Rather, there was an interaction effect such that non-GT students learned better when taught by a teacher and GT students learned better when engaged in SDL. These results amplify the findings of our previous work and show that GT students can learn even advanced material on their own without the aid of a human teacher. This reraises the question that led to the present study of the extent to which students can continue to learn on their own without the aid of human teachers.

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Introduction

The advent of the Internet has changed the way people learn. While people still go to school and learn the basic curriculum through the traditional classroom setting, they are now supplementing their learning with online resources. There are even online courses on platforms such as Coursera, EdX, Udemy, etc. where people can earn certifications. Even less structured ways of learning are from YouTube videos and reading online articles. Self-directed learning (SDL) research has been focused on characteristics of SDL programs that increase its effectiveness (cf., Firat, Sakar, and Yurdakal, 2016; Sumantri and Satriani, 2016), student interest and motivation (cf., Oladoke, 2006; Pintrich, 2004; Song and Bonk, 2016), and student self-efficacy/metacognitive strategies (cf., Dagal and Bayindir, 2016; Saeid, and Eslaminejad, 2017; Schunk, 2008).

Much of SDL research has been conducted on adult populations, so we wanted to expand the work done on children, especially since many of them are supplementing their education with resources from the Internet and are even learning topics that are not offered to them in school. More research with children would also show the factors that impact their learning without the guidance of an adult. One of these factors could be student aptitude.

Many school districts test for student aptitude and place the more advanced students in gifted and talented (GT) programs where they learn curriculum above their grade level. However, these students are still taught by teachers, so it is interesting to see how they will perform if they are left to learn on their own. In our previous study (Leddo et al., 2017), we tested whether there is a difference in performance in GT and non-GT students when taught by human teachers or learn in an SDL environment. The study involved the teaching of introductory computer programming to two groups: a teacher-led one and a self-directed one where students learned from videos. Students in both groups had no prior computer programming experience. Students in both groups individually made a website as their post-test, and these were scored by experienced web designers. The scores showed that GT kids learned the same regardless of whether they were self-directed learners or taught by a teacher, while non-GT kids learned better with a teacher.

Given that introductory computer programming is a relatively simple topic, the question becomes, “How far can students learn on their own?” Can GT students continue to learn advanced material on their own as well as they can with a teacher? This is the research question of the present paper. In order to test this, we chose a topic that is more advanced than one that is ordinarily taught in an introductory high school course or even an Advanced Placement (college-level) course that is offered to high schools. Additionally, we wanted to extend our findings

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beyond just computer science, so we picked a topic in biology. Accordingly, we picked a topic of great interest in biological research these days: cellular senescence and possible anti-aging methods as the material students learned.

This study compares the performance of GT and non-GT students who learned the selected biology topics in both self-directed learning and teacher-led instruction conditions.

Method

Participants

There were 26 high school students from Fairfax County and Loudoun County in Virginia who participated. Eight students were in GT and had taken high school biology, six students were in GT and had not taken high school biology, eight students were not in GT and had taken high school biology, and four students were not in GT and had not taken high school biology. Students were not paid to participate in the experiment.

Instructional videos/materials

The self-directed group was taught with two articles and two YouTube videos. The links to the videos and articles are below.

Cellular Senescence Resources:

1. https://www.youtube.com/watch?v=c0pdoazgNn8

Anti-aging Possibilities Resources:

1. https://www.youtube.com/watch?v=MjdpR-TY6QU&t=386s
2. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4993332/
3. https://www.nature.com/articles/ncomms13103

The materials used in the teacher-led group was a slideshow created from information from the self-directed materials. The link for the slideshow is below:

https://docs.google.com/presentation/d/1hk8tsjKU7iFyml6Rjs4g_tMcOyeJvg-zks-RvC428WM/edit?usp=sharing

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Procedure

The total session lasted two hours. During the two-hour session, students first took a timed pre-test for twenty minutes so we could gauge the amount of information students already knew about the topic. Then, students were randomly assigned to a learning condition. There were 12 assigned to the teacher group and 14 assigned to the self-directed learning group. In the teacher-led group, there were two students in GT and had previously taken high school biology, five students in GT and had not taken high school biology, four students not in GT and had not taken high school biology and one student not in GT and had not taken biology. In the self-directed group, there were six students in GT and had taken biology, one student in GT and had not taken biology, four students not in GT and had taken biology and three students not in GT nor had taken biology.

After they were split into their groups, they learned about cellular senescence and possible anti-aging techniques. Students in the teacher-led group were taught as a group by a medical doctor, who routinely tutors biology to high school students, and who was blind to the fact that her students were part of an experiment on learning. The medical doctor used the instructional materials provided. Students in the self-directed learning condition learned at their own pace through the provided videos and articles. Finally, all students took a timed post-test for twenty minutes to test how much each student learned.

