Assessing Students' Digital Literacy with Interactive Computer-Based Tasks Created in Google Apps Script

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Abstract

This paper presents the development and testing of two interactive computer-based tasks for assessing aspects of students' digital literacy. The tasks were created using Google Apps Script to allow students to work with authentic digital productivity tools. Results from 156 university students indicate that the task requiring analysis of data in a spreadsheet application was significantly more difficult than the task requiring information literacy to make edits in a word processor application. These types of tasks offer more authentic ways for students to engage with digital technology during the assessment of their digital literacy. This study highlights the potential of Google Apps Scripts for developing and delivering tasks in performance-based assessments of students' digital literacy.

Keywords: Assessment, Digital literacy, Digital competence, ICT skills, DigComp framework.

1 INTRODUCTION

The importance of digital literacy has increased considerably in recent years. Personal smart devices not only provide access to a vast amount of information via the internet, but are increasingly able to interact with electronic devices at home and in other daily life situations. The changes brought by modern digital technology make it essential to prepare all people to best take advantage of these new possibilities. Educational systems have a role to play in shaping the digital literacy of young people. However, in order to monitor and support the development of students' digital literacy, a way of assessing digital literacy is needed. Performance-based assessments offer a more authentic approach to measuring digital literacy because they compel students to demonstrate their competence and can thereby ensure a more a reliable and valid measurement.

The concept of digital literacy is much more than simply learning how to use a digital device or how to perform online searches. Digital literacy is a set of skills (how to do something with digital technology), knowledge (what is it possible to do with digital technology), and attitudes (is a person ready and confident to use digital technology). It is the ability to use digital technologies for searching, assessing, creating, managing and communicating information broadly [1, 2, 3]. Thus, digital literacy is concerned with different practices. As such, there exist many terms used by researchers that overlap to various degrees with the concept of digital literacy: e.g., digital competence [4], information and communication technology (ICT) skills [5], computer and information literacy [6], etc. It is thus important to recognize that examples of assessment tasks for measuring aspects of digital literacy can come from prior research that labelled the concept of digital literacy differently.

Siddiq et al. [7] conducted a systematic review to find instruments that assessed the ICT literacy of primary and secondary school students. They found that most tests were comprised of multiple-choice constrained response questions. Only 3 tests out of the 38 reviewed reported applying a performance-based approach, i.e. a test design which mimicked an authentic situation to a large degree. Nine tests reported using tasks with interactive stimulus and response formats. The authors concluded that there is a demand for assessment instruments to measure what is considered to be authentic ways of interacting with technology. Furthermore, [7] found that a large majority of tests focused mainly on assessing students' digital information search, retrieval, evaluation and technical skills. Similarly, Siiman et al. [8] examined interactive computer-based tasks from several large-scale educational assessments related to assessing digital literacy and found that these tasks do not measure many aspects of digital competence that are described, for example, in the DigComp framework [4, 9].

In general, performance-based assessments are preferred over self-report measures, as the latter do not indicate how competent a student is according to standardized metrics [10]. Therefore, in order to better assess the construct of digital literacy, it is preferable to create practical tasks in which the respondent can demonstrate his or her knowledge and skills through performance on a task, rather than selecting an answer from a prescribed set of alternatives.

The use of simulated environments to provide a more authentic test environment when assessing aspects of digital literacy has often required developers to create custom-made simulated environments [6, 11, 12, 13]. Such an approach entails substantial technical effort that diverts resources from the main goal of designing and validating tasks to measure aspects of digital literacy. Researchers would benefit from using an existing technical environment to assess digital literacy and which can be adapted to a variety of contexts. In this paper we propose that Google Apps Scripts be used to create testing environments which can help scholars better measure aspects of digital literacy. We demonstrate this proposed solution by developing two interactive tasks with Google Apps Script and test them with university students via the Moodle learning management system.

2   METHODOLOGY

2.1   Participants

Participants for this study were first-year BA and MA university students studying in the humanities or teacher education curricula at the University of Tartu. Complete data from a total of 156 students was obtained. There were 15 students who were provided with English language versions of the tasks. The remaining students worked on Estonian language versions of the tasks.

2.2   Materials

Two interactive computer-based tasks for assessing aspects of students' digital literacy were developed for this study. In order to allow students to engage with authentic digital productivity tools, Google Apps Script was used for task development. This approach allows interaction with the popular web-based productivity tools offered by Google, such as Google Docs, Google Sheets and Google Slides. It also allows for creation of a new document, spreadsheet or presentation each time a student opens a task, and conveniently stores the file in a Google Drive folder that can be shared with multiple people.

