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# Student perceptions on learning with online resources in a flipped mathematics classroom

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*This article discusses student perceptions of if and how online resources contribute to mathematics learning and motivation. It includes results from an online survey we conducted at the Media Technology department of Aalborg University, Copenhagen, Denmark. For this study, students were given links to various online resources (screencasts, online readings and quizzes, and lecture notes) for out-of-class preparation in a flipped classroom in mathematics. The survey results show support for student perceptions that online resources enhance learning, by providing visual and in depth explanations, and they can motivate students. However, students stated that they miss just-in-time explanations when learning with online resources and they questioned the quality and validity of some of them.*

*Keywords: student perceptions, screencasts, Khan Academy, flipped classroom, mathematics education.*

## INTRODUCTION AND CONTEXT

One of the recent developments in teaching is the flipped (or inversed) classroom approach (Bergmann & Sams, 2012). In a flipped classroom the traditional lecture and homework sessions are inverted. Students are provided with online material in order to gain necessary knowledge before class, while class time is devoted to clarifications and application of this knowledge. The course content, which is provided for self-study, may be delivered in the form of screencasts and/or pre-class reading and exercises, while class time is mainly used for group work activities. The hypothesis is that there could be deep and creative discussions when the teacher and students physically meet. This teaching and learning approach endeavours to make students owners of their learning trajectories, and relies heavily on current technology.

Various researchers and instructional designers have sought to investigate the advances in flipped learning environments (Bishop & Verleger, 2013). According to such studies, students were very positive about their experience and instructional video components in flipped classrooms (Love, Hodge, Grandgenett, & Swift, 2014) and suggested that flipped classroom approach (1) provided them with an engaging learning experience, (2) was effective in helping them learn the content, and (3) increased self-efficacy in their ability to learn independently (Enfield, 2013).

While the aforementioned approaches report on benefits of the flipped classroom, there are also critics to this approach (Kellinger, 2012; Nielsen, 2012). Concerns include among others: criticism about the accessibility to online instructional resources, the growing move towards no homework, lack of accountability for students to complete the out-of-class instruction, poor quality video production, and inability to monitor comprehension and provide just-in-time information when needed.

Taking into consideration the reported strengths and weaknesses, we introduced this instructional model to a statistics course for Media Technology students (Triantafyllou & Timcenko, 2014). The results of this study revealed appealing qualities but also drawbacks of flipped mathematics classrooms. One of our biggest concerns was the resources, which students would get as a preparation for the class. In that study, the students got links to online mathematics courses, lecture slides from a mathematics course they had attended, and screencasts of problem solutions. The screencasts were produced by us using a smart pen. With regard to the screencasts, the results showed that students found them helpful, they appreciated the fact that they could skip or re-watch parts of the solution, and they felt they were supported when studying challenging concepts. Nevertheless, less than half of them watched most of them and they mentioned as a weakness the fact that they cannot ask questions for clarification during a recorded lesson. Moreover, our personal experience was that creating quality screen casts is time consuming and hard.

Therefore, we decided to conduct a survey study in order to further investigate student perceptions and preferences on online resources and especially screencasts as part of a flipped mathematics classroom. The study was carried out during a mathematics workshop, which was implemented using the flipped classroom model. The workshop was offered to fifth semester Media Technology students as an introduction to their computers graphics rendering and computers graphics programming courses. In the following sections, we discuss previous studies on student perceptions on online resources and describe our methodological approach. Afterwards, we present and analyse the results of this survey study. We conclude this paper with a discussion and an outline of future work.

## BACKGROUND

Various researchers have sought to investigate student perceptions and learning with online resources, both in traditional and flipped classrooms (McGarr, 2009). In the case of traditional classrooms, online resources are given to students for revision or preparation for assessments. Regarding student use of such resources, Biehler et al. introduced interactive modules containing domain knowledge, exercises, diagnostic tests and illustrations within blended bridging courses in mathematics and found that slightly more than 50% of the students used the diagnostic tests (Biehler, Fischer, Hochmuth, & Wassong, 2012). Kay and Kletskin introduced problem-based

screencasts covering key areas in mathematics. The screencasts were created as self-study tools, and used by higher education students to acquire pre-calculus skills (Kay & Kletskin, 2012). The results indicated that a majority of students used the screencasts frequently.