Results

The results on the pre-test and the post-test were scored. Many students had some prior knowledge of the topic, which makes sense when talking about an advanced topic, and therefore scored above 0 on the pre-test. Therefore, it did not seem appropriate to use post-test score as the dependent measure for the experimental analysis, since the post-test score was comprised of both what the students already knew about the topic and what they learned during the experiment. Therefore, it was decided to use the post-test minus pre-test test score as the dependent measure. This difference could be thought of as the change in knowledge as a result of instruction.

The change in knowledge scores were virtually the same across students who had previously taken biology and those who had not. Therefore, for the analyses that follows, whether or not a student had previously taken biology was not broken out as a separate variable. Accordingly, Table 1 presents the mean change in knowledge scores of students broken out by aptitude (GT or non GT) and instructional method (self-taught or teacher taught).

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Table 1: Mean Change in Knowledge Scores by Aptitude and Instructional Method

	Self-Taught	Teacher Taught
Gifted and Talented	66.71	48.71
Non-gifted and Talented	47	67.57

A two-way analysis of variance (ANOVA) was performed on the data. Results showed that there was no main effect for aptitude or instructional method (both $F<1$, ns), but there was a significant interaction between aptitude and instructional method, $F(1,22)= 6.92$, $p<.05$. This interaction effect suggests that for more advanced subject matter, non-GT students tend to learn better when taught by a teacher (consistent with the previous findings of Leddo et al., 2017) but that GT students learn better when engaged in self-directed learning. The latter finding departs slightly from the Leddo et al. (2017) finding that GT students learn introductory material equally well when self-taught or taught by teachers.

Discussion

The present results show that, for advanced subject matter, there were no main effects for aptitude (GT vs. non-GT) or learning format (self-directed learning vs. teacher-led instruction). Rather, there was an interaction effect whereby GT students learned better on their own and non-GT students learned better when taught by a teacher. Comparing these results to the original Leddo et al. (2017) study yields some interesting points. First, as in the original study, non-GT students taught by teachers learned as much as GT students did. Second, in the original study, GT students did as well with a teacher as they did on their own, but in the present study, they did better when self-taught than when teacher taught. If anything, it appears that being taught by a teacher may have suppressed learning in the GT group since students in that group scored lower than those in the GT/self-directed learning condition *and* those in the non-GT/teacher condition. The latter suggests that the lower learning performance in the GT/teacher condition was not due to the quality of the teacher as non-GT students in the same session outperformed the GT students.

There are two notable methodological differences between the original study and the present study. First, the subject matter changed from computer programming to biology. On the one

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hand, this extends our previous work showing that GT students fare very well when teaching themselves by showing positive effects in a second domain. On the other hand, the surprising drop in performance of students in the GT/teacher group raises the question of whether effectiveness of teacher-led or student-led instruction depends on the subject matter being taught or how advanced the material is. More research is needed on the relationship between subject matter domain and self-directed vs. teacher-led learning.

The second major methodological difference between the original and the present study is that, in the original study, students had zero prior programming knowledge. Therefore, their final performance score was both their learning gain score and their final knowledge score. On the other hand, all students in Virginia take life science in 7th grade, which means that all students had some exposure to the subject matter, if even at its most basic level, prior to the experiment. That would almost necessarily be the case in practice when one learns advanced concepts. This means that pre-test scores were not zero for the students and post-test scores and learning gain scores were not the same. This could create the problem of ceiling effects whereby the maximum amount of knowledge a student could gain is limited by his/her pre-test score. Fortunately, an examination of the raw scores revealed that no student scored 100% on the post-test, and only three of the students scored above 90% on the post-test. Two of these three students were in the GT/self-directed learning condition, which works against the finding that GT students learn best when teaching themselves.

One factor that neither the original Leddo et al. (2017) nor the present study investigated was the relative efficacy of self-directed vs. teacher-led learning on entire courses of material rather than single lessons. Both the original study and the present one examined single lessons. It would be interesting to see whether these results hold up when students learn a series of lessons or even entire courses.

When taken in the context of the original research question of how far GT students can go teaching themselves, the present study merely pushes the question farther. GT students in the present study did not reach a breaking point such that material presented to them was too difficult for them to learn on their own. This suggests additional research is needed on even more advanced levels of material.

While it is unclear how far GT and other students can go learning on their own compared to being taught by a teacher, there is another factor worth considering. Many self-directed learning media involve presenting students with content, but otherwise providing limited support. For example, in the present study, students were presented with articles and YouTube videos. These

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are non-interactive media that require students to absorb material on their own. Even the popular Khan Academy, used by millions of people, provides limited support: videos, practice problems and feedback on how to solve a problem but not an explanation of a student's actual mistakes. What if the types of support normally provided to students by teachers, e.g., corrective instruction on actual mistakes, answers to student questions as they learn, were made available? Would this raise the bar of what students could learn without human teachers?

The research of Leddo and Garg (2021) may help answer this question. These researchers evaluated technology that uses artificial intelligence (AI), voice and natural language processing technologies to emulate human teachers. In this technology, students learn by watching a video or reading text (their choice). At any time during the instructional process, students can verbally ask questions as they would a human teacher. The software responds verbally with answers. If the software does not understand a question, it can even seek to clarify what the student asks by rephrasing what the student asked or asking the student to ask the question in another way as a human might. When the student has finished with the lesson, the software verbally asks the student questions to ensure the student understood the material. The student speaks his/her answers and receives corrective feedback if his/her answer shows a misunderstanding.