Automated scoring was also achieved using Google Apps Script. This was implemented using a "Generate Code" button in the task. Both tasks instructed students to make changes in a productivity app and when finished press the Generate Code button. The result of pressing the button is an alphanumeric code that the students were instructed to copy into an input box. By pressing the Generate Code button, a student initiates execution of a Google Apps Script program that analyzes whether the changes made are correct, and generates output which for students appears cryptic, but for the task creators is informative for scoring purposes. For example, when a task is first started a message appears saying:

Your code is currently 0.

After pressing the Generate Button the result might be:

Your code is now 20190201152754830-55.

This new code is prefixed with a timestamp which can be used to find the relevant file in the shared Google Drive folder and is post fixed with a numeric value (in this case 55) that corresponds to a certain score for this task.

2.2.1   Task 1

The first task we developed was intended to elicit competences related to information and data literacy. It required students to search the internet for information about a common style for citing sources in scholarly works and correctly apply it to example text in a Google Doc editor. The instructions for Task 1 read as follows:

In her research paper, a student wants to refer to the book "Research Design: Qualitative, Quantitative and Mixed Methods Approaches "by John W. Creswell. The research paper guidelines specify that APA (American Psychological Association) style must be used for reference. Please correct the student's reference below so that it corresponds to APA style. After you have correctly formatted the reference, please click the "Generate code" button and write the code in the text box below.

Figure 1. Screenshot of the interactive area of Task 1
(see https://leosiiman.neocities.org/edulearn2019/task1.html).

At the start of Task 1 the reference text appears to students as:

Creswell. Research Design: Qualitative, Quantitative and Mixed Methods Approaches (4th ed.). Thousand Oaks, CA: SAGE Publications, Inc. 2014.

When correctly formatted according to the APA style format, the reference should look like:

Creswell, J. W. (2014). *Research Design: Qualitative, Quantitative and Mixed Methods Approaches (4th ed.)*. Thousand Oaks, CA: SAGE Publications, Inc.

There are three main changes that need to be performed to successfully complete this task: 1) add the authors' initials after his last name, 2) move the year position to immediately after the author name, and 3) place the book title in italics font. The Estonian version of the task required students to make these same changes to the reference:

Õunapuu. Kvalitatiivne ja kvantitatiivne uurimisviis sotsiaalteadustes. Tartu: Tartu Ülikool 2014.

which when formatted correctly in APA style looks like:

Õunapuu, L. (2014). *Kvalitatiivne ja kvantitatiivne uurimisviis sotsiaalteadustes.* Tartu: Tartu Ülikool.

The scoring of Task 1 was performed automatically by the Google Apps Script and assigned one point for each change that was correctly made.

2.2.2 Task 2

The second task we developed was aimed at digital content creation related to making basic statistical calculations of data and presenting the data visually in a chart. It required students to make calculations by using functions in Google Sheets such as "=STDEV(A2:A25)". The instructions for Task 2 read as follows:

Students' test scores were collected for a study. You can see them below in the "Test scores" column of the spreadsheet. Please use the spreadsheet to calculate the number of students who participated in the test, the average score of the test results, and the standard deviation. Insert them in "Table 1". Then, please create a histogram under "Figure 1" representing the distribution of the test results. Name the horizontal axis "Scores" and the vertical axis "Frequency". Change the value of the horizontal interval so that the value is 5. After you have finished making the table and the histogram, click the "Generate code" button and write the code in the text box below.

Figure 2 shows a screenshot of how the interactive area of task 2 appeared to students. The scoring of Task 2 was performed automatically by the Google Apps Script and calculated one point if all the