As far as student perceptions of online resources are concerned, Biehler et al. found that students considered them helpful, while Kay and Kletskin reported that students viewed online resources as easy to use, effective learning tools, rated them as useful or very useful, and reported significant knowledge gains in pre-calculus concepts.

Factors that determine student perceptions of online resources have been also investigated. In the study by Biehler et al., the results showed that the use of such resources was highly depended on the learning type of the student. Yoon and Sneddon conducted a study on student perceptions of the effective use of lecture recordings (screencasts) in undergraduate mathematics courses and they identified a set of factors that determine student perceptions of live and recorded lectures as competing or complementary. Personal learning styles, study habits, esteem for the lecturer and the possibility of interaction in the lecture can namely make students prefer live lectures rather than lecture recordings (Yoon, Oates, & Sneddon, 2014).

Nevertheless, there are researchers, who challenge the learning that unfolds in online environments (Parslow, 2012; Schwartz, 2013). Such critics claim, for instance, that some online resources have no pedagogical underpinnings, don't allow learners to build knowledge hierarchically, and don't offer meaningful or personalized feedback.

Our past research revealed that Media Technology students encounter challenges in their mathematics learning, because they lack motivation and basic skills in mathematics (Triantafyllou & Timcenko, 2013). In our previous study these students perceived screencasts to be helpful and supporting for out-of-classroom learning, but we wanted to investigate further if and why these students choose to learn using such resources.

## METHODOLOGY

In order to explore student perceptions and preferences on online resources, we conducted an online survey study at the Media Technology Department of Aalborg University Copenhagen. We surveyed fifth semester students, who had just finished a mathematics workshop, which served as an introduction to two semester courses: computer graphics rendering and computer graphics programming. This workshop aimed at recapitulating prerequisite mathematics knowledge for these courses (i.e. linear algebra, geometry and trigonometry).

The mathematics workshop followed a flipped classroom model of instruction. To facilitate this, we created a list of various online resources to provide students with instruction outside of the classroom (before the lectures). We gave students a

detailed reading guide that provided information on the topics covered by each resource and a studying sequence. The online resources included: (1) Selected Khan Academy screencasts and related practice problems (www.khanacademy.org/), (2) Selected sections of the www.mathisfun.com webpage, that contains both explanations, visualizations and quizzes, (3) Selected readings from the www.betterexplained.com webpage, which aims at presenting mathematics in an intuitive way, using text and visualizations, (4) scanned lecture notes from their past mathematics course covering the relevant subjects. We chose different sources, in order to provide support in solving exercises, brief and simple introduction to the related concepts and real-life examples and intuitive explanations. Students had to take an online quiz out of classroom before attending the workshop. The quiz contained questions similar to past mathematics exams. Therefore, the students were aware with this kind of questions. We used the quiz in order to observe student understanding, recurrent misconceptions and common mistakes, since the vast majority of students had passed these exams in the past. The information exchange between the teacher and the students (i.e. resources for out of classroom learning, assignments, news forum) and the quizzes were facilitated by the Moodle VLE.

The online survey used a Likert scale in order to collect student responses on use of the assigned or other online resources, and on perceptions of learning when using them. Items in the survey were measured using 5-point rating scales, with the range of answers from "strongly disagree" to "strongly agree." Moreover, there were items, which gave students the opportunity to provide information in an open-ended manner.

The survey was sent to the 100 students subscribed to the mathematics workshop. Since the survey was optional, it was not possible to ensure all students completed it. Forty six students responded to the survey, yielding a response rate of 46%. The response rate is relatively high, but it should be noted that it was not a simple random sample. For example, there could be bias towards more diligent students (who may be potentially more likely to give positive feedback), or only the students who actually used the online resources. The results of our past study and the large sample size help to some extent to mitigate the influence of this bias.