After learning the material, the student practices solving problems. The student uses an electronic worksheet on which s/he shows his/her step-by-step work. If the student makes a mistake, s/he is given an explanation of what s/he did wrong and what s/he should have done instead. If the student is stuck, s/he can ask the software for a hint. The software evaluates the step-by-step work already done and can give up to three hints, each one more detailed than the last, which includes information taken from the problem the student is working on. The software even allows the student to enter his/her own problems and solve them, while still receiving hints and feedback for mistakes as with software-supplied problems.

Leddo and Garg (2021) tested the software in a study similar to the present one. One group of students was taught by a teacher while a second was taught using the software. The Algebra 2 topic of dividing complex numbers (an advanced topic) was used as the subject matter. In the Leddo and Garg study, students were not identified as GT or non-GT, so this variable was not examined. All students received a pre-test (for which every student scored 0, indicating no prior knowledge of the topic) and a post-test. The results showed that students who used the software scored, on average, 37% higher than those taught by human teachers. An examination of the individual student scores is revealing. No student using the software scored below 70% on the post-test and the average score was 90%. On the other hand, in the teacher-led groups (more than one teacher was used), the individual scores ran the gamut. About one-third scored in the A

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range (90% or above), one-third in the B-C range (70-89%) and one-third scored in the D-F range (below 70%). These results are consistent with the GT/self-directed learning condition results of the present study in that students did better without a teacher than with a teacher, although in Leddo and Garg, the results applied to all students. Moreover, the results of the Leddo and Garg (2021) study suggest that providing supporting technology to students engaged in self-directed learning may very well extend what is possible for students to learn on their own without the aid of human teachers.

Conclusion

With more and more people taking their education into their own hands and with the widespread availability of resources to do so on the Internet, SDL is becoming increasingly relevant and important. While we are not arguing for the replacement of teachers with technology, the findings of our work with technology and self-directed learning may form the basis of a new way of thinking about how to teach millions of students (especially in light of a current teacher shortage in the US) and the ability to develop their talents beyond what can be handled by teachers who must work with diverse student populations of differing abilities, current knowledge levels and learning styles. An alternative may be to allow some of those students to direct their own learning and support them with smart interactive technology.

References

Dagal AB, Bayindir D. (2016). The Investigation of the Relationship between the Level of Metacognitive Awareness, Self-directed Learning Readiness and Academic Achievement of Preschool Teacher Candidates. Universal Journal of Educational Research. 4(11):2533-2540.

Firat M, Sakar AN, Yurdakal IK. (2016). Web Interface Design Principles for Adults' Self-Directed Learning. Turkish Online Journal of Distance Education. 17(4):2

Leddo J, Boddu B, Krishnamurthy S, Yuan K, Chippala S. (2017). The effectiveness of self-directed learning and teacher-led learning on gifted and talented vs. non-gifted and talented students. International Journal of Advanced Educational Research, 2(6):18-21.

Leddo J & Garg K (2021). Comparing the effectiveness of AI-powered educational software to human teachers. International Journal of Social Science and Economic Research, 6(3), 953-963.

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Lee, K., & Kang, S. (2018). Exploratory Research for Development of SDLT(Self-directed Learning Test) for Young Children. The Educational Review, USA. 2(3), 199-208. http://dx.doi.org/10.26855/er.2018.03.001

Morris, T.H. (2019). Self-directed learning: A fundamental competence in a rapidly changing world. Int Rev Educ 65, 633–653. https://doi.org/10.1007/s11159-019-09793-2

Oladoke AO. (2017). Measurement of self-directed learning in online learners. Ph.D. thesis, Capella University. Retrieved from https://www.learntechlib.org/p/118702/.

Pai K M, Rao KR, Punja D, Kamath A. (2014). The effectiveness of self-directed learning (SDL) for teaching physiology to first-year medical students. Australasian Medical Journal. 7(11):448-453.

Pintrich PR. (2004). A conceptual framework for assessing motivation and self-regulated learning in college students. Educational Psychology Review, 16:385-407.

Saeid N, Eslaminejad (2017). T. Relationship between Student's Self-Directed-Learning Readiness and Academic Self-Efficacy and Achievement Motivation in Students. International Education Studies,10(1):225-232.

Schunk DH.(2008). Metacognition, self-regulation, and self-regulated learning: Research recommendations. Educational Psychology Review. 20(4):463-467

Song D, Bonk CJ. (2016). Motivational factors in self-directed informal learning from online learning resources. Cogent Education,3(1):1205838.

Sumantri MS, Satriani R. (2016), The Effect of Formative Testing and Self Directed Learning on Mathematics Learning Outcomes. International Electronic Journal of Elementary Education, 8(3):507-524.