items in the table (i.e., number of students, average score, standard deviation of scores) were correctly filled in and two points if both the table and the figure were correctly completed. Figure 3 shows a screenshot image of the task successfully completed.
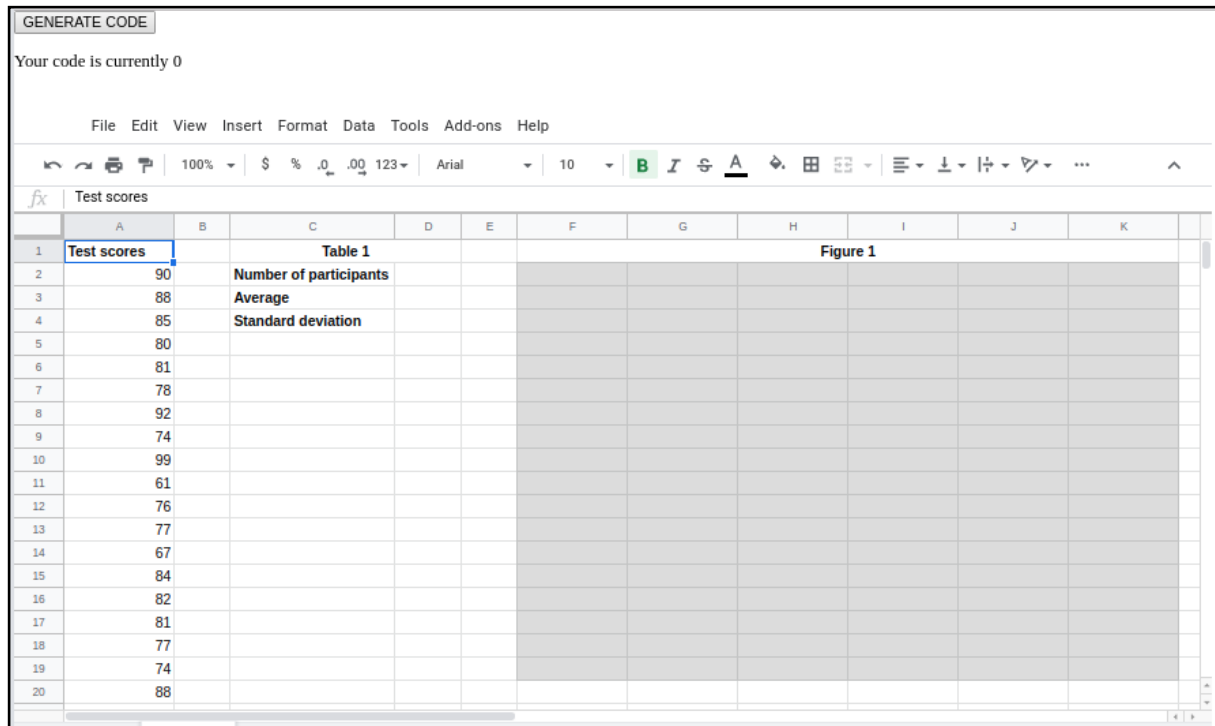

Figure 2. Screenshot of the interactive area of Task 2.
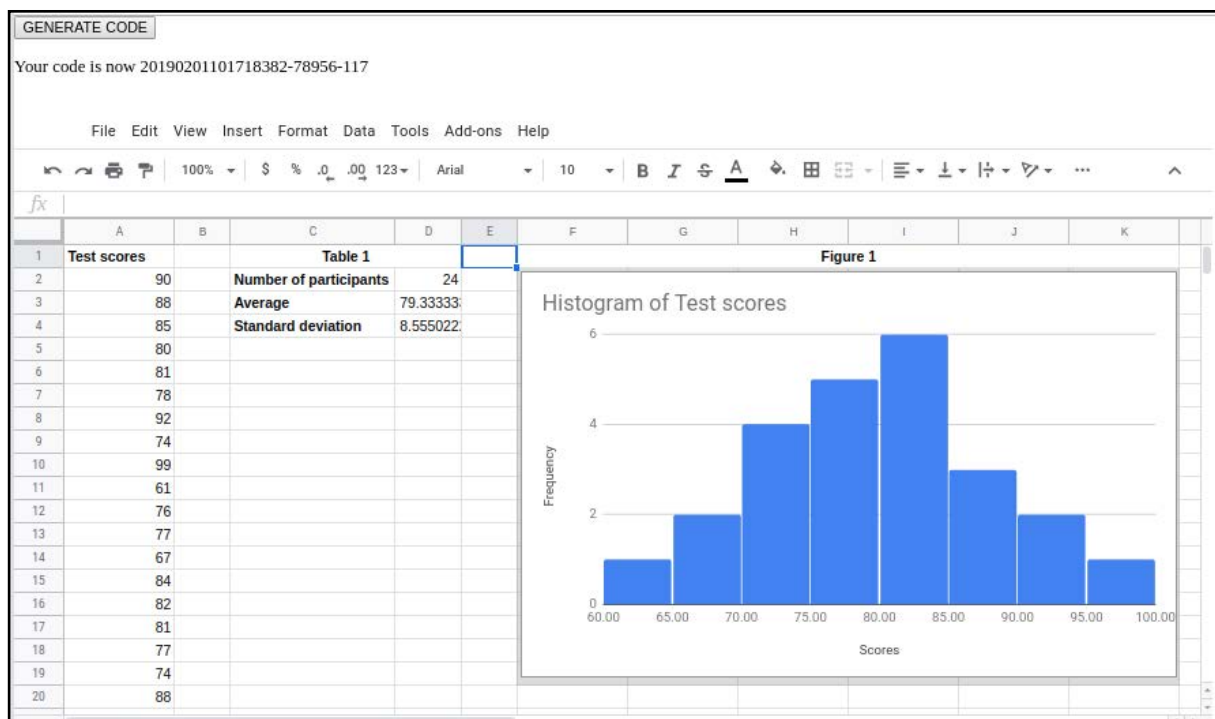*(see https://leosiiman.neocities.org/edulearn2019/task2.html).*