## RESULTS AND ANALYSIS

From the analysis of the survey results, we excluded two responses, because they were incomplete. Therefore we had a sample size of forty four responses (N=44, 61% male and 39% female). Nearly all survey respondents (91%) said that they had used some online resources in mathematics either for the mathematics workshop or in the past (Figure 1). The distribution of usage for the different resources is shown in Figure 2 (students were allowed to select more than one option). One third of the respondents having used some online resources, made also use of resources we did not suggest. These resources are shown in Figure 3.

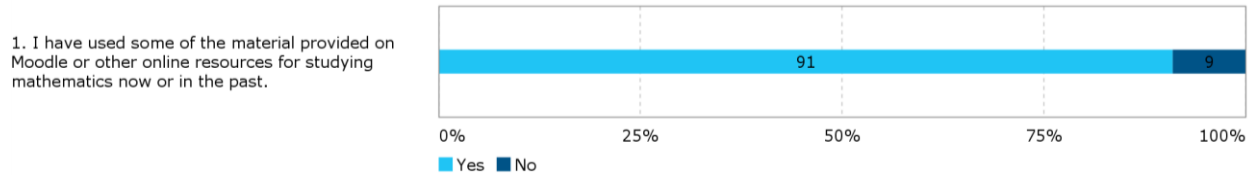


**Figure 1. Proportion of students surveyed who have used online resources for mathematics.**

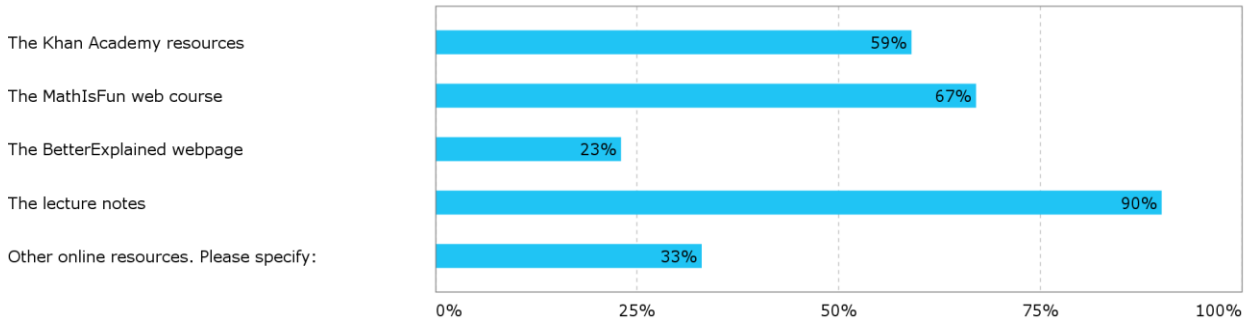


**Figure 2. Distribution of answers to the question "Which material have you used?"**

Students who used online resources were invited to respond to a series of statements on watching Khan Academy screencasts and reading online resources. We made this separation, because watching a problem solution triggers different thinking from reading a text or even a written solution to a problem. In the following analysis, we combine "Strongly agree" and "Agree" answers to summarize those people who agreed with the statements and "Strongly disagree" and "Disagree" answers to summarize people who disagreed with the statements.

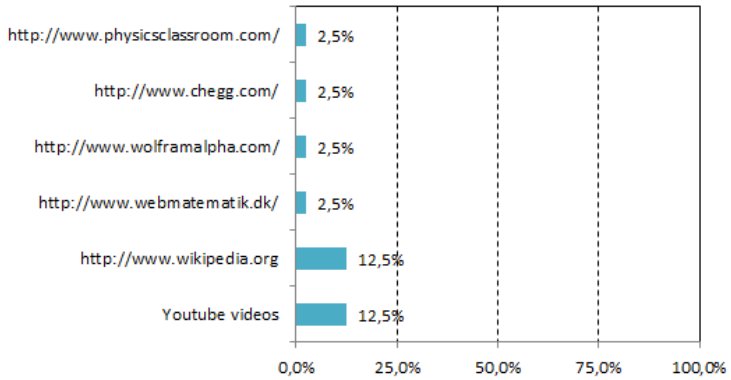


**Figure 3. Distribution of other online resources among survey responses.**

Figure 4 summarizes the results for the statements on Khan Academy screencasts. A significant majority of students who used these screencasts found that watching them has helped with their learning and has improved their understanding (82% and 81% respectively). The statements on screencast contribution on understanding the course material and making mathematics easier received also high agreement scores (78% and 77% respectively). Less strong agreement (72%) was seen with the second statement, which relates to their use for increasing engagement and even less (58%)

with the statement about screencasts increasing opportunities to access other useful information.

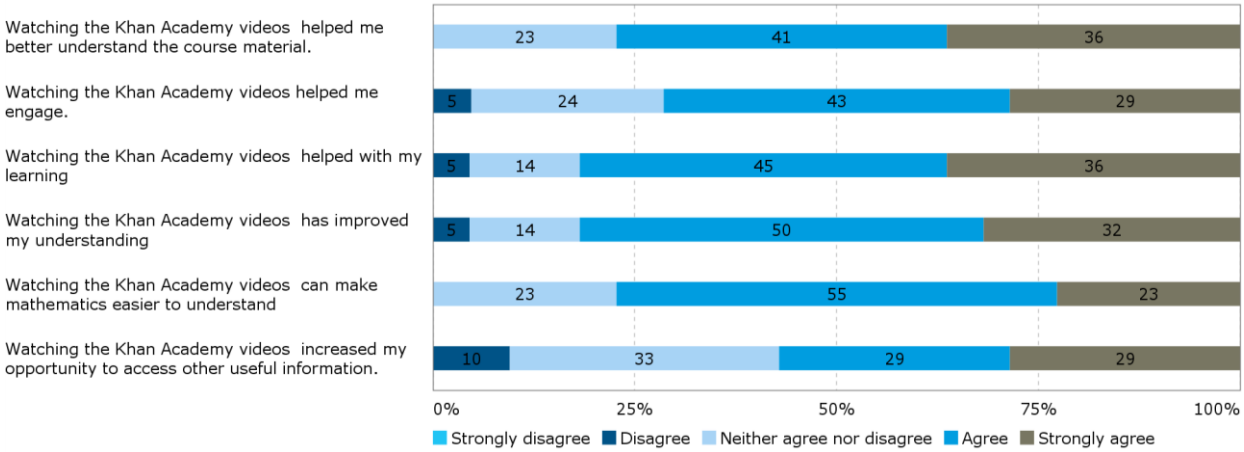


**Figure 4. Percentage agreement and disagreement of students with statements on watching Khan Academy videos (screencasts).**

Figure 5 summarizes the results for the statements on other online resources. The vast majority of students who used some kind of online resources found that reading online resources has helped with understanding the course material and has improved their understanding (90% and 86% respectively). The statements on screencast contribution on improved learning and on increasing opportunities to access other useful information received also high agreement scores (82% and 79% respectively). Less strong agreement (76%) was seen with the fifth statement, which relates reading online resources to making mathematics easier to understand and even less (58%) with the statement on online resources helping students engage.