Figure 3. Screenshot of the interactive area of Task 2 after the task has been successfully completed.

2.3   Procedure

Participants were informed by their instructor to take a test in their Moodle course. The test was applied in two different e-courses. Students who studied in the teacher education curriculum took it in a course about digital literacy, whereas students in the humanities curriculum took the test during an introductory course to humanities. The tasks were available in their respective Moodle course pages and one week was allocated for them to be completed. Students could complete the tasks at home at their own leisure. The directions for completing the tasks asked students to work on them individually and not ask any other person for assistance. However, they were allowed to search the internet for any information that could be useful in completing the tasks. The results of the tasks were saved in Moodle and the data accessible to the authors for analysis.

3   RESULTS AND DISCUSSION

The results of the tasks are presented in Table 1 and show the distribution of points for each task. The results show that while 60% of students received full or partial credit on Task 1, only 49% did so on Task 2. This suggests that analyzing data in a spreadsheet application and creating a graphic visualization is more difficult than searching for information in order to make edits in a word processor application. More generally, it suggests a difference in students' digital literacy between information related tasks and digital content related tasks. A Pearson chi-square test revealed no association between the two tasks ($X^2(2)> = 2.848$, $p = 0.828$).

Table 1. The percentage of participants (N = 156) who received a specified score for Task 1 (max 3 points) and Task 2 (max 2 points).

Score	Task 1, %	Task 2, %
0	39.7	50.7
1	14.1	36.5
2	17.3	12.8
3	28.9	-

Differences between information and digital content creation activities by young people was observed by Siiman et al. [8], who conducted a survey of smart device use and found that student use of these devices, whether at school or outside of school, for content creation was considerably less that their use for information related activities. Van den Beemt et al. [14] investigated the use of interactive media with a range of participant ages and used cluster analysis to distinguish between four groups, which they labeled as 'Traditionalists', 'Gamers', 'Networkers', and 'Producers'. Traditionalists made use of only the basic functions of interactive media (e.g., browsing activities like searching, watching videos or reading news sites) whereas Producers were active content creators. The number of Producers in their study was the least among all four groups and half the number of Traditionalists. Claro et al. [13] measured the ICT skills of students using a performance-based assessment in a virtual environment. Their results showed that most students were able to solve tasks related to the use of information as consumers, but had difficulties when using information as producers.

Overall, our results are consistent with prior findings that show that students are much better at information related tasks compared to content creation tasks. It is thus reasonable to suggest that educational policymakers and educators consider ways of offering students more opportunities for digital content creation activities during learning.

4   CONCLUSIONS

Changes in society have led to the expansion of new practices through which new literacies emerge. Sometimes the change is rather quick and there is not enough time to develop a common and evidence-based understanding of the new literacy. The same might happen with digital literacy. Although research strives to understand what digital literacy is and how to assess it, there is still a long way to go and we do not know whether we can solve it before a new literacy emerges and replaces digital literacy. Although the construct of digital literacy may be labeled differently in the future, it is

important that students are provided with opportunities to improve their digital literacy in areas where they may be weakest.

In this paper, we introduced an example of interactive test items embedded in the Google productivity environment which is but a small step towards adding knowledge to the research field of assessing digital literacy. More studies with a wider range of interactive test items are needed before we can begin to accurately characterize the various aspects of students' digital literacy.

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