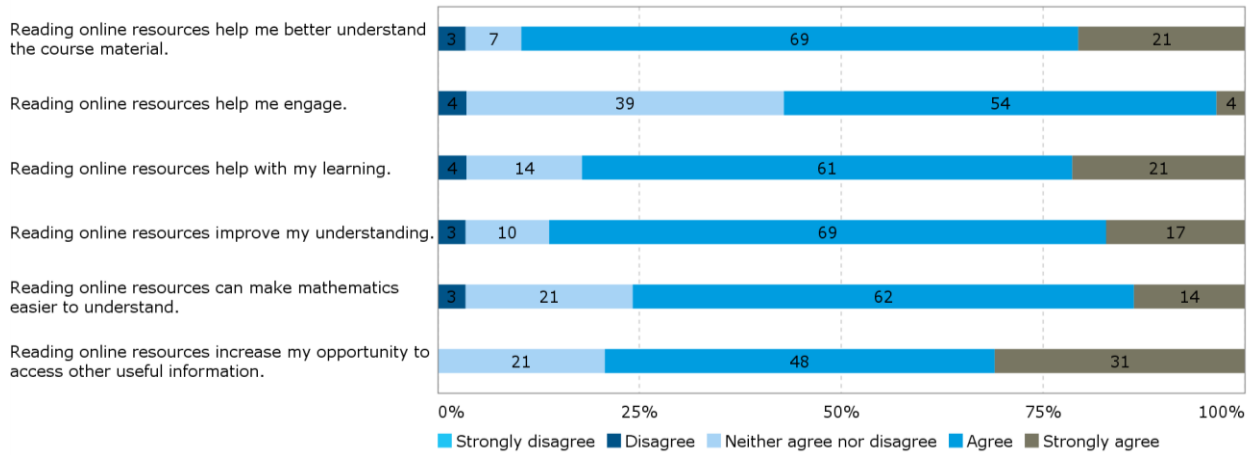


**Figure 5. Percentage agreement and disagreement of students with statements on reading online resources.**

In addition to agreeing or not with these statements, we asked students to define the strong and weak points of these resources. We included these two open-ended questions, because we wanted to give students the opportunity to provide further information on their perceptions in an open-ended manner. The strong and weak

points of Khan Academy screencasts as pointed out by the students are shown in Table 1, while the strong and weak points of reading online resources are shown in Table 2. For building these tables, we have grouped answers with the same meaning but different wording.

| Strong points | Frequency | Weak points | Frequency |
|---|---|---|---|
| The narrator is good at explaining | 27.3% | None | 13.6% |
| You can pause/rewind | 18.2% | They are long | 13.6% |
| Visual explanations | 18.2% | I don't know | 13.6% |
| They come along with quizzes | 18.2% | No one to ask questions | 9.1% |
| They helped me focus | 13.6% | Complicated language | 9.1% |
| Clear structure | 9.1% | They are boring | 4.6% |
| Good tempo/pace of explanation | 9.1% | Too abstract | 4.6% |
| Easy to understand | 4.6% | Sometimes confusing | 4.6% |
| Step by step explanations | 4.6% | Knowledge does not "stick" in memory if you just watch and don't practice yourself | 4.6% |
| They are fun | 4.6% | | |
| Easily accessible | 4.6% | You don't know which video to watch, in case you experience knowledge gaps | 4.6% |

**Table 1. Student perceptions on strong and weak points of Khan Academy screencasts.**

| Strong points | Frequency | Weak points | Frequency |
|---|---|---|---|
| Different explanations for the same topic | 31.0% | No one to ask questions | 20.7% |
| Easily accessible | 17.2% | Debatable quality / validity | 20.7% |
| Visual explanations, animations | 17.2% | Possibly time consuming to find what needed | 13.8% |
| Can be fun | 6.9% | Overwhelming amount of information | 10.34% |
| Explanations on specific topics | 6.9% | Sometimes confusing | 6.9% |
| A fast way to find information | 6.9% | Notation and categorization may differ | 6.9% |
| Easy to understand | 6.9% | Possibly inaccessible due to technical problems | 3.5% |
| Reproducibility | 3.4% | No one to check your understanding | 3.5% |
| You can get help from others | 3.4% | Our brain gets used to search for knowledge, not to memorize it | 3.5% |
| They are fun | 4.6% | | |
| Some come along with quizzes | 4.6% | | |

**Table 2. Student perceptions on strong and weak points of reading online resources.**

Respondents who said that they did not use any online resource for mathematics were asked the reasons for it. Fifty percent of the students mentioned other reasons, namely "I was never introduced to anything good" and "(they are) too complex, no explanations, (I) can't even solve the very first exercise". The other statements were equally favored by students (Figure 6). Students were also asked which tools they use for studying mathematics. Books and notes were mentioned by 50% of the students, pen and paper by 25%, Matlab by 25% and study groups by 25%.

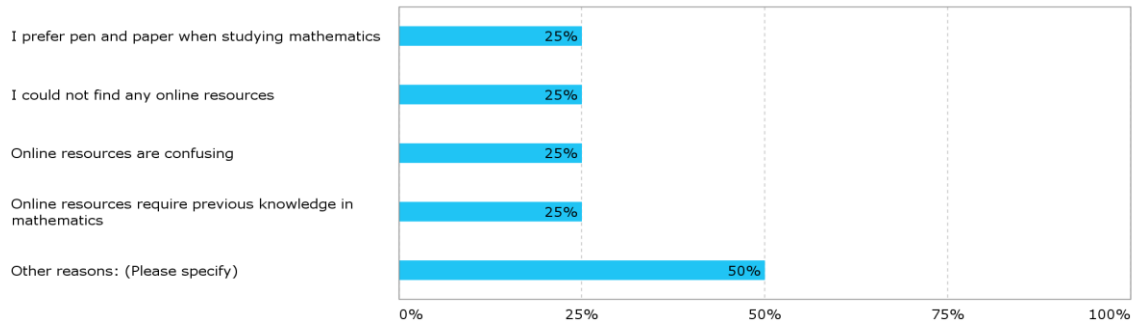


**Figure 6. Distribution of answers to the question "Why have you never used online resources?"**

## DISCUSSION AND CONCLUSION

In this online study, we surveyed Media Technology students on their perceptions on online resources in mathematics. The survey consisted of both close- and open-ended questions in order to better sketch student perceptions. We observed a general consistency between close- and open-ended questions. Regarding Khan Academy screencasts, students found them to provide good and detailed explanations, although some mentioned that they look messy or confusing sometimes. Students perceived them also as being engaging and helping creating focus. The least supported statement on screencasts is the one on screencasts creating links to other useful information. This can be explained by the mission of the Khan Academy website to be a closed environment, where students should find all the information and support they would need (screencasts, practice problems, feedback from teachers/peers, etc). What students missed in screencasts was mostly the ability for just-in-time explanations, being shorter and using less complicated language. However, the last one can be attributed to the fact, that Media Technology students lack basic skills and thus also terminology in mathematics. Another fact worth mentioning is that 13.6% of the students stated that screencasts have no weak points. We would like here to acknowledge the fact that questionnaire data can be biased since survey respondents tend to answer questions in a manner that will be viewed favorably by others (King & Bruner, 2000). Therefore, we plan on incorporating more reliable methods for collecting data on resource usage, such as analyzing log data from Moodle.

Reading online resources were perceived by students to help answering specific questions and understanding the course material. They are perceived also as a means to find links to other useful information and to find different explanations on the same topic. Animations and visualizations are other aspects that students valued with regard to online resources. Nevertheless, 20.7% of the students mentioned the lack of just-in-time explanations and the matter of the quality and validity of such resources. There were also students (13.8%) stating that it could be time consuming to browse the internet for specific information.

As to the reasons for students not to choose online resources, the survey results show some indication that there are students who still prefer books and pen and paper for studying mathematics. However, the number of students who completed the survey and did not use online resources is very small (N=4), therefore we cannot draw any statistically significant conclusions based on these answers.

The survey results indicate that online resources were seen by students completing the online survey as valuable and useful as an aid to learning. We conducted this study in the context of a flipped classroom, where students were asked to prepare themselves before the lectures, by using this aid. Since working with mathematics by themselves is perceived by students the most important learning (Sikko & Pepin, 2013), we believe that the decision of which tools should support this individual learning is a crucial one. Our survey has indicated that watching screencasts is perceived more engaging than reading online resources, while reading online can help to find explanations that make sense to the individual. However, students still perceive face-to-face instruction as paramount, since the problems of the inability to follow comprehension and the lack of just-in-time explanations are still to be solved.

Although the results revealed that students perceive online resources as contributing to their learning and understanding, it is difficult to draw firm conclusions in terms of improvements to student learning as at this stage it has not been possible to measure this quantitatively. In the literature, there are few studies on the flipped classroom that examined student performance throughout a semester. In such cases, mainly pre- and posttest methods have been employed for student assessment. While the results from such studies are encouraging, there is not sufficient evidence for generalization beyond specific contexts (Bishop & Verleger, 2013). Thus, a further quantitative study will be designed for student assessment throughout a whole semester.

## REFERENCES


Bergmann, J., & Sams, A. (2012). Flip your classroom: Reach every student in every class every day. Washington, DC: International Society for Technology in Education.

Biehler, R., Fischer, P. R., Hochmuth, R., & Wassong, T. (2012). Designing and evaluating blended learning bridging courses in mathematics. Proceedings of the 7th Congress of the European Society for Research in Mathematics Education, Rzeszow, Poland, 1971-1980.

Bishop, J. L., & Verleger, M. A. (2013). The flipped classroom: A survey of the research. ASEE National Conference Proceedings, Atlanta, GA.

Enfield, J. (2013). Looking at the impact of the flipped classroom model of instruction on undergraduate multimedia students at CSUN. TechTrends, 57(6), 14-27.

Kay, R., & Kletskin, I. (2012). Evaluating the use of problem-based video podcasts to teach mathematics in higher education. Computers & Education, 59(2), 619-627. doi:http://dx.doi.org/10.1016/j.compedu.2012.03.007

Kellinger, J. J. (2012). The flipside: Concerns about the "New literacies" paths educators might take. The Educational Forum, 76(4) 524-536.

King, M. F., & Bruner, G. C. (2000). Social desirability bias: A neglected aspect of validity testing. Psychology and Marketing, 17(2), 79-103.

Love, B., Hodge, A., Grandgenett, N., & Swift, A. W. (2014). Student learning and perceptions in a flipped linear algebra course. International Journal of Mathematical Education in Science and Technology, 45(3), 317-324. doi:10.1080/0020739X.2013.822582

McGarr, O. (2009). A review of podcasting in higher education: Its influence on the traditional lecture. Australasian Journal of Educational Technology, 25(3), 309-321.

Nielsen, L. (2012). Five reasons I'm not flipping over the flipped classroom. Technology & Learning, 32, 10-46.

Parslow, G. R. (2012). Commentary: The khan academy and the day-night flipped classroom. Biochemistry and Molecular Biology Education, 40(5), 337-338.

Schwartz, M. (2013). Khan academy: The illusion of understanding. Online Learning - Formerly the Journal of Asynchronous Learning Networks, 17(4), 1-14.

Sikko, S. A., & Pepin, B. (2013). Students' perceptions of how they learn best in higher education mathematics courses. Proceedings of the 8th Congress of the European Society for Research in Mathematics Education, Antalya, Turkey, 2446-1980.

Triantafyllou, E., & Timcenko, O. (2013). Developing digital technologies for undergraduate university mathematics: Challenges, issues and perspectives. 21st International Conference on Computers in Education (ICCE 2013), Bali, Indonesia, 971-976.

Triantafyllou, E., & Timcenko, O. (2014). Introducing a flipped classroom for a statistics course: A case study. The EAEEIE (European Association for Education in Electrical and Information Engineering) 25th Annual Conference, (EAEEIE 2014), 5-8. doi:10.1109/EAEEIE.2014.6879373

Yoon, C., Oates, G., & Sneddon, J. (2014). Undergraduate mathematics students' reasons for attending live lectures when recordings are available. International Journal of Mathematical Education in Science and Technology, 45(2), 227-240.